July 2021

Gleeson Quarries Ltd

Huntly Quarry Disposal Sites

# Fill Site 3 – Geotechnical Design Report

Revision A

Report Prepared By
Gaia Engineers, 5 Carmont Place,
Mt Wellington, Auckland 1060,
New Zealand

GAIA ENGINEERS

## Revision History

| Revision No | Prepared By | Description | Date |
|---|---|---|---|
| A | MK | For Consent | 23/07/2021 |
| | | | |
| | | | |
| | | | |

Prepared by:

Matthew Kernot
Senior Engineering Geologist
Gaia Engineers Ltd

Reviewed by:

Dr. Ka-Ching Cheung
Director (Geotechnical)
Gaia Engineers Ltd

Date: 23rd June 2020

# Table of Contents





5 Carmont Place, Mt Wellington, Auckland 1060, New Zealand
PO Box 51 295 Pakuranga, Auckland 2140
www.gaia-engineers.co.nz

Appendices:



Table of Tables:



Table of Figures



Drawing List:

| DRAWING NO: | DRAWING TITLE: | REVISION: |
|---|---|---|
| 2325-74-01 | GENERAL NOTES - SHEET 1 OF 4 | A |
| 2325-74-02 | GENERAL NOTES - SHEET 2 OF 4 | A |

| DRAWING NO: | DRAWING TITLE: | REVISION: |
|---|---|---|
| 2325-74-03 | GENERAL NOTES - SHEET 3 OF 4 | A |
| 2325-74-04 | GENERAL NOTES - SHEET 4 OF 4 | A |
| 2325-74-05 | SAFETY IN DESIGN | A |
| 2325-74-06 | OVERALL PROJECT LAYOUT WITH EXISTING CONTOURS | A |
| 2325-74-07 | OVERALL PROJECT GEOLOGICAL MAP | A |
| 2325-74-08 | PROPOSED LAYOUT AND SITE INVESTIGATION PLAN | A |
| 2325-74-09 | TOE KEY AREA, BASAL AND UNDERFILL DRAINAGE PLAN | A |
| 2325-74-10 | STAGE 1.1 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-11 | STAGE 1.2 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-12 | STAGE 2 - LAYOUT - DRAINAGE BLANKET ARRANGEMENT | A |
| 2325-74-13 | STAGE 2.1 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-14 | STAGE 2.2 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-15 | STAGE 3 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-50 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 1 | A |
| 2325-74-51 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 2 | A |
| 2325-74-52 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 3 | A |
| 2325-74-53 | DEEP SUBSOIL DRAIN SECTIONS | A |
| 2325-74-101 | TYPICAL BUND AND MANAGED FILL ARRANGEMENT AND DETAIL | A |
| 2325-74-102 | TYPICAL DRAINAGE DETAILS | A |
| 2325-74-103 | DISPLACEMENT MONITORING LAYOUT | A |

# EXECUTIVE SUMMARY

Gaia Engineers Ltd have been engaged by Gleeson Quarries Ltd to undertake detailed geotechnical design of the managed fill placement area known as Fill Site 3 located to the north of the existing Huntly Quarry pit as shown in Figure 1.

Concept designs and geotechnical analyses were previously carried out for a total of four fill sites as shown in Figure 2 and Drawing No.: 2325-74-06 included in Appendix A. Our key findings and recommendations are presented in the following report reference: 2325-12-GQ-01 (Huntly Quarry Disposal Sites - Geotechnical Assessment)_Rev C

Specifically, this report presents our key findings and recommendations for the development of Fill Site 3. The Fill Site 3 area is proposed to primarily accommodate imported managed fill material which typically comprise wet and soft, material which often contains organics, concrete and bricks. This material is typically not suitable for use as engineered or structural fill in other projects.

Site investigations for Fill Site 3 have been undertaken in two stages. The first stage involved the excavation of test pits during June, 2019 to the maximum reach of the available excavator. The results of this investigation were presented in the above mentioned concept report – 2325-12-GQ-01 (Huntly Quarry Disposal Sites - Geotechnical Assessment)_Rev C. It was found that the site comprises a similar gully system to the neighbouring proposed fill sites, but that this gully is buried under a significant volume of historic mining fill. The test-pits were unable to reach the base of the mining fill.

In support of the detailed design undertaken and presented in this report, two machine boreholes were carried out. The target of these boreholes was to obtain an indication of the thickness and composition of the existing mining fill. The borehole investigation also indicated that the invert of the buried gully and the ultimate toe of the Historic Mining Fill is likely founded on basement greywacke material. The stability design of the fill however does not rely on the presence of basement greywacke material.

The general design of the fill consists of:

- A 2m deep toe-key into the existing mining fill at the toe of the lowest structural bund
- Inter-bench external batter angles of 3H:1V for structural bunds and 6H:1V for Managed Fill
- 5m wide external benches
- 0.4m thick drainage blanket at the base and between stage 1 and 2 of the fill

In addition to the proposed drainage blankets installed within the fill, a basal drainage blanket with a network of underfill drains consisting of a main carrier drain and smaller collector drains will be necessary to ensure the long-term stability of the fill.

Likewise, rates of filling will be guided by displacement monitoring of the completed fill stages. Excessive displacement will be necessary to monitor the stability of the fill both during and after construction.

# 1 Introduction

Gaia Engineers Ltd. have been engaged by Gleeson Quarries Ltd. to provide a geotechnical design for a managed fill placement area known as Fill Site 3 as shown in Figure 1 as well as Drawing No.: 2325-74-06 included in Appendix A.

## 1.1 Previous Work

The proposed fill site was previously covered along with three other nearby fill sites in the concept design and geotechnical appraisal report produced by Gaia titled as below:

- 2325-12-GQ-01 (Huntly Quarry Disposal Sites - Geotechnical Assessment)_Rev C

## 1.2 Scope of Works

The scope of works for this report includes:

a. Undertaking a review of existing geological and geotechnical data;
b. Carry out machine borehole investigation to assess historic mining fill under Fill Site 3 area;
c. Perform analysis of the structural data, trial pit data and any other investigations data appropriate to complete geotechnical investigations;
d. Assess ground conditions, review stability and risks associated with the potential fill site;
e. Undertake detailed stability analyses covering both the existing and the proposed slopes;
f. Provide comments and recommendations on geotechnical matters relating to civil design and construction;
g. Provide engineering plans for the proposed overburden fill disposal area.

## 1.3 Information Provided

The following data and reports were provided and reviewed in preparation of this report:

- Survey Data from Pilbrow Surveying Ltd. covering Fill Sites 2 to 5 as surveyed during April 2019 including:
    - Topographic contours
    - High resolution orthorectified aerial images
- Huntly Quarry Fill Assessment & Design by Terra Mining Consultants Ltd. dated June 2019.
- Geological and Resource Assessment of Huntly Quarry by Stevens & Associates and Terra Mining Consultants Ltd. dated July 2006.

# 2 Existing Information Review

The reports and data listed in Section 1.3 were reviewed in this project. A summary of materials referenced in the report is presented in the following sections:

## 2.1 Pilbrow Surveying Topographic Models and Aerial Photography – April 2019

Survey data provided by Pilbrow Surveying Ltd. has been used to develop a 3D surface model of the proposed fill sites using the software Eureka by Maptek. Test pit data collected during the site investigation undertaken during the previous appraisal report, and in support of this report, was also input into the 3D model. Orthorectified aerial images provided by Pilbrow were then overlain on the surface models. These models along with field notes aided in the production of the engineering geological map included in Drawing 2325-74-06 are also presented in Appendix A.

## 2.2 Geological and Resource Assessment of Huntly Quarry – 2006 (Stevens & Associates, Terra Mining Ltd.)

This report covered the geological assessment of the Huntly Quarry pit as well as the exploration and assessment of a potential resource block to the west of the existing pit. A series of deep boreholes were drilled around the perimeter of the existing pit and also in the proposed block to the west. A 3D geological model was created that covered the existing pit and extended towards the so called 35-year expansion line. Geological modelling and mapping did not extend into the currently proposed fill site areas.

Boreholes HQ006 and HQ007 provide some information regarding the boundary between the Waikato Coal Measures and the Newcastle Group Greywacke near the existing main pit. However, the projection of this boundary westward and northward into the proposed fill sites becomes increasingly uncertain and therefore may be unreliable. This geological boundary is not expected to be a governing factor regarding the stability and design of the proposed fill sites and will not be relied on for modelling.

The investigation undertaken during the production of the Terra Mining 2006 report also included geological mapping of the quarry pit. This included observation and discussion of bedding, folding and faulting structures. These structures are important for the steep rock-cut stability in the main pit. However, due to the depth to the basement material and the thickness of overburden present, these geological structures do not influence the stability at Fill Site 3.

## 2.3 Huntly Quarry Fill Assessment & Design – June 2019 (Terra Mining Ltd.)

This report presented revised aggregate potential and required overburden stripping volumes as well as conceptual fill surfaces for the four proposed fill sites. These concept surfaces have been used as the basis of the investigation and reporting presented here.

Compared to the fill assessment report, Fill Site 3 has increased the toe-bund length to wrap around the north-eastern flank of the gully.

# 3 Site Description

## 3.1 Location

Fill Site 3 and its relation to the quarry pit and surrounding proposed fill sites is presented in Figure 1 as well as in Drawing No.: 2325-74-06. The site is accessed via the Huntly Quarry located at 300 Riverview Road in the northern Waikato township of Huntly.

## 3.2 Site Topography

Fill Site 3 is a broad gully being approximately 250m wide from ridge to ridge that trends in a north-westerly direction. The upper reaches of this gully are characterised by moderately steep 2.5H:1V slopes formed in weathered Waikato Coal Measures material. The gully head slopes exhibit terracettes indicative of shallow downslope soil creep movements. No signs of deeper instability either historic or recent have been observed.

The base of the gully has been obscured by fill which we understand was placed up until approximately 30 years ago.

A small pond was previously located towards the eastern side of the fill area. The pond was formed as a depression in the historic mining fill as a water source for the stock that previously grazed the area. The pond has since been drained via surface drains cut approximately 3m deep into the existing fill. The surface drains exit the fill area into the neighbouring eastern gully.

The general layout and topographical features of Fill Site 3 are shown in Figure 1 below:


Figure 1: Oblique Image looking South at Fill Site 3 Showing Topographic Features

## 3.3 Geomorphology

The geomorphology of the natural ridge area at the head of the Fill 3 gully exhibits some evidence of creep terracettes. These creep features are attributed to the thicker weathering profile of the underlying Waikato Coal Measures material. Seasonal wetting and drying of these soils cause the soils to creep downslope.

To our knowledge, no high-resolution survey of the Fill 3 gully prior to filling is available for review. However, it is believed that the underlying geology of Gully 3 is similar to that of the neighbouring gullies to the east and south. Likewise, the remnant exposed ridges and flanks of Gully 3 are geomorphologically similar to the neighbours. It is therefore interpreted that the pre-existing geomorphology of Gully 3 is similar to the neighbouring gullies.

# 4 Site Investigation

Test pit site investigations were commenced on the 17th of June 2019 during the geotechnical appraisal and concept design stage. 13 (No's.) test pits were excavated within the Fill Site 3 area pits by means of a 30t excavator to a maximum depth of 5.5m deep at the time.

In an attempt to reach the base of the historic mining fill a deep test pit to 12m depth was excavated with a long-reach excavator on the 25th of October 2019. The long-reach excavator was still to short to penetrate the base of the fill.

In preparation of this detailed design, 2 (No.) machine boreholes were drilled to depths of 24.0m and 25.95m to assess the thickness of the historic fill and to test the strength via Standard Penetration Testing (SPT). Borehole BH301 penetrated the historic fill and encountered interpreted weathered Newcastle Group greywacke. Borehole BH302 penetrated the historic fill and encountered weathered Waikato Coal Measures mudstone. The boreholes were positioned to target the invert of the gully and therefore the corresponding thickness of the historic mining fill.

Tests pits around the flanking gully were able to assess the weathered Waikato Coal Measures material. No representative surfaces for engineering geological mapping were observed in the faces of the pit walls. This does not discount the potential for unfavourable structural features. However, the visibility of structural features tends to become obscured as the material becomes more weathered. This was observed to be the case during the test pit investigations.

The soils and weak rock units exposed in the pit walls were logged generally in accordance with the NZGS Field description of soil and rock guidelines by a Gaia Engineers Ltd. engineering geologist. In addition, field shear vane readings were taken in exposed soil materials within the test pits where possible.

The locations of the test pits are shown on Drawing No.: 2325-74-06 included in Appendix A. Test Pit logs and machine borehole logs are presented in Appendix B.

Table 1 presents a summary of the measured field vane shear strengths and SPT N-values in each geological unit:

Table 1: Summary of In-Situ Strength Tests

| Geological Unit | Minimum Measured Vane Shear Strength (kPa) | Maximum Measured Vane Shear Strength (kPa) | SPT N-Value |
|---|---|---|---|
| Historic Mining Fill | 55 | 188+ | 2 to 27 |
| Residually to Completely Weathered Waikato Coal Measures Material | 140 | 188+ | 25 to 38 |
| Residually to Completely Weathered Newcastle Group Material | N/A | N/A | 25 to 50+ |
| Notes: | 1) 188kPa is the maximum BS1377 corrected vane shear strength value for the dial used during the test-pit investigation | | |

Description of the lithologies encountered during the test pit investigation are discussed in Section 5.

# 5 Geology

## 5.1 Regional Geology and Structure

Reference to GNS Science QMap 1:250,000 series shows that the proposed four fill sites of the Huntly Quarry Fill Disposal project are underlain by Newcastle Group Siltstone and Waikato Coal Measures of the Te Kuiti Group. The Huntly Area is situated on the north-western flank of the Hakarimata and Taupiri Ranges – a north-east to south-west tending mountain range.

The regional structural fabric of this range consists of similarly trending anticlinal and synclinal fold structures. One of the major synclinal fold features is mapped as running through the quarry area and bifurcating Fill Site 5. A large north to south trending inactive fault is present to the west of the quarry and fill sites. The north-south trending fault line forms the larger drainage gully that Fill Site 2 and the pre-filled alignment of Fill Site 3 flows into.

An annotated geological map from the GNS Science New Zealand Geology Web Map is presented below:

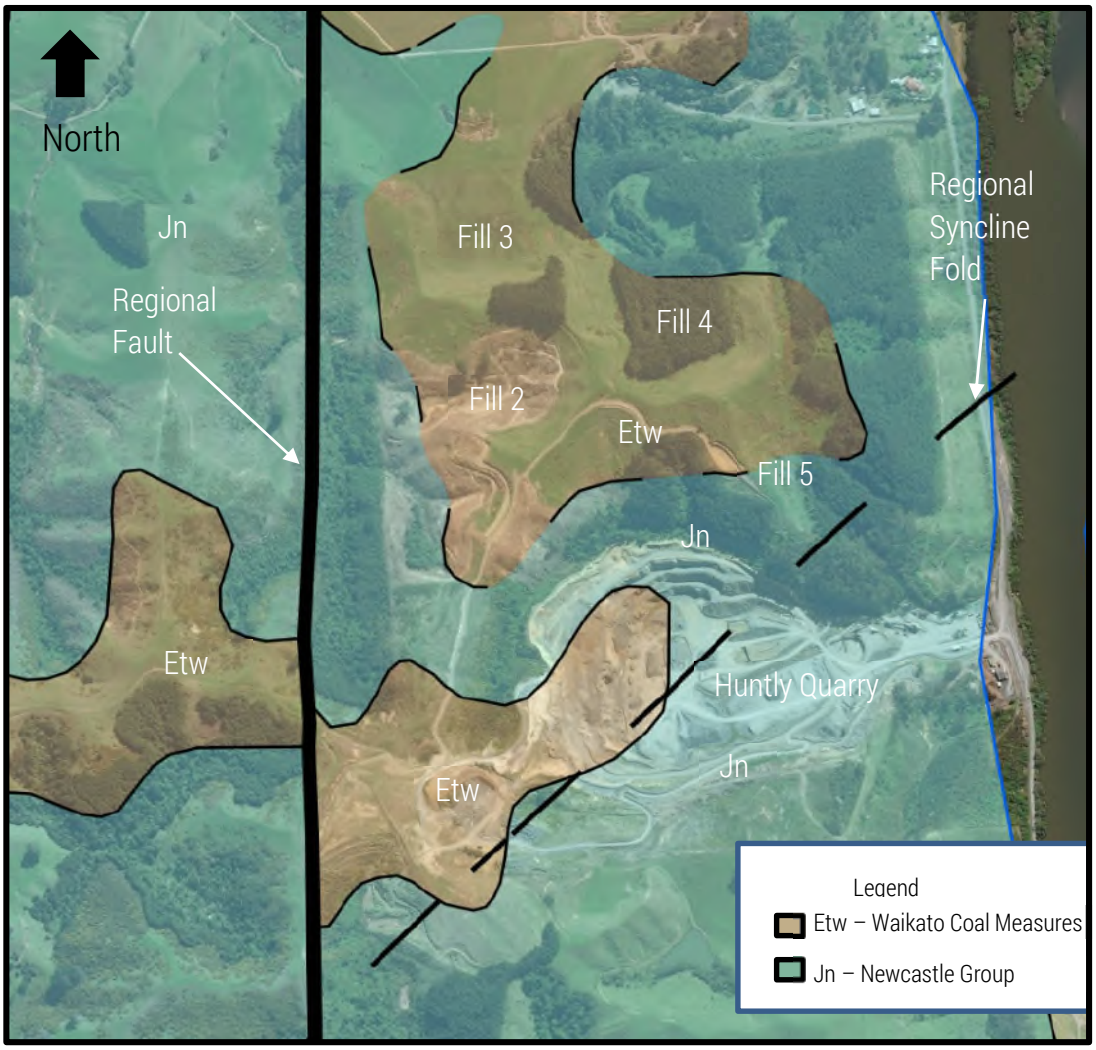



Figure 2: Published Geological Map of the Huntly Quarry and Fill Sites. *Modified from GNS Science Web Map Service Under Creative Commons Licence*

## 5.2 Local Stratigraphy

The following geological units have been observed or inferred within the Fill Site 3 area:

### 5.2.1 Historic Mining Fill

The flat area of Fill Site 3 is underlain by fill placed until approximately 30 years ago. The historic fill comprises predominantly overburden stripping from adjacent neighbouring coal mines that are no longer in production. Accordingly, the overburden material is mostly Waikato Coal Measures mudstone. The mudstone is broken into gravel and cobble sized particles and is variably weathered from highly to slightly weathered. The mudstone gravels are typically bound in a matrix of soil strength completely weathered Waikato Coal Measures silt. Lenses of lower strength (soft to firm) clays with variable organic content are also common throughout the observed fill. These lenses are inferred to be stripped alluvium and colluvium from pre-existing gullies.

No as-built records, completion or design reports are available to confirm the position and pedigree of the historic fill present. As such, sufficient sensitivity checks of the proposed fill to historic fill variability will be undertaken. Also, deep drainage and construction deformation monitoring will be undertaken to mitigate potential poor performance of the underlying fill.

### 5.2.2 Waikato Coal Measures

A late Eocene to Early Oligocene aged basal unit of the Te Kuiti Group, the Waikato Coal Measures unconformably overly the basement rock at the Huntly Quarry. This unit is typically weathered to soils up to a depth of approximately 5 to 6 metres as observed within the surrounding ridges. The weathering profile of this unit is typically thinner towards the invert of the incised gully. The position of the Waikato Coal Measures and stratigraphically lower Newcastle Group greywacke beneath the historic fill in Fill Site 3 has been obscured.

The weathered soil consists of stiff, light coloured silts and clays with minor amounts of fine sand. Beyond this depth the unit typically presents as a very weak to weak mudstone and fine-grained sandstone.

In the locality of the Huntly Quarry, bedding of this unit is more discernible in the carbonaceous and coal bearing seams. Investigations within the Fill Site 3 were not able to directly observe or measure the bedding orientation of the Waikato Coal Measures. Additional discussion on Waikato Coal Measures bedding is provided in Section 5.3.

### 5.2.3 Newcastle Group

Late Triassic aged rocks of the Newcastle Group, part of the Murihiku terrane make up the basement bedrock material present at the subject site. Less weathered examples of this material are currently exploited as an aggregate resource at the Huntly Quarry. The weathered soils are described as stiff silts with minor amounts of fine sand. The unweathered material (as exposed in the quarry pit) is described as strong, jointed, dark grey siltstone and mudstone.

Within Fill Site 3, only highly weathered to moderately weathered greywacke of this group was encountered in the last runs of BH301. At this weathering grade the material exhibited a very weak rock strength. However, the sample that was returned showed a heavily jointed rock mass and loss of inferred weaker jointing infill components.

Observation of basement greywacke in this borehole indicates that the invert of the gully at this point had eroded down to the weathered basement rock.

### 5.3 Waikato Coal Measures Bedding Assessment

Direct establishment of the Waikato Coal Measures bedding direction within the Fill Site 3 area was not made. Test-pit investigations did not encounter defined bedding planes suitable for measurement. Likewise, bedding was not visible on any of the existing cuttings directly surrounding the Fill Site 3 gully. As such, bedding direction in the immediate vicinity of the fill cannot be accurately determined.

Overburden stripping for the main quarry pit has progressed since the initial resource consent stage investigation (2019). The cut has exposed a large Waikato Coal Measures slope which is annotated in Figure 3 below:

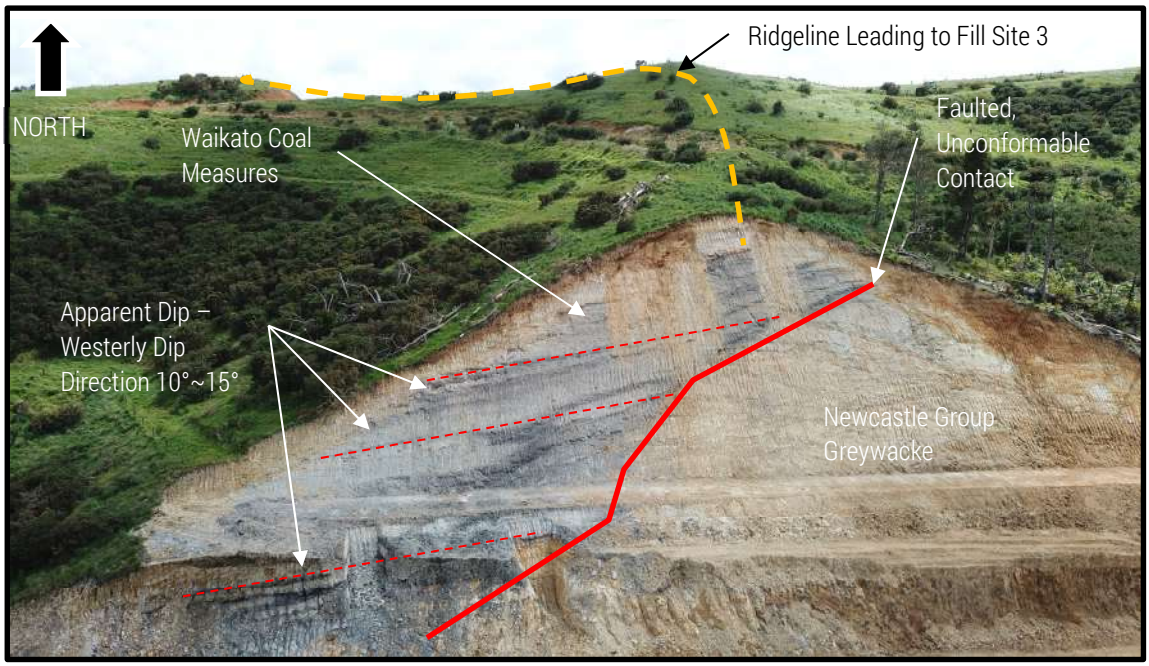



**Figure 3: Aerial Image Looking North at the Waikato Coal Measures Cut Slope Above the Main Quarry Pit**

The cutting presents the largest indication of Waikato Coal Measures bedding direction in the Huntly Quarry area. At this exposure, the Waikato Coal Measures dips with an apparently westerly dip of between 10° and 15°.

Sporadic, large-scale cross-bedding in the same apparent direction as the main bedding is also visible. Bedding and cross-bedding aligned textural shears are visible at the macro scale within the rock fabric.

No weakened layer was present at the interface between the weathered rock and the capping residually weathered soil.

The large cut has a gradient of approximately 1H:1V and a height of 20m from the crest to the first bench. The cut has been in the current configuration since approximately October 2019 with no large-scale instability noted. Some drop-out of the overlying soils at the crest of the slope has been observed but is not related to structural defects.

The lack of instability in this slope would indicate that the shears present in the rock texture are may primarily be influential in the bedding direction only as the slope direction and bedding direction are almost perpendicular. As such, the bulk strength parameters for this material are sufficient to remain stable in this slope cut geometry. That mean this slope is not a good candidate for back-analysis of the stability properties of the bedding aligned structural defects due to the slope orientation being perpendicular to the bedding dip. However, the apparent stability of the slope in the non-bedding aligned direction gives confidence to the bulk parameters adopted models used for the design of Fill Site 3.

Projection of the westerly bedding direction observed in the cut exposure into Fill Site 3 would imply favourable stability conditions along the eastern slopes of the fill. The relationship of the cut exposure to Fill Site 3 is shown in Figure 4 below:

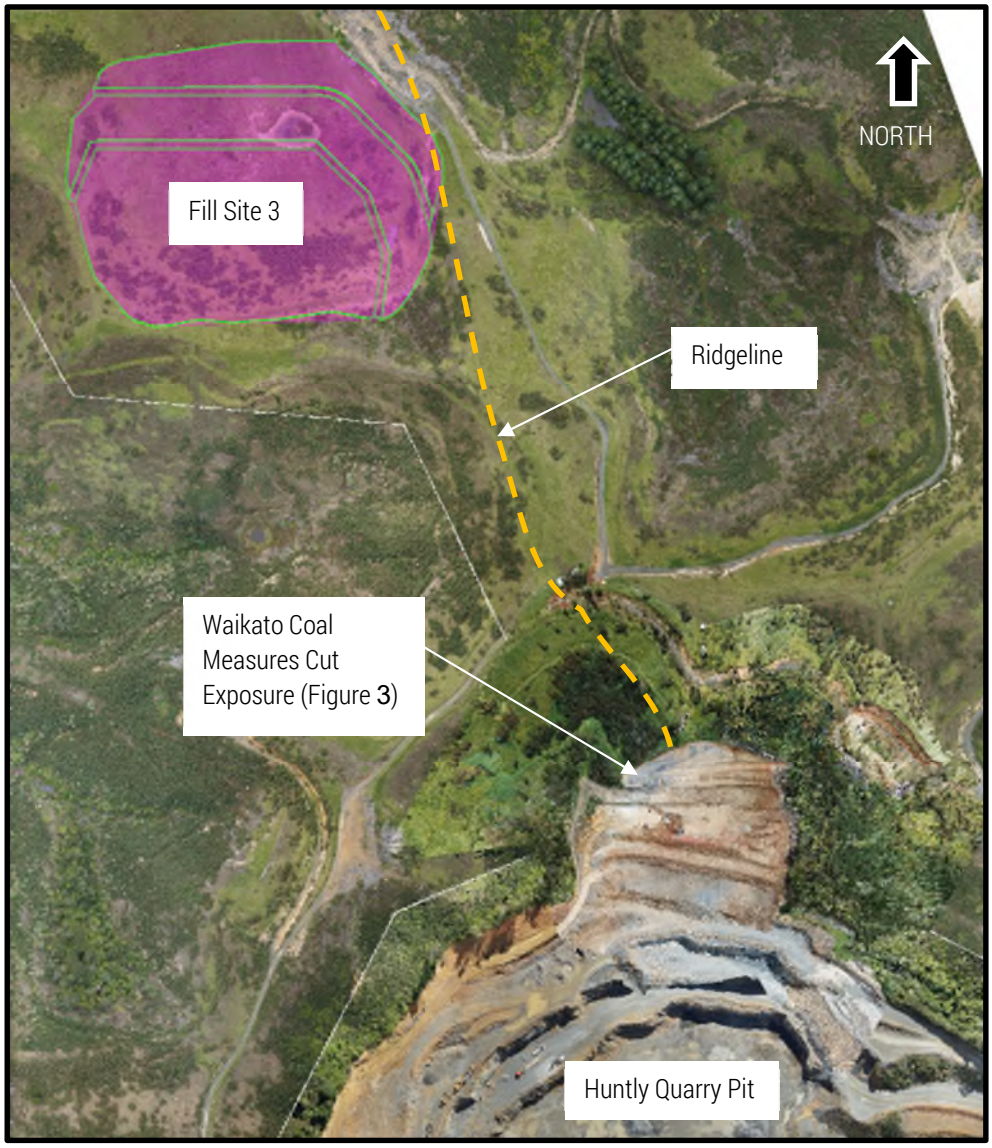



Figure 4: Location of Figure 3 Cut Exposure in Relation to Fill Site 3.

## 5.4 Geological/Geotechnical Risks and Mitigation

The three geological units categorised during site investigations and detailed in the previous section present different properties that need to be considered in the current design as discussed below.

### 5.4.1 Historic Mining Fill

Historic mining fill will be the main founding material supporting the proposed managed fill. The main geotechnical risks caused by the existing historic fill relate to settlement and stability. The primary mitigation strategies for limiting the effects of settlement and stability are through the installation of a deep sub-soil drainage network and through on-going displacement monitoring of the new fill as it is placed.

The deep-drainage network will provide a means to both draw-down perched groundwater tables that have been observed within the historic fill and to allow suitable drainage paths for pore-water pressure dissipation during surcharge with imported managed fill.

Displacement monitoring points will be established upon the completion of each structural bund and upon the finished fill surface. Monitoring the position of the fill for both horizontal movement and settlement with a high degree of accuracy will guide the rate at which the new fill is to be placed. If accelerations in settlement or displacement are noted, then the rate at which managed fill is placed can be slowed or stopped until pore-pressures in the underlying fill have dissipated sufficiently indicated by settlement slowing to an acceptable rate. During the filling, the stability and displacement performance shall be continuously reviewed to minimise unexpected failure and/or large deformations.

Stability analysis which is detailed in Section 7 has demonstrated using suitably conservative parameters for the historic fill that if underlying pore-pressures in the historic fill are suitably controlled then the proposed fill is sufficiently insensitive to variation within the historic fill founding material.

### 5.4.2 Waikato Coal Measures Bedding

Planes of weakness that run parallel to the bedding of the Waikato Coal Measures mudstone are known to be associated with this unit. Bedding aligned planes of weakness can govern the stability of the slopes and result in failures where the bulk strength properties of the material would suggest that is otherwise unlikely. In our experience, the weakest zones of the Waikato Coal Measures stratigraphy can be found beneath the residually weathered soil, near the interface with the relatively unweathered rock. Whilst slips involving the material above these weak planes are known to occur in this material type, it should be noted that this mechanism has not been observed at the Huntly Quarry.

The north-eastern toe of the fill is considered to be most at risk of loss of support due to bedding aligned weakness in the supporting Waikato Coal Measure Slope. The stability of the slope was assessed using worst credible conditions for failure due to bedding aligned shears. As mitigation, the proposed fill has been set-back from the existing slope crest by 25m as guided by the stability analysis described in Section 7.

Sensitivity of the design to the presence of bedding parallel weaknesses is checked for during the slope stability analysis as described and discussed in Section 7.2.

### 5.4.3 Newcastle Group Greywacke

The invert of the pre-existing gully and the downslope toe of the pre-existing fill are inferred to be founded on basement greywacke. The depth to the unweathered greywacke has not been confirmed in this area. However, very weak to weak, highly to moderately weathered rock was observed within a single borehole, BH301, which is inferred to represent the invert of the gully.

The Newcastle Group greywacke is a more competent material from a geotechnical perspective but the position of the greywacke contact beneath the pre-existing fill is uncertain. Therefore, the design will be undertaken on the presumption that the Waikato Coal Measure mudstone persists beneath the pre-existing fill to the toe of the gully. No reliance will be placed on Newcastle Group material persisting beneath the proposed fill structure.

## 5.5 Groundwater

A perched groundwater table was identified within the historic mining fill during the initial test pit investigation at Fill Site 3. The perched groundwater table was observed to be non-continuous and within 5m depth of the existing ground surface. Seepages from the perched groundwater table when encountered were often fast.

No information is available on the regional ground water tables. However, it is inferred that the natural groundwater table flows out of the Fill Area 3 gully system in the north-westerly alignment of the gully. The stability of the proposed works is not found to be influenced by a continuous regional groundwater table.

Perched groundwater within the historic mining fill is considered to be one of the primary stability risks to the proposed managed fill. Control of perched groundwater table will be achieved through the construction of a subsoil drainage network.

# 6 Proposed Fill Design

The proposed fill design adopts approximately the same footprint as originally proposed by Terra Mining in the 2019 Huntly Quarry Fill Assessment & Design. Slight modifications have been made to allow for sufficient set back from the adjacent slopes and the bench geometries to promote drainage and fill capacity.

The toe of the fill is set-back approximately 40m from the northern property boundary and 25m from the crest of the slope to the south-east.

The external batters of the containment bunds are formed out of engineered fill material and adopt a 3H:1V slope face gradient. Where managed fill forms the external batters in the top stages of the fill, the external batter gradients of managed fill will be 6H:1V or flatter.

The basal bund (Stage 1 Bund) is required to be keyed a minimum of 2m vertically into the existing ground and built to the design height prior to placement of managed fill. All structural bunds have been designed with a 5m height to reduce the overall amount of structural fill required.

The geometries for the proposed fill at Fill Site 3 are summarised in Table 2. A typical detail showing the proposed bund geometry is presented in Drawing No.: 2325-74-101 included in Appendix A.

Table 2: Summary of Proposed Fill Design Geometries

| Bund Level | Approximate RL Represented | External Batter Gradient | Minimum Top of Bund Width | Maximum Internal Batter Gradient | Proposed External Berm/Bench Width |
|---|---|---|---|---|---|
| Bunds – Stage 1 to 2 | 66 to 100 | 3H:1V | 5m | 1.5H:1V | 5m |
| Upper Stages – Managed Fill | 81 to 100 | 6H:1V (maximum) | N/A | N/A | N/A |
| Notes: | 1) The top of the fill has a nominal a drainage gradient of approximately 10% and 15% to the north-east respectively. | | | | |

The proposed fill geometries result in a calculated total volume of approximately 478,500m$^3$. The proposed fill area has a footprint of approximately 43,370m$^2$.

Swale drains will be required along the length of each external bench to convey water from the internal drainage blankets and also stormwater received by the bench and external batters. The bench swales will drain to the north-western extents of the fill where water will be taken to the toe of the fill by drop flume structures.

The stormwater design for the bench level swales and the eastern and western flumes will need to be undertaken by a stormwater design specialist and is outside the scope of this report.

# 7 Slope Stability Analysis

Primary slope stability assessment has been carried our using limit equilibrium methods in the program SLIDE by RocScience. GLE/Morgernstern-Price as well as Bishop methods have been checked.

Displacement analysis of the proposed fill has also been carried out using finite element modelling (FEM) in the program RS2 by RocScience. The intention of the displacement modelling is to assess the potential ground deformation extents in the historic mining fill near the neighbouring property boundary. Poisson ratio of the historic fill has been exaggerated to assess toe bulging.

Three representative cross sections have been developed and analysed. The subject cross sections and the target slope stability check component is summarised in Table 3 below:

Table 3: Cross Sections for Slope Stability Analyses

| Cross Section | Main Reason for Analysis |
|---|---|
| Cross Section 1 | Main Stability check of the proposed fill. Additionally used for displacement analysis. |
| Cross Section 2 | Checking the stability of the proposed and historic fill along the alignment of the Fill 3 gully. |
| Cross Section 3 | Stability check of the proposed fill to the neighbouring gully to the east. |

The geological models used for analyses have been determined using the test pit and borehole site investigation data in conjunction with mapping of existing exposures and published geological maps. The borehole investigation was able to confirm the approximate thickness of the historic mining fill. Basement rock conditions along the length of the Fill Site 3 gully and the neighbouring gully to the east cannot be adequately confirmed. As such the models have adopted worst credible case ground conditions including extension of the Waikato Coal Measures unit to the toe of both the main gully and the adjacent eastern gully.

The presence of the unweathered rock boundary was not confirmed with sufficient confidence to be relied upon. As such, slope stability models have placed the unweathered bedrock boundary at a conservatively deep level based on where the boundary is observed within the main quarry pit. The design of the managed fill is not reliant on the presence of unweathered bedrock material.

## 7.1 Geotechnical Parameters

Geotechnical parameters adopted in the limit equilibrium slope stability analyses are summarised in Table 4 and Table 5 below:

Table 4: Slope Stability Analysis – Geotechnical Soil Strength Parameters for Natural Subgrade Materials

| Soil Unit | Mohr-Coulomb Parameters | | | Undrained Strength Parameters | |
|---|---|---|---|---|---|
| | Unit Weight ($kN/m^3$) | Cohesion - c' (kPa) | Angle of internal friction – Φ (°) | Vertical Stress Ratio | Undrained Shear Strength – Su (kPa) |
| Residually Weathered Waikato Coal Measures | 17 ~ 18 | 5 | 30 | N/A | 70 |
| Waikato Coal Measures Bedding Parallel Shears | 20 | 10<br>0 Note1 | 30<br>18 to 21 Note1 | N/A | N/A |
| Residually and Completely Weathered Greywacke | 18 ~ 19 | 8 | 30 | N/A | 100 ~ 150 |
| Note | 1) See Section 7.2, Figure 5 & Figure 6 for anisotropic material strength properties and angular distribution | | | | |

Table 5: Slope Stability Analysis – Generalised Hoek-Brown Rock Strength Geotechnical Parameters for Natural Subgrade Materials

| Geological Unit | Unit Weight ($kN/m^3$) | Unconfined Compressive Strength (MPa) | GSI Note 1 | Material Constant (mi) | Disturbance Factor (D) |
|---|---|---|---|---|---|
| Moderately to Slightly Weathered Waikato Coal Measures Mudstone | 20-22 | 2.5 | 30 | 7 | 0.0 |
| Highly Weathered Greywacke | 19 | 0.5 | 30 | 18 | 0.0 |
| Moderately Weathered Greywacke | 20-22 | 5 | 40 | 18 | 0.0 |
| Slightly to Unweathered Greywacke | 26 | 50 | 50 | 18 | 0.0 |
| Notes: | 1) Geological Strength Index. | | | | |

Table 6: Slope Stability Analysis – Geotechnical Soil Strength Parameters for Fill Materials

| Fill Material | Mohr-Coulomb Parameters | | | Undrained Strength Parameters | |
|---|---|---|---|---|---|
| | Unit Weight ($kN/m^3$) | Cohesion - c' (kPa) | Angle of internal friction – Φ (°) | Vertical Stress Ratio | Undrained Shear Strength – Su (kPa) |
| Historic Mining Fill | 18 | 0 | 28 | 0.3 | 40 |
| Proposed Structural Fill | 18 | 5 | 30 | N/A | 135 |
| Proposed Managed Fill | 15-16 | 0 | 28 | 0.3 | 30 |
| Managed Fill – Material Strength Sensitivity | N/A | N/A | N/A | 0.22 | 20 |

## 7.2 Waikato Coal Measures Bedding Parallel Shears

Planes of weakness that align parallel with the bedding orientation are known to be associated with the Waikato Coal Measures group materials. This weak layer is typically found directly overlying the less weathered rock layers.

Discrete and measurable bedding of the Waikato Coal Measures was not observed in the test pits carried out for Fill Site 3 nor clearly in the neighbouring gullies. However, the latest overburden cuts above the quarry pit show that the bedding of the WCM is folded, mimicking the surface topography forming ridges and gullies. Folded bedding was observed aligning downslope from the ridgelines.

With discrete bedding directions not present, stability models have adopted worst credible bedding related weakness. To do this, an anisotropic strength function that decreases the material strength over an angular range has been adopted. The angular range coincides with the surficial slope angles. Worst credible strength parameters have been derived by back-analysing the existing slopes to a Factor of Safety ≈ 1.2 along the coal measured rock interface. FoS ≈ 1.2 has been selected instead of FoS = 1.0 as these slopes show no signs of recent instability.

The anisotropic strength parameters are summarised in Figure 5 and Figure 6.

Figure 5: Waikato Coal Measures - Bedding Parallel Shears Strength Parameters – Sensitivity check for Main Gully Alignment

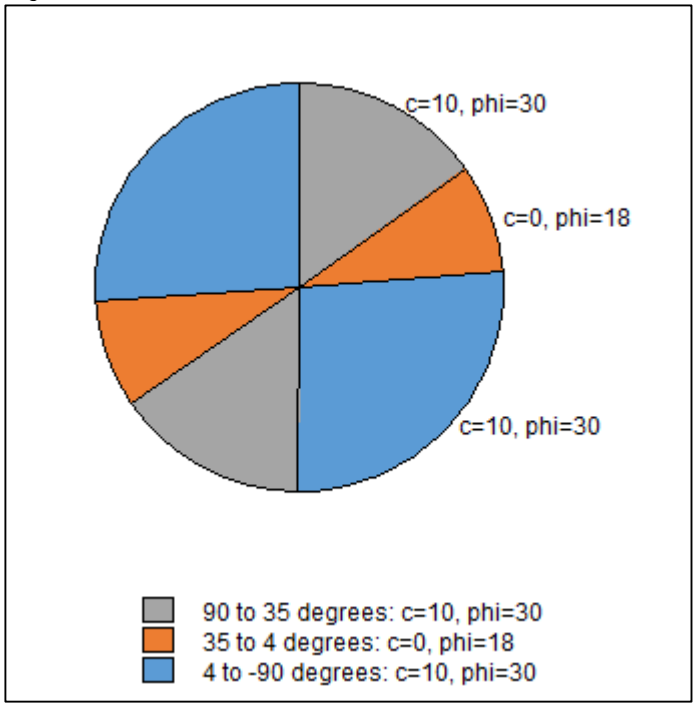
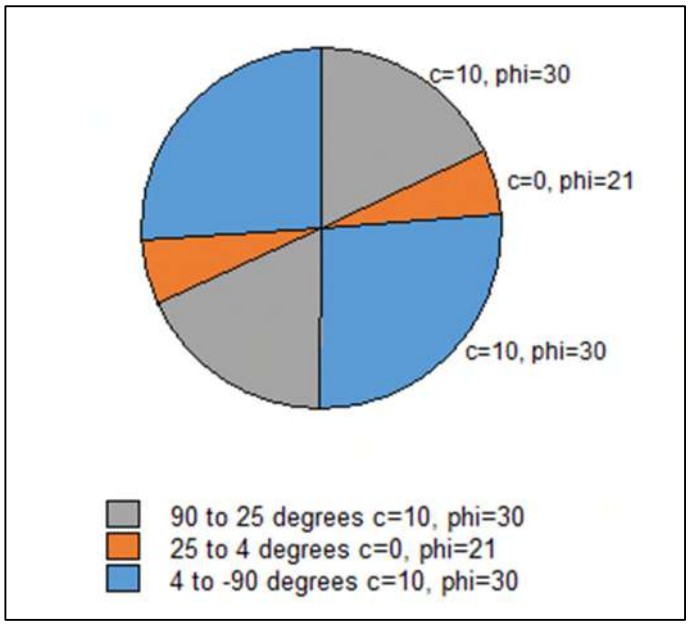


Figure 6: Waikato Coal Measure - Bedding Parallel Shears Strength Parameters - Long Term Parameters for Eastern Gully Flank




## 7.3 Fill Staging and Sensitivity Checks

Slope stability design checks using 2 "stages" of filling have been undertaken. Each stage comprises a 10m vertical lift of managed fill which are separated by drainage blankets. Each main stage is further separated into two sub-stages which are contained behind 5m high structural fill bunds.

In order to model this construction method, each filling stage has been analysed with additional checks used to test the sensitivity of the design to the importation of material with low strength and/or high-water content.

It is expected that throughout the course of placing an individual stage of material, pore-water pressure will be allowed to partially dissipate through the basal and inter-stage drainage blankets. This process is expected to be guided by the ability of construction machinery to track over the surface of the placed managed fill.

The fill staging checks were only undertaken on Cross Section 1 as it is the most representative of the full fill thickness. Fully undrained loading cases including the underlying historic mining fill were found to have the lowest factors of safety. However, sufficient factors of safety were able to be achieved through the use of deep drainage within the historic mining fill.

## 7.4 Pore-Water Pressure

Pore-water pressure within the proposed fill material and the historic mining fill is a dominant factor governing the stability of the fill. As such, two methods of modelling pore-water pressures have been checked. Firstly, residual pore-water pressures have been modelled within both the structural fill bund material and managed fill material using an Ru coefficient. Secondly, a piezometric water head has been modelled on the top of each main filling stage.

Control of pore-water pressure within both the proposed fill material and the historic mining fill is achieved through the use of deep drainage within the existing fill and drainage blankets both at the base of the fill and at 10m vertical intervals within the fill. Likewise, monitoring during the placement of the drainage blanket and fill will help to shorten the excess pore water pressure dissipation period.

Stability assessment for this fill has demonstrated that the design is able to tolerate full saturation of each fill stage (Hu=1 for each piezometric water table).

## 7.5 Seismic Design

Seismic design criteria have been selected based on the recommendations provided in AS/NZS 1170.5:2004 and the New Zealand Transport Agency Bridge Manual, Third edition, Amendment 3, 2018.

The proposed fill has been classified with an "Importance Level" of 2 and analysed for an annual probability of exceedance of the damage control limit state (DCLS) earthquake event of 1/500 years.

The corresponding peak ground acceleration (PGA) for the site based on the above information was calculated to be 0.24g for class C subsoil conditions.

The Bridge Manual also provides a design earthquake magnitude of 5.8 for the Huntly area.

## 7.6 Acceptance Criteria

Acceptable stability of the proposed fill is to be determined by the calculated Factor of Safety (FoS). The calculated slip circle with the lowest factor of safety affecting the fill is reported for each design case. The design cases tested and the corresponding minimum FoS required is reported Table 7 below:

**Table 7: Design Cases and Required Factor of Safety**

| Design Case | Required Factor of Safety (FoS) |
|---|---|
| Long-term Conditions – Moderate Groundwater Level | >1.4 |
| Extreme Groundwater Conditions | >1.3 |
| Construction Pore-Water Pressure and Medium-Term Strength Conditions | >1.2 |
| Material Strength Sensitivity Strength Conditions | >1.0 |
| DCLS Seismic Loading | >1.2 or <150mm of displacement if FoS <1 |

## 7.7 Results

A summary of the critical Factor of Safety for each case is presented in Table 8 below.

Table 8: Summary of Slope Stability Analysis Results

| Cross Section | Design Case | Assessed Factor of Safety |
|---|---|---|
| Fill 3 – Cross Section 1 | Existing Slope | 1.185 |
| | Completed Fill – Piezometric Tables – Hu=1 | 1.439 |
| | Completed Fill – Ru=0.2 Pore-Water Pressure | 1.500 |
| | Completed Fill – Undrained Strength Case | 1.336 |
| | Completed Fill – Undrained Strength Case W/ Deep Drainage | 1.360 |
| | Stage 1 Filling – Long Term Strength | 1.608 |
| | Stage 1 Filling – Undrained Strength | 1.636 |
| | Stage 1 Filling – Material Variability | 1.579 |
| | Stage 2 Filling – Material Variability | 1.513 |
| | Stage 2 Filling – Medium Term Strength | 1.636 |
| | DCLS Seismic Loading | 0.693 |
| Fill 3 – Cross Section 2 | Existing Slope | 0.899 (min.), 1.195 (Selected Circle)[Note 1] |
| | Completed Managed Fill | 0.897 (min.), 1.195 (Selected Circle)[Note 1] |
| | | 2.030 (Lowest FoS Affecting Fill) |
| | Completed Managed Fill – Undrained Strength | 1.516 |
| Fill 3 – Cross Section 3 | Existing Slope | 0.880 (Min.), 1.452 (25m offset from Slope Crest) |
| | Proposed Managed Fill | 0.886 (min.), 1.457 (Fill Internal), 1.505 (Toe of Fill) |
| | Proposed Managed Fill – Undrained Strength | 1.179 (Min.), 1.647 (Fill internal), 1.593 (Toe of Fill) |
| | Proposed Managed Fill – High GWL | 0.886 (Min.), 1.457 (Fill Internal), 1.268 (Toe of Fill)[Note 2] |
| Notes | 1) Demonstration that the additional managed fill is not lowering the global stability of the gully system.<br>2) Will be controlled via subsoil drainage | |

## 7.8 Seismic Induced Displacement

The Factory of Safety under DCLS seismic loading was calculated to be less than the required 1.2. As such, seismically induced displacement has been calculated using the methods described by Jibson (2007), Ambraseys & Srbulov (1995) and Anderson et al (2008).

The critical ground acceleration for Cross Section 1 was calculated to be 0.09g where the global FoS was ≈ 1 and deep drainage was installed.

Based on the above parameters the calculated seismic induced displacement with a 50% confidence level was determined to be 20mm. A displacement of this magnitude will have negligible impact on a fill slope of this nature that is able to be maintained by the owner.

## 7.9 Finite Element Modelling Displacement Analysis

FEM displacement checks of the fill were carried out on using the model derived for Cross Section 1. The intention of the FEM displacement checks was to assess the potential impact for ground movement in the neighbouring property to the north. It is anticipated that movement within the historic fill due to surcharge from the imported fill has the potential to cause vertical (upwards) bulging.

The Poisson's ratio for the Historic Mining Fill was exaggerated to 0.49 to better visualise the shape change caused by surcharging of the existing fill with the proposed imported fill. As such, the magnitudes calculated by the FEM are not considered to be quantitative.

Modelling found that designed setback of 40m from the toe of the fill to the northern property boundary will be sufficient to accommodate noticeable surface displacement caused by the construction of the managed fill. It was observed that the displacement beyond the 40m setback quickly become insignificant.

Nevertheless, displacement monitoring markers will be installed between the property boundary and the toe of the fill to assess response of the historic fill to the surcharge or the imported fill. If excessive or accelerating displacements are noted during surveying the rate of managed fill placement will have to be slowed or stopped and the design reviewed by a chartered professional geotechnical engineer.

## 7.10 Discussion and Conclusions

The stability analyses have demonstrated that the proposed managed fill design is sufficiently stable. Stability of the fill has been assessed with the anticipation of the variable nature of imported managed fill. As such, low strength parameters have been used and consideration has been given to the anticipated construction sequence of the fill.

The critical loading case for the fill has been assessed as the short-term undrained strength conditions within the fill materials and the underlying thickness of historic mining fill. Factor of Safety in the fill can be improved effectively by mitigating pore-water pressures increases within the underlying historic fill via the installation of deep drainage trenches. Likewise, pore-pressures within the imported fill can be allowed to dissipate along the proposed drainage blankets.

Expected displacement due to the design seismic loading is calculated to be <15mm which is considered to be tolerable to a fill of this nature.

The influence of bedding aligned weaknesses within the Waikato Coal Measures has been conservatively assessed in the absence of high confidence structural bedding information. Worst credible weakness planes downslope of the eastern fill extents have resulted in the adoption of a 25m setback from the downslope crest.

# 8 Proposed Fill Construction Recommendations

Based on our review of existing geological/geotechnical information, walk-over inspection/mapping, test pit, machine borehole investigation and subsequent slope stability analyses and design, we are of the opinion that the selected site is generally suitable for use as a fill sites for placement of managed fill subject to the following construction recommendations.

The following sections outline our recommendations regarding drainage, construction methodology and monitoring in order to ensure the designed stability factors are achieved. Where possible the following sections have been arranged in the anticipated order of construction. These recommendations should be read in conjunction with the relevant construction drawings presented in Appendix A for additional information.

## 8.1 Sediment Control and Stormwater Discharge

The anticipated location of the sediment control pond has been shown on Drawing No.: 2325-74-08. The location of this pond is not anticipated to adversely affect the stability of the proposed fill due to being located sufficiently away from any existing slopes. The proposed sediment pond will be founded above the level of the proposed toe-key to mitigate undermining of the managed fill.

Changes to the proposed location of the sediment control pond location should be referred to the geotechnical designer for review.

It should be noted that the specific design of the sediment control pond, related sediment control devices and stormwater conveyance channels/swales/flumes is outside the scope of this report and our work.

## 8.2 Haul Roads

It will be necessary during construction of the managed fill to transport fill materials to the working toe of the fill. An existing track to the toe of the fill currently exists down from the eastern side of the proposed managed fill. If additional roads or upgrades to the existing track are required, the location of these may affect ground stability. Upgrades or new haul roads shall be specifically designed as necessary. Specific design of new haul roads is outside the scope of this report.

## 8.3 Stripping

Prior to commencement of filling – vegetation and topsoil along with soft and otherwise deleterious material shall be removed to stockpile to expose subgrade conditions. Subgrade conditions shall be inspected by a suitably qualified geo-professional familiar with the recommendations of this report prior to commencement for installation of drainage or placement of fill.

Topographic surveys of the stripped surface are to be collected prior to installation of the basal drainage blanket as described in Section 8.4.3.

The proposed fill has a footprint of approximately 43,370m$^2$. The average observed topsoil thickness is 0.3m which gives an estimated topsoil volume of approximately 7,220m$^3$. This topsoil volume does not include earthworks areas outside of the fill footprint such as the sediment control pond area.

## 8.4 Drainage

As discussed previously, control of pore-water pressure both within the historic mining fill and the proposed managed fill is critical to achieving the design stability. The following drainage items are recommended:

### 8.4.1 Deep Subsoil Drain

The deep subsoil drain is intended to allow for pore-pressure and perched groundwater dissipation from the historic mining fill.

The deep subsoil drain is positioned along existing surficial swale drains. It is intended that these existing swale drains are deepened and extended to form the deep subsoil drains.

The anticipated location of the deep subsoil drain is shown in Drawing No.: 2325-74-08 & 09 included in Appendix A

The drain is to comprise an up to 10m deep, 1.5m wide trench with two 160mm Φ punched drainage coils. Using dual coils allows for reserve capacity should sections of an individual drainage pipe become blocked. Care must be taken to ensure that each drainage pipe is bedded into the backfill material and maintains a minimum fall gradient of between 1% and 3% downslope.

The bottom 1m of the trench is to be backfilled with General All Passing 65mm (GAP65) aggregate with less than 4% fines. Typical grading profiles of the proposed aggregate is to be provided by the contractor for approval by the designer to ensure compatibility. GAP type aggregate has been specified instead of typical drainage aggregate due to the ability of the GAP material to form a self-filtering structure. This mitigates the necessity to use a geotextile separation filter between the drain and the surrounding country. The aggregate material should be un-weathered blue rock.

The typical detail for the deep subsoil drain is shown in Drawing No: 2325-74-102

It is anticipated that the deep subsoil drain will be the first installed during the construction of the managed fill. Outflows of the drain will be monitored for response to rainfall and placement of surcharging managed fill.

The position of the carrier drain is to be as-built surveyed.

### 8.4.2 Collector Drains

The collector drain is to be installed along the invert of minor surficial overland flowpaths or where soft and/or wet areas are discovered during stripping.

It should be noted that these locations will require confirmation during stripping activities and additional drains may be required where soft/wet areas are located.

Collector drains are to comprise an approximately 0.6m deep, 0.3m wide trench with a single 160mm Φ punched drainage coil placed. The collector drain is to maintain a minimum fall gradient of between 1% and 3% towards to tie into the toe-key buttress/chimney drain. Backfill material for the collector drain is to comprise the same GAP material as used in the Carrier Drain discussed in Section 8.4.1.

Collector drains are to be joined into the deep-subsoil drain via the chimney/buttress drain under the eastern section of the toe-key. The positions of the drains are to be as-built surveyed.

### 8.4.3 Buttress & Chimney Drain

A buttress and chimney drain will be formed to connect the deep subsoil drain and the basal drainage blanket under the toe-key area. The buttress and chimney drain will convey water from the basal drainage blanket and any collector drains to the deep subsoil drain to exit the fill area.

The buttress and chimney drain are to comprise a 1.5m wide trench, 10m long, excavated to the deep-subsoil drain. Three (no.) punched 160mm Φ punched drainage coils are to be arranged vertically and equally spaced within the trench. The base of the drainage coil is to be teed into the deep subsoil drain and suspended vertically and centrally within the trench. The trench shall then be backfilled with the <4% fines GAP65 to the level of the basal drainage blanket.

### 8.4.4 Basal Drainage Blanket

All fill must be placed on a basal drainage blanket as generally indicated in Drawing No.: 2325-23-04, this includes the toe-key area. The basal drainage layers serve to provide a preferential drainage path to convey any seepages and excess pore-water from the fill material above to the deep subsoil drain and out of the fill area.

The basal drainage blanket is to comprise a 400mm thick layer of aggregate graded to fall down-slope towards the buttress & chimney drain at a minimum gradient of 1% to 3%.

The recommended aggregate is to have a nominal size of All Passing 65mm (GAP65) material with less than 4% fines. A typical grading profile is to be provided by the contractor for approval by the designer prior to placing the material.

Cuts and Fills of less than 1m may be undertaken prior to placing the basal drainage blanket in order to re-grade the basal drainage blanket subgrade to achieve the minimum gradient of 1% to 3%.

### 8.4.5 Internal Drainage Blankets

An internal drainage blanket is to be installed at 10m vertical intervals during construction of the fill. The internal drainage blankets are required to relieve pore-water pressure from the fill material as it is placed and also to provide preferential drainage paths for any groundwater that is able to infiltrate into the fill structure.

Internal drainage blankets are to comprise a 400mm thick layer of aggregate that has been graded to fall towards the corresponding structural bund and daylighting along the length of the fill into the bench swale drain. Minimum gradient is to be 1% to 3% towards these swales.

The recommended aggregate is to comprise the same modified GAP65 with less than 4% fines material. Internal drainage blanket material may comprise moderately weathered material (quarry grade brown to blue-brown) with less than 4% fines. Contractors are to provide typical grading profile and samples of the nominated material for approval by the designer prior to placing the material.

## 8.5 Structural Containment Bunds

Prior to bulk placement of managed fill, it will be required to construct a structural containment bund at each level. The structural bund serves two purposes:

1) To accurately define the external shape of the fill
2) To ensure the designed global stability of the fill.

Structural bunds are to comprise higher specification material that has been compacted and tested as specified in Section 8.7.1.

Where the structural bund directly overlies a drainage blanket, similar drainage blanket material is to be placed upon the inside batter of the bund. This hydraulically connects the back of the bund to the drainage blanket and ensure water is not trapped behind the structural bund. The drainage blanket material should be stopped approximately 1m vertical from the top of the bund to allow capping material to limit surface water infiltration into the lower drainage blanket.

The general details and layout of the structural bunds is shown on Drawing No.: 2325-74-101 shown in Appendix A.

### 8.5.1 Basal Bund (Stage 1)

The basal bund will need to be constructed to the full dimensions of 5m height and 5m crest width. With external and internal batter angles of 3H:1V and 1.5H:1V respectively.

The basal bund will need to be keyed into underlying ground. The basal toe-key is to consist of a minimum of 2m undercut from the original ground levels under the basal bund.

It is important that the basal drainage blanket be continued under the basal structural bund which ultimately drains via the chimney/buttress drain into the Deep Subsoil drain and away from the site. Drainage blanket material should not extend outside of the bund footprint to avoid stormwater infiltration.

### 8.5.2 Stage 2 Structural Bunds

In order to minimise the amount of structural fill required (and therefore compaction monitoring) and to provide flexibility to construction program an inter-bench split bund system has been designed. This means that individual structural bunds may be 5m high instead of 10m high from bench to bench. This effectively reduces the width of the bund at the base and therefore the amount of structural fill required.

### 8.5.3 External Benches

The fill has been designed with 5m wide external benches. These benches serve two purposes:

1) To allow drainage along swale drains to a flume drains at north-western extent of the fill
2) To allow access maintenance machinery to maintain the swale drains and batter faces.

Benches are graded with a back-slope towards the inner swale drain to avoid stormwater flowing over the crest of the batter.

The dimensions and details of the swale drain running along the inside edge of the bench will need to be specified by a stormwater design expert and is outside the scope of this report and our work.

## 8.6 Non-Structural Managed Fill

Material placed behind the structural bunds may comprise non-structural managed fill. This material has a lower specification requirement than those for the structural bund materials.

It is anticipated that this material will consist of imported materials that have been deemed generally unsuitable for other earthworks projects. These materials may include but are not limited to: peat, topsoil and clay materials either too wet or too soft for typical earthworks.

Managed fill materials are considered to be unsuitable for typical testing and fill control regimes. Instead, placement of the managed fill is to be guided by the performance of the material under the passage of the earthmoving plant. Material that is too soft or wet will become difficult to work with earthmoving equipment and should serve as an indication that additional conditioning or blending with drier/stiffer material is required.

### 8.6.1 "Bottom Up" Filling

As noted in Section 3.3, the upper reaches of the natural gully comprise weathered soil that is prone to creep type movements. It is therefore recommended that the fills shall be constructed from the toe

up. Fill should be transported to the base of the fill area and progressively built up in sub-horizontal layers.

It is not recommended that fill be end-tipped from the head of the gully and pushed down the slopes. Doing so may overload the underlying soils and lead to failure – a potential risk to staff as well as filling progress.

### 8.6.2 Maximum Managed Fill Gradients During Filling

Manged fill type materials cannot maintain gradients steeper than approximately 1H:6V without exhibiting failure. Managed fill should not be placed at gradients steeper than 1H:6V during filling works.

## 8.7 Fill Control

Monitoring and testing of the fill placed during construction will be required. The monitoring methodology and specifications have been developed based on two fill classes that will be used for construction of the fill – Structural and Non-Structural Fill. The provided specifications are intended to cover a range of suitable material to aid in ease of testing and construction.

### 8.7.1 Structural Fill Specifications

It is anticipated that the structural fill will be sourced from concurrent overburden stripping activities at the Huntly Quarry pit and is therefore expected to consist of both Waikato Coal Measures material and residually through moderately weathered Newcastle Group Greywacke. Table 9 and Table 10 presented below provide the testing requirements for structural fill based on cohesive and non-cohesive material respectively.

**Table 9: Compaction Control Criteria & Frequency of Testing – Structural Cohesive Fill (Structural Bunds)**

| Fill Type | Test Parameter | Laboratory Test/ Test Method | Frequency of Test | Acceptance Criteria |
|---|---|---|---|---|
| Cohesive Structural Fill – Structural Bunds | Water Content | NZS4402:1986 Test 2.1 – Determination of Water Content | 1 Test per 400m$^3$ of compacted fill. | N/A |
| | Strength – Vane Shear Strength | NZGS 2001 Guideline for Handheld Shear Vane Test | 1 set (3 points) per 400m$^3$ placed with a min of 2 tests for each area worked each day and no more than every 0.5m thickness of fill placed. | Average minimum Su ≥ 135 kPa – site-won from overburden soil. No single test less than 120kPa |
| | Compacted in-situ air voids. | NZS 4407:2015 TEST 4.2 Nuclear Moisture-Density gauge (NDM) direct transmission mode | 1 set (3 points) per 400m$^3$ placed with a min of 2 tests for each area worked each day and no more than every 0.5m thickness of fill placed. One soil sample and shear vane test point shall be taken directly beneath NDM test location for laboratory water content test for calculation of air void.) | ≤ 7% Air Voids |

| | | | | |
|---|---|---|---|---|
| | NZ Standard compaction curve - determine air voids and vane shear strength at a range of moisture content; also MDD, OWC & solid density | NZS 4402:1986 TEST 4.1.1 - NZ Standard Compaction Test<br><br>NZS 4402:1986 TEST 2.1 & 2.7.2 | 1 set (5 points) per material type and source then 1 test per 5000 $m^3$ for that material type and source | N/A |

Table 10: Compaction Control Criteria & Frequency of Testing – Structural Non-Cohesive Fill (Brown Rock)

| Fill Type | Test Parameter | Laboratory Test/ Test Method | Frequency of Test | Acceptance Criteria |
|---|---|---|---|---|
| Non-Cohesive Structural Fill (Brown Rock) – Structural Bunds | Particle Size Distribution | Visual Check | All Material Placed | No particles larger than 200mm |
| | | Laboratory Particle Size Distribution (NZS4402:test 2.8.1) | 1 test per 5000$m^3$ of source material | No organic content; and <7% passing 75µm sieve |
| | Deformation - Fill Condition | Proof Rolling - NZTA F1 fully loaded truck with at least 8-tonnes per axle or equivalent approved | Continuous field observation and recording and proof rolling as required by supervising engineer. | No more than 5mm elastic displacement under wheel loading. |
| | In-situ density, in-situ compacted dry density, in-situ water content | NZS 4407:2015 Test 4.3 Nuclear moisture-density gauge (NDM) backscatter mode | 1 set (1 point) per 400 $m^3$ placed with a min. of 2 tests for each area worked each day and no more than every 0.5m thickness of fill placed. | ≥ 95% OF MDD (NZ Heavy Compaction Test 4.1.2) |
| | Crushing Resistance | NZS4407:2015 – Test 3.10 The Crushing Resistance of Coarse Aggregate Under a Specified Load | 2 Tests per material per source material | 100kN (min) |
| | Weathering Resistance | NZS4407:2015 – Test 3.11 The Weathering Quality Index of Coarse Aggregate | 2 Tests per material per source material | CA or better |

### 8.7.2 Non-Structural Managed Fill

Monitoring of the non-structural managed fill component will be limited to performance observations of the fill material. Table 11 below outlines the required proof-roll frequency and acceptance criteria.

Table 11: Compaction Control Criteria & Frequency of Testing – Managed Fill (Non-Structural)

| Fill Type | Deformation and Trafficability Acceptance Criteria |
|---|---|
| Managed Fill (Non-Structural) | All placed soil fill shall be uniformly spread and track rolled by a bulldozer.<br>The bulldozer should be able to track easily across the surface without sinking into the material.<br>Material that is untrafficable by the bulldozer should be conditioned or blended before additional layers are spread.<br>Monitoring of the deformation and trafficability shall be continuously observed by a geo-professional.<br>This requirement also applies for the safety of equipment operators and personnel working over soft ground |

### 8.7.3 Fill Testing Requirements

All laboratory, shear vane and nuclear densometer testing is to be carried out by an IANZ approved laboratory. The position of each test should be recorded by GPS with a minimum of ±0.2m accuracy in plan and 0.2m in elevation.

Test failures within structural fill material should be relayed back to the contractor immediately. The failed area must be re-tested once the contractor rectifies the reason for failure.

Control of the non-structural managed fill should be undertaken by the contractor with spot-checks undertaken by a geo-professional familiar with the contents of this report or when requested by the contractor. Material that is too wet and/or soft for trafficking by the bulldozer should either be conditioned or blended with drier material. Due to the expected variability in the material being imported into the site, management of fill moisture levels and trafficability should be carefully monitored by the contractor. Failure to do so may result in areas of managed fill that are untrafficable and consequently losing the ability to place more managed fill until the underlying material is rectified.

This requirement also applies for the safety of equipment operators and personnel working over soft ground

## 8.8 Displacement Monitoring

Displacement monitoring of the fill will be required during construction and after completion of the fill. Successive monitoring points should be established at each bench level with additional monitoring points installed on the finished surface. The monitoring points nominally consist of a waratah fencing standard driven into the fill that can be checked periodically by a surveyor.

A monitoring point layout plan and typical detail is included in Appendix A, Drawing No.: 2325-74-103

The monitoring frequency and alert trigger levels are presented in Table 12 below:

Table 12: Displacement Monitoring Frequency and Alert Trigger Levels

| Monitoring Point Type | Monitoring Frequency | Alert Trigger Level |
|---|---|---|
| Survey Monitoring Point – Steel Waratah Fencing Standard | Monthly. Increase to weekly if alert trigger level is exceeded | 100mm net lateral displacement of structural fill<br>100mm net vertical displacement of structural fill |
| Notes: | 1) The alert levels may be revised during construction in response to observed displacements.<br>2) If alert levels are triggered, the fill profile may need to be redesigned and the construction filling speed may need to be reduced. | |

### 8.8.1 Pore-Water Pressure monitoring

Due to the installation of regularly spaced drainage blankets and fill placement monitoring which includes control of the fill material water content, we are of the opinion that standpipe piezometers are not required unless displacement monitoring alert triggers are exceeded.

If displacements and/or settlements exceed the alert trigger levels during the displacement monitoring recommended in Section 8.8, the installation of standpipe piezometers or similar within the fill will be required in order to monitor the pore-water pressure conditions.

Location and details of these piezometers if required will be determined by the supervising geotechnical engineer upon review of the displacement data.

### 8.8.2 Excessive Displacement Mitigation Response

Response to excess displacement will be determined based on the mechanism inferred to be driving the displacement.

If excessive pore-pressure is discovered following installation of the standpipe piezometers as mentioned in Section 8.8.1 mitigation options will include removal of the fill material generating the excess pore-pressure if practical to do so. Otherwise, bored sub-horizontal drains will be required to relieve excess pore-water pressures.

If excessive displacement is determined to not be a result of excess pore-pressure, the excessive fill material which caused the excessive deformation will be removed in order to reduce the downslope driving force and improve the stability. This avoids overly conservative design of the fill slope. This is to be determined based on the monitoring results.

# 9 Conclusions

This geotechnical design report covers the detailed investigation and design of Fill Site 3 undertaken by Gaia Engineers as part of the Huntly Quarry Fill Disposal Areas project.

The toe of proposed fill is located on the relatively flat surface of the historic mining fill at RL 67 and rises to tie into the existing ridgeline at RL100. Two external benches will be placed at 10m vertical intervals and will be 5m wide allowing for bench level drainage and maintenance access. External batter angles will be controlled by the construction of structural bunds. The external batters for the structural bunds will be 3H:1V whilst the final layer of managed fill will tie into the existing ridgeline using batters flatter than 6H:1V.

Based on the results of the existing information review, test pit investigation, fill design and stability analysis undertaken in preparation of this report, we are satisfied that the proposed fill is able to be constructed and be sufficiently stable. Stability of the fill is reliant on the correct implementation of the design including installation of the subsoil drains, drainage blankets, control of external batter angles and adherence to the appropriate fill specifications. Sensitivity of the fill to instability within the underlying Waikato Coal Measures material has been assessed and found to remain stable under worst credible conditions.

The proposed deep subsoil drain will provide a suitable drainage path for perched groundwater tables and excess pore-pressures developed in the Historic Mining Fill due to the surcharge loading of the proposed fill. Success of the deep subsoil drains will be monitored through surface displacement monitoring of markers placed at the toe of the fill and on subsequently completed fill stages. Excessive or accelerating displacements will result in a slowing of the rate of filling.

Detailed construction recommendations and methodology is provided in Section 8

All referenced drawings are included in Appendix A.

Site investigation logs are included in Appendix B.

Outputs for slope stability calculations are included in Appendix C.

# 10 Limitations

## 10.1 Specific Limitations

Design aspects relating to stormwater handling including but not limited to: swale drains, flumes, sediment ponds are outside of the scope of this report and our work. These structures should be specifically designed by a stormwater expert familiar with this report.

## 10.2 General Limitations

*This report has been prepared for the sole use of our client, Gleeson Quarries Ltd., for the particular brief and on terms and conditions agreed with our client. It may not be used or relied on (in whole or part) by anyone else, or for any other purpose or in another contexts, without our prior written agreement.*

*The factual logs presenting descriptions of the soils and geology based on our observations of the samples recovered in the fieldwork and may not be truly representative of the underlying ground conditions.*

*To the maximum extent permitted by law, Gaia Engineers Ltd disclaims all liability and responsibility (in contract or tort, including negligence, or otherwise) for any loss or damage whatsoever which may be suffered as a result of any reliance by any third party on this report, whether that loss is caused by any fault or negligence on the part of Gaia Engineers Ltd or otherwise.*

*Our interpretation of the geotechnical information is based on field investigations at discrete locations. Therefore, variation of ground conditions away from the investigations can be expected. No guarantee is expressed or implied as to the nature of the ground conditions between or beyond investigation conditions. This report covers the Fill Disposal Site 3 at the Huntly Quarry as described within and does not make any conclusion or recommendations regarding any other aspects of the quarry.*

# 11 Risk and Mitigation

Table 13: Key Geotechnical Risk and Mitigation Strategy

| Likely Risk | Mitigation Strategy |
|---|---|
| Ground Conditions:<br>Position of Geological/Geotechnical Unit boundaries differs from design. Worse conditions than those designed for could lead to slope instability<br>Presence of Bedding Parallel Shears and Weaknesses within the Waikato Coal Measures are encountered | Specific design of toe-keys to cut-off bedding parallel weaknesses. No permanent cuts that daylight bedding parallel weaknesses. |
| Groundwater Conditions:<br>Groundwater table is higher than observed and/or groundwater springs are encountered. | Sufficient contingency in construction budget for additional drainage measures. |
| Land Slips:<br>Slips within the weathered soils of the existing valleys during construction | Avoidance of placing undue load on the natural soil slopes by not end-tipping material from the gully head.<br>Maintaining positive drainage across all active earthworks sites and shaping of finished ground.<br>Not directing catchment stormwater flows onto active earthworks areas and conveying water to a safe discharge point |
| Displacement Monitoring:<br>Excessive Fill Displacements Measured | Install stand-pipe piezometers to monitor pore-water pressures.<br>Installation of sub-horizontal bored drains<br>Remove material causing deformation and replace with compacted hard-fill or soft-pit-run<br>Reduce Rate of Filling |
| Seismically induced displacement:<br>Displacement causing sloughing of material from external batters | Reinstate drainage capacity of swale drains if blocked by slip material<br>Remove remnant displaced material and replace with compacted structural fill. |
| Working on soft managed fill | Managed Fill needs to be track rolled sufficiently to avoid machines, operators and personnel sinking into the ground |

# 12 Safety in Design (SiD) Considerations

A Safety in Design matrix is included in on drawing 2358-74-05 included in Appendix A. It is anticipated that prior to construction the document will be finalised with the contractor and added to during construction.


5 Carmont Place, Mt Wellington, Auckland 1060, New Zealand
PO Box 51 295 Pakuranga, Auckland 2140
www.gaia-engineers.co.nz

# APPENDIX A – Design Drawings

| DRAWING NO: | DRAWING TITLE: | REVISION: |
|---|---|---|
| 2325-74-01 | GENERAL NOTES - SHEET 1 OF 4 | A |
| 2325-74-02 | GENERAL NOTES - SHEET 2 OF 4 | A |
| 2325-74-03 | GENERAL NOTES - SHEET 3 OF 4 | A |
| 2325-74-04 | GENERAL NOTES - SHEET 4 OF 4 | A |
| 2325-74-05 | SAFETY IN DESIGN | A |
| 2325-74-06 | OVERALL PROJECT LAYOUT WITH EXISTING CONTOURS | A |
| 2325-74-07 | OVERALL PROJECT GEOLOGICAL MAP | A |
| 2325-74-08 | PROPOSED LAYOUT AND SITE INVESTIGATION PLAN | A |
| 2325-74-09 | TOE KEY AREA, BASAL AND UNDERFILL DRAINAGE PLAN | A |
| 2325-74-10 | STAGE 1.1 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-11 | STAGE 1.2 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-12 | STAGE 2 - LAYOUT - DRAINAGE BLANKET ARRANGEMENT | A |
| 2325-74-13 | STAGE 2.1 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-14 | STAGE 2.2 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-15 | STAGE 3 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-50 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 1 | A |
| 2325-74-51 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 2 | A |
| 2325-74-52 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 3 | A |
| 2325-74-53 | DEEP SUBSOIL DRAIN SECTIONS | A |
| 2325-74-101 | TYPICAL BUND AND MANAGED FILL ARRANGEMENT AND DETAIL | A |
| 2325-74-102 | TYPICAL DRAINAGE DETAILS | A |
| 2325-74-103 | DISPLACEMENT MONITORING LAYOUT | A |

Gaia Engineers

P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz

# DRAWING REGISTER & TRANSMITTAL NOTICE

Client: GLEESON QUARRIES

Project / job No. 2325/74

Site / Drawing Type: HUNTLY QUARRY DISPOSAL SITES - FILL 3 AREA

| | |
|---|---|
| DAY | 23 |
| MONTH | 07 |
| YEAR | 21 |

| Drawing No. | Drawing Title | Issue |
|---|---|---|
| 2325-74-01 | GENERAL NOTES - SHEET 1 OF 4 | A |
| 2325-74-02 | GENERAL NOTES - SHEET 2 OF 4 | A |
| 2325-74-03 | GENERAL NOTES - SHEET 3 OF 4 | A |
| 2325-74-04 | GENERAL NOTES - SHEET 4 OF 4 | A |
| 2325-74-05 | SAFETY IN DESIGN | A |
| 2325-74-06 | OVERALL PROJECT LAYOUT WITH EXISTING CONTOURS | A |
| 2325-74-07 | OVERALL PROJECT GEOLOGICAL MAP | A |
| 2325-74-08 | PROPOSED LAYOUT AND SITE INVESTIGATION PLAN | A |
| 2325-74-09 | TOE KEY AREA, BASAL AND UNDERFILL DRAINAGE PLAN | A |
| 2325-74-10 | STAGE 1.1 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-11 | STAGE 1.2 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-12 | STAGE 2 - LAYOUT - DRAINAGE BLANKET ARRANGEMENT | A |
| 2325-74-13 | STAGE 2.1 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-14 | STAGE 2.2 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-15 | STAGE 3 - LAYOUT - BUND AND MANAGED FILL ARRANGEMENT | A |
| 2325-74-50 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 1 | A |
| 2325-74-51 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 2 | A |
| 2325-74-52 | GEOLOGICAL AND PROPOSED FILL - CROSS SECTION 3 | A |
| 2325-74-53 | DEEP SUBSOIL DRAIN SECTIONS | A |
| 2325-74-101 | TYPICAL BUND AND MANAGED FILL ARRANGEMENT AND DETAIL | A |
| 2325-74-102 | TYPICAL DRAINAGE DETAILS | A |
| 2325-74-103 | DISPLACEMENT MONITORING LAYOUT | A |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

| Distribution | Number of Copies |
|---|---|
| GLEESON QUARRIES | 1 |
| | |
| | |

Reason for Issue: I

A = APPROVAL
B = AS BUILT
C = CONSTRUCTION
I = INFORMATION
P = PRELIMINARY
R = REQUESTED
T = TENDER
V = PEER REVIEW
X = PRICING
Y = CONSENT

DRAWING SIZE: A3

## GENERAL:

1. ALL THE DIMENSIONS ARE IN METERS UNLESS OTHERWISE STATED.
2. COORDINATE SYSTEM - HORIZONTAL: NZGD2000 MT EDEN CIRCUIT - VERTICAL DATUM: AUCKLAND VERTICAL DATUM 1946.
3. DO NOT SCALE OFF THESE DRAWINGS. ALL DIMENSIONS AND LEVELS SHALL BE VERIFIED PRIOR TO COMMENCING ANY WORK.
4. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DRAWING NOS. 2325-74-02 TO 2325-74-103 AND REPORT REFERENCE.: 2325-74-GQ-01.
5. THE CONTRACTOR SHALL ENSURE THAT THE LATEST REVISIONS OF DRAWINGS WHICH ARE ISSUED FOR CONSTRUCTION (IFC) ARE USED PRIOR TO COMMENCING ANY WORK.
6. THE CONTRACTOR SHALL UNDERTAKE WORKS ENSURING THAT ALL THE CONDITIONS OF THE RESOURCE CONSENT ARE ADHERED TO.
7. THE CONTRACTOR SHALL UNDERTAKE POSITIVE IDENTIFICATION OF UNDERGROUND AND OVERHEAD SERVICES PRIOR TO COMMENCEMENT OF ANY CONSTRUCTION WORKS.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF UNDERGROUND AND OVERHEAD SERVICES DURING CONSTRUCTION. THE CONTRACTOR'S CONSTRUCTION METHODOLOGY SHALL ACCOUNT FOR ANY EXISTING, NEW AND TEMPORARY SERVICES.
9. SHOULD THE PROPOSED EARTHWORKS OR DRAINAGE WORKS INTERFERE WITH EXISTING SERVICES THE SUPERVISING GEOTECHNICAL ENGINEER SHALL BE NOTIFIED PRIOR TO COMMENCEMENT OF WORKS.
10. THE CONSTRUCTION SPECIFICATIONS SHALL BE FOLLOWED FOR THE RELEVANT DESIGN ITEMS. WHERE DISCREPANCIES OCCUR, THE SUPERVISING GEOTECHNICAL ENGINEER SHALL BE NOTIFIED.
11. ALL TEMPORARY WORKS REQUIRE SPECIFIC DESIGN. TEMPORARY WORKS MUST NOT ADVERSELY AFFECT THE PERMANENT WORKS DESIGN.
12. PROPERTY BOUNDARIES SHOULD BE VERIFIED ONSITE PRIOR TO CONSTRUCTION BY A REGISTERED SURVEYOR.
13. HEALTH AND SAFETY OF ALL PEOPLE SHALL BE PRIORITISED DURING ALL ASPECTS OF THE CONSTRUCTION WORKS. ALL WORKS SHALL COMPLY WITH THE LATEST REVISIONS OF THE FOLLOWING DOCUMENTS:
    a. HEALTH AND SAFETY AT WORK ACT 2015,
    b. NEW ZEALAND BUILDING CODE INCLUDING F5: CONSTRUCTION AND DEMOLITION HAZARDS 1992,
    c. PROJECT HEALTH AND SAFETY PLANS.
14. ALL PERSONAL WORKING ON THE SITE MUST BE SAFETY INDUCTED AND HAVE THE RELEVANT AND CURRENT CERTIFICATES TO CARRY OUT THE CONSTRUCTION WORKS.

## EARTHWORKS CONSTRUCTION METHODOLOGY & SPECIFICATION:

**GENERAL**

1. ALL EARTHWORKS SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE REQUIREMENTS OF NZTA SPECIFICATIONS FOR EARTHWORKS CONSTRUCTION (NZTA F/1, NEW ZEALAND TRANSPORT AGENCY, 1997).
2. THE FOLLOWING STANDARDS AND SPECIFICATIONS ARE REFERENCED AND APPLICABLE TO THIS SPECIFICATION. THIS SPECIFICATION SHALL TAKE PRECEDENCE IF THERE IS ANY VARIANCE BETWEEN THE REFERENCED SPECIFICATIONS AND THIS SPECIFICATION:
    - SPECIFICATION FOR PIPE SUBSOIL DRAIN CONSTRUCTION (NZTA F/2, NEW ZEALAND TRANSPORT AGENCY, 2013);
    - SPECIFICATION FOR GEOTEXTILE WRAPPED AGGREGATE SUBSOIL DRAIN CONSTRUCTION (NZTA F/6, NEW ZEALAND TRANSPORT AGENCY, 2003);
    - SPECIFICATION FOR GEOTEXTILES (NZTA F/7:2003, NEW ZEALAND TRANSPORT AGENCY, 2003):
    - METHODS OF TESTING SOILS FOR CIVIL ENGINEERING PURPOSES (NZS 4402:1986, STANDARD NEW ZEALAND);
    - METHODS OF SAMPLING AND TESTING ROAD AGGREGATES (NZS 4407:2015, STANDARDS NEW ZEALAND);
    - GUIDELINES FOR HAND HELD SHEAR VANE TEST (NEW ZEALAND GEOTECHNICAL SOCIETY, 2001).
    - NEW ZEALAND BUILDING CODE (NZ B1 BUILDING CODE, MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT).
    - NZTA P39 STANDARD SPECIFICATION FOR HIGHWAY LANDSCAPE TREATMENTS (NZTA P39:2013)

**EROSION & SEDIMENT CONTROL**

1. THE CONTRACTOR IS RESPONSIBLE FOR THE ESTABLISHMENT OF TEMPORARY ENVIRONMENTAL AND SEDIMENT CONTROL MEASURES, INCLUDING EROSION PROTECTION AS REQUIRED IN ACCORDANCE WITH THE RESOURCE CONSENT CONDITIONS.
2. EROSION, SEDIMENT CONTROL PLAN WILL BE PREPARED BY SOUTHERN SKIES ENVIRONMENTAL LTD.

**ACCESS TO WORK SITES**

1. THE CONTRACTOR IS RESPONSIBLE FOR THE ESTABLISHMENT OF TEMPORARY TRAFFIC MANAGEMENT CONTROLS AND TEMPORARY CONSTRUCTION ACCESS TO SITE.
2. MAIN HAUL ROAD ACCESS IS AVAILABLE FROM THE EXISTING QUARRY HAUL ROADS AND TRACKS INTO FILL SITE 3.
3. ANY ADDITIONAL TRACK CUTTING OR ROAD FORMING REQUIRED TO ACCESS THE SITE SHALL BE REFERRED TO THE GEOTECHNICAL DESIGNER AND SUBJECT TO SPECIFIC GEOTECHNICAL DESIGN.

**SITE CLEARING, STRIPPING & TOPSOIL STRIPPING**

1. SITE CLEARING SHALL COMPRISE THE REMOVAL OF ALL MATERIALS THAT WILL NOT FORM PART OF THE DESIGN WITHIN THE EXTENT OF EARTHWORK AS SPECIFIED IN THE DRAWINGS.
2. STRIPPING, CLEARING AND TOPSOIL REMOVAL SHALL BE CARRIED OUT IN ACCORDANCE WITH THE PROJECT DEVELOPED MAATAURANGA MAAORI ENVIRONMENTAL MONITORING PLAN (MMEMP) .
3. RELIC ARCHAEOLOGICAL ITEMS OR HUMAN REMAINS MAY BE PRESENT WITHIN THE PROJECT SITE. THE CONTRACTOR MUST STOP WORK IMMEDIATELY AND NOTIFY THE POLICE, NEW ZEALAND HISTORIC PLACES TRUST, AND KAUMATUA REPRESENTING THE LOCAL TANGATA WHENUA. WORK SHALL NOT RECOMMENCE IN THE AFFECTED AREA UNTIL ANY NECESSARY STATUTORY AUTHORISATIONS OR CONSENTS HAVE BEEN OBTAINED.
4. TOPSOIL AND SURFICIAL ORGANIC SOILS SHALL BE REMOVED WITHIN THE LIMITS OF FILL AREAS IN ACCORDANCE WITH NZTA F/1 (1997). THE SITE SHALL BE CLEARED OF RUBBISH, DEBRIS, & WOODY VEGETATION PRIOR TO TOPSOIL STRIPPING.
5. CLEARING SHALL ALSO INCLUDE THE REMOVAL OF ALL ABANDONED PIPES AND SERVICES WITHIN THE EXTENT OF THE SITE.
6. TOPSOIL STOCKPILES SHALL NOT BE PLACED IN LOCATIONS WHERE THEY MAY CAUSE GROUND INSTABILITY. THE HEIGHT OF ANY TOPSOIL STOCKPILES SHALL NOT BE HIGHER THAN 2.5m HIGH, IF MORE THAN 2.5m HIGH PROCEED WITH AGREEMENT OF THE SUPERVISING GEOTECHNICAL ENGINEER. THE SURFACE OF THE STOCKPILE SHALL ALSO BE SHAPED TO PROVIDE FREE DRAINING OF STORMWATER. THE SIDE SLOPE SHALL BE NO STEEPER THAN 1.5H:1V TO AVOID EROSION.
7. ALL CUTS SHALL BE CARRIED OUT IN A SAFE MANNER. ALL TEMPORARY CUTS SHALL BE FORMED TO STABLE PROFILES BY THE CONTRACTOR TO ENSURE THE STABILITY OF SUCH SLOPES IS MAINTAINED DURING THE EARTHWORKS. ALL CUTS/EXCAVATIONS INTENDED FOR FILLING SHALL BE INSPECTED AND APPROVED BY THE SUPERVISING GEOTECHNICAL ENGINEER PRIOR TO BACK FILLING.
8. EXCAVATED AREAS SHALL BE FENCED OFF TO ELIMINATE ANY DANGER TO PERSON OR PROPERTY. THE CONTRACTOR SHALL ENSURE THAT APPROPRIATE MEASURES ARE USED AT ALL TIMES TO PROTECT WORKS AND MEMBERS OF THE PUBLIC FROM THE HAZARDS OF EXCAVATION.
9. ALL TEMPORARY STOCKPILE SURFACES SHALL BE SHAPED TO ELIMINATE PONDING AND INFILTRATION OF WATER INTO THE STOCKPILE. EROSION OF THE SOIL SURFACE SHALL BE AVOIDED.
10. EXCAVATIONS ARE LIKELY TO ENCOUNTER THE PERCHED GROUNDWATER TABLE WITHIN THE HISTORIC FILL. THE CONTRACTOR SHALL DEWATER AS NECESSARY TO CONTROL GROUNDWATER LEVELS WITHIN THE EXCAVATION. THE DEWATERING SYSTEM USED MUST PREVENT THE BASE AND SIDE OF THE EXCAVATION COLLAPSING DURING CONSTRUCTION. INSTALL TEMPORARY SHORING AS NECESSARY TO SUPPORT EXCAVATIONS.
11. THE PROPERTIES OF EARTHWORK MATERIALS IN THE PROJECT SITE ARE SENSITIVE TO WATER CONTENT CHANGES WITHIN THE SOILS ESPECIALLY IN WET WEATHER CONDITIONS OR DUE TO THE INFLUENCE OF THE GROUNDWATER. THEREFORE,
    - AT THE END OF EACH WORKING DAY OR WHEN WET WEATHER IS EXPECTED, ALL CUT AND FILL SURFACES SHALL BE GRADED TO DRAIN OFF WATER TO THE OUTSIDE OF THE EARTHWORK AREA.
    - THE EXPOSED SURFACES SHALL ALSO BE ROLLED AND SEALED BY A SMOOTH DRUM ROLLER TO MINIMISE THE STORMWATER EROSION AND INFILTRATION INTO THE SUBGRADE AND CAUSING DAMAGE BY THE WET WEATHER CONDITIONS.
    - FOLLOWING PERIODS OF WET WEATHER, ALL IN-SITU SOIL AND COMPACTED FILL WHERE THEIR STRENGTH IS SOFTENED TO BELOW THE STRENGTH REQUIREMENT AS SPECIFIED IN THIS SPECIFICATION SHALL BE REMOVED AND REPLACED WITH SUITABLY COMPACTED MATERIALS.
    - SUBJECT TO THE APPROVAL OF THE SUPERVISING GEOTECHNICAL ENGINEER, MATERIAL MAY BE RE-USED IF IT IS RE-TESTED AND RESULTS DEMONSTRATE THAT THE MATERIAL SATISFIES THE REQUIREMENTS OF THIS SPECIFICATION.
12. THE FINISHED SURFACES OF EARTHWORKS SHALL CONFORM TO THE LEVELS, LINES, GRADE AND CONTOURS SHOWN ON THE DESIGN DRAWINGS.
13. THE CONTRACTOR SHALL PROVIDE TEMPORARY WORKING PLATFORM AND FALL PROTECTION FENCING, WHERE REQUIRED.
14. UPON COMPLETION OF CONSTRUCTION WORKS, THE CONTRACTOR SHALL REMOVE ALL SURPLUS MATERIALS, SITE OFFICES AS WELL AS RUBBISH AND DEBRIS FROM THE SITE. THE PROJECT SITE SHALL BE THOROUGHLY CLEANED, GRASSED AND REPLANTED. REMOVED FENCING SHALL BE REPLACED.

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |

Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz

Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K.C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K.C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: GENERAL NOTES
SHEET 1 OF 4

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-01 Rev. A

## DEEP SUBSOIL AND COLLECTOR SUBSOIL DRAINS SPECIFICATION & CONSTRUCTION METHODOLOGY:

CARRIER AND COLLECTOR DRAINS SHALL BE CONSTRUCTED AS PER THE TYPICAL DESIGN DETAILS SHOWN ON THE DRAWINGS 2325-74-102 AND TO THE FOLLOWING CONSTRUCTION METHODOLOGY. ALL DRAINAGE PIPES AND INSTALLATION METHODOLOGY SHALL COMPLY WITH THE NZTA F2:2013 "SPECIFICATION FOR PIPE SUBSOIL DRAIN CONSTRUCTION" UNLESS SPECIFIED OTHERWISE WITHIN THIS SPECIFICATION OR DRAWINGS.

1. DEEP SUBSOIL DRAINAGE ALIGNMENTS ARE TO BE GUIDED BY THE SET-OUT POINTS GIVEN FOR THE DEEP SUBSOIL DRAIN SHOWN ON DRAWING 2325-74-09.
2. BUTTRESS CHIMNEY DRAIN TO BE INSTALLED UNDER TOE-KEY AS SHOWN ON DRAWING 2325-74-102.
3. COMPLETED MUCK-OUTS MUST BE INSPECTED BY THE SUPERVISING GEOTECHNICAL ENGINEER.
4. EXCAVATE TRENCH TO THE DIMENSIONS AND TARGET DEPTH AS DETAILED ON THE DRAWINGS.
5. THE EXCAVATION IS LIKELY TO ENCOUNTER PERCHED GROUNDWATER SEEPAGES. EXCAVATIONS SHALL BE DEWATERED, AS NECESSARY.
6. THE LENGTH OF TRENCH EXCAVATED SHALL BE LIMITED TO WHAT CAN BE SUCCESSFULLY COMPLETED IN ONE SHIFT
7. INSTALL TEMPORARY SHORING AS NECESSARY TO SUPPORT TRENCH SIDEWALLS FROM COLLAPSE.
8. PLACE 150mm THICK MODIFIED GAP65 (LESS THAN 4% FINES) DRAINAGE FILTER MATERIAL IN BASE OF EXCAVATION.
9. INSTALL 2x PUNCHED PE 160mm DIAMETER NEXUS HI-WAY GRADE DUAL WALL DRAINAGE COIL OVER THE PREPARED DRAINAGE FILTER BED FOR THE SECTION OF DRAIN.
10. COMPLETED DRAINS SHALL BE AS-BUILT BY THE CONSTRUCTION SURVEYOR AND INSPECTED BY THE SUPERVISING GEOTECHNICAL ENGINEER PRIOR TO BACKFILLING.
11. BACKFILL TRENCH WITH MODIFIED GAP65 DRAINAGE FILTER MATERIAL (LESS THAN 4% FINES) UP TO A THICKNESS OF 1.0m.
12. COMPACT MODIFIED GAP65 DRAINAGE FILTER MATERIAL WITH DIGGER BUCKET.
13. PLACE CHIMNEY DRAINS IN THE LOCATIONS SHOWN IN DRAWING 2325-74-09 AND 102.
14. BACKFILL THE REMAINDER OF THE TRENCH WITH SOIL SPOIL FROM THE EXCAVATION. PLACE BACKFILL IN 300mm LOOSE LIFTS AND COMPACT WITH DIGGER BUCKET.
15. DISPOSE OF WASTE CUT MATERIALS EITHER OFF SITE OR INTO THE MANAGED FILL.

## DRAINAGE BLANKET SPECIFICATION AND CONSTRUCTION METHODOLOGY:

1. DRAINAGE BLANKETS ARE TO BE PLACED IN THE LOCATIONS SHOWN ON DRAWINGS 2325-74-09 TO 102.
2. DRAINAGE BLANKET SUBGRADES ARE TO PREPARED SUCH THAT MINIMUM DRAINAGE GRADIENTS OF 1 TO 3% ARE ACHIEVED. DRAINAGE DIRECTION FOR EACH BLANKET IS INDICATED ON DRAWING 2325-74-101.
3. DRAINAGE BLANKET MATERIAL IS TO COMPRISE MODIFIED GAP65 DRAINAGE FILTER MATERIAL.
4. DRAINAGE BLANKET THICKNESS IS TO BE MINIMUM 0.4m AS MEASURED PERPENDICULAR FROM THE UNDERLYING SUBGRADE.
5. FINISHED DRAINAGE BLANKETS SHALL BE INSPECTED BY THE SUPERVISING GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF FILL MATERIAL.

## DRAINAGE FILTER MATERIAL SPECIFICATION:

THE DRAINAGE FILTER MATERIAL SHALL COMPLY WITH THE FOLLOWING MODIFIED GAP65 SPECIFICATION AND LIMITED FINES GRADING:

- THE AGGREGATE USED MUST BE MODIFIED GAP65 FREE FROM CLAY, ALL ORGANIC MATTER AND OTHER DELETERIOUS MATERIALS.
- MINIMUM CRUSHING RESISTANCE > 100KN IN ACCORDANCE WITH NZS4407 TEST 3.10 (CRUSHING RESISTANCE OF COARSE AGGREGATE UNDER SPECIFIED LOAD).
- WEATHERING RESISTANCE CA OR BETTER IN ACCORDANCE WITH NZS4407 TEST 3.11.
- THE DRAINAGE FILTER MATERIAL SHALL BE LIGHTLY COMPACTED BY THE BACK OF THE BUCKET OF A BACKHOE.
- THE PARTICLE SIZE DISTRIBUTION SHALL BE WITHIN THE LIMITS PRESENTED IN TABLE 1 BELOW.

TABLE 1: MODIFIED GAP65 DRAINAGE FILTER MATERIAL

| MODIFIED GAP65 | PERCENT PASSING (%) | |
|---|---|---|
| SIEVE SIZE (mm) | LOWER LIMIT | UPPER LIMIT |
| 63 | 100 | 100 |
| 37.5 | 80 | 90 |
| 19 | 50 | 70 |
| 9.5 | 30 | 55 |
| 4.75 | 20 | 40 |
| 2.36 | 15 | 30 |
| 1.18 | 10 | 22 |
| 0.6 | 6 | 18 |
| 0.3 | 4 | 14 |
| 0.15 | 2 | 10 |
| 0.075 | 0 | 4 |

## FILL PLACEMENT, BENCHING & COMPACTION:

1. MANAGED FILL (NON-STRUCTURAL) SHALL ONLY BE PLACED IN THE DESIGNED MANAGED FILL AREAS OF FILL SITE 3. NO MANAGED FILL CAN BE USED IN THE STRUCTURAL FILL AREAS.
2. THE COMPACTION REQUIREMENTS SHALL BE DETERMINED BY THE CONTRACTOR DEPENDING ON THE EQUIPMENT USED AND NUMBER OF PASSES REQUIRED TO ACHIEVE THE COMPACTION CRITERIA.
3. FILL TO BE PLACED ON EXISTING SLOPES STEEPER THAN 3H:1V SHALL BE BENCHED IN ACCORDANCE WITH NZTA EARTHWORKS SPECIFICATION F/1 PRIOR TO FILL COMMENCEMENT.
4. FOR BUND CONSTRUCTION FILL (STRUCTURAL FILL), EACH COMPACTION LAYER SHALL BE NO MORE THAN 200mm FOR COHESIVE FILL AND 300mm FOR NON-COHESIVE FILL LOOSE LIFT THICKNESS.
5. FOR MANAGED FILL (NON-STRUCTURAL), EACH SPREAD LOOSE LIFT SHALL BE NO MORE THAN 300mm. IF THE SPECIFIED COMPACTION REQUIREMENT CANNOT BE ACHIEVED THEN THE LOOSE LIFT THICKNESS SHALL BE REDUCED.
6. NO FILL SHALL BE PLACED OVER PREVIOUSLY PLACED FILL THAT:
   - HAS NOT ACHIEVED THE REQUIRED STANDARD OF THIS SPECIFICATION;
   - HAS BECOME CONTAMINATED OR UNFIT FOR USE AS ENGINEERED FILL;
   - HAS DETERIORATED FROM THE REQUIRED FILL STANDARDS; AND
   - HAS NOT BEEN TESTED BY THE CONTRACTOR TO DEMONSTRATE COMPLIANCE WITH THIS SPECIFICATION.
7. AT THE END OF EACH WORKING DAY, ALL EARTHWORK SURFACES SHALL BE SEALED WITH A GENTLE SLOPE TO MINIMISE THE POTENTIAL RISK OF STORMWATER INFILTRATION AND EROSION. ANY DAMAGE CAUSED BY SURFACE STORMWATER FLOWS SHALL BE REPAIRED BY TRIMMING BACK TO REMOVE ALL DISTURBED, LOOSE AND WET SOIL. APPROPRIATE BACKFILLING AND COMPACTION SHALL BE UNDERTAKEN TO SATISFY THE SPECIFICATION REQUIREMENTS.
8. AT THE BEGINNING OF EACH WORKING DAY, ALL COHESIVE STRUCTURAL FILL SURFACES FORMING STRUCTURAL BUNDS SHALL BE SCARIFIED/PAD FOOTED/DISCING TO A DEPTH OF AT LEAST 150mm THICK TO PROVIDE A BONDING LAYER PRIOR TO PLACING NEW FILL ABOVE FOR COMMENCEMENT COMPACTION.
9. FILL MUST BE RAISED IN APPROXIMATELY HORIZONTAL LAYERS STARTING AT THE LOWEST PART OF THE FILL SITE. AFTER COMPLETION OF COMPACTION, QUALITY CONTROL TESTING SHALL BE UNDERTAKEN WITHIN THE SAME DAY. THE COORDINATES, REDUCED LEVEL, MATERIAL TYPE OF THE TESTED MATERIAL SHALL BE RECORDED AND SUBMITTED TO SUPERVISING GEOTECHNICAL ENGINEER.
10. IN ORDER TO ENSURE ADEQUATE COMPACTION OF THE MATERIALS FORMING THE FINAL FILL SURFACE PROFILE AND TO PROVIDE A SAFE WORKING EDGE, ALL FILL BATTER FACES SHALL BE OVERFILLED AND COMPACTED TO ENSURE THAT THE COMPACTED FILL AT THE SLOPE EDGE SATISFIES THE SPECIFIED COMPACTION REQUIREMENT. SLOPE FACES SHALL THEN BE TRIMMED BACK TO THE REQUIRED DESIGN PROFILE.
11. VARIATION OF PROPERTIES IS EXPECTED FOR SITE WON MATERIALS. THE CONTRACTOR SHALL COLLECT SUFFICIENT MATERIAL SAMPLES FROM THE FIELD FOR LABORATORY COMPACTION TESTS, AS WELL AS COMPACTION FIELD TRIALS IN ADVANCE OF PLACEMENT TO DEFINE THE REPRESENTATIVE MAXIMUM DRY DENSITY (MDD), OPTIMUM WATER CONTENT, VANE SHEAR STRENGTH, AIR VOID, SOLID DENSITY, AND COMPACTION METHODS TO ACHIEVE THE STRUCTURAL FILL COMPACTION REQUIREMENTS AS PER TESTING AND CONSTRUCTION VERIFICATIONS SECTION.
12. PRIOR TO PLACEMENT OF ANY FILL, THE PREPARED SUBGRADE SHALL BE INSPECTED BY THE SUPERVISING GEOTECHNICAL ENGINEER.
13. PRIOR TO COMPACTION, THE FILL MATERIALS SHALL BE SPREAD UNIFORMLY IN HORIZONTAL LAYERS. THE MATERIALS SHALL BE UNIFORMLY CONDITIONED TO AN APPROPRIATE WATER CONTENT BY AERATION AND DRYING OR WETTING AND/OR BY BLENDING AND MIXING SUITABLE "WET" AND "DRY" MATERIALS. WHERE DRYING OF THE SOILS IS REQUIRED, THE CONSTRUCTOR SHALL DISC THE SOIL AND ALLOW IT TO DRY UNIFORMLY TO ITS FULL DEPTH BEFORE COMPACTION.
14. WHERE WETTING IS REQUIRED, THIS SHALL BE PERFORMED BY SPRINKLING EQUIPMENT ENSURING UNIFORM, CONTROLLED DISTRIBUTION OF WATER IN CONJUNCTION WITH BLADING AND DISCING.
15. IN ALL CASES, THE FILL SHALL BE MIXED AND CONDITIONED THOROUGHLY SO THAT IMMEDIATELY PRIOR TO COMPACTION THE MATERIAL TYPE AND THE WATER CONTENT OF THE FILL IS REASONABLY UNIFORM WITHIN THE AREA BEING WORKED.
16. THE CONSTRUCTOR SHALL DEVELOP AN APPROPRIATE WET WEATHER METHODOLOGY WHICH SHALL BE APPROVED BY THE SUPERVISING GEOTECHNICAL ENGINEER.

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |

Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz

Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K.C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K.C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: GENERAL NOTES
SHEET 2 OF 4

Project No. 2325/74
Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3
Drawing No. 2325-74-02 Rev. A

FILE LOCATION J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\74\2325-74-01_05.dwg
PLOT DATE:2021-07-23

## TESTING, COMPACTION CONTROL AND CONSTRUCTION VERIFICATIONS:

1. THE TESTING SCHEME, CONSTRUCTION VERIFICATIONS REQUIREMENTS AND CONSTRUCTION HOLD POINTS ARE PROVIDED BELOW AND ON THE DRAWINGS.

2. THE SUPERVISING GEOTECHNICAL ENGINEER SHALL BE NOTIFIED AT LEAST 72 HOURS IN ADVANCE FOR ANY INSPECTION OF CONSTRUCTION WORKS.

3. THE CONTRACTOR SHALL WORK WITH AND COOPERATE AS NECESSARY TO PERMIT THE SUPERVISING GEOTECHNICAL ENGINEER TO CONDUCT ANY INSPECTIONS AND TESTS REQUIRED WITH COMPLETE SAFETY AND ACCURACY OF TEST RESULTS. IF SO, REQUESTED THE CONTRACTOR SHALL REMOVE SURFACE LAYERS TO EXPOSE THE LEVEL AT WHICH INSPECTION AND/OR TESTING IS REQUIRED BY THIS SPECIFICATION.

4. THE CONTRACTOR IS RESPONSIBLE FOR THE ENGAGEMENT OF IANZ ACCREDITED TESTING LABORATORY AND THEY ARE RESPONSIBLE FOR ENSURING THE TESTING IS CARRIED OUT IN ACCORDANCE WITH THE TEST METHODS AND MINIMUM TESTING FREQUENCIES PRESENTED IN TABLE 2.

5. RESULTS OF THE TESTING SHALL BE SUBMITTED TO THE DESIGNER FOR APPROVAL AS SOON AS POSSIBLE FOLLOWING TESTING AND ONLY TESTING SUPERVISED AND CONDUCTED BY AN IANZ REGISTERED LABORATORY SHALL BE RECOGNISED BY THE DESIGNER.

6. WHERE TESTING OR INSPECTION OF THE FILL/DRAINAGE FILTER MATERIAL MATERIALS CONFIRMS THAT THE FILL/DRAINAGE FILTER MATERIAL DOES NOT MEET THE REQUIRED STANDARDS, THE MATERIAL IS TO BE EXCAVATED AND RE-WORKED REPLACED BY THE CONTRACTOR AND INSPECTED BY THE DESIGNER.

7. COMPLETION OF ADDITIONAL FILLING PRIOR TO INSPECTION AND APPROVAL IS UNDERTAKEN AT THE RISK OF THE CONTRACTOR. SHOULD THE INITIAL MATERIAL FAIL TO MEET THE REQUIRED STANDARDS, ALL MATERIALS ABOVE THIS FILL WILL ALSO REQUIRE EXCAVATION, RE-WORKING AND RE-COMPACTION.

8. COMPACTION CONTROL OF COHESIVE STRUCTURAL FILL
   - PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL COLLECT SUFFICIENT SAMPLE OF THE STRUCTURAL FILL FOR LABORATORY TESTING. THE FOLLOWING TESTS WILL BE REQUIRED PRIOR AND DURING PLACEMENT:
   - NZS4402:TEST 2.1 - DETERMINATION OF THE WATER CONTENT
   - NZS4402:TEST 4.1.1 - NZ STANDARD COMPACTION TEST WITH SHEAR VANE TESTING
   - NZS4402:TEAT 4.1.2 - NZ HEAVY COMPACTION TEST
   - FIELD CONTROL FOR COHESIVE MATERIALS SHALL BE BY AIR VOIDS, FIELD DENSITY AND UNDRAINED SHEAR STRENGTH CRITERIA, MEASURED USING LABORATORY WATER CONTENT TESTING, FIELD NUCLEAR DENSOMETER AND HANDHELD SHEAR VANE.
   - TESTING SHALL BE UNDERTAKEN IN ACCORDANCE WITH TABLE 2, WITH THE LOCATION AND LEVEL OF EACH TEST RECORDED FOR REPORTING. TABLE 2 PROVIDES THE MINIMUM COMPACTION CONTROL CRITERIA

9. COMPACTION CONTROL OF NON-COHESIVE STRUCTURAL FILL
   - PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL COLLECT SUFFICIENT SAMPLE OF THE THE STRUCTURAL FOR LABORATORY TESTING. THE FOLLOWING TESTS WILL BE REQUIRED PRIOR AND DURING PLACEMENT:
   - NZS4402:TEST 2.1 - DETERMINATION OF THE WATER CONTENT
   - NZS4402:TEAT 4.1.2 - NZ HEAVY COMPACTION TEST
   - FIELD CONTROL FOR COMPACTION OF NON-COHESIVE STRUCTURAL FILL SHALL BE BY COMPACTED FIELD DRY DENSITY USING NUCLEAR DENSOMETER.
   - TESTING SHALL BE UNDERTAKEN IN ACCORDANCE WITH TABLE 2, WITH THE LOCATION AND LEVEL OF EACH TEST RECORDED FOR REPORTING. TABLE 2 PROVIDES THE MINIMUM COMPACTION CONTROL CRITERIA.

10. COMPACTION CONTROL OF MANAGED FILL
    - FIELD CONTROL AND VERIFICATION OF NON-STRUCTURAL MANAGED FILL MATERIAL IS THROUGH PROOF ROLLING.

TABLE 2: EARTHWORK SPECIFICATION TESTING FREQUENCY & REQUIREMENTS

| FILL TYPE | TEST PARAMETER | LABORATORY TEST/ TEST METHOD | FREQUENCY OF TEST | ACCEPTANCE CRITERIA |
|---|---|---|---|---|
| NON-STRUCTURAL FILL - MANAGED FILL | DEFORMATION - FILL CONDITION | TRAFFICABILITY | CONTINUOUS FIELD OBSERVATION AND RECORDING AND PROOF ROLLING AS REQUIRED BY SUPERVISING GEOTECHNICAL ENGINEER | BULLDOZER SHALL BE ABLE TO EASILY TRAFFIC THE MANAGED FILL AND WORK THE MATERIAL WITHOUT SINKING |
| COHESIVE STRUCTURAL FILL - CONTAINMENT BUNDS | WATER CONTENT | NZS4402:1986 TEST 2.1 – DETERMINATION OF WATER CONTENT | 1 TEST PER 400m³ OF COMPACTED FILL | NA |
| | STRENGTH - VANE SHEAR STRENGTH | NZGS 2001 GUIDELINE FOR HANDHELD SHEAR VANE TEST | 1 SET (3 POINTS) PER 400m³ PLACED WITH A MIN OF 2 TESTS FOR EACH AREA WORKED EACH DAY AND NO MORE THAN EVERY 0.5m THICKNESS OF FILL PLACED | AVERAGE MINIMUM Su ≥ 135 kPa SITE-WON FROM OVERBURDEN SOIL NO SINGLE TEST LESS THAN 120kPa |
| | COMPACTED IN-SITU AIR VOIDS | NZS 4407:2015 TEST 4.2 NUCLEAR MOISTURE-DENSITY GAUGE (NDM) DIRECT TRANSMISSION MODE | 1 SET (3 POINTS) PER 400³ PLACED WITH A MIN OF 2 TESTS FOR EACH AREA WORKED EACH DAY AND NO MORE THAN EVERY 0.5m THICKNESS OF FILL PLACED. ONE SOIL SAMPLE AND SHEAR VANE TEST POINT SHALL BE TAKEN DIRECTLY BENEATH NDM TEST LOCATION FOR LABORATORY WATER CONTENT TEST FOR CALCULATION OF AIR VOID.) | ≤ 7% AIR VOIDS |
| | NZ HEAVY COMPACTION CURVE - DETERMINE AIR VOIDS AND VANE SHEAR STRENGTH AT A RANGE OF MOISTURE CONTENT; ALSO MDD, OWC, SOLID DENSITY | NZS 4402:1986 TEST 4.1.2 - NZ HEAVY COMPACTION TEST<br>NZS 4402:1986 TEST 2.1 & 2.7.2 | 1 SET (5 POINTS) PER MATERIAL TYPE AND SOURCE THEN 1 TEST PER 5000m³ FOR THAT MATERIAL TYPE AND SOURCE | NA |
| NON-COHESIVE STRUCTURAL FILL (BROWN ROCK) - STRUCTURAL BUNDS | PARTICLE SIZE DISTRIBUTION | VISUAL CHECK | ALL MATERIAL PLACED | NO PARTICLES LARGER THAN 200mm |
| | | LABORATORY PARTICLE SIZE DISTRIBUTION (NZS4402:TEST 2.8.1) | 1 TEST PER 5000m³ OF SOURCE MATERIAL | OF PARTICLE PASSING 65mm SIEVE: NO ORGANIC CONTENT; AND <4% PASSING 75μm SIEVE |
| | DEFORMATION - FILL CONDITION | PROOF ROLL - NZTA F1 FULLY LOADED TRUCK WITH AT LEAST 8-TONNES PER AXLE OR EQUIVALENT APPROVED | CONTINUOUS FIELD OBSERVATION AND RECORDING AND PROOF ROLLING AS REQUIRED BY SUPERVISING ENGINEER | NO MORE THAN 5mm ELASTIC DISPLACEMENT UNDER WHEEL LOADING |
| | IN-SITU DENSITY, IN-SITU COMPACTED DRY DENSITY, IN-SITU WATER CONTENT | NZS 4407:2015 TEST 4.3 NUCLEAR MOISTURE-DENSITY GAUGE (NDM) BACKSCATTER MODE | 1 SET (1 POINT) PER 400m³ PLACED WITH A MIN. OF 2 TESTS FOR EACH AREA WORKED EACH DAY AND NO MORE THAN EVERY 0.5m THICKNESS OF FILL PLACED | ≥ 95% OF MDD (NZ HEAVY COMPACTION TEST 4.1.2) |
| | CRUSHING RESISTANCE | NZS4407:2015 - TEST 3.10 THE CRUSHING RESISTANCE OF COARSE AGGREGATE UNDER A SPECIFIED LOAD | 2 TESTS PER MATERIAL PER SOURCE MATERIAL | 100kN (MIN) |
| | WEATHERING RESISTANCE | NZS4407:2015 - TEST 3.11 THE WEATHERING QUALITY INDEX OF COARSE AGGREGATE | 2 TESTS PER MATERIAL PER SOURCE MATERIAL | CA OR BETTER |
| MODIFIED GAP65 DRAINAGE FILTER MATERIAL | CRUSHING RESISTANCE | NZS4407:2015 – TEST 3.10 THE CRUSHING RESISTANCE OF COARSE AGGREGATE UNDER A SPECIFIED LOAD | 3 PER SOURCE THEN 1 PER 5000m³ | 100kN (MIN) |
| | WEATHERING RESISTANCE | NZS4407:2015 – TEST 3.11 THE WEATHERING QUALITY INDEX OF COARSE AGGREGATE | 2 TESTS PER MATERIAL PER SOURCE MATERIAL | CA OR BETTER |
| | PARTICLE SIZE DISTRIBUTION/GRADING (PSD) | NZS4407:2015 – TEST 3.8 PARTICLE SIZE DISTRIBUTION | 3 PER SOURCE THEN 1 PER 1000m³ | REFER TO TABLE 1 |

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| A | 23/07/21 | ISSUED FOR INFORMATION |

Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz

Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K.C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K.C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: GENERAL NOTES
SHEET 3 OF 4

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-03 Rev. A

PLOT DATE:2021-07-23

FILE LOCATION J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\74\2325-74-01_05.dwg

## GEOTECHNICAL INSPECTIONS:

1. THE CONTRACTOR SHALL INFORM THE SUPERVISING GEOTECHNICAL ENGINEER FOR VERIFICATION OF THE ACTUAL GROUND CONDITIONS WITH THOSE ASSUMED IN THE DESIGN (REFER TO HOLD POINTS SECTION).

2. THE CONTRACTOR SHALL PROVIDE AT LEAST 72 HOURS ADVANCE NOTICE TO THE SUPERVISING GEOTECHNICAL ENGINEER FOR PREPARATION OF GEOTECHNICAL INSPECTIONS IN THE PROJECT. GEOTECHNICAL INSPECTION FOR THE FOLLOWING WORKS SHALL BE REQUIRED:

   - SITE CLEARING;
   - ALL FOUNDATION SUBGRADES FOR CUT, FILL AND DRAINAGE;
   - ALL SUBSOIL DRAINAGE INSTALLATIONS. ALL WORKS SHALL BE SUBJECTED TO APPROVAL BY THE SUPERVISING GEOTECHNICAL ENGINEER PRIOR TO COVERING WITH FILL;
   - CUT SIDE SLOPE IF REQUIRED AND SPECIFICALLY DESIGNED;
   - FILLING SPEED RESTRICTION AT INSTABILITY PRONE AREAS IF IDENTIFIED;
   - TEMPORARY EXCAVATIONS;
   - UNDERFILL DRAINS AND DRAINAGE BLANKETS;
   - EMBANKMENT FILL CONSTRUCTION;
   - IN PROCESS INSPECTION OF FILL MATERIALS;

3. THE SUPERVISING GEOTECHNICAL ENGINEER WILL UNDERTAKE REGULAR INSPECTION OF FILL COMPACTION. THE CONTRACTOR SHALL PROVIDE SAFE ACCESS FOR SUPERVISING GEOTECHNICAL ENGINEER TO CARRY OUT THEIR INSPECTION WORKS. THE FOLLOWING SECTION PRESENTS THE HOLD POINTS.

## HOLD POINTS:

THE SUPERVISING GEOTECHNICAL ENGINEER SHALL BE GIVEN A MINIMUM OF 72 HOURS NOTIFICATION OF THE FOLLOWING ITEMS FOR INSPECTION/REVIEW AND APPROVAL, PRIOR TO PROGRESSING WITH THE NEXT ELEMENT OF WORK. ALL OTHER PARTS SHALL BE GIVEN NOTICE AND/OR REQUIRED ITEMS AS STIPULATED IN THE RESOURCE CONSENT CONDITIONS FOR LUC0176/20.

1. APPROVAL AND SUPERVISION AS REQUIRED BY THE RESOURCE CONSENT CONDITIONS FOR TOPSOIL REMOVAL AND STRIPPING.

2. PRE-START MEETING INVOLVING WAIKATO DISTRICT COUNCIL, IWI REPREENTATIVES, CONTRACTOR AND THE SUPERVISING GEOTECHNICAL ENGINEER PRIOR TO WORK COMMENCEMENT.

3. ACCEPTANCE OF THE EROSION AND SEDIMENT CONTROL PLAN AND THE INSTALLED EROSION AND SEDIMENT CONTROL BY THE WAIKATO DISTRICT COUNCIL.

4. ACCEPTANCE OF THE QUARRY MANAGEMENT PLAN BY THE WAIKATO DISTRICT COUNCIL.

5. CONTRACTOR'S CONSTRUCTION AND QA METHODOLOGY FOR EACH ELEMENT OF WORKS (EARTHWORKS MANAGEMENT PLAN)
   a. THE EARTHWORKS MANAGEMENT PLAN IS TO COVER ALL ITEMS LISTED IN THE RESOURCE CONSENT CONDITIONS;
   b. REVIEW OF CONTRACTOR'S CONSTRUCTION METHODOLOGY (WORK INSTRUCTION DOCUMENT);
   c. REVIEW OF CONTRACTOR'S METHODOLOGY ON TESTING, INSPECTION, AND HOLD POINTS (INSPECTION AND TESTING PLAN).

6. VERIFICATION OF DEEP SUBSOIL DRAIN INSTALLATION.
   a. INSPECTION OF THE PREPARED SUBSOIL DRAINAGE TRENCHES OR SECTIONS OF BEFORE PLACING BEDDING AND DRAINAGE COILS.

7. VERIFICATION OF STRIPPED SUBGRADE CONDITIONS PRIOR TO PLACING DRAINAGE BLANKET AND/OR FILL MATERIAL.
   a. VISUAL INSPECTION OF THE BASE OF THE TOPSOIL AND UNSUITABLE MATERIAL STRIPPED SURFACE.
   b. VISUAL INSPECTION OF THE TOE-BUND EXCAVATION PRIOR TO FILLING.
   c. CONFIRMATION OF MINIMUM GRADING REQUIREMENTS FOR DRAINAGE BLANKET SUBGRADE.

8. PLACEMENT OF SUBSOIL DRAINAGE LINES PRIOR TO BACK FILLING
   a. VISUAL INSPECTION THE INSTALLATION OF SUBSOIL DRAINS WITHIN THE BASE OF THE EXCAVATION.
   b. VISUAL INSPECTION OF THE CONNECTION BETWEEN THE PIPES WHERE REQUIRED.

9. VERIFICATION OF FINISHED SUB-STAGE SURFACES PRIOR TO PLACEMENT OF SUBSEQUENT DRAINAGE BLANKET LAYER.

## DISPLACEMENT MONITORING NOTES:

1. ALL DISPLACEMENT MONITORING LOCATIONS TO BE INSTALLED ON SITE HAS BEEN SPECIFIED ON THE DRAWING 2325-74-103.

2. DISPLACEMENT MARKERS SHALL BE INSTALLED AS THE FILL IS CONSTRUCTED AT THE EARLIEST OPPORTUNITY. THIS MEANS DISPLACEMENT MARKERS WILL BE INSTALLED PROGRESSIVELY WITH THE COMPLETION OF EACH FILL SUB-STAGE.

3. ALL DISPLACEMENT MARKERS SHALL BE CLEARLY MARKED AND CORDONED OFF FROM CONSTRUCTION TRAFFIC.

4. DISPLACEMENT MARKERS SHALL ONLY BE REMOVED WHERE DIRECTED BY DESIGNER.

5. WHERE DISPLACEMENT MONITORING MARKERS ARE DAMAGED, THEY SHALL BE REPLACED IMMEDIATELY.

6. THE SUPERVISING GEOTECHNICAL ENGINEER IS TO BE NOTIFIED AT THE EARLIEST OPPORTUNITY IF THE ALERT LEVEL DESCRIBED IN TABLE 3 IS REACHED.

7. MONITORING IS TO BE PROVIDED BY A REGISTERED SURVEYOR AT THE FREQUENCY DESCRIBED IN TABLE 3.

TABLE 3: DISPLACEMENT MARKER MONITORING FREQUENCY

| MONITORING POINT TYPE | LOWER LIMIT | UPPER LIMIT |
|---|---|---|
| DISPLACEMENT MARKER - STEEL WARATAH FENCING STANDING | MONTHLY, INCREASE TO WEEKLY IF ALERT TRIGGER LEVEL IS EXCEEDED | 100mm NET LATERAL DISPLACEMENT OF STRUCTURAL FILL |
| | | 100mm NET VERTICAL DISPLACEMENT OF STRUCTURAL FILL |

MONITORING FREQUENCY MAY BE REVISED DURING CONSTRUCTION DUE TO OBSERVED DISPLACEMENTS.

## SUBMITTALS:

THE CONTRACTOR SHALL PREPARE AN EARTHWORKS MANAGEMENT PLAN IN COMPLIANCE WITH RESOURCE CONSENT CONDITIONS WORK PLAN PRIOR TO THE START OF THE WORKS. IN ADDITION TO THE REQUIREMENTS OF THE RESOURCE CONSENT CONDITIONS, THE WORK PLAN SHALL ALSO INCLUDE THE FOLLOWING ITEMS:

1. A PROGRAMME IN SUFFICIENT DETAIL TO IDENTIFY THE MAJOR PORTIONS OF THE WORKS AND RELATED ACTIVITIES. START DATES SHALL BE IDENTIFIED.

2. A DETAILED QUALITY CONTROL PLAN DESCRIBING THE METHODS OF CONSTRUCTION, TEST METHODS, INSPECTIONS REQUIRED AND STANDARDS TO BE APPLIED TO MEASURE THE PROGRESS AND QUALITY OF THE WORK DURING CONSTRUCTION. THE QUALITY CONTROL PLAN IS TO BE SUBMITTED FOR APPROVAL BY THE DESIGNER AT LEAST 20 DAYS PRIOR TO THE START OF THE WORKS. NO WORKS SHALL BE COMMENCED PRIOR TO THE RECEIPT OF WRITTEN ACCEPTANCE OF THE WORK PLAN FROM THE DESIGNER (DESIGN HOLD POINT 1).

3. DETAILED METHOD STATEMENTS AND DETAILS OF CONSTRUCTION ACTIVITIES INCLUDING BUT NOT LIMITED TO:

   a. SITE INSTALLATION AND WORKING AREAS,
   b. PLANT AND EQUIPMENT INCLUDING LOADING AND PROPOSED AREAS OF WORK FOR EACH PIECE OF EQUIPMENT,
   c. CONTROL PROCEDURES,
   d. WORKING DOCUMENTS SUCH AS LAYOUT, DRAWINGS, REPORTS,
   e. SAFETY AND ENVIRONMENTAL RISK ASSESSMENT,
   f. SET OUT METHODOLOGY.

## AS-BUILT RECORDS & DRAWINGS:

A SET OF AS-BUILT RECORDS AND DRAWINGS ARE TO BE COMPILED DETAILING ALL QUALITY CONTROL AND MEASUREMENT DATA, AND FINAL CONSTRUCTION COORDINATES AND LAYOUTS. AS-BUILT RECORDS SHALL INCLUDE THE FOLLOWING ITEMS:

1. LOCATION AND EXTENTS OF INSTALLED SUBSOIL DRAINS.

2. ACCEPTANCE TESTING OF BACK FILL FOR DRAINAGE AND EARTHWORKS MATERIAL.

3. RECORDS OF MATERIAL TESTING AS PER THE TESTING SPEC.

4. EVIDENCE OF DESIGNER HOLD POINTS.

THE CONTRACTOR SHALL OBTAIN ANY NECESSARY CONSENTS REQUIRED FOR WORKS. THE CONTRACTOR SHALL PROVIDE A COPY OF THE CONSTRUCTION PRODUCER STATEMENT (PS3) AND A CONSTRUCTION CERTIFICATE AS GIVEN IN ANNEX A2 OF THE NZTA HIGHWAY STRUCTURES DESIGN GUIDE 1ST EDITION ON COMPLETION OF THE CONSTRUCTION OF EACH PART OF THE WORKS.

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| A | 23/07/21 | ISSUED FOR INFORMATION |

Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz

Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K.C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K.C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES FILL 3 AREA

Drawing Title: GENERAL NOTES SHEET 4 OF 4

Project No. 2325/74

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-04 Rev. A

PLOT DATE:2021-07-23

FILE LOCATION J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\74\2325-74-01_05.dwg

# SAFETY IN DESIGN INFORMATION

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING SET, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS.

| | |
|---|---|
| **INVESTIGATION & DESIGN** | |
| WORKING AT HEIGHTS OR DEPTH | FALLING RISK ABOVE EXCAVATIONS, EMBANKMENTS AND TEMPORARY CUT SLOPES - INSTALL FALL RESTRAINTS / HANDRAILS TO PROTECT ANY MAINTENANCE OR INSPECTION PERSONNEL. PROVIDE SAFETY HARNESS AND AVOID STANDING TOO CLOSE TO CUTTING EDGES. |
| **SETUP, CONSTRUCTION & COMMISSIONING** | |
| WORKING AT HEIGHTS OR DEPTH | EXCAVATION, EMBANKMENTS AND TEMPORARY CUT SLOPES - INSTALL FALL RESTRAINTS / HANDRAILS TO PROTECT ANY MAINTENANCE OR INSPECTION PERSONNEL. |
| MOBILE PLANT & EQUIPMENT | WORKING AROUND MOBILE PLANT AND EQUIPMENT COULD RESULT IN INJURY - WEAR REQUIRED & SUITABLE PPE AT ALL TIMES. MAINTAIN AWARENESS OF PLANT LOCATION AND MOVEMENT. USE AN OBSERVER IF WORK INVOLVES BENDING OVER (WRITING, NOTES, TAKING PHOTOGRAPHS OR SOIL/ROCK SAMPLING) WHERE THE PLANT IS OPERATING. |
| INSTABILITY | UNSTABLE GROUND COULD RESULT IN SLIPS AND INJURIES DURING CONSTRUCTION - CARRY OUT ONGOING GEOLOGICAL HAZARD MAPPING AND GEOTECHNICAL MONITORING OF THE SITE. CARRY OUT PRE-WORK INSPECTIONS. CARRY OUT DRONE SURVEY AND ONGOING RISK-BASED HAZARD ASSESSMENT. POSITION SITE FACILITIES AND ACCESSES IN LOW RISK AREAS. |
| | RISK OF LOCAL SLOPE FAILURE IN EMBANKMENT CUT - DESIGN OF FILL EMBANKMENTS TO ACHIEVE APPROPRIATE FACTORS OF SAFETY. RISK OF LOCAL SLOPE FAILURES TO BE MANAGED DURING CONSTRUCTION WITH SITE DRAINAGE, GRASSING, PLANTING ETC TO PROTECT FILL SLOPE. |
| | THE EXCAVATIONS FOR COUNTERFORT TRENCHES ARE EXPECTED TO ENCOUNTER SATURATED GROUND BELOW THE GROUNDWATER TABLE. TEMPORARY SHORING SHOULD BE USED TO SUPPORT THE SIDE WALLS OF EXCAVATIONS AND TO PREVENT POTENTIAL COLLAPSE. PERSONAL NOT TO ENTER ANY EXCAVATIONS WITHOUT APPROPRIATE TEMPORARY SHORING. |
| STABILITY OF TEMPORARY WORKS | COULD CAUSE COLLAPSE AND HARM TO WORKERS - CARRY OUT TEMPORARY WORKS DESIGN PRIOR TO CONSTRUCTION BY SUITABLY QUALIFIED ENGINEER. ENSURE ONGOING REGULAR OBSERVATIONS AND MONITORING OF TEMPORARY WORKS BY AN EXPERIENCED GEOTECHNICAL ENGINEER. |
| EXCAVATION | EXCAVATION RESULTS IN REMOVAL OF MATERIAL TO GREATER THAN 1.5M DEPTH - STAGING OF EXCAVATIONS TO MINIMISE EXPOSED CUT FACE. INVESTIGATE USE OF REMOTELY OPERATED EQUIPMENT. |
| GROUND CONDITIONS | GROUND CONDITIONS ENCOUNTERED ON SITE COULD DIFFER FROM EXPECTED. ADOPT RISK FOCUSSED APPROACH WHEN PLANNING GEOTECHNICAL INVESTIGATIONS. CARRY OUT ONGOING GEOTECHNICAL INSPECTIONS OF CUT FACES. CARRY OUT FURTHER DESIGN WORK AS REQUIRED TO SUIT GROUND CONDITIONS ENCOUNTERED ON SITE. |
| WORKING CLOSE TO LIVE TRAFFIC | APPROPRIATE TRAFFIC MANAGEMENT TO BE ESTABLISHED. |
| INJURY TO PERSONNEL WORKING AROUND OPEN EXCAVATIONS | EXCAVATED AREAS SHOULD HAVE BARRIERS AROUND THEM FOLLOWING EXCAVATION. CONSTRUCTION METHODOLOGY SHOULD BE STAGED TO MINIMISE THE NUMBER OF AREAS OF EXPOSED AT ANY ONE TIME. |
| WORKING AT HEIGHTS ADJACENT TO SLOPES | TEMPORARY FENCING INSTALLED TO ISOLATE THE HAZARD AND PREVENT PERSONNEL FROM FALLING. |
| ALL SOIL AND ROCK EXCAVATIONS | SHOULD BE INSPECTED BY AN EXPERIENCED GEOTECHNICAL ENGINEER /ENGINEERING GEOLOGIST PRIOR TO ANY PERSONNEL WORKING NEAR OR IN THEM, TO ASSESS THE RISK OF INSTABILITY AND TO PROVIDE ADVICE ON ANY SUPPORT MEASURES REQUIRED. ALL TEMPORARY WORKS NEED TO BE DESIGNED AND/OR CHECKED BY A SUITABLY QUALIFIED GEOTECHNICAL ENGINEER PRIOR TO CONSTRUCTION. |
| WORKING ON SOFT MANAGED FILL | MANAGED FILL MAY BE SOFT ENOUGH FOR EQUIPMENT AND PERSONAL TO SINK INTO. MANAGED FILL SHALL NOT BE PLACED IN PERMANENT POSITION UNLESS THE TRAFFICABILITY REQUIREMENTS ARE MET VIA CONDITIONING BY EXPERIENCED OPERATORS AS REQUIRED. |
| STRIKING UNDERGROUND OR OVERHEAD SERVICES | ALL ASPECTS OF THE EARTHWORKS MANAGEMENT PLAN COVERING TRANSPOWER ASSETS MUST BE FOLLOWED. |
| **MAINTENANCE & OPERATION** | |
| CCTV CHECKS AND FLUSHING OF SUBSOIL DRAINS.<br>ONGOING SLOPE MONITORING VIA REGULAR SURVEYING OF DEFORMATION SURFACE MONITORING MARKERS. | |
| **DISPOSAL** | |
| DECOMMISSION / REMOVAL OF ENGINEERED FILLS AND MODIFICATION OF CUT SLOPES | COULD RESULT IN COLLAPSE OF SLOPES AND EMBANKMENTS INJURING WORKERS OR DAMAGING ADJACENT INFRASTRUCTURE - TEMPORARY WORKS DESIGN AND SPECIFIC CONSTRUCTION METHODOLOGY WILL BE REQUIRED. OBTAIN ALL REQUIRED APPROVALS PRIOR TO COMMENCING ANY WORKS. |

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |

Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz

Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K.C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K.C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

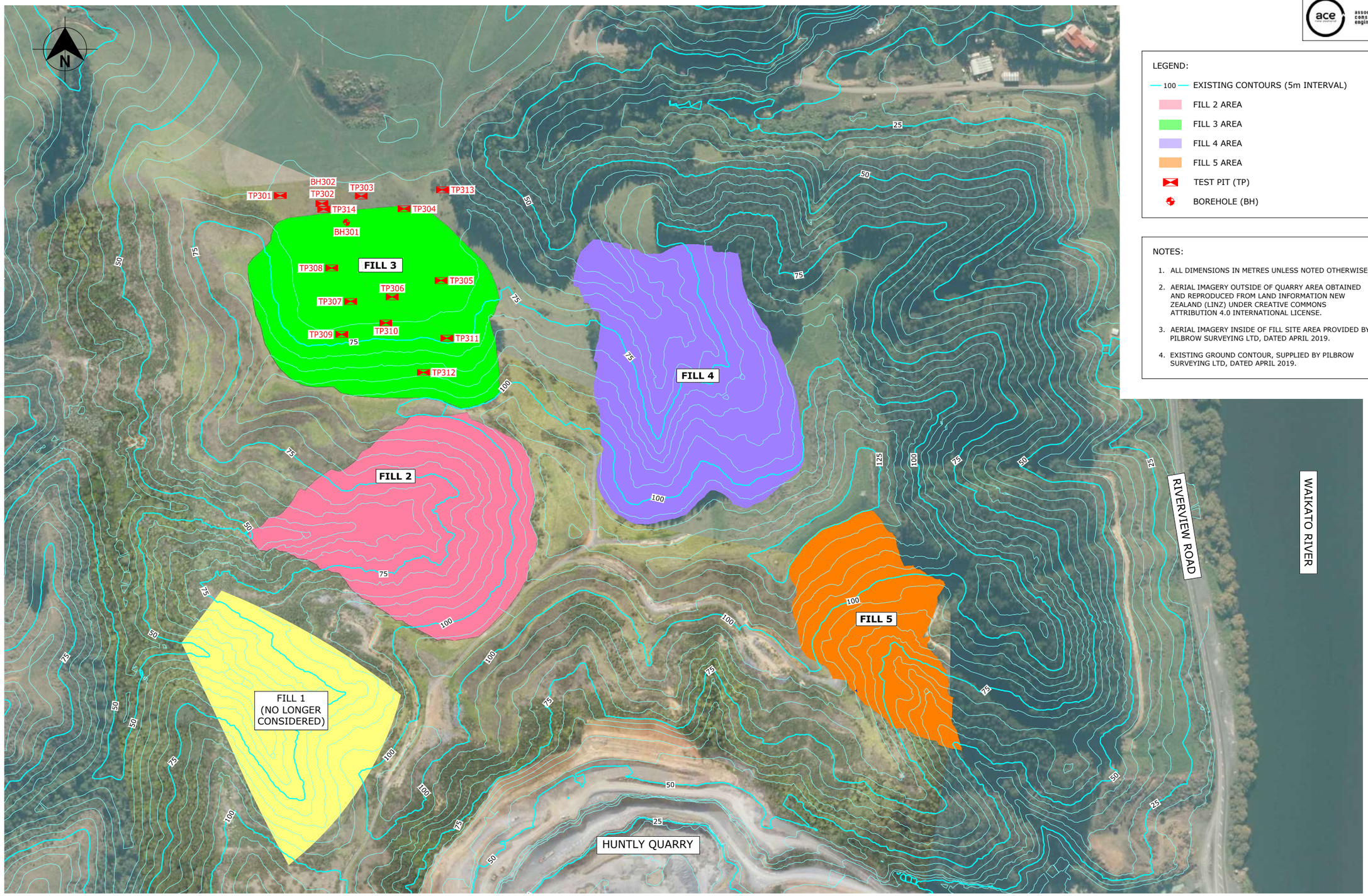
Drawing Title: SAFETY IN DESIGN

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-05 Rev. A

FILE LOCATION J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\74\2325-74-01_05.dwg PLOT DATE:2021-07-22




LEGEND:

- 100 EXISTING CONTOURS (5m INTERVAL)
- FILL 2 AREA
- FILL 3 AREA
- FILL 4 AREA
- FILL 5 AREA
- TEST PIT (TP)
- BOREHOLE (BH)

NOTES:

1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL IMAGERY OUTSIDE OF QUARRY AREA OBTAINED AND REPRODUCED FROM LAND INFORMATION NEW ZEALAND (LINZ) UNDER CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENSE.
3. AERIAL IMAGERY INSIDE OF FILL SITE AREA PROVIDED BY PILBROW SURVEYING LTD, DATED APRIL 2019.
4. EXISTING GROUND CONTOUR, SUPPLIED BY PILBROW SURVEYING LTD, DATED APRIL 2019.

# OVERALL PROJECT LAYOUT WITH EXISTING CONTOURS

SCALE 1:4000 (A3)

ORIGINAL IN COLOUR

1:2000@ A1
1:4000@ A3
0 20 40 60 80 100 120 140 160 180 200 m

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

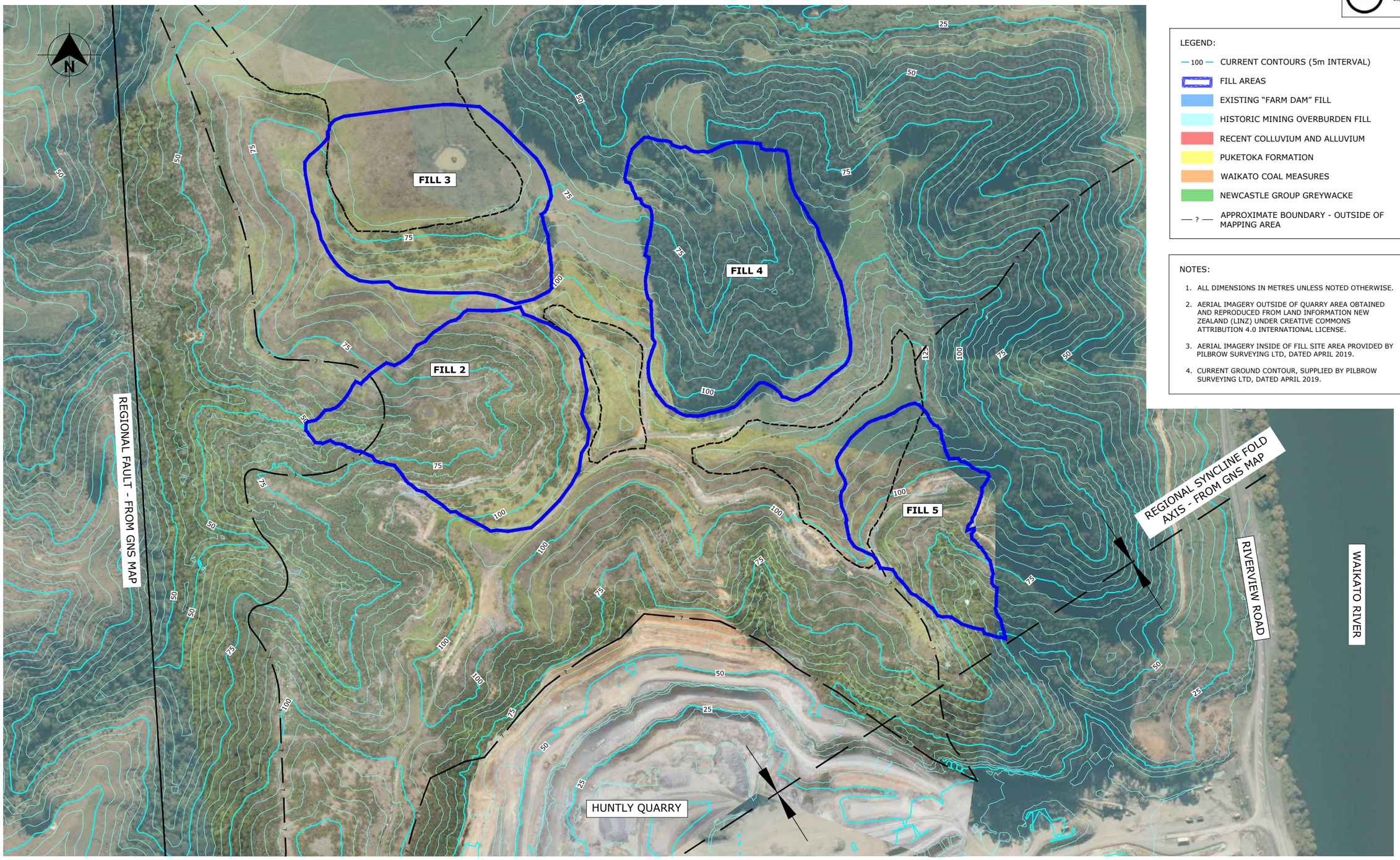
Drawing Title: OVERALL PROJECT LAYOUT
WITH EXISTING CONTOURS

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-06 Rev. A

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\74\2325-74-06.dwg
PLOT DATE: 2021-07-22




LEGEND:

- 100 — CURRENT CONTOURS (5m INTERVAL)
- FILL AREAS
- EXISTING "FARM DAM" FILL
- HISTORIC MINING OVERBURDEN FILL
- RECENT COLLUVIUM AND ALLUVIUM
- PUKETOKA FORMATION
- WAIKATO COAL MEASURES
- NEWCASTLE GROUP GREYWACKE
- — ? — APPROXIMATE BOUNDARY - OUTSIDE OF MAPPING AREA

NOTES:

1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL IMAGERY OUTSIDE OF QUARRY AREA OBTAINED AND REPRODUCED FROM LAND INFORMATION NEW ZEALAND (LINZ) UNDER CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENSE.
3. AERIAL IMAGERY INSIDE OF FILL SITE AREA PROVIDED BY PILBROW SURVEYING LTD, DATED APRIL 2019.
4. CURRENT GROUND CONTOUR, SUPPLIED BY PILBROW SURVEYING LTD, DATED APRIL 2019.

# OVERALL PROJECT GEOLOGICAL MAP

SCALE 1:4000 (A3)

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |

Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz

Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

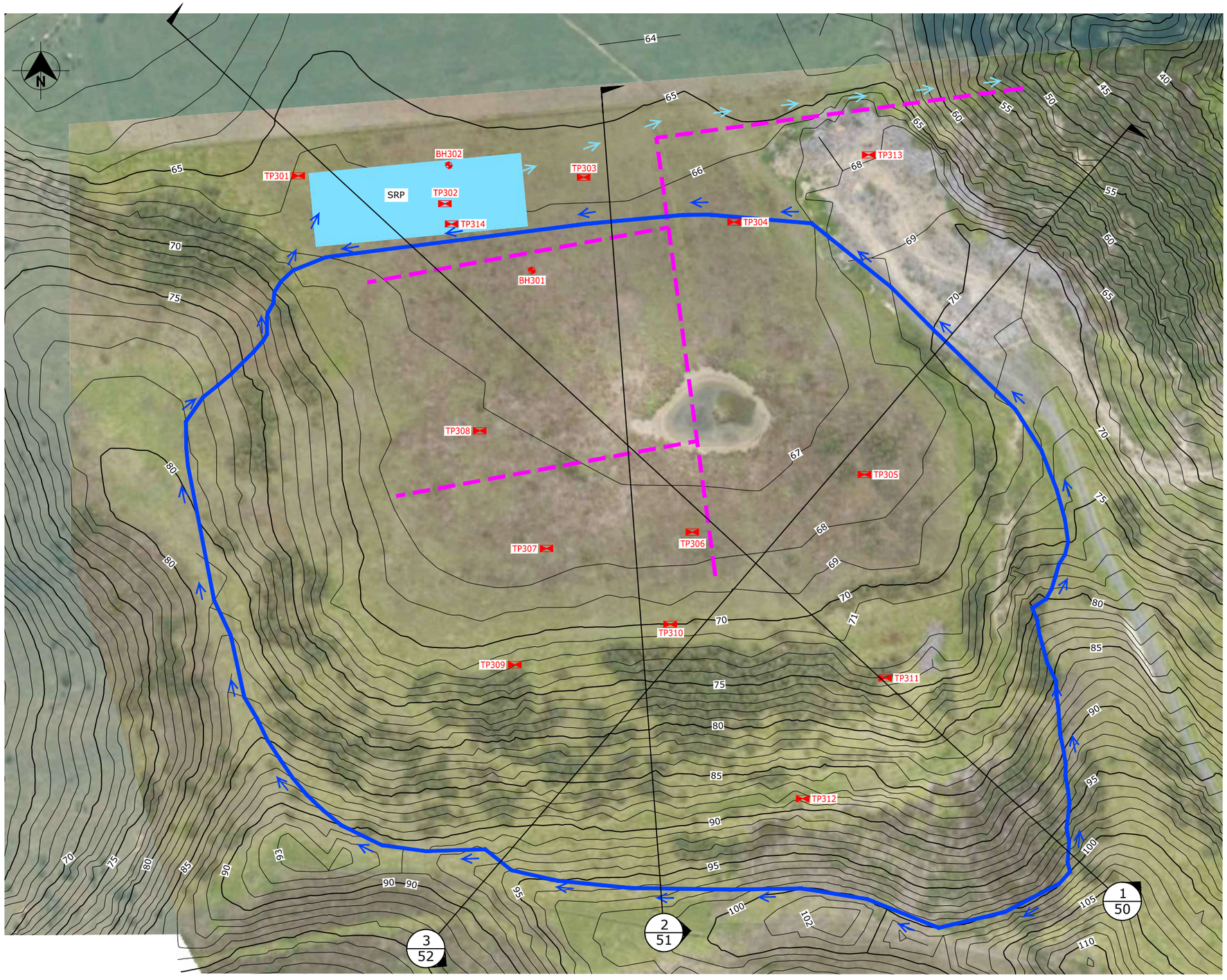
Drawing Title: OVERALL PROJECT GEOLOGICAL MAP

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-07 Rev. A

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\SG_Drawings\74\2325-74-07.dwg
PLOT DATE: 2021-07-22




LEGEND:

- EXISTING CONTOURS (1m INTERVAL) — 100 —
- PROPOSED FILL 3 AREA
- SRP (DESIGN BY OTHERS)
- TEST PIT (TP)
- BOREHOLE (BH)
- WATER FLOW DIRECTION
- DEEP SUBSOIL DRAIN

NOTES:

1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL IMAGERY OUTSIDE OF QUARRY AREA OBTAINED AND REPRODUCED FROM LAND INFORMATION NEW ZEALAND (LINZ) UNDER CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENSE.
3. AERIAL IMAGERY INSIDE OF FILL SITE AREA PROVIDED BY PILBROW SURVEYING LTD, DATED APRIL 2019.
4. EXISTING GROUND CONTOUR, SUPPLIED BY PILBROW SURVEYING LTD, DATED APRIL 2019.
5. COORDINATED DATUM:NZGD 2000 MOUNT EDEN CIRCUIT.
6. COLLECTOR DRAINS ARE TO BE INSTALLED IN DEPRESSIONS AND SEEPAGE LOCATIONS AND TO BE CONFIRMED ON SITE BY THE ENGINEER.
7. ALL SWALE DRAINS, SCOUR PROTECTION AND OUTLET CHANNEL TO BE DESIGN AND SPECIFIED BY STORMWATER DESIGN SPECIALIST.

**VOLUME (APPROXIMATE):**

| | |
|---|---|
| **SITE AREA** | **43,370 m²** |
| **TOPSOIL STRIPPING (0.2m THICK)** | **7,220 m³** |
| **TOE KEY TOTAL MATERIAL:** | **14,360 m³** |
| **DRAINAGE BLANKET** | **2,900 m³** |
| **STRUCTURAL FILL (BUND)** | **11,460 m³** |
| **FILL 3 TOTAL MATERIAL:** | **478,500 m³** |
| **DRAINAGE BLANKET** | **17,080 m³** |
| **STRUCTURAL FILL (BUND)** | **75,840 m³** |
| **MANAGED FILL** | **385,580 m³** |

# PROPOSED LAYOUT AND SITE INVESTIGATION PLAN

SCALE 1:1250 (A3)

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES FILL 3 AREA

Drawing Title: PROPOSED LAYOUT AND SITE INVESTIGATION PLAN

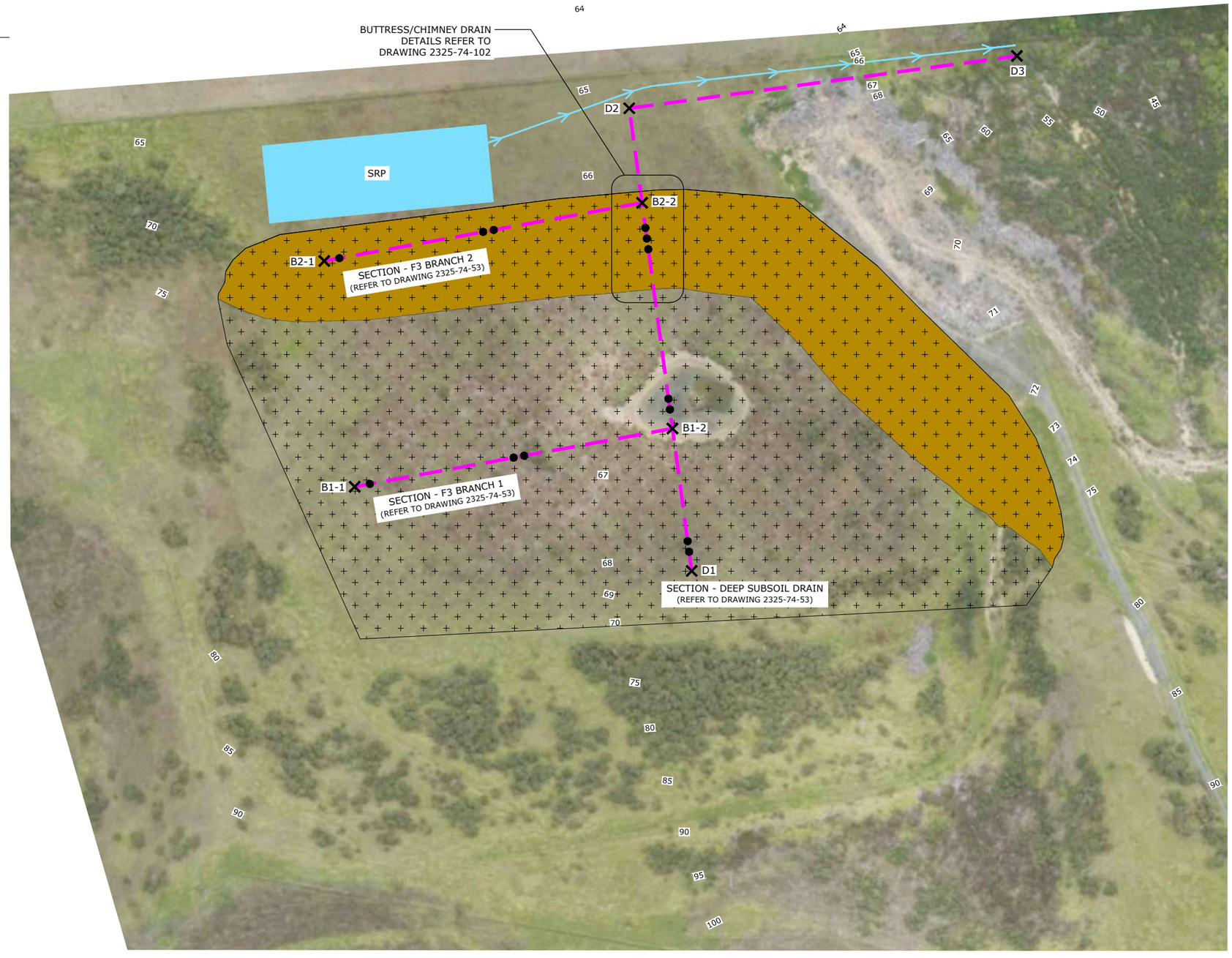
Project No. 2325/74

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-08 Rev. A

PLOT DATE:2021-07-22

FILE LOCATION :\\2325_Huntly Quarry_Disposal Sites\50_Drawings\74\2325-74-08.dwg




LEGEND:

- 80 — EXISTING CONTOURS (1m INTERVAL)
- DRAINAGE BLANKET
- UNDERCUT FOR TOE KEY
- SRP (DESIGN BY OTHERS)
- SWALE DRAINS & WATER FLOW DIRECTION (DESIGN BY OTHERS)
- DEEP SUBSOIL DRAIN
- DEEP SUBSOIL DRAIN SET-OUT POINT ✕
- CHIMNEY DRAIN ●

NOTES:

1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL IMAGERY OUTSIDE OF QUARRY AREA OBTAINED AND REPRODUCED FROM LAND INFORMATION NEW ZEALAND (LINZ) UNDER CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONAL LICENSE.
3. AERIAL IMAGERY INSIDE OF FILL SITE AREA PROVIDED BY PILBROW SURVEYING LTD, DATED APRIL 2019.
4. EXISTING GROUND CONTOUR, SUPPLIED BY PILBROW SURVEYING LTD, DATED APRIL 2019.
5. COORDINATED DATUM: NZGD 2000 MOUNT EDEN CIRCUIT.
6. MUCKOUT OF ENTIRE STAGE 1 GENERAL FILL FOOTPRINT TO BE COMPLETED TO THE SATISFACTION OF THE INSPECTING ENGINEER.
7. DEEP SUBSOIL DRAINS TO BE INSTALLED PRIOR TO FILLING WORKS COMMENCING.
8. ALL SWALE DRAINS, SCOUR PROTECTION AND OUTLET CHANNEL TO BE DESIGN AND SPECIFIED BY STORMWATER DESIGN SPECIALIST.

**TOE KEY & DRAINAGE BLANKET VOLUME (APPROX.):**

| | |
|---|---|
| **DRAINAGE BLANKET** | **9,160m³** |
| **STRUCTURAL FILL (BUND)** | **11,460m³** |

DEEP SOIL DRAIN SET-OUT POINTS ✕

| ALIGNMENT | ID | EASTING | NORTHING | RLm |
|---|---|---|---|---|
| DEEP SUBSOIL DRAIN | D1 | 433687.66 | 721545.02 | 59.17 |
| | D2 | 433670.29 | 721673.86 | 55.27 |
| | D3 | 433778.31 | 721688.43 | 52.00 |
| BRANCH 1 | B1-1 | 433593.78 | 721568.47 | 60.67 |
| | B1-2 | 433682.32 | 721584.66 | 57.97 |
| BRANCH 2 | B2-1 | 433585.30 | 721631.33 | 58.77 |
| | B2-2 | 433673.84 | 721647.52 | 56.07 |

# TOE KEY AREA, BASAL AND UNDERFILL DRAINAGE PLAN

SCALE 1:1250 (A3)

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| A | 23/07/21 | ISSUED FOR INFORMATION |

Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz

Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES FILL 3 AREA

Drawing Title: TOE KEY AREA, BASAL AND UNDERFILL DRAINAGE PLAN

Project No. 2325/74

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-09 Rev. A

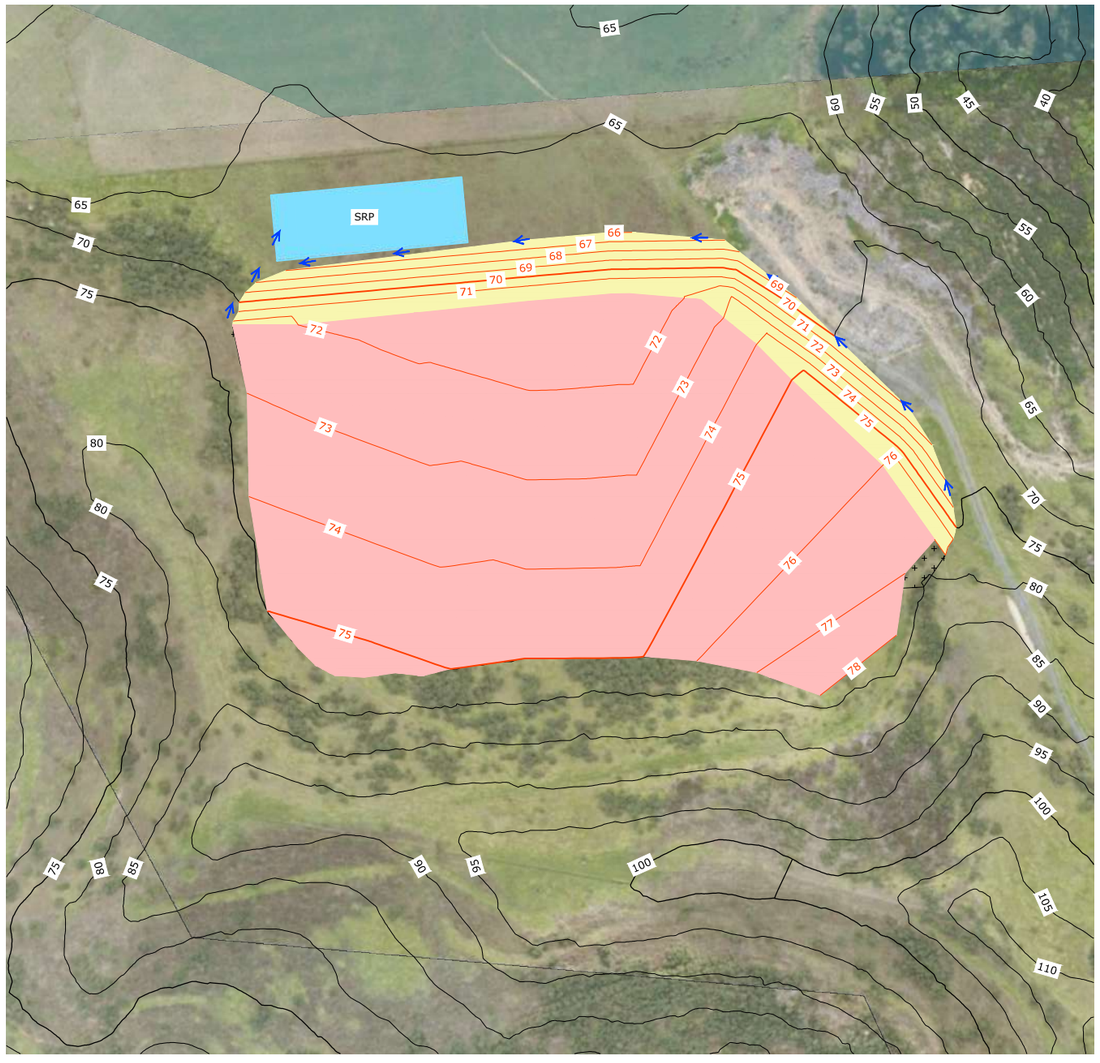
FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\SO_Drawings\2325-74-09.dwg
PLOT DATE: 2021-07-22

LEGEND:

- 100 — EXISTING CONTOURS (5m INTERVAL)
- 70 — PROPOSED FILL CONTOURS (1m INTERVAL)
- STRUCTURAL FILL (BUND)
- MANAGED FILL
- DRAINAGE BLANKET
- WATER FLOW DIRECTION

**VOLUME (APPROX.):**
**BUND 22,350m³**

**VOLUME (APPROX.):**
**MANAGED FILL 103,390m³**


## STAGE 1.1 STRUCTURAL FILL (BUND) LAYOUT
SCALE 1:2000

## STAGE 1.1 MANAGED FILL LAYOUT
SCALE 1:2000

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: STAGE 1.1 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-10 Rev. A

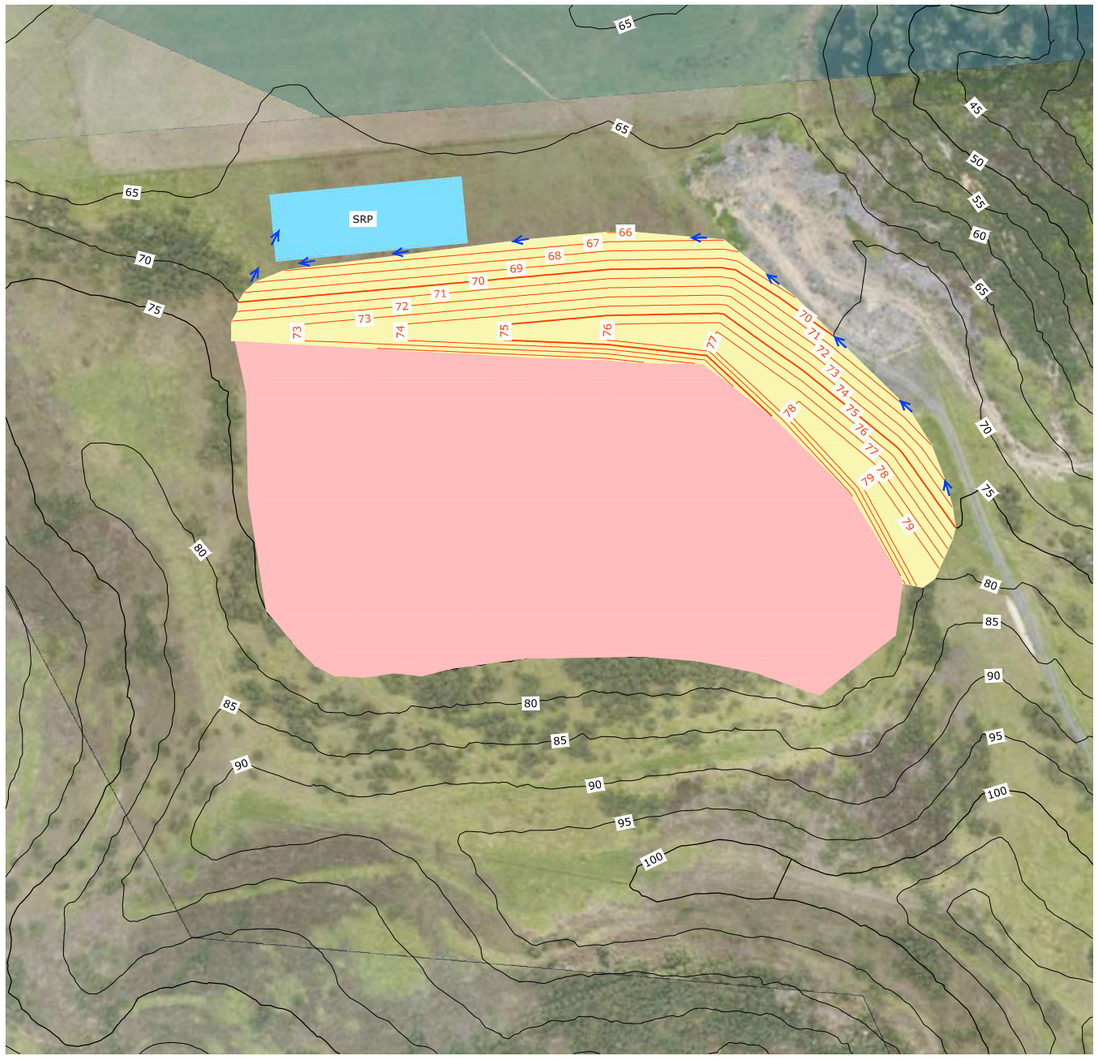
FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\SQ_Drawings\74\2325-74-10.dwg
PLOT DATE: 2021-07-22

LEGEND:

- EXISTING CONTOURS (5m INTERVAL)
- PROPOSED FILL CONTOURS (1m INTERVAL)
- STRUCTURAL FILL (BUND)
- MANAGED FILL
- WATER FLOW DIRECTION

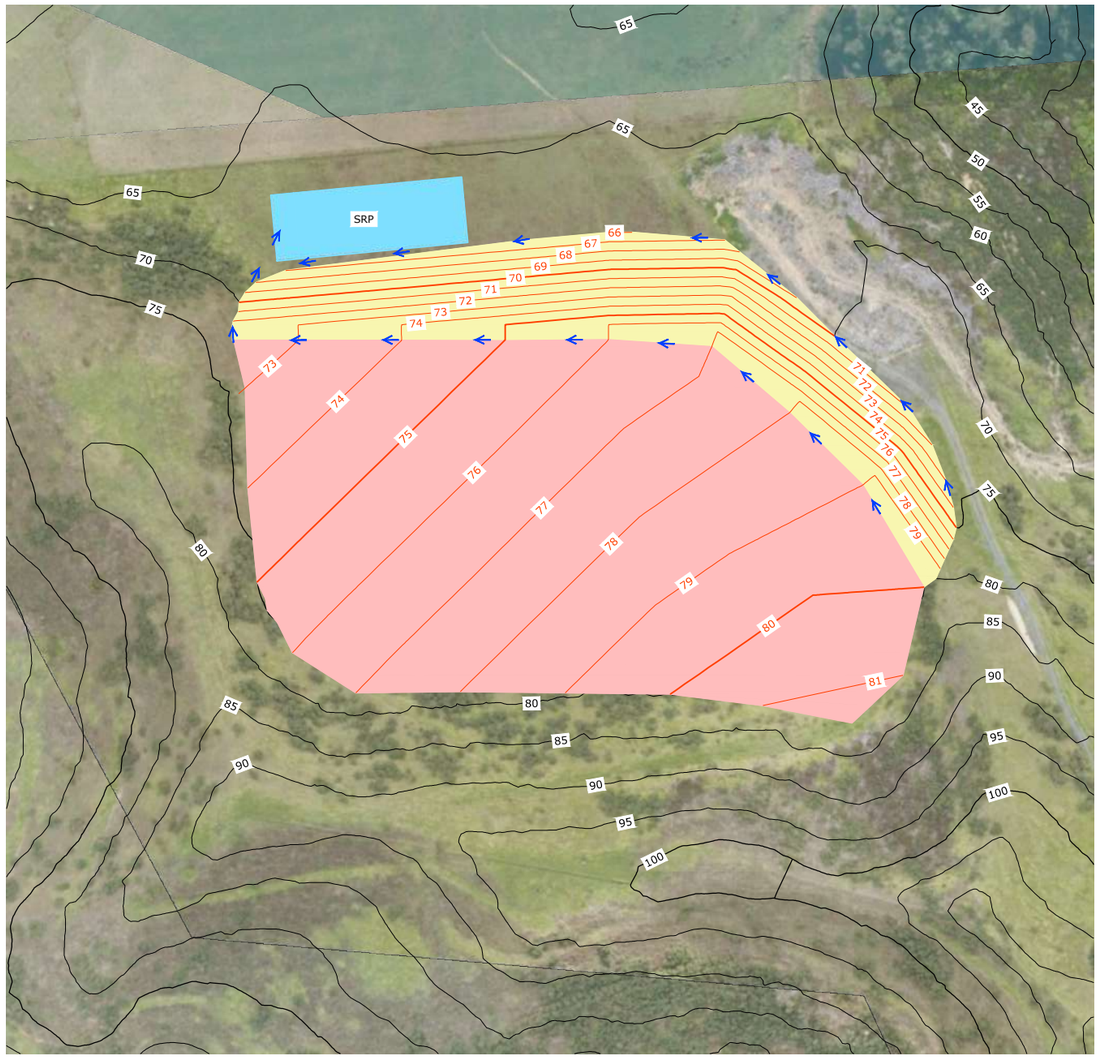
**VOLUME (APPROX.):**
**BUND 10,080m³**

**VOLUME (APPROX.):**
**MANAGED FILL 60,220m³**




## STAGE 1.2 STRUCTURAL FILL (BUND) LAYOUT

SCALE 1:2000




## STAGE 1.2 MANAGED FILL LAYOUT

SCALE 1:2000

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: STAGE 1.2 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-11 Rev. A

PLOT DATE:2021-07-22

FILE LOCATION :\\2325_Huntly Quarry_Disposal Sites\SO_Drawings\74\2325-74-11.dwg

LEGEND:

- 100 — EXISTING CONTOURS (5m INTERVAL)
- 70 — PROPOSED FILL CONTOURS (1m INTERVAL)
- STRUCTURAL FILL (BUND)
- MANAGED FILL
- DRAINAGE BLANKET
- WATER FLOW DIRECTION

**VOLUME (APPROX.):**
**DRAINAGE BLANKET: 10,820m³**

N


## STAGE 2 DRAINAGE BLANKET LAYOUT

SCALE 1:2000

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: STAGE 2 - LAYOUT
DRAINAGE BLANKET ARRANGEMENT

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-12 Rev. A

PLOT DATE:2021-07-22

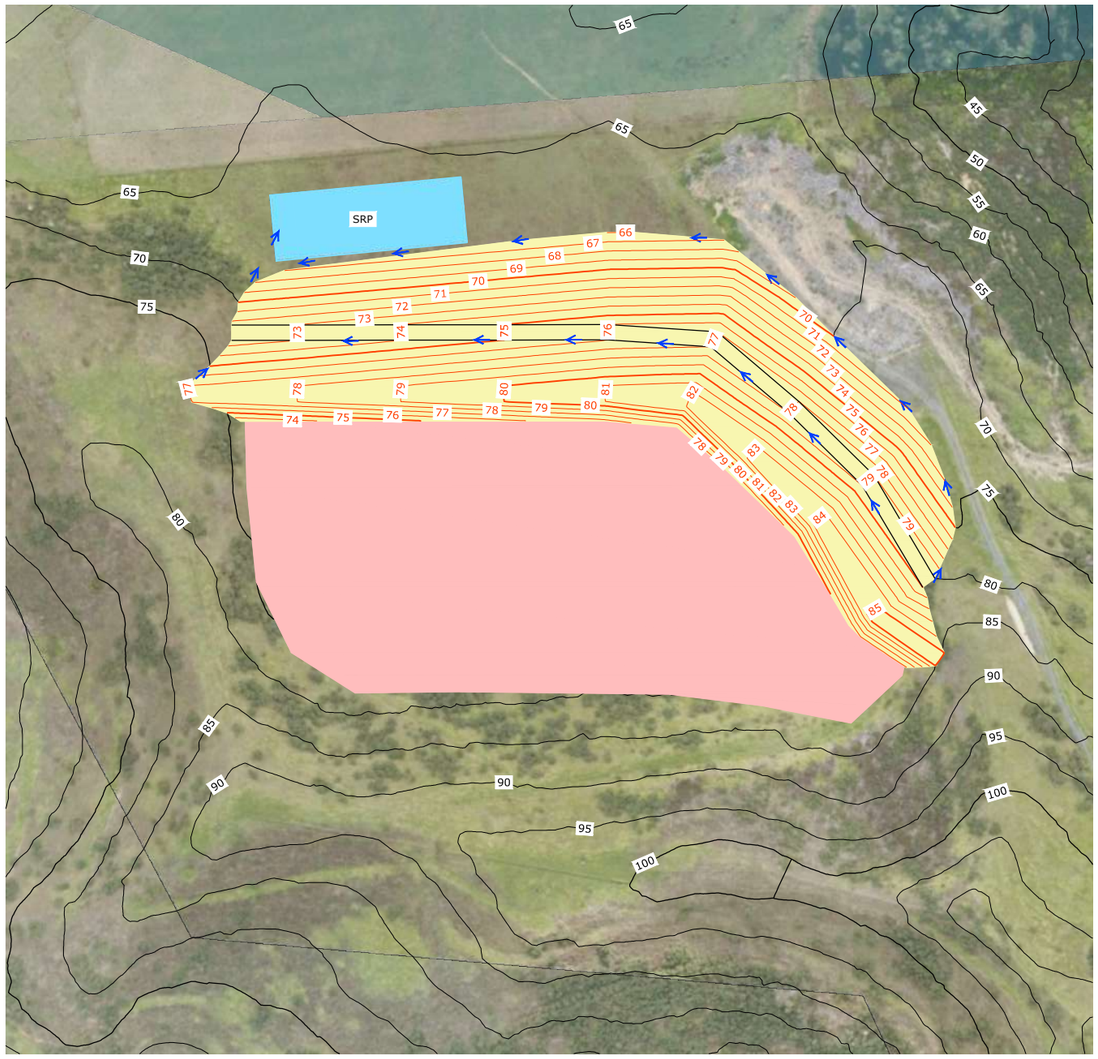
FILE LOCATION:\\2325_Huntly Quarry_Disposal Sites\55_Drawings\74\2325-74-12.dwg

LEGEND:

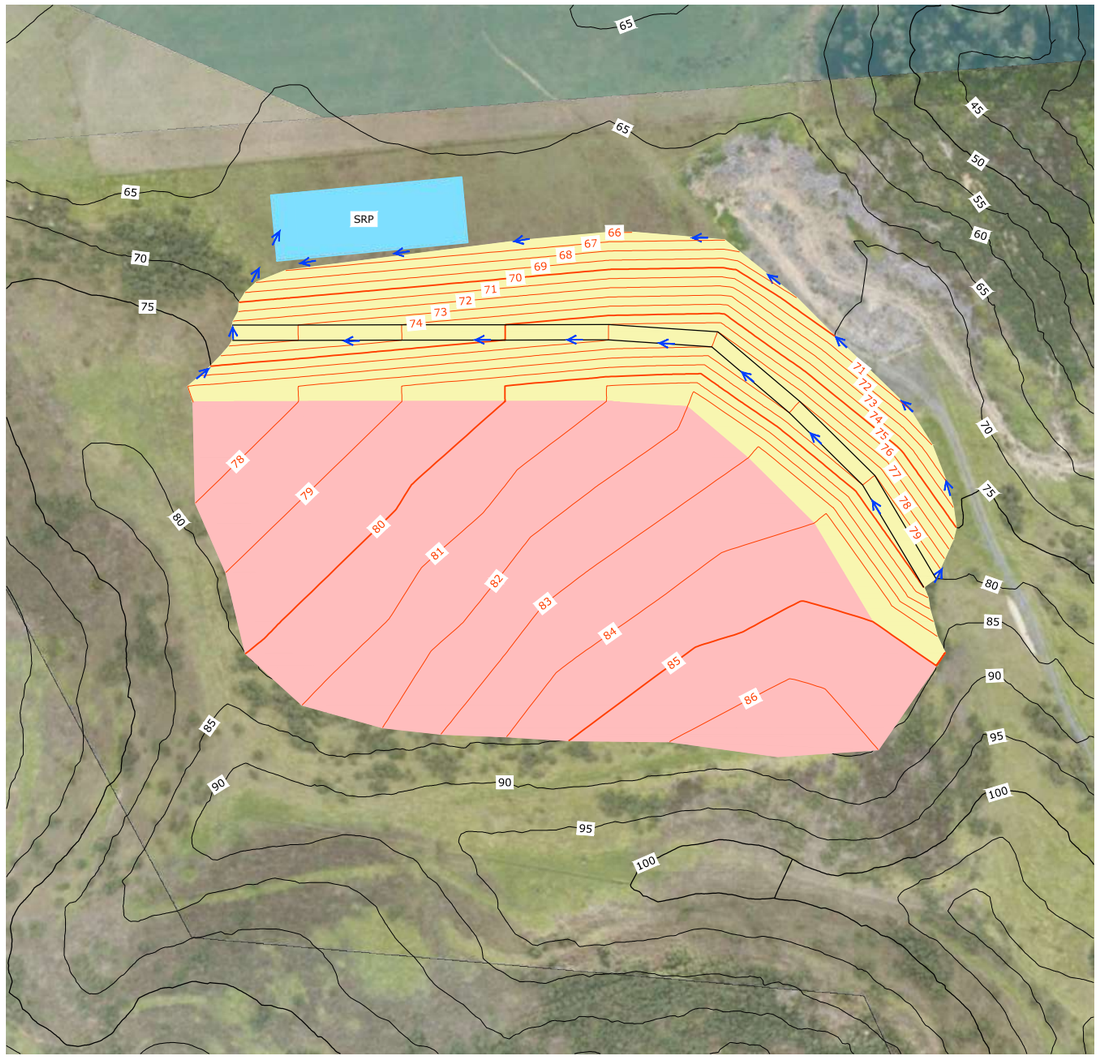
- EXISTING CONTOURS (5m INTERVAL)
- PROPOSED FILL CONTOURS (1m INTERVAL)
- STRUCTURAL FILL (BUND)
- MANAGED FILL
- WATER FLOW DIRECTION

**VOLUME (APPROX.):**
**BUND 16,600m³**

**VOLUME (APPROX.):**
**MANAGED FILL 80,130m³**




## STAGE 2.1 STRUCTURAL FILL (BUND) LAYOUT
SCALE 1:2000




## STAGE 2.1 MANAGED FILL LAYOUT
SCALE 1:2000

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: STAGE 2.1 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-13 Rev. A

PLOT DATE:2021-07-22

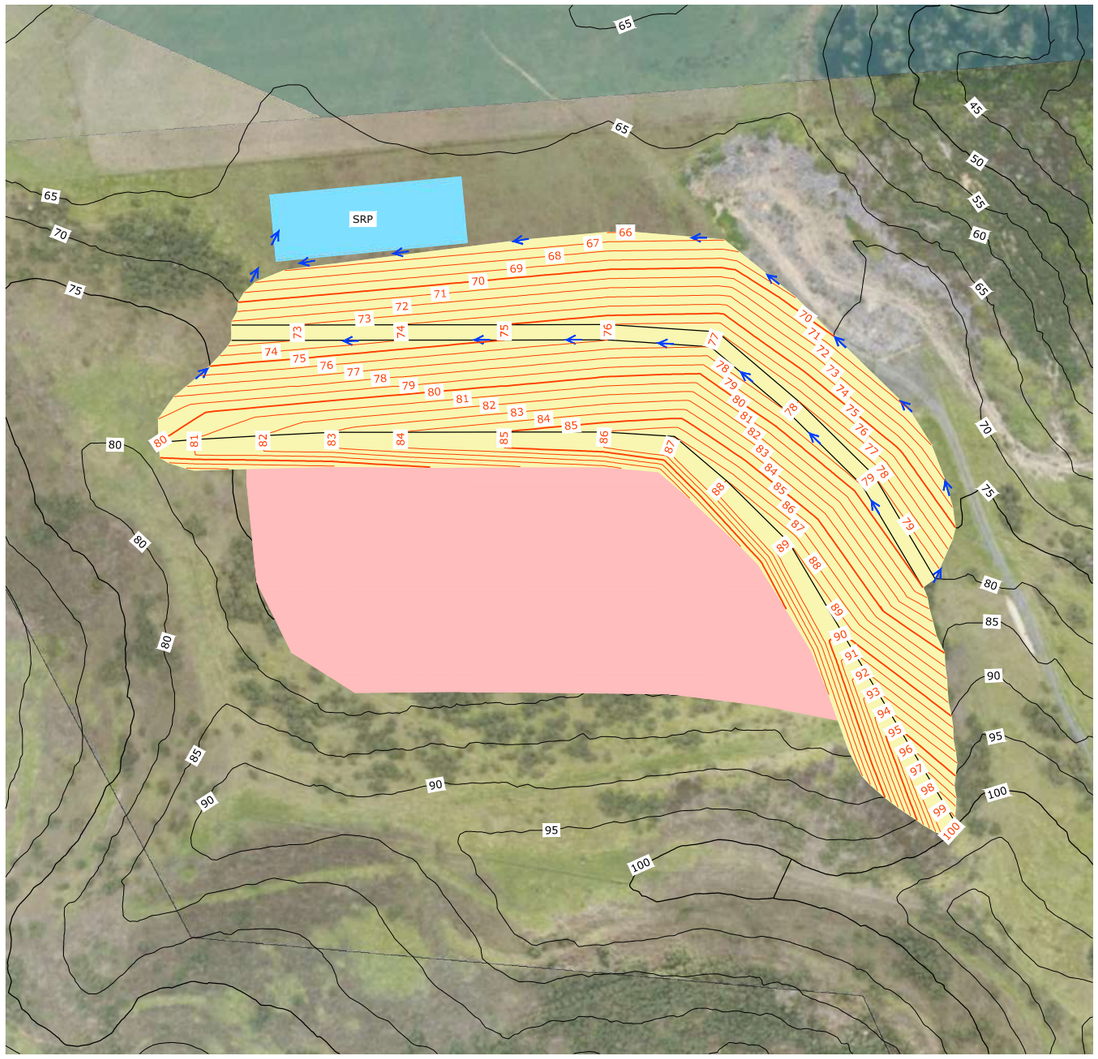
FILE LOCATION :\\2325_Huntly Quarry_Disposal Sites\SO_Drawings\74\2325-74-13.dwg

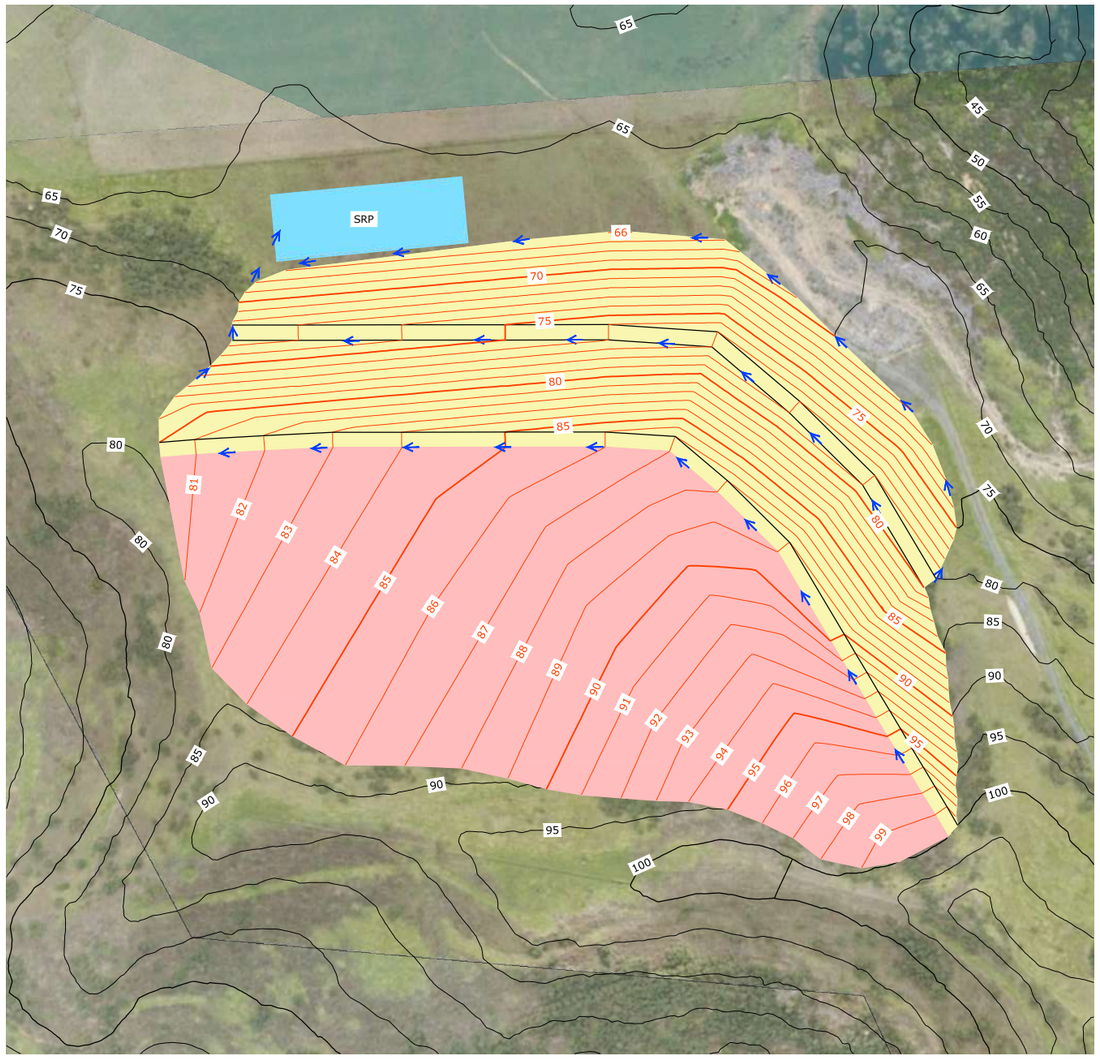
LEGEND:

- EXISTING CONTOURS (5m INTERVAL)
- PROPOSED FILL CONTOURS (1m INTERVAL)
- STRUCTURAL FILL (BUND)
- MANAGED FILL
- WATER FLOW DIRECTION

**VOLUME (APPROX.):**
**BUND 26,810m³**

**VOLUME (APPROX.):**
**MANAGED FILL 100,440m³**




## STAGE 2.2 STRUCTURAL FILL (BUND) LAYOUT
SCALE 1:2000

## STAGE 2.2 MANAGED FILL LAYOUT
SCALE 1:2000

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: STAGE 2.2 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-14 Rev. A

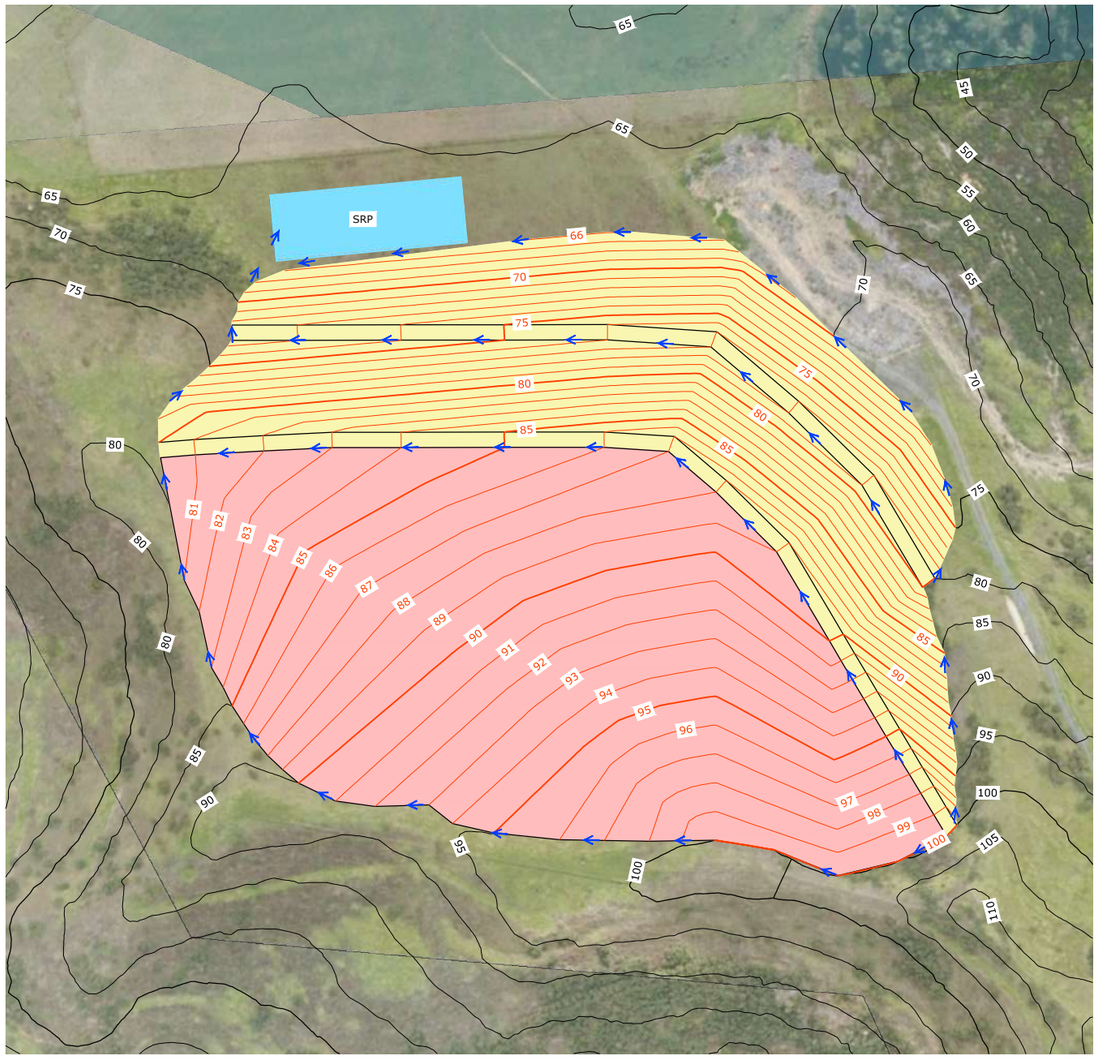
FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\SD_Drawings\A1\2325-74-14.dwg
PLOT DATE: 2021-07-22

**VOLUME (APPROX.):**
**MANAGED FILL 41,400m³**

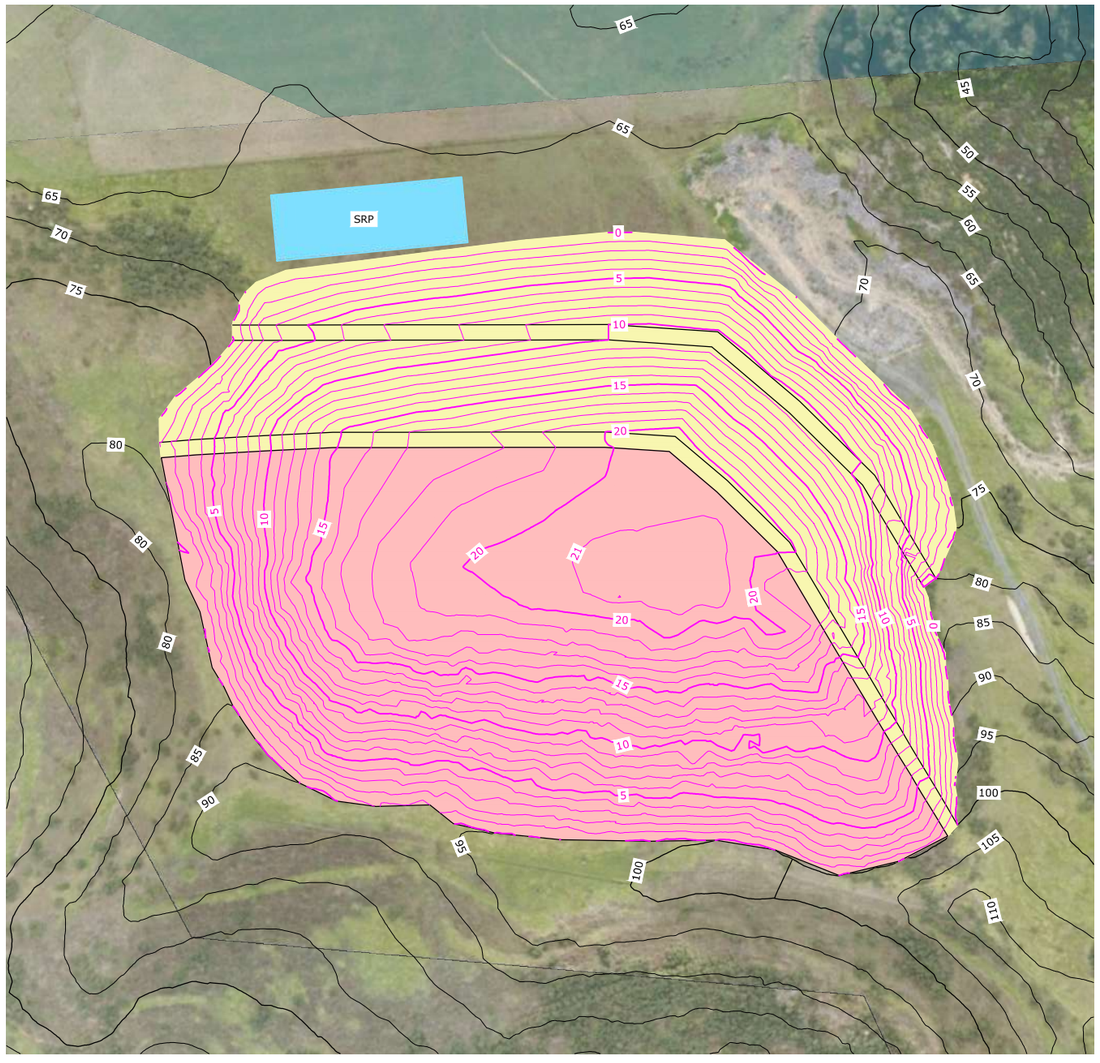
LEGEND:
- 100 — EXISTING CONTOURS (5m INTERVAL)
- 70 — PROPOSED FILL CONTOURS (1m INTERVAL)
- STRUCTURAL FILL (BUND)
- MANAGED FILL
- WATER FLOW DIRECTION

**VOLUME (APPROX.):**

| | |
|---|---|
| **DRAINAGE BLANKET** | **17,080m³** |
| **STRUCTURAL FILL (BUND)** | **75,840m³** |
| **MANAGED FILL** | **385,580m³** |




STAGE 3 MANAGED FILL LAYOUT
SCALE 1:2000




OVERALL FILL CONTOURS
SCALE 1:2000

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

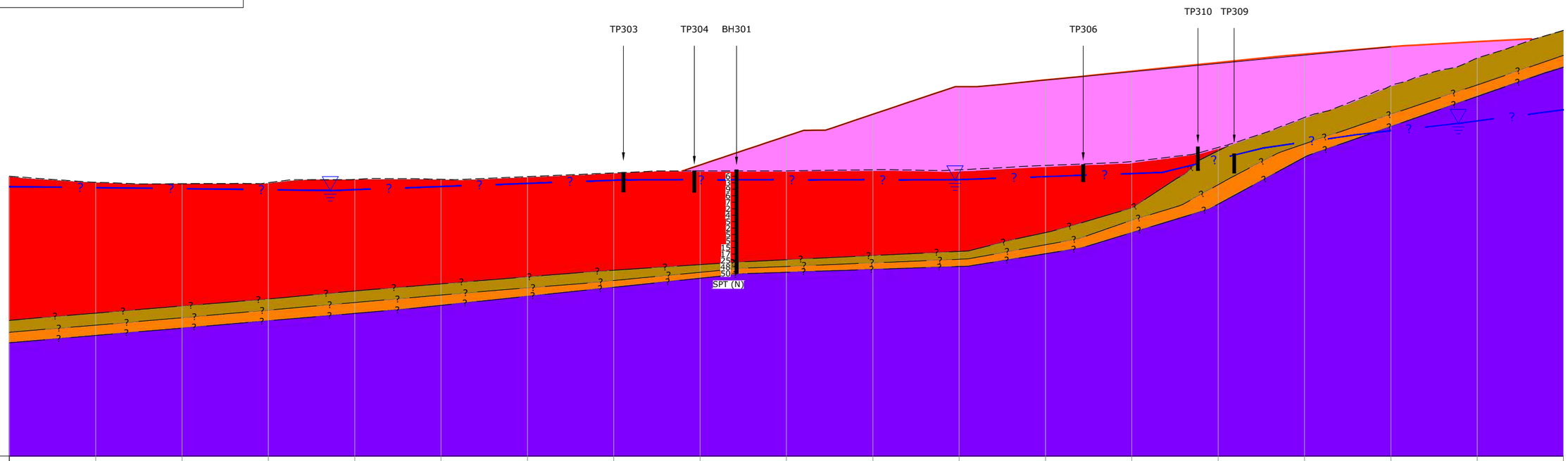
Drawing Title: STAGE 3 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/74
Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3
Drawing No. 2325-74-15
Rev. A

PLOT DATE:2021-07-22
FILE LOCATION:\\2325_Huntly Quarry_Disposal Sites\55_Drawings\2325-74-15.dwg

LEGEND:

- PROPOSED FILL
- HISTORIC MINING FILL
- RESIDUALLY WEATHERED WAIKATO COAL MEASURES - STIFF TO VERY STIFF CLAY/SILT
- COMPLETELY WEATHERED WAIKATO COAL MEASURES - VERY STIFF TO HARD SILT
- MODERATELY TO SLIGHTLY WEATHERED WAIKATO COAL MEASURES - VERY WEAK MUDSTONE/FINE SANDSTONE
- WATER LEVEL




DATUM: 0.00m

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROPOSED LEVELS | | | | | | | | 67.40 | 74.09 | 79.14 | 85.53 | 87.09 | 89.10 | 91.13 | 93.08 | 94.77 | 95.98 | |
| CURRENT LEVELS | 64.79 | 63.40 | 63.07 | 63.29 | 64.06 | 64.08 | 64.71 | 65.55 | 66.00 | 66.01 | 66.29 | 66.27 | 67.28 | 68.17 | 71.44 | 78.40 | 85.74 | 92.13 | 98.57 |
| CUT/FILL DEPTHS | | | | | | | | 1.40 | 8.08 | 12.85 | 19.25 | 19.82 | 20.93 | 19.69 | 14.68 | 9.03 | 3.84 | |
| CHAINAGE | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 320 | 340 | 360 | 380 |

## SECTION 1/08

SCALE 1:1000 (A3)

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: GEOLOGICAL AND PROPOSED FILL CROSS SECTION 1

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

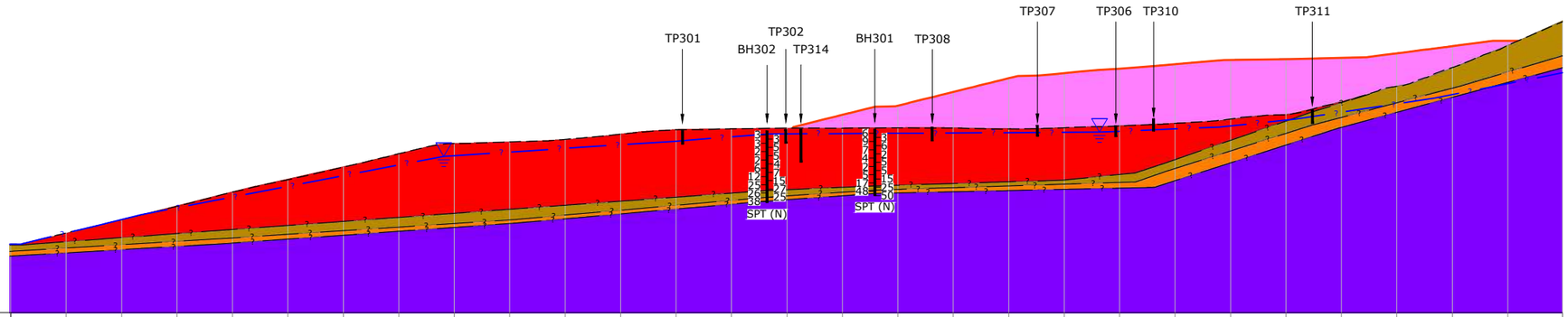
Drawing No. 2325-74-50 Rev. A

PLOT DATE: 2021-07-22

FILE LOCATION: I:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2325-74-50_52.dwg

LEGEND:

- PROPOSED FILL
- HISTORIC MINING FILL
- RESIDUALLY WEATHERED WAIKATO COAL MEASURES - STIFF TO VERY STIFF CLAY/SILT
- COMPLETELY WEATHERED WAIKATO COAL MEASURES - VERY STIFF TO HARD SILT
- MODERATELY TO SLIGHTLY WEATHERED WAIKATO COAL MEASURES - VERY WEAK MUDSTONE/FINE SANDSTONE
- WATER LEVEL




DATUM: 0.00m

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROPOSED LEVELS | | | | | | | | | | | | | | | | 71.41 | 74.68 | 79.68 | 84.61 | 86.42 | 88.01 | 89.69 | 91.22 | 91.51 | 91.96 | 93.59 | 96.17 | 98.11 | | | |
| CURRENT LEVELS | 24.74 | 28.77 | 33.58 | 38.40 | 43.50 | 47.97 | 52.53 | 57.38 | 61.00 | 61.63 | 62.54 | 64.42 | 66.00 | 66.32 | 66.63 | 66.58 | 66.68 | 66.63 | 66.26 | 66.72 | 67.39 | 68.30 | 69.88 | 71.40 | 75.91 | 81.67 | 88.47 | 96.43 | 105.00 | | |
| CUT/FILL DEPTHS | | | | | | | | | | | | | | | | 4.83 | 8.00 | 13.05 | 18.35 | 19.70 | 20.62 | 21.38 | 21.34 | 20.11 | 16.05 | 11.92 | 7.70 | 1.68 | | | |
| CHAINAGE | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 320 | 340 | 360 | 380 | 400 | 420 | 440 | 460 | 480 | 500 | 520 | 540 | 560 | | |

## SECTION 2/08

SCALE 1:2000 (A3)

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: GEOLOGICAL AND PROPOSED FILL CROSS SECTION 2

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

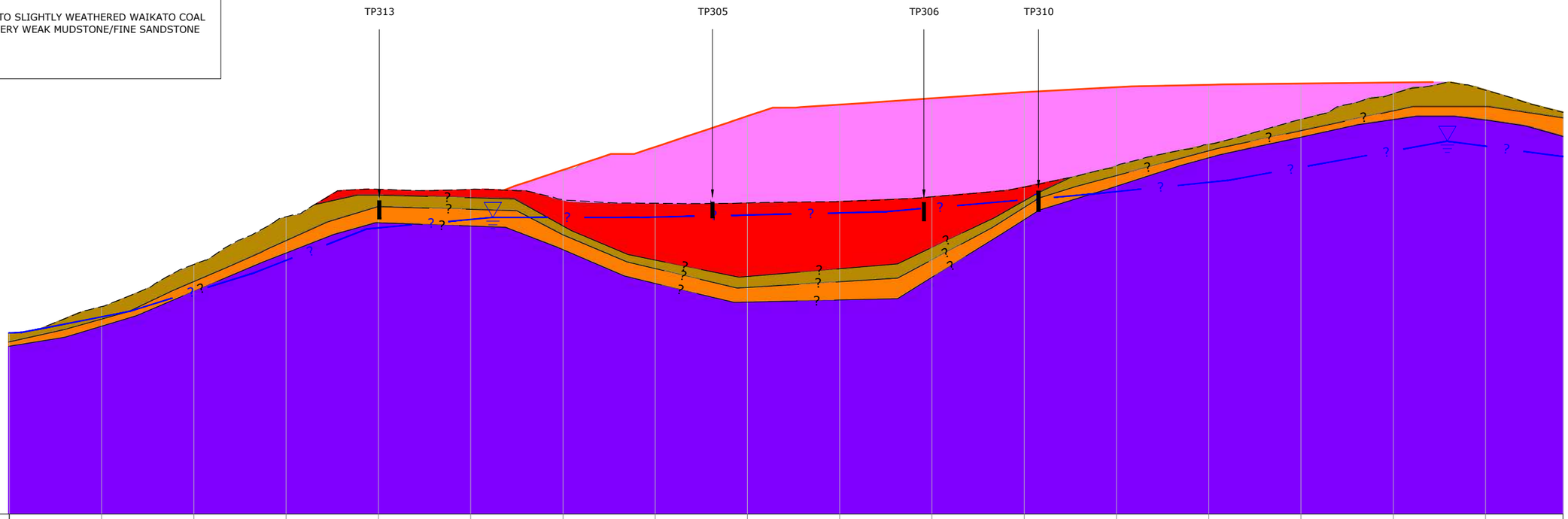
Drawing No. 2325-74-51 Rev. A

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\SO_Drawings\74\2325-74-SO_S2.dwg

PLOT DATE: 2021-07-22

LEGEND:

- PROPOSED FILL
- HISTORIC MINING FILL
- RESIDUALLY WEATHERED WAIKATO COAL MEASURES - STIFF TO VERY STIFF CLAY/SILT
- COMPLETELY WEATHERED WAIKATO COAL MEASURES - VERY STIFF TO HARD SILT
- MODERATELY TO SLIGHTLY WEATHERED WAIKATO COAL MEASURES - VERY WEAK MUDSTONE/FINE SANDSTONE
- WATER LEVEL




DATUM: 0.00m

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROPOSED LEVELS | | | | | | 74.53 | 79.52 | 86.20 | 88.69 | 90.04 | 91.42 | 92.46 | 93.00 | 93.26 | 93.49 | | |
| CURRENT LEVELS | 39.32 | 44.93 | 54.06 | 64.41 | 70.35 | 70.33 | 68.09 | 67.32 | 67.39 | 67.68 | 68.71 | 70.81 | 75.39 | 80.03 | 85.51 | 91.05 | 91.81 | 87.00 |
| CUT/FILL DEPTHS | | | | | | | 6.44 | 12.20 | 18.81 | 21.00 | 21.33 | 20.61 | 17.07 | 12.96 | 7.75 | 2.44 | | |
| CHAINAGE | 0 | 20 | 40 | 60 | 80 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 | 280 | 300 | 320 | 337 |

SECTION 3/08
SCALE 1:1000 (A3)

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES FILL 3 AREA

Drawing Title: GEOLOGICAL AND PROPOSED FILL CROSS SECTION 3

Project No. 2325/74

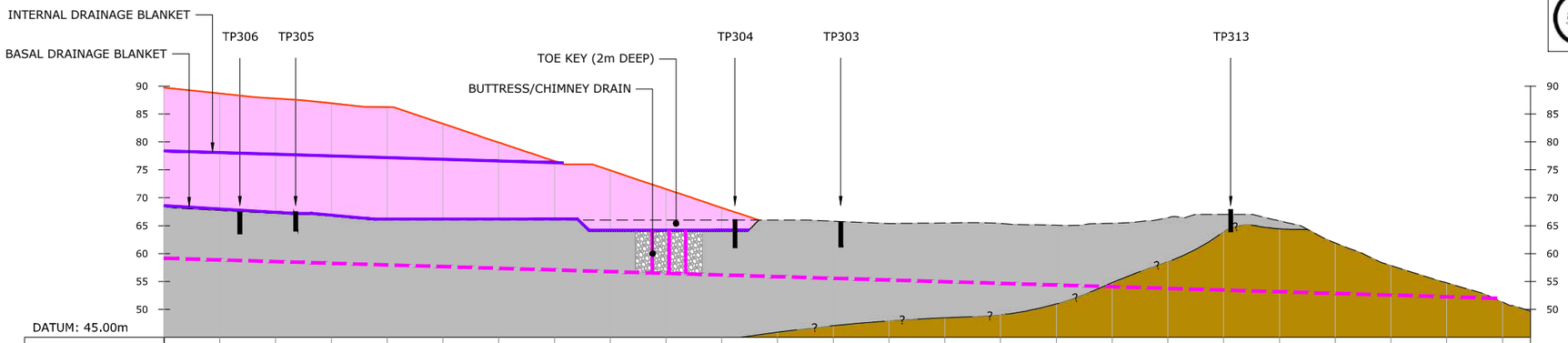
Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-52 Rev. A

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2A\2325-74-50_52.dwg
PLOT DATE: 2021-07-22

LEGEND:

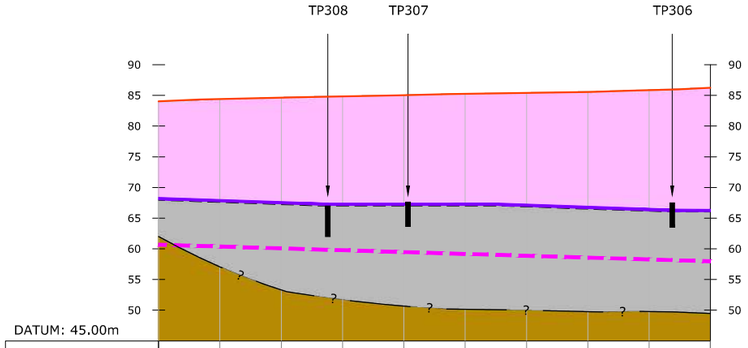
- PROPOSED FILL
- HISTORIC MINING FILL
- WAIKATO COAL MEASURES
- DEEP SUBSOIL DRAIN IN 3% GRADING
- DRAINAGE BLANKET




| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROPOSED LEVELS | 89.74 | 88.69 | 87.77 | 86.94 | 86.24 | 83.26 | 79.91 | 76.58 | 74.90 | 71.56 | 68.22 | | | | | | | | | | | | | | | | |
| CURRENT LEVELS | 68.41 | 67.73 | 67.18 | 66.68 | 66.00 | 66.00 | 66.00 | 66.00 | 66.00 | 66.00 | 66.00 | 66.00 | 65.81 | 65.37 | 65.49 | 65.37 | 65.09 | 65.43 | 66.40 | 67.00 | 65.85 | 61.91 | 57.87 | 54.76 | 51.33 | 49.68 |
| CUT/FILL DEPTHS | 21.33 | 20.96 | 20.59 | 20.25 | 20.24 | 17.26 | 13.91 | 10.58 | 8.90 | 5.56 | 2.22 | | | | | | | | | | | | | | | | |
| CHAINAGE | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 245 | |

## SECTION - F3 DEEP SUBSOIL DRAIN

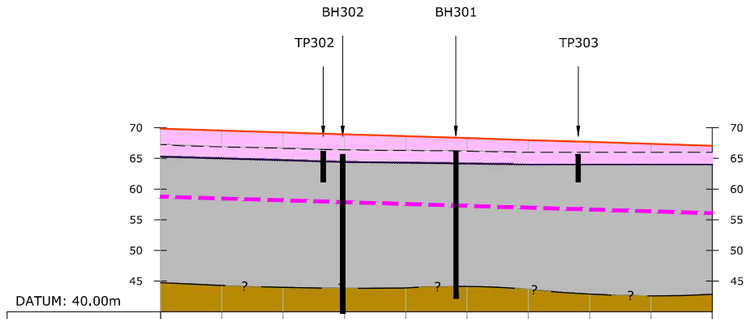
SCALE 1:1000 (A3)




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PROPOSED LEVELS | 84.05 | 84.41 | 84.65 | 84.84 | 85.03 | 85.25 | 85.41 | 85.56 | 85.86 | 86.24 |
| CURRENT LEVELS | 67.93 | 67.55 | 67.20 | 67.00 | 67.00 | 67.00 | 66.83 | 66.46 | 66.13 | 66.00 |
| CUT/FILL DEPTHS | 16.12 | 16.86 | 17.44 | 17.84 | 18.03 | 18.25 | 18.57 | 19.10 | 19.73 | 20.24 |
| CHAINAGE | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |

## SECTION - F3 BRANCH 1

SCALE 1:1000 (A3)




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PROPOSED LEVELS | 69.84 | 69.53 | 69.23 | 68.92 | 68.61 | 68.30 | 67.99 | 67.68 | 67.38 | 67.07 |
| CURRENT LEVELS | 67.26 | 66.88 | 66.64 | 66.39 | 66.27 | 66.18 | 66.00 | 66.00 | 66.00 | 66.00 |
| CUT/FILL DEPTHS | 2.59 | 2.65 | 2.59 | 2.52 | 2.33 | 2.12 | 1.99 | 1.68 | 1.38 | 1.07 |
| CHAINAGE | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |

## SECTION - F3 BRANCH 2

SCALE 1:1000 (A3)

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: DEEP SUBSOIL DRAIN SECTIONS

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-53 Rev. A

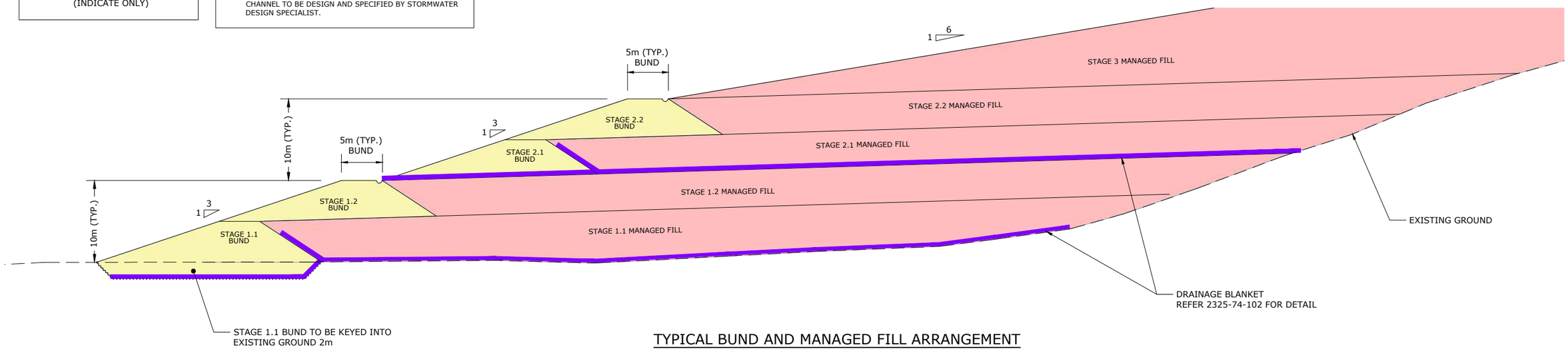
FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2412325-74-53.dwg PLOT DATE: 2021-07-22

LEGEND:

- STRUCTURAL FILL (BUND)
- MANAGED FILL
- DRAINAGE BLANKET (INDICATE ONLY)

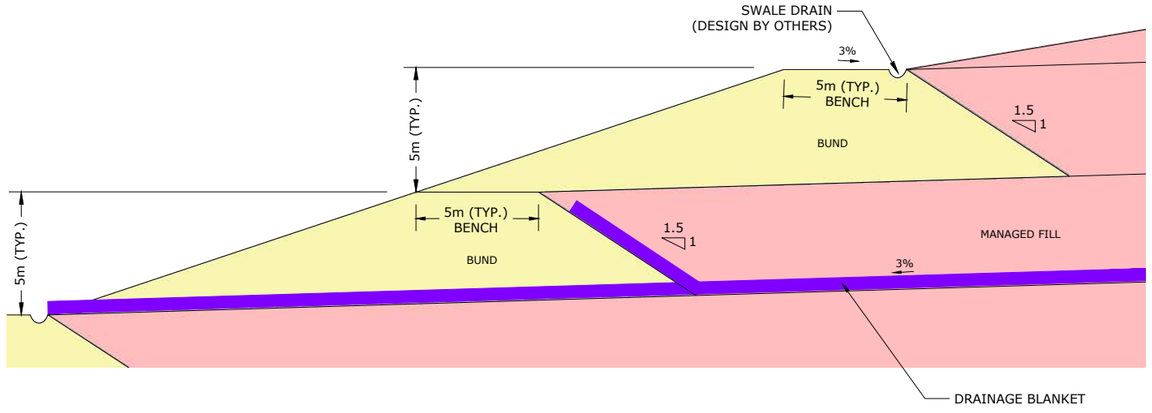
NOTES:

1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. ALL BENCHES TO BE BACK-BENCHED WITH 3% GRADIENT INTO SWALE DRAIN.
3. ALL SWALE DRAINS, SCOUR PROTECTION AND OUTLET CHANNEL TO BE DESIGN AND SPECIFIED BY STORMWATER DESIGN SPECIALIST.




## TYPICAL BUND AND MANAGED FILL ARRANGEMENT

SCALE 1:500




## TYPICAL BUND AND MANAGED FILL DETAIL

SCALE 1:250

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | |
|---|---|---|
| Project Director: K. C. CHEUNG | Signature: | Date: |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: TYPICAL BUND AND MANAGED FILL ARRANGEMENT AND DETAIL

Project No. 2325/74

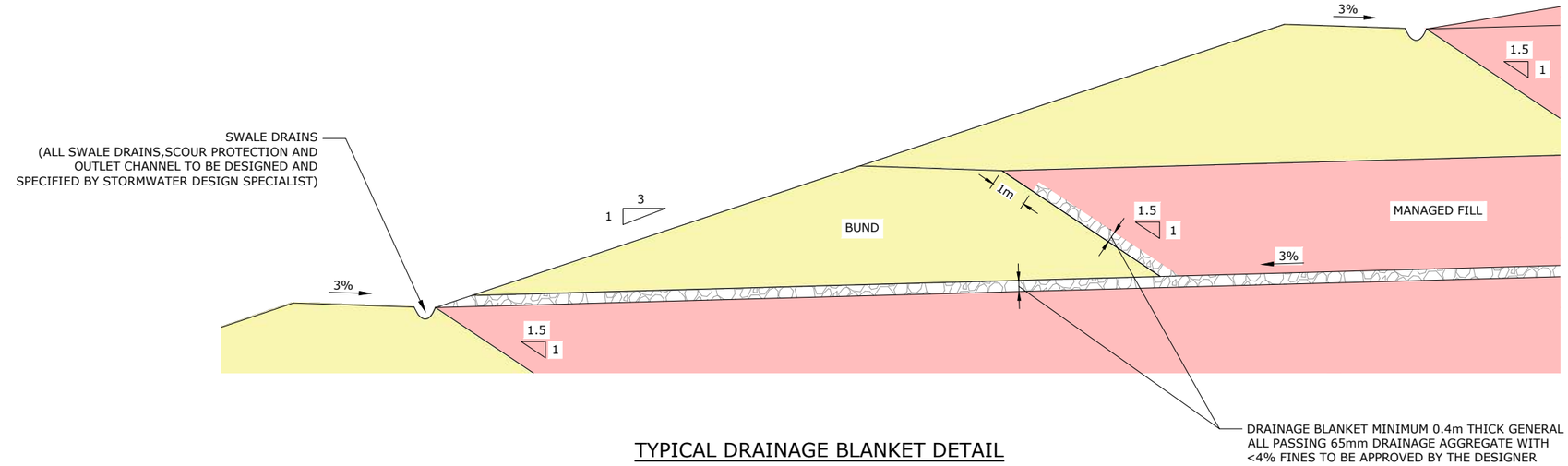
Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-101 Rev. A

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\90_Drawings\7A\2325-74-101_r02.dwg
PLOT DATE: 2021-07-22

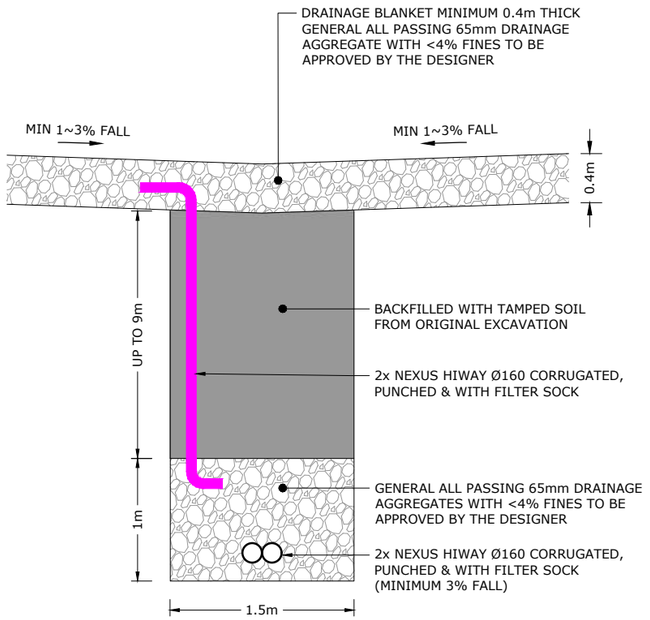
LEGEND:

- STRUCTURAL FILL (BUND)
- MANAGED FILL
- DRAINAGE BLANKET



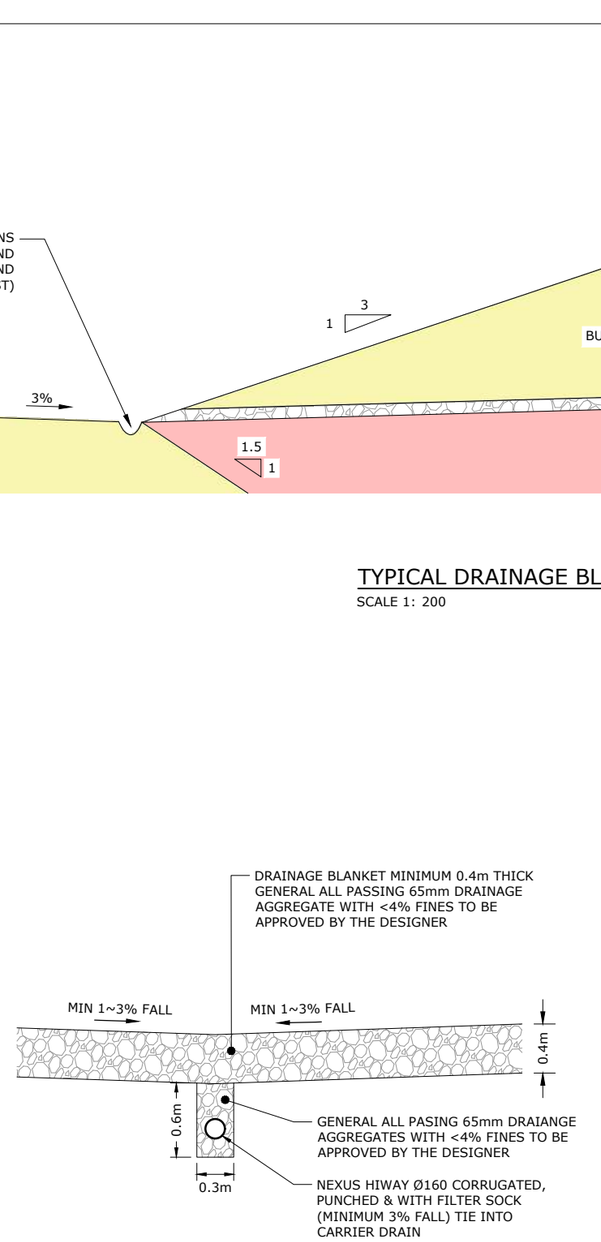

## TYPICAL DRAINAGE BLANKET DETAIL

SCALE 1: 200




## TYPICAL DRAINAGE DETAIL 1
## DEEP SUBSOIL DRAIN

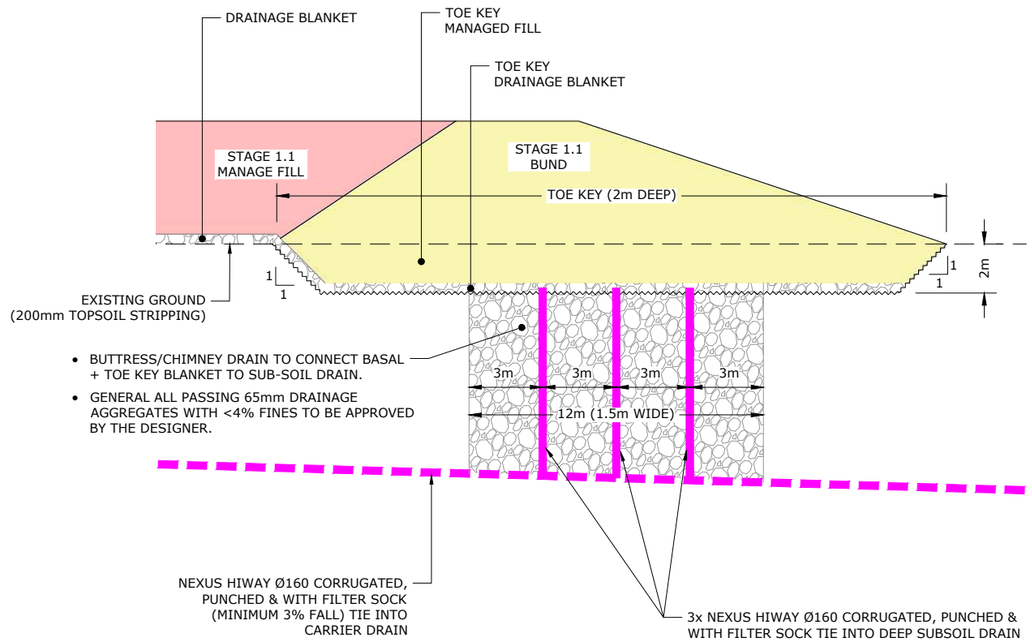
N. T. S.




NOTE:
COLLECTOR DRAINS TO BE INSTALLED WHERE NATURAL SEEPAGES IN SUBGRADE ARE ENCOUNTERED

## TYPICAL DRAINAGE DETAIL 2
## COLLECTOR DRAIN

N. T. S.




## TYPICAL DRAINAGE DETAIL 3
## BUTTRESS/CHIMNEY DRAIN

N. T. S.

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| | | Signature: | Date: |
|---|---|---|---|
| Project Director: | K. C. CHEUNG | | |
| Designed: | M. KERNOT | | |
| Design Review: | K. C. CHEUNG | | |
| Drawn: | S. CHEN | | |
| Drafting Check: | M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES FILL 3 AREA

Drawing Title: TYPICAL DRAINAGE DETAILS

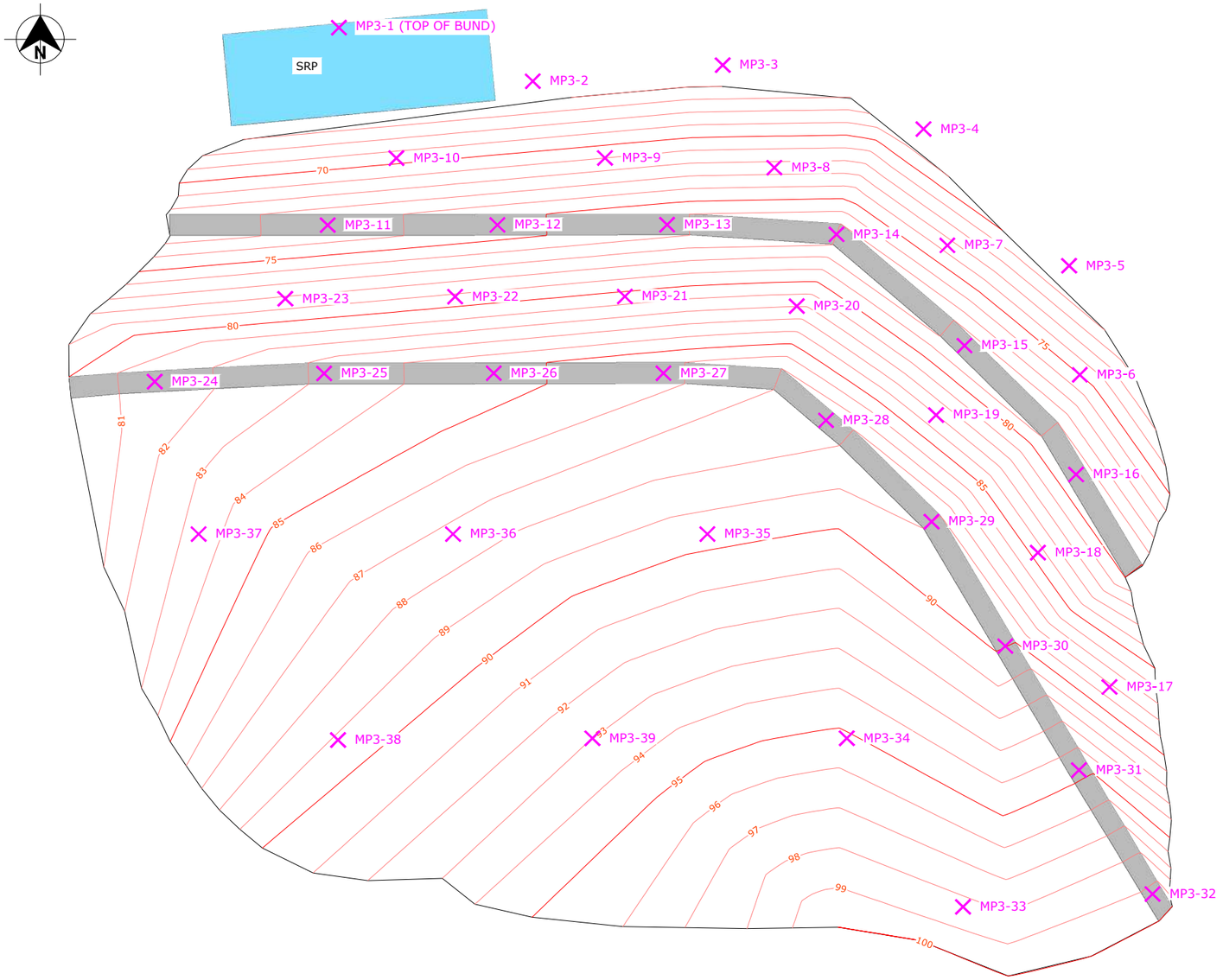
Project No. 2325/74

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-102 Rev. A

FILE LOCATION: J:\2325_Huntly_Quarry_Disposal_Fees\05_Drawings\74\2325-74-101_102.dwg

PLOT DATE: 2021-07-23




## DISPLACEMENT MONITORING LAYOUT

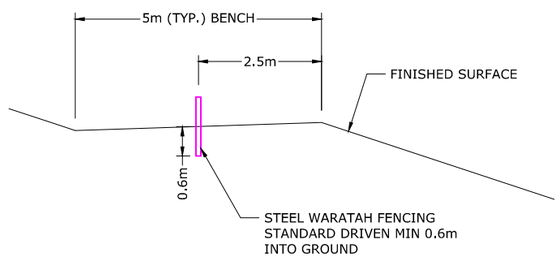
SCALE 1:1250 (A3)

| DISPLACEMENT MONITORING SET-OUT POINT | | | | | |
|---|---|---|---|---|---|
| ID | EASTING | NORTHING | ID | EASTING | NORTHING |
| MP3-1 | 433595.51 | 721665.10 | MP3-21 | 433662.95 | 721601.71 |
| MP3-2 | 433641.25 | 721652.46 | MP3-22 | 433622.94 | 721601.66 |
| MP3-3 | 433686.04 | 721656.25 | MP3-23 | 433582.89 | 721601.16 |
| MP3-4 | 433733.39 | 721641.19 | MP3-24 | 433552.08 | 721581.63 |
| MP3-5 | 433767.74 | 721608.96 | MP3-25 | 433592.03 | 721583.55 |
| MP3-6 | 433770.26 | 721583.24 | MP3-26 | 433632.05 | 721583.60 |
| MP3-7 | 433739.03 | 721613.75 | MP3-27 | 433672.06 | 721583.60 |
| MP3-8 | 433698.21 | 721632.09 | MP3-28 | 433710.41 | 721572.50 |
| MP3-9 | 433658.27 | 721634.37 | MP3-29 | 433735.31 | 721548.60 |
| MP3-10 | 433609.08 | 721634.32 | MP3-30 | 433752.69 | 721519.26 |
| MP3-11 | 433592.89 | 721618.52 | MP3-31 | 433770.06 | 721490.03 |
| MP3-12 | 433632.90 | 721618.57 | MP3-32 | 433787.44 | 721460.81 |
| MP3-13 | 433672.93 | 721618.62 | MP3-33 | 433742.72 | 721457.79 |
| MP3-14 | 433712.87 | 721616.34 | MP3-34 | 433715.30 | 721497.53 |
| MP3-15 | 433743.07 | 721590.11 | MP3-35 | 433682.43 | 721545.69 |
| MP3-16 | 433769.39 | 721559.73 | MP3-36 | 433622.43 | 721545.69 |
| MP3-17 | 433777.28 | 721509.62 | MP3-37 | 433562.43 | 721545.69 |
| MP3-18 | 433760.39 | 721541.31 | MP3-38 | 433595.30 | 721497.12 |
| MP3-19 | 433736.38 | 721573.74 | MP3-39 | 433655.30 | 721497.53 |
| MP3-20 | 433703.50 | 721599.43 | | | |

LEGEND:

- 100 — PROPOSED FILL CONTOURS (1m INTERVAL)
- BENCH (5m WIDE)
- DISPLACEMENT MONITORING POINT

| DISPLACEMENT MONITORING FREQUENCY AND ALERT TRIGGER LEVELS | | |
|---|---|---|
| MONITORING POINT TYPE | MONITORING FREQUENCY | ALERT TRIGGER LEVEL |
| STEEL WARATAH FENCING STANDING | MONTHLY INCREASE TO WEEKLY IF ALERT TRIGGER LEVEL IS EXCEEDED | 100mm NET LATERAL DISPLACEMENT |
| | | 100mm NET VERTICAL DISPLACEMENT |
| NOTE: THE ALERT LEVELS MAYBE REVISED DURING CONSTRUCTION IN RESPONSE TO OBSERVED DISPLACEMENTS | | |




## TYPICAL DISPLACEMENT MONITORING DETAIL

N. T. S.

ORIGINAL IN COLOUR

INFORMATION

| Rev. | Date | Revision Details |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| A | 23/07/21 | ISSUED FOR INFORMATION |


Gaia Engineers
P O Box 51 295, Pakuranga
Auckland 2140
5 Carmont Place, Mt Wellington
Auckland 1060
New Zealand
Tel: 09 276 5673
Mobile: 021 426 012
Email: info@gaia-engineers.co.nz


Client: Gleeson Quarries

Client:

| Project Director: | Signature: | Date: |
|---|---|---|
| K. C. CHEUNG | | |
| Designed: M. KERNOT | | |
| Design Review: K. C. CHEUNG | | |
| Drawn: S. CHEN | | |
| Drafting Check: M. KERNOT | | |

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 3 AREA

Drawing Title: DISPLACEMENT MONITORING LAYOUT

Project No. 2325/74

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-74-103 Rev. A

PLOT DATE:2021-07-22

FILE LOCATION J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2325-74-103.dwg

# APPENDIX B – Test Pit & Borehole Logs

| Description | No. Sheets: |
|---|---|
| Test Pit Log Report Sheets | 30 |
| Borehole Logs Sheets | 12 |


5 Carmont Place, Mt Wellington, Auckland 1060, New Zealand
PO Box 51 295 Pakuranga, Auckland 2140
www.gaia-engineers.co.nz

GAIA ENGINEERS

# TEST PIT LOG

TEST PIT ID. **TP301**

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 17/06/2019 |
| COORDINATES: | E.433564.9m | GROUND R.L (m): | 66.00m | PIT FINISHED: | 17/06/2019 |
| | N.721662.7m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.30 m<br>TOPSOIL | | | | | | | | | | |
| 0.30-5.20 m<br>Clayey SILT with some organic inclusions; grey, orange and dark brown mottles. Very stiff, moist, low plasticity. | | | | | 188+ | | | | | |
| @1.0m - becoming grey with less organics | 1 | | | | 123 | 55 | | | | 65.0 |
| | | | | | 188+ | | | | | |
| | 2 | | | | 188+ | | | | | 64.0 |
| @2.5m - becoming stiff, dark grey with some inclusions of green-grey sandy SILT | | | Historic Mining Fill | | 188+ | | | | | |
| @3.0m - mottles of inferred Waikato Coal Measures weathered soils (moderate to highly plastic light grey and orange, silty CLAY) | 3 | | | | 75 | 41 | | | | 63.0 |
| @3.5m - becoming very stiff | | | | | 188+ | | | | | |
| @4.0m - inclusions of inferred Waikato Coal Measures mudstone boulders and coal | 4 | | | | 106 | 27 | | | | 62.0 |
| | | | | | 188+ | | | | | |
| @4.8m - increase in mudstone boulders, fast seepage observed | | | | ▼ | | | | | | |
| | 5 | | | | UTP | | | | | 61.0 |
| End of Pit @ 5.2 m | | | | | | | | | | |
| | 6 | | | | | | | | | 60.0 |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Encountered @ 4.8m |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP301

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

# TEST PIT LOG

TEST PIT ID. TP302

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 17/06/2019 |
| COORDINATES: | E.433608.1m | GROUND R.L (m): | 66.10m | PIT FINISHED: | 17/06/2019 |
| | N.721654.5m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.10 m<br>TOPSOIL<br>0.10-0.30 m<br>Silty CLAY; orange and light grey; Very stiff, moist, low plasticity.<br>0.30-5.00 m<br>Clayey SILT; dark grey and black with coal/carbonaceous inclusions<br>@0.5m - becoming dark grey, broken moderately weathered mudstone | 1 | | Historic Mining Fill | | UTP<br>UTP<br>UTP | | 2 4 6 8 10 12 | | | 66.0<br>65.0 |
| @3.0m - becoming stiff, blue-grey with some fine sand with limonite and organic staining | 2<br>3<br>4 | | | | 188+<br>130<br>89<br>68<br>75 | 14<br>27<br>27<br>27 | | | | 64.0<br>63.0<br>62.0 |
| End of Pit @ 5.0 m | 5<br>6 | | | | 75<br>55 | 27<br>14 | | | | 61.0 |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP302

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

# TEST PIT LOG

TEST PIT ID. TP303

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 17/06/2019 |
| COORDINATES: | E.433648.9m | GROUND R.L (m): | 65.70m | PIT FINISHED: | 17/06/2019 |
| | N.721662.2m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.10 m<br>TOPSOIL | | | | | | | | | | |
| 0.10-0.30 m<br>Clayey SILT; red, orange and light grey. Very stiff, moist, low plasticity, insensitive. | | | | | | | | | | |
| 0.30-1.50 m<br>Clayey SILT with some carbonized wood fragments and mudstone boulders; dark grey. Very stiff, moist, low plasticity. | | | | | 102 | 55 | | | | |
| | 1 | | | | UTP | | | | | 65.0 |
| @1.2m - fast seepage encountered | | | | | | | | | | |
| 1.50-4.50 m<br>Silty CLAY with trace organic staining; light blue-grey. Very stiff, wet, moderate plasticity. | | | | | UTP | | | | | |
| | 2 | | Historic Mining Fill | | 95 | 55 | | | | 64.0 |
| @2.0m - becoming stiff | | | | | | | | | | |
| | | | | | | | | | | 63.0 |
| @3.0m - with trace fine sand and fine gravel sized white clasts | 3 | | | | 68 | 41 | | | | |
| | | | | | | | | | | 62.0 |
| | 4 | | | | 61 | 34 | | | | |
| End of Pit @ 4.5 m | | | | | 75 | 41 | | | | |
| | | | | | | | | | | 61.0 |
| | 5 | | | | | | | | | |
| | | | | | | | | | | 60.0 |
| | 6 | | | | | | | | | |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP303

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

GAIA ENGINEERS

# TEST PIT LOG

TEST PIT ID. **TP304**

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 17/06/2019 |
| COORDINATES: | E.433693.2m | GROUND R.L (m): | 66.10m | PIT FINISHED: | 17/06/2019 |
| | N.721649.1m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.10 m<br>TOPSOIL | | | | | | | | | | 66.0 |
| 0.10-0.50 m<br>Clayey SILT; light brown-orange. Very stiff, moist, low plasticity | | | | | 188+ | | | | | |
| 0.50-1.50 m<br>Slightly weathered MUDSTONE boulders in silty CLAY matrix; dark grey with black and light grey mottles. Hard/tightly packed, moist. | 1 | | | | 188+ | | | | | 65.0 |
| 1.50-5.00 m<br>Silty CLAY; light blue-grey. Stiff, moist, moderate plasticity. | | | | | 82 | 41 | | | | |
| @2.0m - with some fine sand, remnant mudstone fabric visible | 2 | | Historic Mining Fill | | 68 | 41 | | | | 64.0 |
| | | | | | 75 | 41 | | | | |
| | 3 | | | | 68 | 41 | | | | 63.0 |
| | 4 | | | | 75 | 34 | | | | 62.0 |
| End of Pit @ 5.0 m | 5 | | | | 75 | 41 | | | | 61.0 |
| | 6 | | | | | | | | | |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP304

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

# TEST PIT LOG

TEST PIT ID. TP305

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 17/06/2019 |
| COORDINATES: | E.433731.6m | GROUND R.L (m): | 67.60m | PIT FINISHED: | 17/06/2019 |
| | N.721574.8m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.10 m<br>TOPSOIL<br>0.10-1.00 m<br>Clayey SILT; orange-brown. Very stiff, moist, low plasticity<br><br>@0.5 to 1.0m - very weak moderately weathered mudstone inclusions | | | | | 188+ | | | | | 67.0 |
| 1.00-3.50 m<br>Silty BOULDERS with some silty and clay; dark grey with black and light grey mottles. Tightly packed; moist; slightly weathered mudstone; silt and clay, low plasticity.<br><br>@1.5m - mudstone inclusions becomes medium to coarse gravel sized.<br><br>@2.0m - fast seepage encountered | 1<br>2<br>3 | | Historic Mining Fill | ▼ | 95<br>136<br>82<br>89 | 27<br>27<br>30<br>34 | | | | 66.0<br>65.0 |
| End of Pit @ 3.5 m | 4<br>5<br>6 | | | | 95 | 27 | | | | 64.0<br>63.0<br>62.0 |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872<br>Terminated Due to Pit Collapsing | Groundwater encountered @ 2.0m |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP305

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

GAIA ENGINEERS

# TEST PIT LOG

TEST PIT ID. **TP306**

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 17/06/2019 |
| COORDINATES: | E.433680.9m | GROUND R.L (m): | 67.50m | PIT FINISHED: | 17/06/2019 |
| | N.721557.8m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.10 m<br>TOPSOIL | | | | | | | | | | |
| 0.10-0.60 m<br>Clayey SILT with trace topsoil; dark orange, light grey and grey mottles. Very stiff, moist, low plasticity | | | | | 129 | 48 | | | | 67.0 |
| 0.60-1.50 m<br>Silty CLAY with some cobbles; grey. Very stiff, moist, low plasticity; cobbles are moderately weathered mudstone, fractured. | 1 | | | | UTP | | | | | |
| 1.50-4.00 m<br>Silty COBBLES with some clay and boulders; brownish grey. Loosely packed; moist; slightly weathered mudstone; silt and clay, low plasticity. | | | Historic Mining Fill | | 116 | 41 | | | | 66.0 |
| @2.0m - mudstone cobbles become fine to coarse gravel. | 2 | | | | 109 | 41 | | | | 65.0 |
| | 3 | | | | 129 | 55 | | | | 64.0 |
| End of Pit @ 4.0 m | 4 | | | | 143 | 41 | | | | 63.0 |
| | 5 | | | | | | | | | 62.0 |
| | 6 | | | | | | | | | |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872<br>Terminated Due to Pit Collapsing | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP306

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

# TEST PIT LOG

TEST PIT ID. TP307

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 17/06/2019 |
| COORDINATES: | E.433638.0m | GROUND R.L (m): | 67.60m | PIT FINISHED: | 17/06/2019 |
| | N.721553.0m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) 2 4 6 8 10 12 | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-1.00 m<br>Clayey SILT; light brown-orange and brown mottles. Stiff, moist, low plasticity. | 1 | | Historic Mining Fill | | | | | | | 67.0 |
| 1.00-4.00 m<br>Clayey SILT with some gravel; grey-brown. Stiff, moist, low plasticity; gravels are fine to coarse, mudstone. | 2 | | | | | | | | | 66.0 |
| | 3 | | | | | | | | | 65.0 |
| | 4 | | | | | | | | | 64.0 |
| End of Pit @ 4.0 m | 5 | | | | | | | | | 63.0 |
| | 6 | | | | | | | | | 62.0 |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP307

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

# TEST PIT LOG

TEST PIT ID. TP308

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 18/06/2019 |
| COORDINATES: | E.433618.3m | GROUND R.L (m): | 67.00m | PIT FINISHED: | 18/06/2019 |
| | N.721587.7m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.10 m<br>TOPSOIL | | | | | | | | | | |
| 0.10-0.50 m<br>Clayey SILT; light brown-orange, grey and brown mottles. Very stiff, moist, low plasticity. | | | | | 188+ | | | | | |
| 0.50-5.00 m<br>Clayey SILT with some gravel; grey and brown mottles. Very stiff, moist, low plasticity; gravels are moderately weathered mudstone and coal fragments. | 1 | | | | 188+ | | | | | 66.0 |
| @1.5m - increase in side of mudstone gravel to cobbles and boulders | | | | | 188+ | | | | | |
| | 2 | | Historic Mining Fill | | 188+ | | | | | 65.0 |
| | | | | | 188+ | | | | | |
| | 3 | | | | 188+ | | | | | 64.0 |
| @4.0m - fast seepage encountered | 4 | | | ▼ | 188+ | | | | | 63.0 |
| | | | | | 188+ | | | | | |
| End of Pit @ 5.0 m | 5 | | | | | | | | | 62.0 |
| | 6 | | | | | | | | | 61.0 |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Encountered @ 4.0m |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP308

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

GAIA ENGINEERS

# TEST PIT LOG

TEST PIT ID. **TP309**

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 18/06/2019 |
| COORDINATES: | E.433628.6m | GROUND R.L (m): | 71.60m | PIT FINISHED: | 18/06/2019 |
| | N.721518.8m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.20 m<br>TOPSOIL | | | | | | | | | | |
| 0.20-1.20 m<br>Silty CLAY; light grey and orange. Very stiff, moist, moderate to high plasticity. | | | | | 188+ | | | | | 71.0 |
| | 1 | | | | 188+ | | | | | |
| 1.20-4.00 m<br>Completely weathered, light grey with orange streaks, MUDSTONE; extremely weak [clayey SILT; Hard, moist, non plastic]. | | | | | 188+ | | | | | 70.0 |
| @2.0 to 2.5m - becoming brown orange with red and pink streaks | 2 | | Waikato Coal Measures | | 143 | 55 | | | | 69.0 |
| | 3 | | | | 136 | 49 | | | | 68.0 |
| 4.00-5.50 m<br>Highly weathered, brown-orange with pink and red streaks, MUDSTONE; extremely weak [clayey SILT; hard, moist, non plastic] | 4 | | | | 143 | 41 | | | | 67.0 |
| | 5 | | | | 188+ | | | | | |
| End of Pit @ 5.5 m | | | | | | | | | | 66.0 |
| | 6 | | | | | | | | | |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP309

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

GAIA ENGINEERS

# TEST PIT LOG

TEST PIT ID. **TP310**

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 18/06/2019 |
| COORDINATES: | E.433674.4m | GROUND R.L (m): | 70.00m | PIT FINISHED: | 18/06/2019 |
| | N.721530.7m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.20 m<br>TOPSOIL | | | | | | | | | | |
| 0.20-1.80 m<br>Silty BOULDERS with some silty and clay; dark grey with black and light grey mottles. Tightly packed; moist; slightly weathered mudstone; silt and clay, low plasticity. | 1 | | Historic Mining Fill | | UTP<br>UTP<br>UTP | | | | | 69.0 |
| 1.80-3.00 m<br>Silty CLAY; orange and light grey. Very stiff, moist, low plasticity. | 2 | | | | 188+ | | | | | 68.0 |
| 3.00-4.50 m<br>Completely weathered, light grey and orange with pink streaks, MUDSTONE; extremely weak [clayey SILT; Hard, moist, non plastic]. | 3 | | Waikato Coal Measures | | 188+ | | | | | 67.0 |
| | 4 | | | | 188+ | | | | | 66.0 |
| End of Pit @ 4.5 m | 5 | | | | 188+ | | | | | 65.0 |
| | 6 | | | | | | | | | 64.0 |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP310

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

# TEST PIT LOG

TEST PIT ID. TP311

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 18/06/2019 |
| COORDINATES: | E.433737.7m | GROUND R.L (m): | 73.20m | PIT FINISHED: | 18/06/2019 |
| | N.721514.9m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.30 m<br>TOPSOIL | | | | | | | | | | 73.0 |
| 0.30-1.00 m<br>Silty CLAY; red, light grey and orange-brown. Very stiff, moist, moderate plasticity. | | | | | 143 | 55 | | | | |
| 1.00-5.00 m<br>Completely weathered, light grey with orange streaks, MUDSTONE; extremely weak<br>[clayey SILT; Very stiff, moist, non plastic] | 1 | | | | 140 | 48 | | | | 72.0 |
| | | | | | 188+ | | | | | |
| | 2 | | Waikato Coal Measures | | | | | | | 71.0 |
| @3.0m - becoming light grey and pink with MnO staining | 3 | | | | 188+ | | | | | 70.0 |
| | 4 | | | | 188+ | | | | | 69.0 |
| End of Pit @ 5.0 m | 5 | | | | 188+ | | | | | 68.0 |
| | 6 | | | | | | | | | |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

| GAIA ENGINEERS | Test Pit Photographs | TP311 | |
|---|---|---|---|
| | | PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325 |

Image Not Available

# TEST PIT LOG

TEST PIT ID. TP312

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 18/06/2019 |
| COORDINATES: | E.433713.3m | GROUND R.L (m): | 87.80m | PIT FINISHED: | 18/06/2019 |
| | N.721479.4m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.20 m<br>TOPSOIL | | | | | | | | | | |
| 0.20-1.50 m<br>Silty CLAY; brown-orange. Very stiff, moist, moderate plasticity. | 1 | | | | 188+ | | | | | 87.0 |
| 1.50-4.00 m<br>Silty CLAY; light grey, red and orange. Very stiff, moist, moderate plasticity. | 2 | | Waikato Coal Measures | | 188+ | | | | | 86.0 |
| | 3 | | | | 188+ | | | | | 85.0 |
| End of Pit @ 4.0 m | 4 | | | | 188+ | | | | | 84.0 |
| | 5 | | | | | | | | | 83.0 |
| | 6 | | | | | | | | | 82.0 |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP312

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

# TEST PIT LOG

TEST PIT ID. TP313

1:30 Sheet 1 of 1

| | | | | | |
|---|---|---|---|---|---|
| PROJECT: | Huntly Quarry Disposal Sites | CLIENT: | Gleeson Quarries Ltd. | JOB No: | 2325 |
| LOCATION: | Huntly Quarry | SURVEY CIRCUIT: | NZGD2000 Mt Eden Circuit | PIT STARTED: | 18/06/2019 |
| COORDINATES: | E.433732.8m | GROUND R.L (m): | 67.90m | PIT FINISHED: | 18/06/2019 |
| | N.721668.8m | DATUM: | Auckland Vertical Datum 1946 | WEATHER: | Fine |

| Soil/Rock Description | Depth(m) | Graphic Log | Geologic Unit | Ground water | Vane Shear Strength (kPa) Tp | Vane Shear Strength (kPa) Tr | Scala (blows/100mm) | Sample ID | Sample Type | R.L (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-1.10 m<br>Clayey SILT; brown-orange. Stiff, moist, low plasticity. | 1 | | FILL (Forrestry) | | 89<br>143 | 41<br>68 | | | | 67.0 |
| 1.10-1.20 m<br>TOPSOIL (buried) | | | | | | | | | | |
| 1.20-4.00 m<br>Clayey SILT; brown-orange. Very stiff, moist, low plasticity | 2 | | Waikato Col Measures | | 188+<br>146 | 76 | | | | 66.0 |
| @3.6m - becoming light grey and orange, trace rock fabric visible | 3 | | | | 145 | 76 | | | | 65.0 |
| End of Pit @ 4.0 m | 4 | | | | 143 | 82 | | | | 64.0 |
| | 5 | | | | | | | | | 63.0 |
| | 6 | | | | | | | | | 62.0 |

| | | | |
|---|---|---|---|
| Contractor: | Gleeson Civil Ltd. | Remarks: | Groundwater notes: |
| Plant: | Hitatch 30t Excavator | SV readings corrected to BS1377 - Dial No. 1872 | Groundwater Not Encountered |
| Logged: | MK | | |
| Checked: | KCC | | |
| Approved: | KCC | Logged in accordance with NZ Geotechnical Society (2005) guidelines | |

GAIA ENGINEERS

# Test Pit Photographs

## TP313

PROJECT: Huntly Quarry Disposal Sites | JOB No: 2325

# TEST PIT LOG

**TEST PIT ID:** TP314

Sheet 1 of 3

PROJECT: Huntly Quarry Fill Sites | CLIENT: Gleeson Quarries Ltd. | JOB No.: 2325

LOCATION: Huntly Quarry Fill Site - 300 Riverview Roac
CO-ORDINATES: E.433610m N.721648m
SURVEY CIRCUIT: MTEDEN2000
GROUND R.L (m): 66.27m
DATUM: NZVD1946
PIT STARTED: 25/10/2019
PIT FINISHED: 25/10/2019
WEATHER: Overcast

| Soil / Rock Description | Depth (m) | Graphic Log | Geological Unit | Ground Water | Vane Shear Strength (kPa) $T_p$ | Vane Shear Strength (kPa) $T_r$ | Scala (Blows / 0mm) 2 4 6 8 10 12 | Sample ID | Sample Type | R.L. (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.00-0.30 m<br>Topsoil | | TS | | Groundwater Not Encountered | | | | | | 66 |
| 0.30-12.00 m<br>SILT, with some clay, with minor gravel and cobbles, with trace carbonaceous; grey with brown and black mottles.<br>Stiff to very stiff; moist; gravel, medium to coarse, slightly weathered, Mudstone, cobbles, slightly weathered, Mudstone. | 1<br>2<br>3<br>4 | | Fill | | | | | | | 65<br>64<br>63<br>62 |

Contractor: Gleeson Civil
Plant: 30t Excavator
Logged: MK
Checked: KCC
Approved:

Remarks

Groundwater Notes:

Revision:

Logged in accordance with NZ Geotechnical Society (2005) guidelines

# TEST PIT LOG

**TEST PIT ID:** TP314
Sheet 2 of 3

PROJECT: Huntly Quarry Fill Sites | CLIENT: Gleeson Quarries Ltd. | JOB No.: 2325

LOCATION: Huntly Quarry Fill Site - 300 Riverview Roac
CO-ORDINATES: E.433610m N.721648m
SURVEY CIRCUIT: MTEDEN2000
GROUND R.L (m): 66.27m
DATUM: NZVD1946
PIT STARTED: 25/10/2019
PIT FINISHED: 25/10/2019
WEATHER: Overcast

| Soil / Rock Description | Depth (m) | Graphic Log | Geological Unit | Ground Water | Vane Shear Strength (kPa) $T_p$ | Vane Shear Strength (kPa) $T_r$ | Scala (Blows / 0mm) 2 4 6 8 10 12 | Sample ID | Sample Type | R.L. (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| [CONT] 0.30-12.00 m<br>SILT, with some clay, with minor gravel and cobbles, with trace carbonaceous; grey with brown and black mottles.<br>Stiff to very stiff; moist; gravel, medium to coarse, slightly weathered, Mudstone, cobbles, slightly weathered, Mudstone.<br><br>5.0m - 5.5m: CLAY, with some silt; bluish grey. Firm; moist to wet. | 6<br>7<br>8<br>9 | | [CONT] Fill | Groundwater Not Encountered | | | | | | 61<br>60<br>59<br>58<br>57 |

Contractor: Gleeson Civil
Plant: 30t Excavator
Logged: MK
Checked: KCC
Approved:

Remarks

Groundwater Notes:

Revision:

Logged in accordance with NZ Geotechnical Society (2005) guidelines

# TEST PIT LOG

**TEST PIT ID:** TP314
Sheet 3 of 3

PROJECT: Huntly Quarry Fill Sites | CLIENT: Gleeson Quarries Ltd. | JOB No.: 2325

LOCATION: Huntly Quarry Fill Site - 300 Riverview Roac
CO-ORDINATES: E.433610m N.721648m
SURVEY CIRCUIT: MTEDEN2000
GROUND R.L (m): 66.27m
DATUM: NZVD1946
PIT STARTED: 25/10/2019
PIT FINISHED: 25/10/2019
WEATHER: Overcast

| Soil / Rock Description | Depth (m) | Graphic Log | Geological Unit | Ground Water | Vane Shear Strength (kPa) $T_p$ | Vane Shear Strength (kPa) $T_r$ | Scala (Blows / 0mm) 2 4 6 8 10 12 | Sample ID | Sample Type | R.L. (m) |
|---|---|---|---|---|---|---|---|---|---|---|
| [CONT] 0.30-12.00 m<br>SILT, with some clay, with minor gravel and cobbles, with trace carbonaceous; grey with brown and black mottles.<br>Stiff to very stiff; moist; gravel, medium to coarse, slightly weathered, Mudstone, cobbles, slightly weathered, Mudstone. | 11 | | [CONT] Fill | Groundwater Not Encountered | | | | | | 56 |
| End of Pit @ 12.0m | 12 | | | | | | | | | 55 |
| | 13 | | | | | | | | | 54 |
| | 14 | | | | | | | | | 53 |
| | | | | | | | | | | 52 |

Contractor: Gleeson Civil
Plant: 30t Excavator
Logged: MK
Checked: KCC
Approved:

Remarks

Groundwater Notes:

Revision:

Logged in accordance with NZ Geotechnical Society (2005) guidelines

# TEST PIT PHOTOGRAPHS

**TEST PIT ID:** TP314

PROJECT: Huntly Quarry Fill Sites | CLIENT: Gleeson Quarries Ltd. | JOB No.: 2325

# BOREHOLE LOG

**HOLE NO.:** BH301

**CLIENT:** Gleeson Quarries Ltd.

**PROJECT:** Huntly Quarry Fill Sites

**JOB NO.:** 2325

**SITE LOCATION:** Huntly Quarry Fill Site - 300 Riverview Road, Huntly Fill Site 3

**START DATE:** 01/03/2021

**CO-ORDINATES:** 721635mN , 433634mE **GROUND RL:** 66.28 m

**END DATE:** 03/03/2021

**SURVEY CIRCUIT:** MTEDEN2000 **DATUM:** NZVD1946 **WEATHER:** Fine



| GEOLOGY | MATERIAL DESCRIPTION (See Classification & Symbology sheet for details) | DEPTH (m) | RL (m) | SAMPLE TYPE | TCR (%) | GRAPHIC | WEATHERING | STRENGTH | SPT DATA | VANE SHEAR STRENGTH (kPa) | NOTES, DEFECTS, SAMPLES & LABORATORY TEST RESULTS | METHOD | WATER LEVEL | PIEZOMETER INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fill | Clayey SILT, with minor organic staining; light brown-orange.<br>Stiff; low plasticity. | 0 | 66 | | 73 | | | | | | | Rotary cored | Water Level Not Measured | |
| | Clayey SILT, with minor fibrous organic clasts, with trace gravel; brown, grey and black mottles.<br>Firm; low plasticity; gravel, coarse, slightly weathered, Mudstone. | 1 | 65 | | 22 | | | | 2, 2 / 2, 2, 1, 1<br>N=6 | | | | | |
| | Core Loss: 1.95 to 2.4m | 2 | 64 | | 0 | | | | | | | | | |
| | Clayey SILT, with minor fibrous organic clasts, with trace gravel; brown, grey and black mottles.<br>Firm; low plasticity; gravel, coarse, slightly weathered, Mudstone. | 3 | 63 | | 100<br>100 | | | | 2, 1 / 1, 1, 1, 0<br>N=3 | | | | | |
| | Core Loss: 3.45 to 3.9m | 4 | 62 | | 0 | | | | | | | | | |
| | Clayey SILT, with minor fibrous organic clasts, with trace gravel; brown, grey and black mottles.<br>Firm; low plasticity; gravel, coarse, slightly weathered, Mudstone. | 5 | 61 | | 100<br>100 | | | | 4, 6 / 3, 2, 2, 2<br>N=9 | | | | | |
| | Core Loss: 4.95 to 5.6m | 6 | 60 | | 0 | | | | | | | | | |
| | Clayey SILT, with minor fibrous organic clasts, with trace gravel; brown, grey and black mottles.<br>Firm; low plasticity; gravel, coarse, slightly weathered, Mudstone. | 7 | 59 | | 100<br>100<br>100 | | | | 1, 1 / 1, 1, 2, 2<br>N=6 | | | | | |
| | Core Loss: 7.95 to 8.6m | 8 | 58 | | 0 | | | | 1, 1 / 2, 2, 1, 2<br>N=7 | | | | | |
| | Clayey SILT, with minor fibrous organic clasts, with trace gravel; brown, grey and black mottles.<br>Firm; low plasticity; gravel, coarse, slightly weathered, Mudstone. | 9 | 57 | | 100 | | | | | | | | | |
| | Silty CLAY; brown and blue-grey, oxidises to light brown.<br>Soft to firm; high plasticity. | | | | 100 | | | | 0, 0 / 0, 0, 1, 1<br>N=2 | | | | | |
| | Core Loss: 9.45 to 9.9m | | | | 0 | | | | | | | | | |

**REMARKS**

**LOGGED BY:** MK

**CHECKED BY:** JB

**APPROVED BY:** KCC

**STATUS:** FINAL

**CONTRACTOR:** Drill Force

**RIG:** Tractor

**DRILLER:** Conan

| REF | DATE / TIME | LEVEL | REMARK |
|---|---|---|---|

LOGGED IN ACCORDANCE WITH NEW ZEALAND GEOTECHNICAL SOCIETY GUIDELINES (2005)

**Gaia Engineers Ltd**

5 Carmont Place,
Mt Wellington
Auckland 1060,
New Zealand

P O Box 51 295,
Pakuranga
Auckland 2140,
New Zealand

info@gaia-engineers.co.nz

# BOREHOLE LOG

**HOLE NO.:** BH301

**CLIENT:** Gleeson Quarries Ltd.
**PROJECT:** Huntly Quarry Fill Sites

**JOB NO.:** 2325

**SITE LOCATION:** Huntly Quarry Fill Site - 300 Riverview Road, Huntly Fill Site 3
**START DATE:** 01/03/2021
**CO-ORDINATES:** 721635mN , 433634mE **GROUND RL:** 66.28 m
**END DATE:** 03/03/2021
**SURVEY CIRCUIT:** MTEDEN2000 **DATUM:** NZVD1946 **WEATHER:** Fine
**PAGE:** 2 OF 3

| GEOLOGY | MATERIAL DESCRIPTION (See Classification & Symbology sheet for details) | DEPTH (m) / RL (m) | SAMPLE TYPE | TCR (%) | GRAPHIC | WEATHERING | STRENGTH | SPT DATA | VANE SHEAR STRENGTH (kPa) | NOTES, DEFECTS, SAMPLES & LABORATORY TEST RESULTS | METHOD | WATER LEVEL | PIEZOMETER INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fill | Silty CLAY; brown and blue-grey, oxidises to light brown. Soft to firm; high plasticity. | 56 | | | | | | | | | | | |
| | Clayey SILT, with some fibrous organics (decomposed wood fragments); light grey and light brown. Stiff; low plasticity. | | | 100 | | | | 0, 1 / 1, 1, 1, 1 N=4 | | | | | |
| | Core Loss: 10.95 to 11.2m | 11 / 55 | | 0 | | | | | | | | | |
| | Clayey SILT, with trace fibrous organics; light grey and light brown. Stiff; low plasticity. | | | 100 | | | | | | | | | |
| | Clayey SILT, with trace organic inclusions and staining and sand; dark brown, light blue-grey and light brown. Low plasticity; sand, pumiceous . | 12 / 54 | | 100 | | | | 0, 0 / 0, 1, 2, 2 N=5 | | | | | |
| | | 13 / 53 | | 100 | | | | | | | | | |
| | | | | 100 | | | | 0, 0 / 0, 0, 1, 1 N=2 | | | | | |
| | | 14 / 52 | | 100 | | | | | | | | | |
| | Clayey sandy SILT, with trace organic staining; dark brown. Stiff; low plasticity. | | | | | | | | | | | | |
| | 14.9m - 15.1m: Some organic disseminated fibers | 15 / 51 | | 100 | | | | 0, 1 / 2, 1, 1, 1 N=5 | | | Rotary cored | Water Level Not Measured | |
| | | 16 / 50 | | 100 | | | | | | | | | |
| | | | | 100 | | | | 1, 0 / 1, 1, 1, 2 N=5 | | | | | |
| | Core Loss: 16.95 to 17.4m | 17 / 49 | | 0 | | | | | | | | | |
| | Clayey sandy SILT, with trace organic staining; dark brown. Stiff; low plasticity. | | | 100 | | | | | | | | | |
| | Clayey SILT, with some gravel; brownish. Low plasticity; gravel, Sandstone. | 18 / 48 | | 100 | | | | 2, 3 / 2, 4, 4, 5 N=15 | | | | | |
| | Silty CLAY; brown-orange and dark brown mottles. Stiff; low plasticity. | | | | | | | | | | | | |
| | GRAVEL. Gravel, medium, subangular. | 19 / 47 | | 100 | | | | | | | | | |
| | TOPSOIL; dark brown. | | | | | | | | | | | | |
| | Core Loss: 19.5 to 19.95m | | | 0 | | | | 2, 5 / 5, 5, 4, 3 N=17 | | | | | |

**REMARKS**
**LOGGED BY:** MK
**CHECKED BY:** JB
**APPROVED BY:** KCC
**STATUS:** FINAL
**CONTRACTOR:** Drill Force
**RIG:** Tractor
**DRILLER:** Conan

| REF | DATE / TIME | LEVEL | REMARK |
|---|---|---|---|

LOGGED IN ACCORDANCE WITH NEW ZEALAND GEOTECHNICAL SOCIETY GUIDELINES (2005)


**Gaia Engineers Ltd**
5 Carmont Place,
Mt Wellington
Auckland 1060,
New Zealand

P O Box 51 295,
Pakuranga
Auckland 2140,
New Zealand

info@gaia-engineers.co.nz

# BOREHOLE LOG

**HOLE NO.:** BH301

**CLIENT:** Gleeson Quarries Ltd.
**PROJECT:** Huntly Quarry Fill Sites

**JOB NO.:** 2325

**SITE LOCATION:** Huntly Quarry Fill Site - 300 Riverview Road, Huntly Fill Site 3
**START DATE:** 01/03/2021
**CO-ORDINATES:** 721635mN , 433634mE **GROUND RL:** 66.28 m
**END DATE:** 03/03/2021
**SURVEY CIRCUIT:** MTEDEN2000 **DATUM:** NZVD1946 **WEATHER:** Fine
**PAGE:** 3 OF 3

| GEOLOGY | MATERIAL DESCRIPTION (See Classification & Symbology sheet for details) | DEPTH (m) / RL (m) | SAMPLE TYPE | TCR (%) | GRAPHIC | WEATHERING | STRENGTH | SPT DATA | VANE SHEAR STRENGTH (kPa) | NOTES, DEFECTS, SAMPLES & LABORATORY TEST RESULTS | METHOD | WATER LEVEL | PIEZOMETER INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Newcastle Group | Core Loss: 19.95 to 20.9m | 21 / 45 | | 100 | | | | 5, 5 / 6, 4, 4, 11 N=25 | | | Rotary cored | Water Level Not Measured | |
| | GRAVEL; greyish. Gravel, medium to coarse, subround. | | | | | | | | | | | | |
| | Completely weathered; greyish brown; SILTSTONE; extremely weak; sandy SILT with MnO staining on defects, non plastic. | 22 / 44 | | 100 | | EW | | | | | | | |
| | Moderately weathered; orange and light brown; fine fabric, thinly laminated; SILTSTONE; very weak. | 23 / 43 | | 100 | | HW | | 2, 4 / 10, 17, 11, 10 N=48 | | | | | |
| | | | | 0 | | | | | | | | | |
| | Slightly weathered; grey ; SILTSTONE; moderately strong. | 24 / 42 | | 100 | | MW | | 2, 8 / 50 for 60mm N=50 for 60mm | | | | | |
| | EOH: 24.00m | | | | | | | | | | | | |

**REMARKS**
**LOGGED BY:** MK
**CHECKED BY:** JB
**APPROVED BY:** KCC
**STATUS:** FINAL
**CONTRACTOR:** Drill Force
**RIG:** Tractor
**DRILLER:** Conan

| REF | DATE / TIME | LEVEL | REMARK |
|---|---|---|---|

LOGGED IN ACCORDANCE WITH NEW ZEALAND GEOTECHNICAL SOCIETY GUIDELINES (2005)


**Gaia Engineers Ltd**
5 Carmont Place,
Mt Wellington
Auckland 1060,
New Zealand

P O Box 51 295,
Pakuranga
Auckland 2140,
New Zealand

info@gaia-engineers.co.nz

GAIA ENGINEERS

# CORE PHOTOS

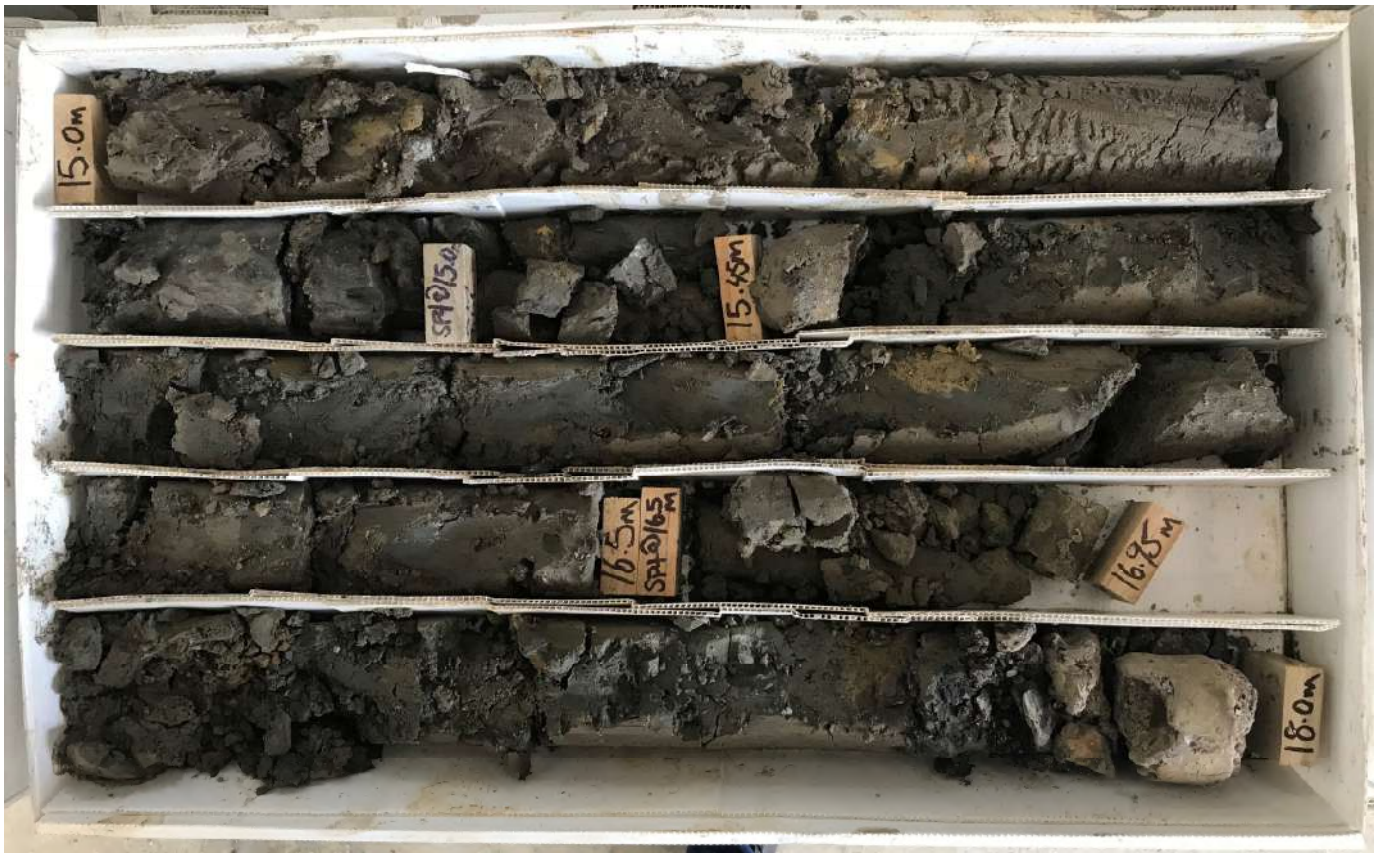
**HOLE NO.:** BH301

**JOB NO.:** 2325


0.00-6.00m


6.00-10.50m


10.50-14.40m




14.40-18.00m

GAIA ENGINEERS

# CORE PHOTOS

**HOLE NO.:** BH301

**JOB NO.:** 2325


18.00-24.00m

# BOREHOLE LOG

**HOLE NO.:** BH302

**CLIENT:** Gleeson Quarries Ltd.
**PROJECT:** Huntly Quarry Fill Sites

**JOB NO.:** 2325

**SITE LOCATION:** Huntly Quarry Fill Site - 300 Riverview Road, Huntly Fill Site 3
**START DATE:** 24/02/2021

**CO-ORDINATES:** 721666mN , 433609mE **GROUND RL:** 65.64 m
**END DATE:** 26/02/2021

**SURVEY CIRCUIT:** MTEDEN2000 **DATUM:** NZVD1946 **WEATHER:** Fine
**PAGE:** 1 OF 3

| GEOLOGY | MATERIAL DESCRIPTION (See Classification & Symbology sheet for details) | DEPTH (m) | RL (m) | SAMPLE TYPE | TCR (%) | GRAPHIC | WEATHERING | STRENGTH | SPT DATA | VANE SHEAR STRENGTH (kPa) | NOTES, DEFECTS, SAMPLES & LABORATORY TEST RESULTS | METHOD | WATER LEVEL | PIEZOMETER INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fill | TOPSOIL.<br>Silty CLAY; light grey and brown.<br>High plasticity. | 0 | 65 | | | | | | | | | | | |
| | Silty CLAY, with some organic inclusions; dark brown, grey and black mottles.<br>Stiff; low plasticity. | 1 | | | 58 | | | | | | | | | |
| | CLAY & SILT, with trace organic staining and sand; grey, blue-grey and dark brown mottles.<br>Stiff; low plasticity; sand, fine, pumiceous. | 2 | 64 | | 33 | | | | 1, 2 / 1, 1, 0, 1<br>N=3 | | | | | |
| | 2.4m - 2.4m: with some organic staining, dark grey and dark brow mottles | 3 | 63 | | 87 | | | | 0, 0 / 0, 1, 1, 1<br>N=3 | | | | | |
| | Core Loss: 3.45 to 4.4m | 4 | 62 | | 90<br>0 | | | | | | | | | |
| | Silty CLAY; light grey and light brown-orange mottles .<br>Firm; high plasticity. | 5 | 61 | | 100<br>100 | | | | 1, 0 / 1, 0, 1, 1<br>N=3 | | | Rotary cored | | |
| | 5.3m - 5.3m: becoming dark brown-orange and dark brown, some fibrous organic inclusions | 6 | 60 | | 100 | | | | 2, 2 / 1, 1, 2, 1<br>N=5 | | | | | |
| | Sandy SILT; dark brown with occaisional orange mottles.<br>Stiff; low plasticity. | 7 | 59 | | 100<br>100 | | | | 0, 0 / 1, 0, 0, 1<br>N=2 | | | | | |
| | Clayey SILT, with trace organic inclusions; dark brown with occaisional orange mottles.<br>Firm; high plasticity. | 8 | 58 | | 57 | | | | 1, 1 / 1, 1, 2, 1<br>N=5 | | | | | |
| | Clayey SILT, with some organic staining; dark brown and grey mottles.<br>Stiff; low plasticity. | 9 | 57 | | 100<br>48 | | | | | | | | | |
| | | | 56 | | | | | | | | | | | |

**REMARKS**

**LOGGED BY:** MK
**CHECKED BY:** JB
**APPROVED BY:** KCC
**STATUS:** FINAL
**CONTRACTOR:** Drill Force
**RIG:** Tractor
**DRILLER:** Conan

| REF | DATE / TIME | LEVEL | REMARK |
|---|---|---|---|
| 1 | 25/02/2021 | 2.00 | Start of Day |
| 1 | 26/02/2021 | 4.90 | Start of Day |

LOGGED IN ACCORDANCE WITH NEW ZEALAND GEOTECHNICAL SOCIETY GUIDELINES (2005)


**Gaia Engineers Ltd**

5 Carmont Place,
Mt Wellington
Auckland 1060,
New Zealand

P O Box 51 295,
Pakuranga
Auckland 2140,
New Zealand

info@gaia-engineers.co.nz

# BOREHOLE LOG

**HOLE NO.:** BH302

**CLIENT:** Gleeson Quarries Ltd.
**PROJECT:** Huntly Quarry Fill Sites

**JOB NO.:** 2325

**SITE LOCATION:** Huntly Quarry Fill Site - 300 Riverview Road, Huntly Fill Site 3
**START DATE:** 24/02/2021

**CO-ORDINATES:** 721666mN , 433609mE **GROUND RL:** 65.64 m
**END DATE:** 26/02/2021

**SURVEY CIRCUIT:** MTEDEN2000 **DATUM:** NZVD1946 **WEATHER:** Fine


| GEOLOGY | MATERIAL DESCRIPTION (See Classification & Symbology sheet for details) | DEPTH (m) / RL (m) | SAMPLE TYPE | TCR (%) | GRAPHIC | WEATHERING | STRENGTH | SPT DATA | VANE SHEAR STRENGTH (kPa) | NOTES, DEFECTS, SAMPLES & LABORATORY TEST RESULTS | METHOD | WATER LEVEL | PIEZOMETER INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fill | [CONT] Clayey SILT, with some organic staining; dark brown and grey mottles. Stiff; low plasticity.<br>10.2m - 10.2m: with trace mudstone inclusions | 10 / 55 | | 48 | | | | 0, 1 / 0, 0, 1, 1<br>N=2 | | | | | |
| | Silty CLAY, with trace orgnanic staining and sand; dark grey brown. Stiff to very stiff; high plasticity; sand, fine. | 11 / 54 | | 100 | | | | | | | | | |
| | 11.4m - 11.4m: trace sandy silt inclusions | 12 / 53 | | 100 | | | | 0, 0 / 0, 2, 1, 1<br>N=4 | | | | | |
| | 12.9m - 12.9m: becoming light grey mottles | 13 / 52 | | 100 | | | | | | | | | |
| | | 14 / 51 | | 100 | | | | 0, 0 / 1, 2, 1, 2<br>N=6 | | | | | |
| | | 15 / 50 | | 100 | | | | 0, 0 / 2, 1, 2, 2<br>N=7 | | | Rotary cored | | |
| | 15.5m - 15.5m: becoming dark grey-brown, no inclusions | 16 / 49 | | 100 | | | | | | | | | |
| | 17.0m - 17.0m: becoming light grey and orange mottles, trace sandy silt inclusions | 17 / 48 | | 100 | | | | 1, 2 / 3, 2, 3, 4<br>N=12 | | | | | |
| | 17.4m - 17.6m: CLAY; light blue-grey and orange mottles. Firm; high plasticity. | 18 / 47 | | 100 | | | | 4, 5 / 3, 2, 5, 5<br>N=15 | | | | | |
| | Silty GRAVEL. Stiff; gravel, medium to coarse, rounded to subangular, moderately weathered, Mudstone. | 19 / 46 | | 100 | | | | 3, 5 / 5, 6, 7, 7<br>N=25 | | | | | |

**REMARKS**

**LOGGED BY:** MK
**CHECKED BY:** JB
**APPROVED BY:** KCC
**STATUS:** FINAL
**CONTRACTOR:** Drill Force
**RIG:** Tractor
**DRILLER:** Conan

| REF | DATE / TIME | LEVEL | REMARK |
|---|---|---|---|
| 1 | 25/02/2021 | 2.00 | Start of Day |
| 1 | 26/02/2021 | 4.90 | Start of Day |

LOGGED IN ACCORDANCE WITH NEW ZEALAND GEOTECHNICAL SOCIETY GUIDELINES (2005)

**Gaia Engineers Ltd**

5 Carmont Place,
Mt Wellington
Auckland 1060,
New Zealand

P O Box 51 295,
Pakuranga
Auckland 2140,
New Zealand

info@gaia-engineers.co.nz

# BOREHOLE LOG

**HOLE NO.:** BH302

**CLIENT:** Gleeson Quarries Ltd.
**PROJECT:** Huntly Quarry Fill Sites

**JOB NO.:** 2325

**SITE LOCATION:** Huntly Quarry Fill Site - 300 Riverview Road, Huntly Fill Site 3
**START DATE:** 24/02/2021

**CO-ORDINATES:** 721666mN , 433609mE **GROUND RL:** 65.64 m
**END DATE:** 26/02/2021

**SURVEY CIRCUIT:** MTEDEN2000 **DATUM:** NZVD1946 **WEATHER:** Fine


| GEOLOGY | MATERIAL DESCRIPTION (See Classification & Symbology sheet for details) | DEPTH (m) / RL (m) | SAMPLE TYPE | TCR (%) | GRAPHIC | WEATHERING | STRENGTH | SPT DATA | VANE SHEAR STRENGTH (kPa) | NOTES, DEFECTS, SAMPLES & LABORATORY TEST RESULTS | METHOD | WATER LEVEL | PIEZOMETER INSTALLATION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fill | CLAY & SILT, with trace gravel; dark brown, brown and orange mottles. Very stiff; low plasticity; gravel, coarse, Mudstone. | 0 / 45 | | | | | | | | | | | |
| Fill | Silty CLAY; dark grey and dark brown mottles. Very stiff; low plasticity. | 0.6 / 44.4 | | 100 | | | | 3, 4 / 5, 6, 7, 9 N=27 | | | | | |
| Fill | Slightly weathered; dark brown; fine fabric, laminated; SILTSTONE; weak. | 1.2 / 43.8 | | 100 | | | | | | | | | |
| Fill | Clayey SILT, with some gravel; dark grey and dark brown mottles. Hard; low plasticity; gravel, coarse, subround, slightly weathered, Mudstone. | 1.5 / 43.5 | | | | | | | | | | | |
| Waikato Coal Measures | Highly weathered; dark brown; fine fabric, laminated; SILTSTONE; extremely weak. Clayey SILT, with minor coal inclusions. Hard; non-plastic. | 2.1 / 42.9 | | 100 | | | | 2, 4 / 4, 7, 8, 7 N=26 | | | Rotary cored | | |
| Waikato Coal Measures | | 3.0 / 42.0 | | 100 | | HW | EW | 2, 3 / 5, 7, 7, 6 N=25 | | | | | |
| Waikato Coal Measures | 25.3m - 25.4m: Slightly weathered; dark grey-brown; , laminated; CLAYSTONE; very weak. | 5.3 / 40.3 | | | | MW | VW | 5, 10 / 10, 6, 10, 12 N=38 | | | | | |
| Waikato Coal Measures | EOH: 25.95m | 5.95 / 39.7 | | | | | | | | | | | |

**REMARKS**
**LOGGED BY:** MK
**CHECKED BY:** JB
**APPROVED BY:** KCC
**STATUS:** FINAL
**CONTRACTOR:** Drill Force
**RIG:** Tractor
**DRILLER:** Conan

| REF | DATE / TIME | LEVEL | REMARK |
|---|---|---|---|
| 1 | 25/02/2021 | 2.00 | Start of Day |
| 1 | 26/02/2021 | 4.90 | Start of Day |

LOGGED IN ACCORDANCE WITH NEW ZEALAND GEOTECHNICAL SOCIETY GUIDELINES (2005)

**Gaia Engineers Ltd**
5 Carmont Place,
Mt Wellington
Auckland 1060,
New Zealand

P O Box 51 295,
Pakuranga
Auckland 2140,
New Zealand

info@gaia-engineers.co.nz

GAIA ENGINEERS

# CORE PHOTOS

**HOLE NO.:** BH302

**JOB NO.:** 2325


0.00-3.45m


3.45-7.50m


7.50-12.00m


12.00-13.95m

13.95-16.50m

16.50-19.00m


19.00-21.90m


21.45-25.95m

GAIA ENGINEERS

# CORE PHOTOS

**HOLE NO.:** BH302

**JOB NO.:** 2325

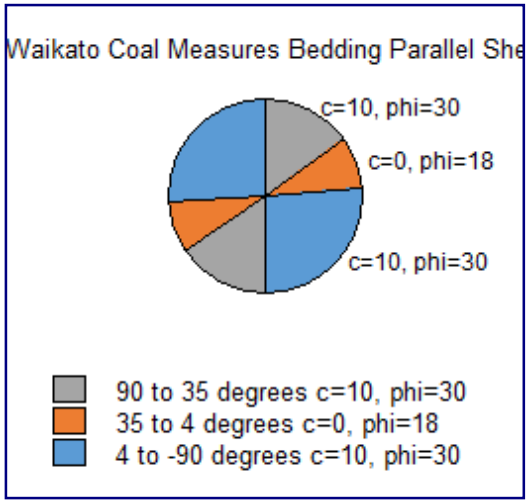

21.90-24.45m

# APPENDIX C – Slope Stability Analysis Outputs

| Description | No. Sheets: |
|---|---|
| Slope Stability Analysis Outputs | 23 |


5 Carmont Place, Mt Wellington, Auckland 1060, New Zealand
PO Box 51 295 Pakuranga, Auckland 2140
www.gaia-engineers.co.nz

GLE / Morgenstern-Price
Search Method:Auto Refine Search
Divisions along slope:50
Circles per division:10
Number of iterations:5
Divisions to use in next iteration:50%
Number of vertices per surface:12
Minimum Elevation:Not Defined
Minimum Depth:Not Defined
Minimum Area:Not Defined
Minimum Weight:Not Defined
Every available surface
1.185
Factor of Safety: 1.185
Axis Location: 298.242, 194.526
Left Slip Surface Endpoint: 290.765, 69.418
Right Slip Surface Endpoint: 378.294, 98.092





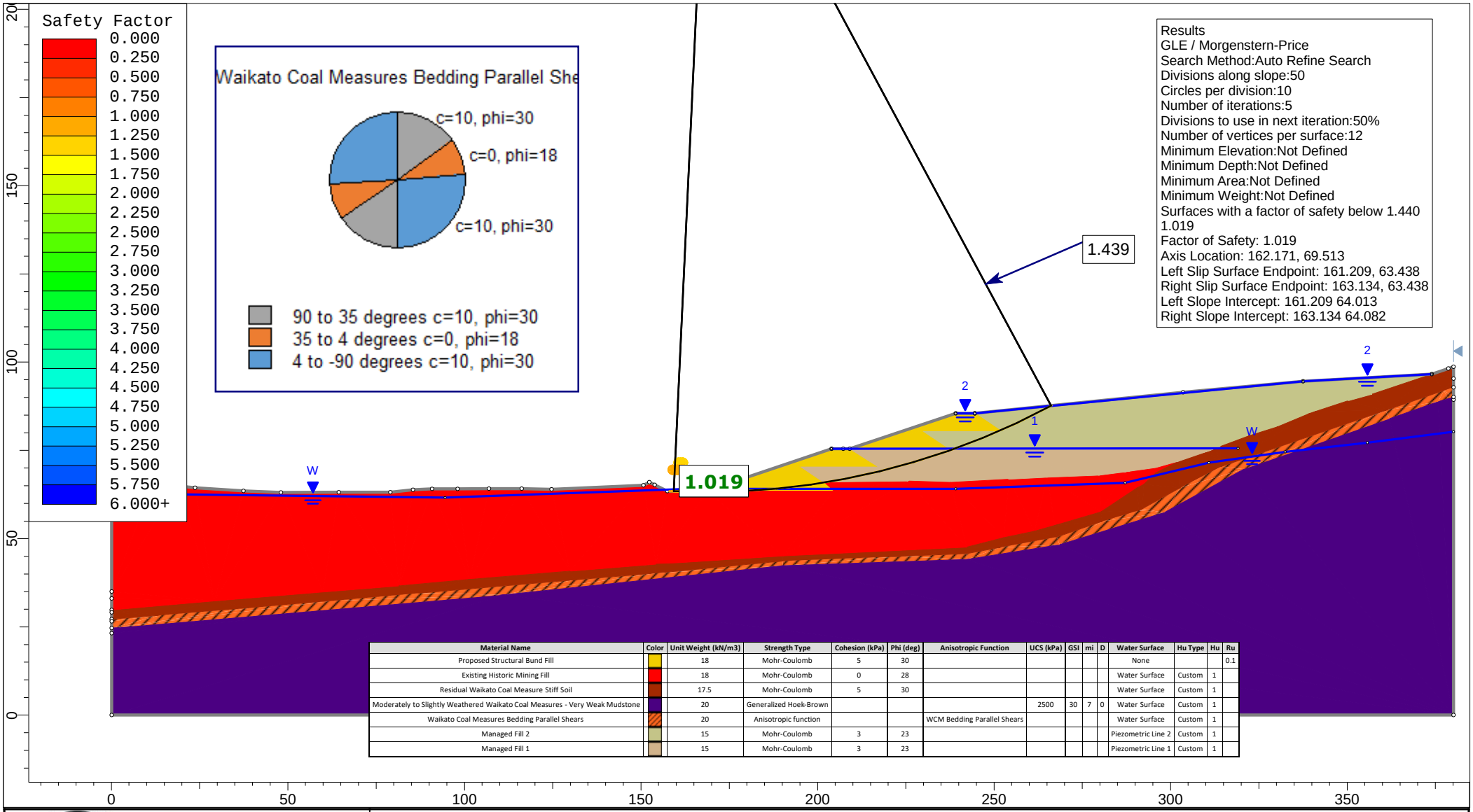


| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Existing Slope - Master Scenario | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

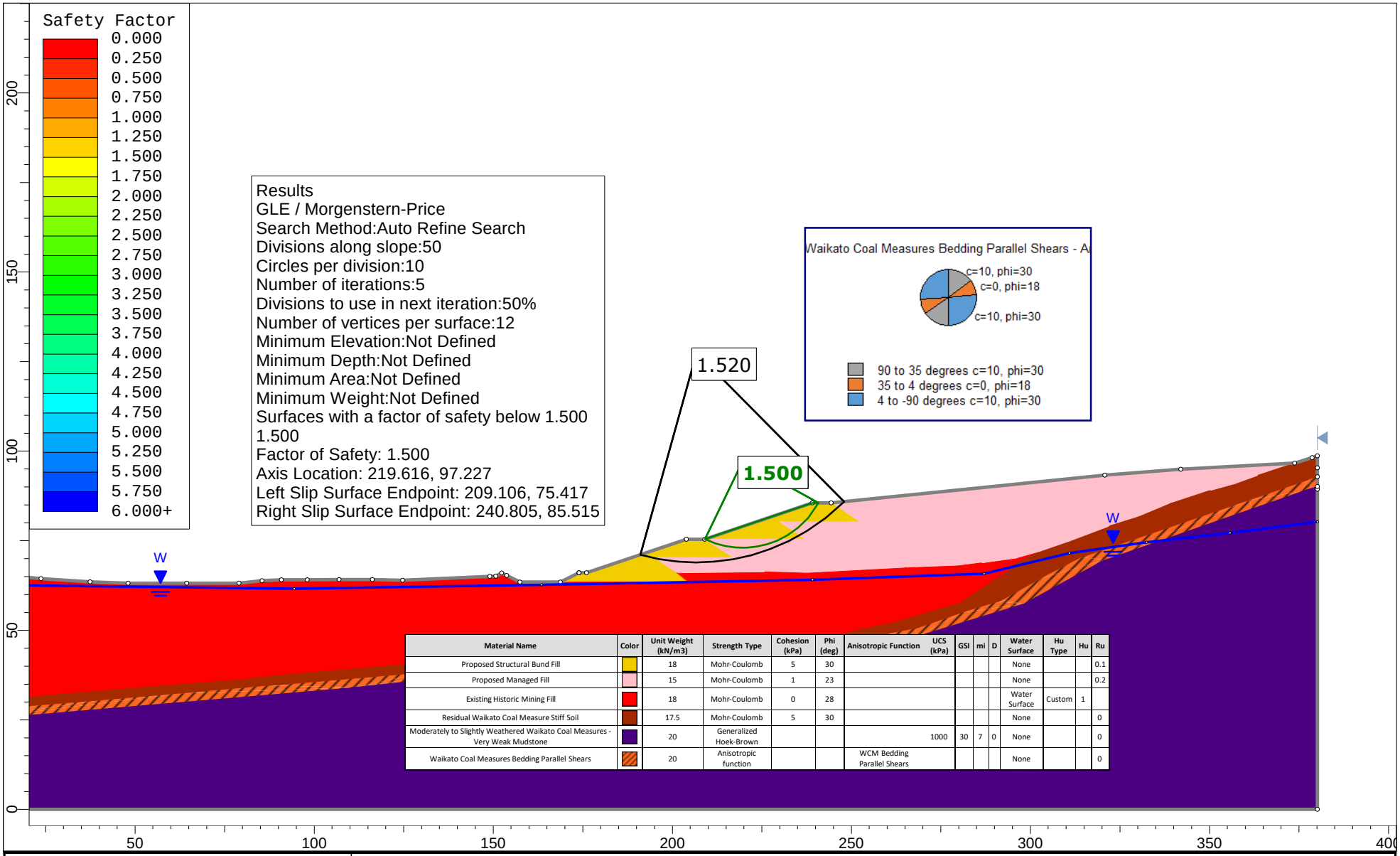



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | None | | | 0.1 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 | |
| Managed Fill 2 | | 15 | Mohr-Coulomb | 3 | 23 | | | | | | Piezometric Line 2 | Custom | 1 | |
| Managed Fill 1 | | 15 | Mohr-Coulomb | 3 | 23 | | | | | | Piezometric Line 1 | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 2 - Master Scenario | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

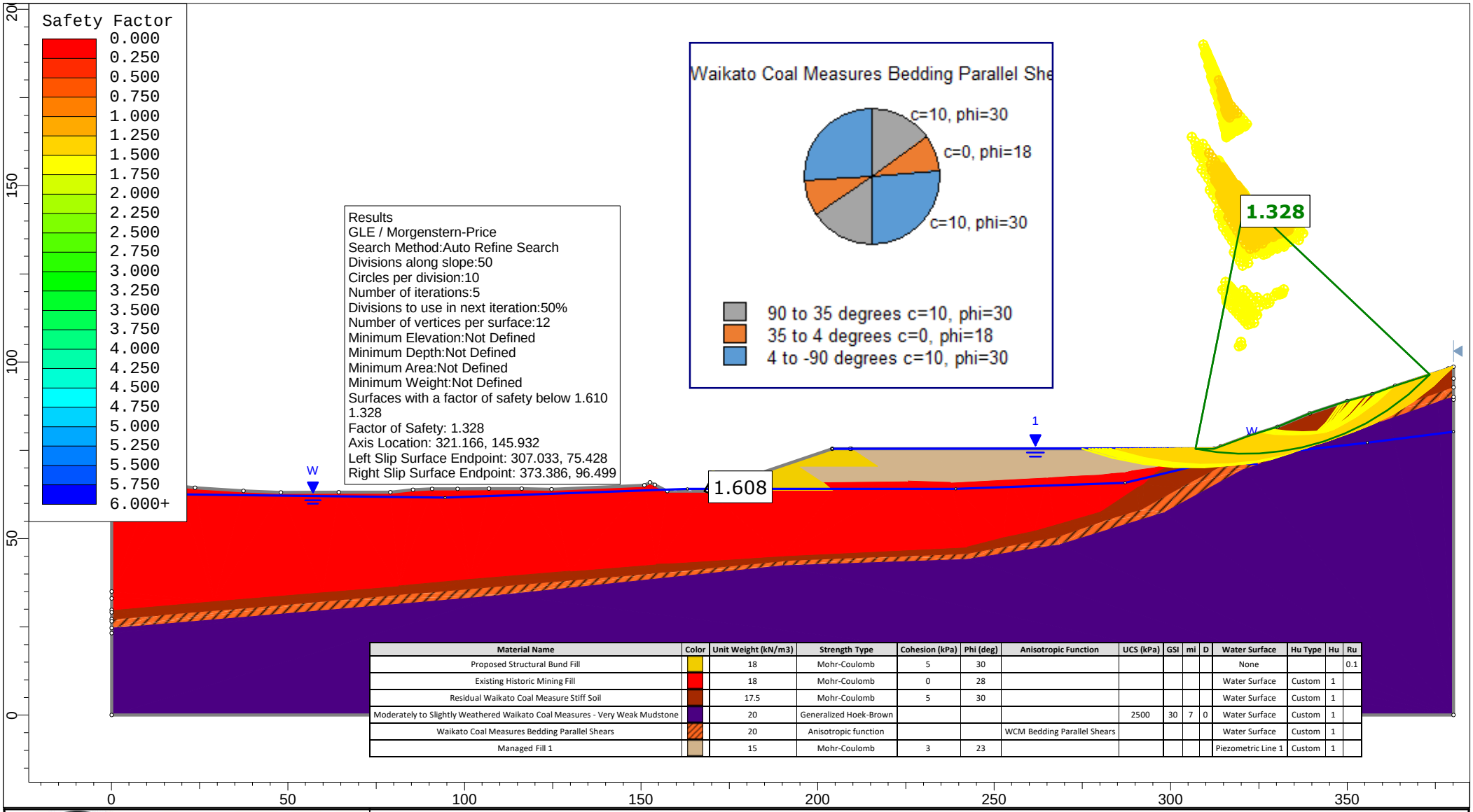



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | None | | | 0.1 |
| Proposed Managed Fill | | 15 | Mohr-Coulomb | 1 | 23 | | | | | | None | | | 0.2 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | None | | | 0 |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 1000 | 30 | 7 | 0 | None | | | 0 |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | None | | | 0 |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Final Profile - Master Scenario | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Final Profile.slmd |

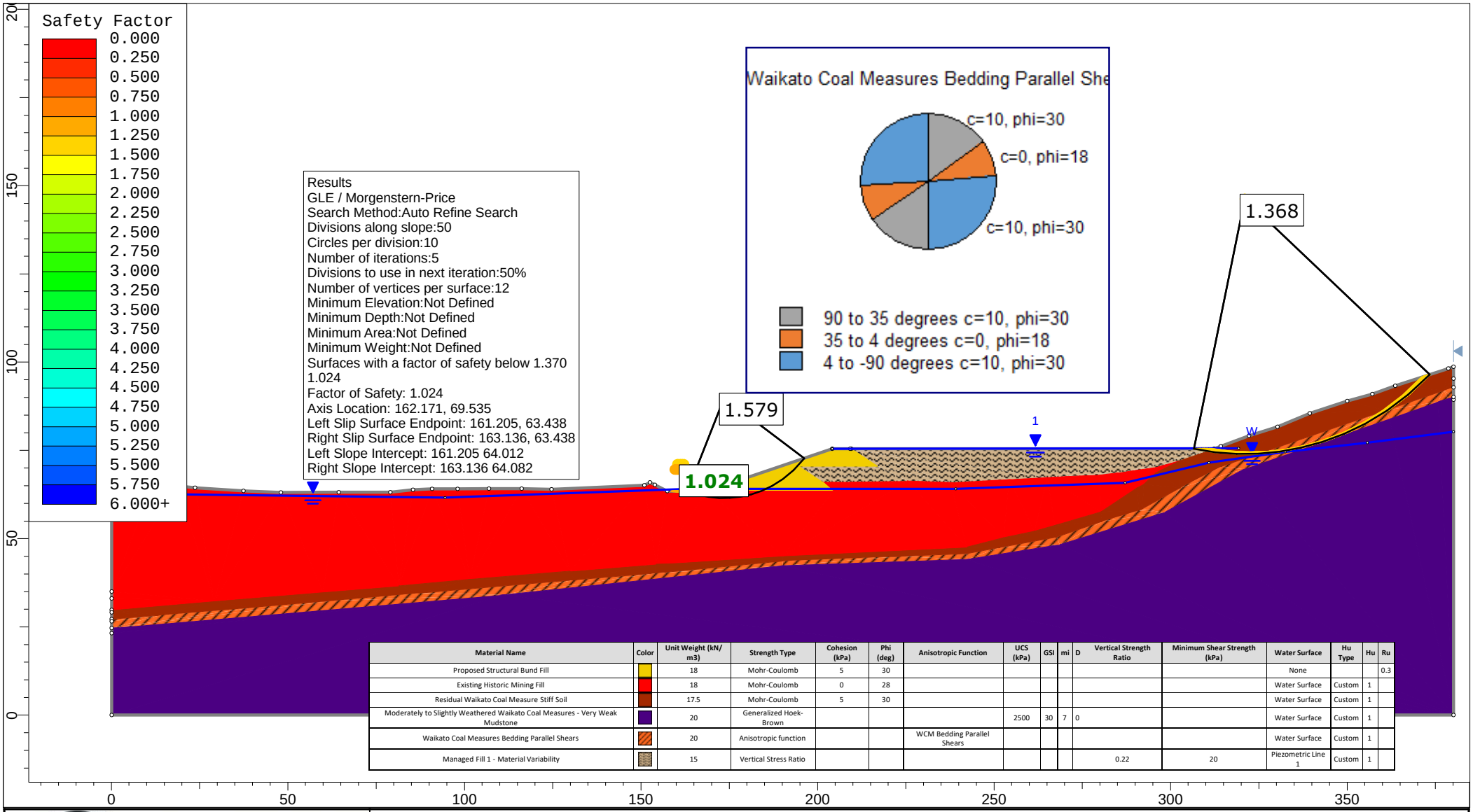



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | None | | | 0.1 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 | |
| Managed Fill 1 | | 15 | Mohr-Coulomb | 3 | 23 | | | | | | Piezometric Line 1 | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 1 - Master Scenario | | |
| *Drawn By* | MK | *Scale* | 1:1500 |
| *Company* | Gaia Engineers | | |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

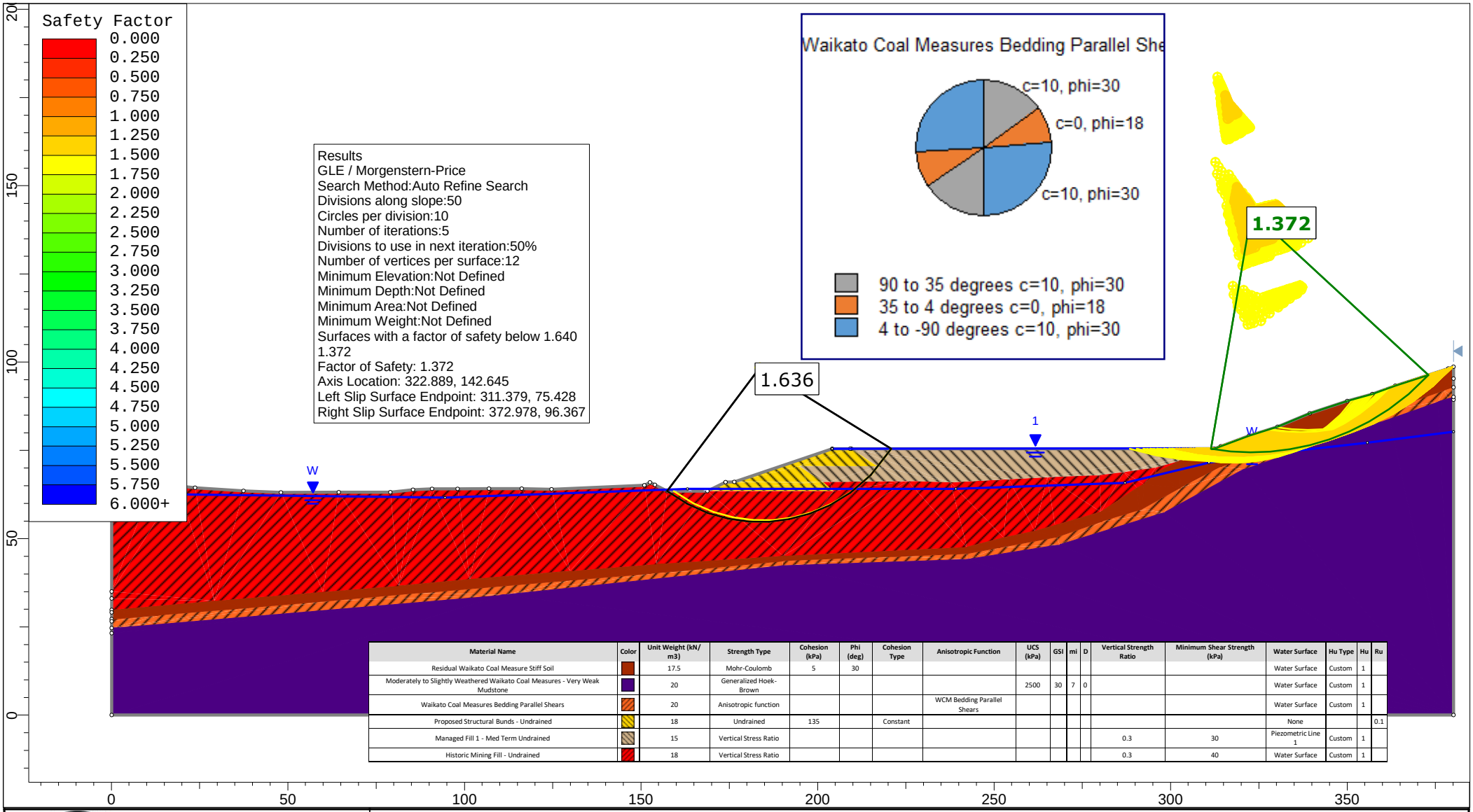



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | | | None | | | 0.3 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Managed Fill 1 - Material Variability | | 15 | Vertical Stress Ratio | | | | | | | | 0.22 | 20 | Piezometric Line 1 | Custom | 1 | |

SLIDEINTERPRET 9.010

GAIA ENGINEERS

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 1 - Material Variability | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

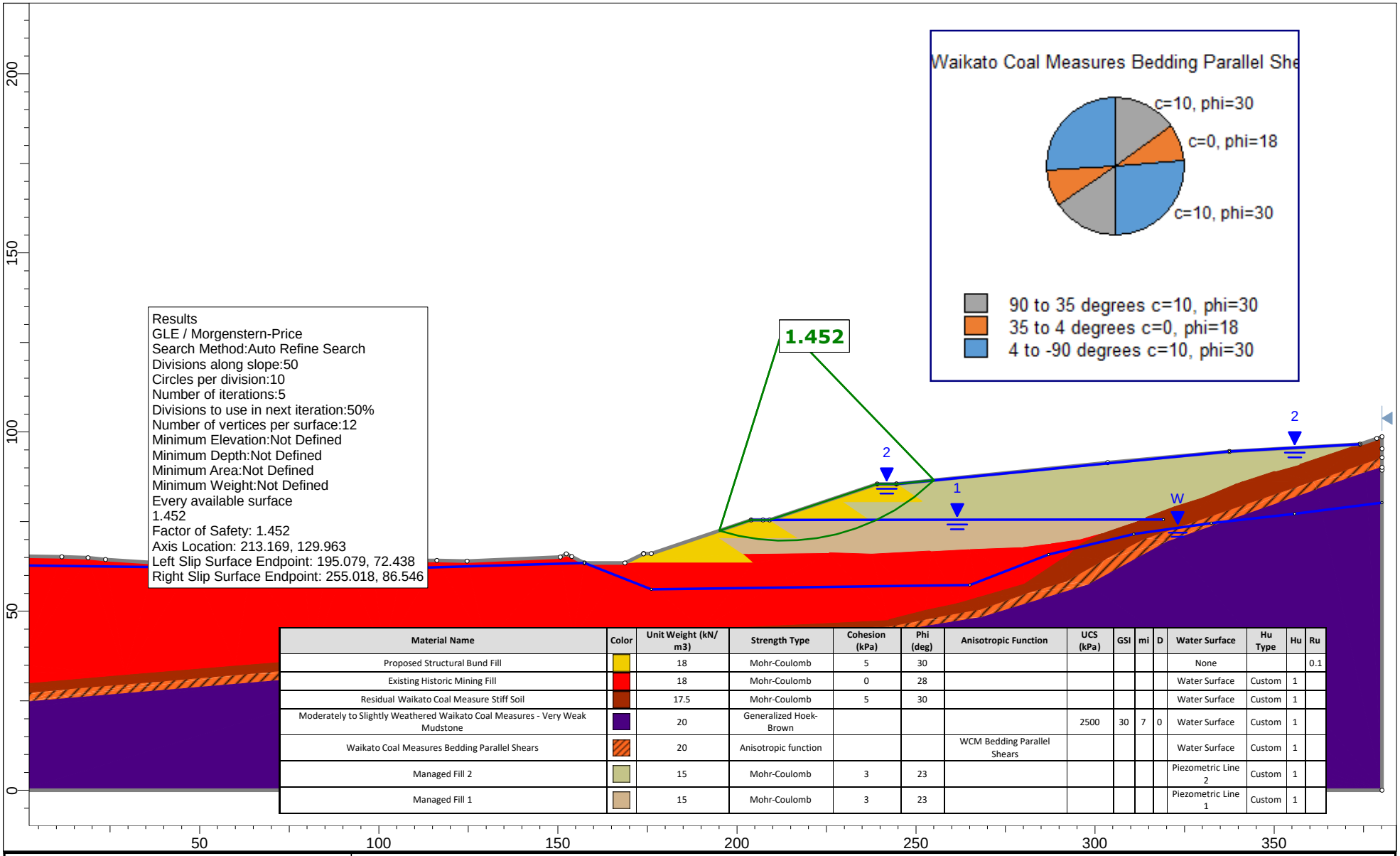



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Cohesion Type | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Proposed Structural Bunds - Undrained | | 18 | Undrained | 135 | | Constant | | | | | | | | None | | | 0.1 |
| Managed Fill 1 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 1 | Custom | 1 | |
| Historic Mining Fill - Undrained | | 18 | Vertical Stress Ratio | | | | | | | | | 0.3 | 40 | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 1 - Undrained Strength | | |
| *Drawn By* | MK | *Scale* | 1:1500 |
| *Company* | Gaia Engineers | | |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

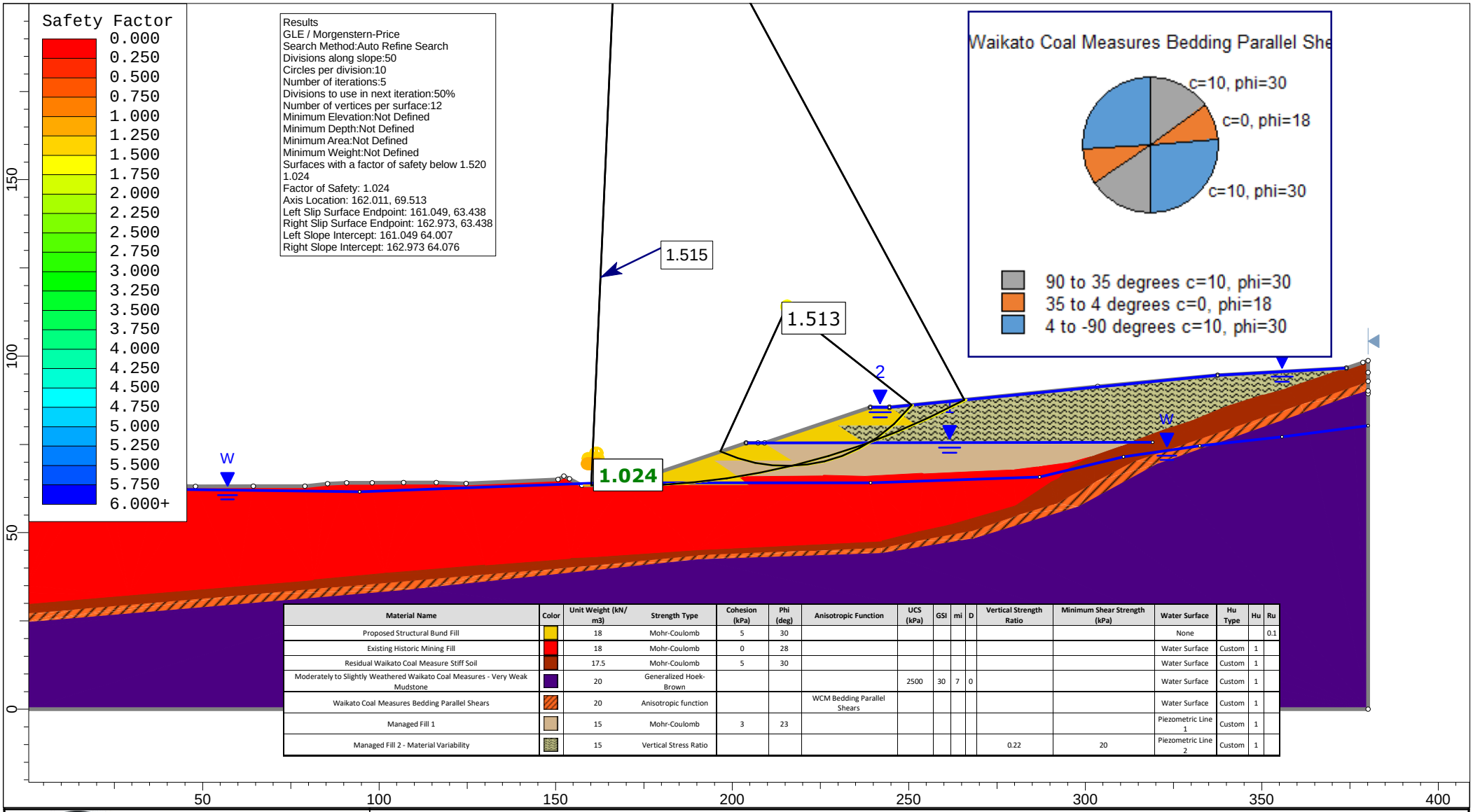



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | None | | | 0.1 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 | |
| Managed Fill 2 | | 15 | Mohr-Coulomb | 3 | 23 | | | | | | Piezometric Line 2 | Custom | 1 | |
| Managed Fill 1 | | 15 | Mohr-Coulomb | 3 | 23 | | | | | | Piezometric Line 1 | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 2 - Finished Fill w/ Deep Drainage | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | | *File Name* Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

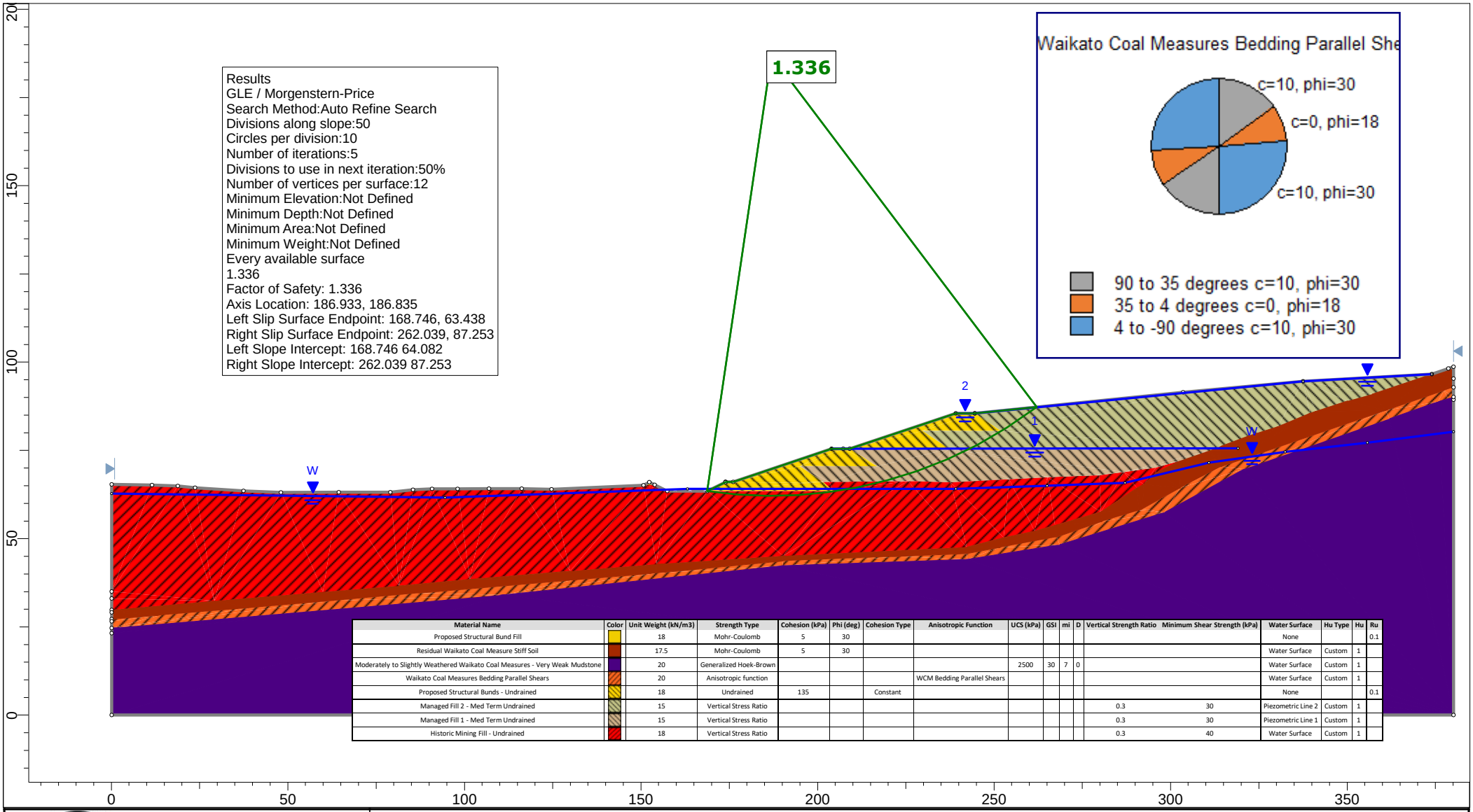



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | | | None | | | 0.1 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Managed Fill 1 | | 15 | Mohr-Coulomb | 3 | 23 | | | | | | | | Piezometric Line 1 | Custom | 1 | |
| Managed Fill 2 - Material Variability | | 15 | Vertical Stress Ratio | | | | | | | | 0.22 | 20 | Piezometric Line 2 | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 2 - Material Variability | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

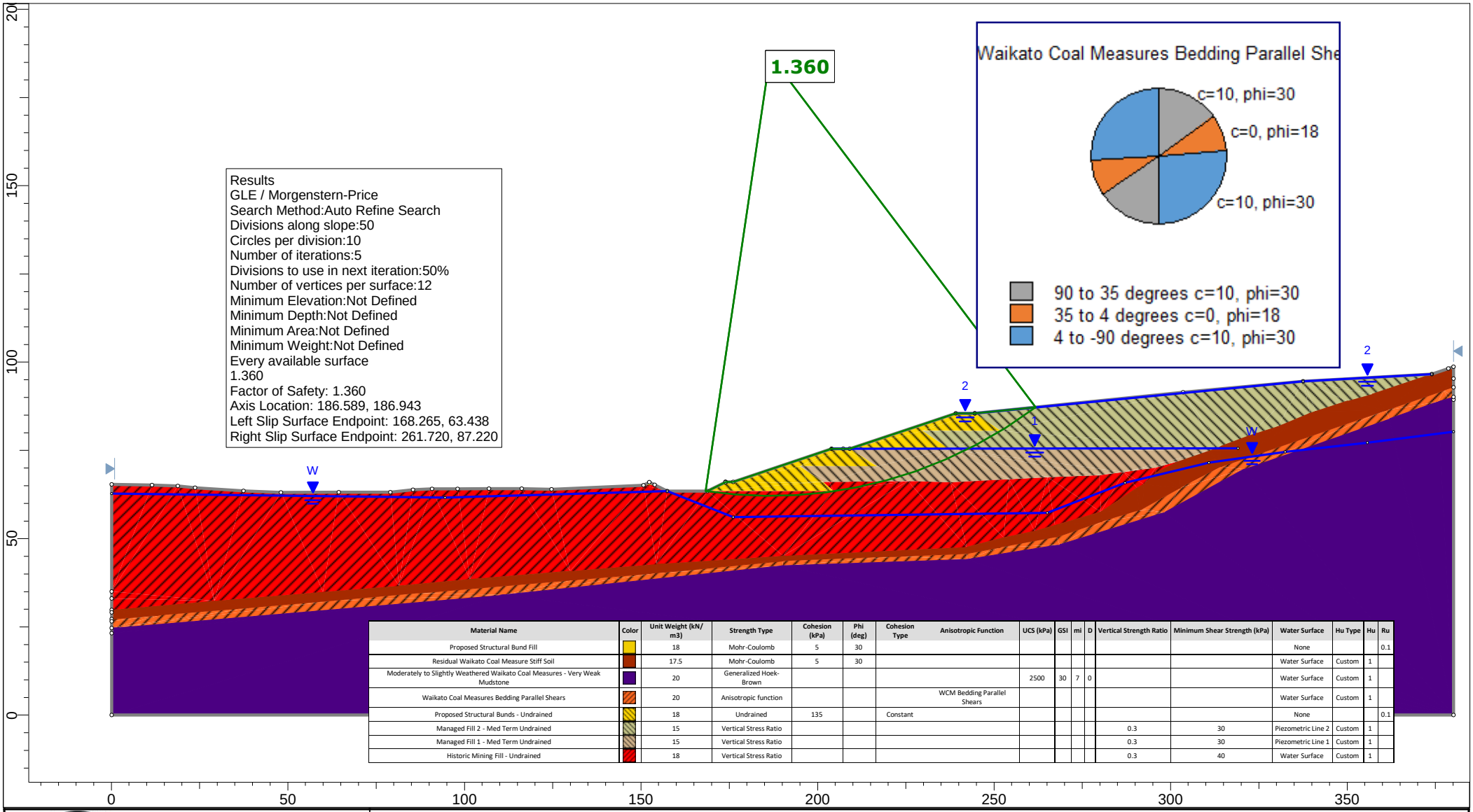



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Cohesion Type | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | | | | None | | | 0.1 |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Proposed Structural Bunds - Undrained | | 18 | Undrained | 135 | | Constant | | | | | | | | None | | | 0.1 |
| Managed Fill 2 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 2 | Custom | 1 | |
| Managed Fill 1 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 1 | Custom | 1 | |
| Historic Mining Fill - Undrained | | 18 | Vertical Stress Ratio | | | | | | | | | 0.3 | 40 | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 2 - Undrained Strength | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

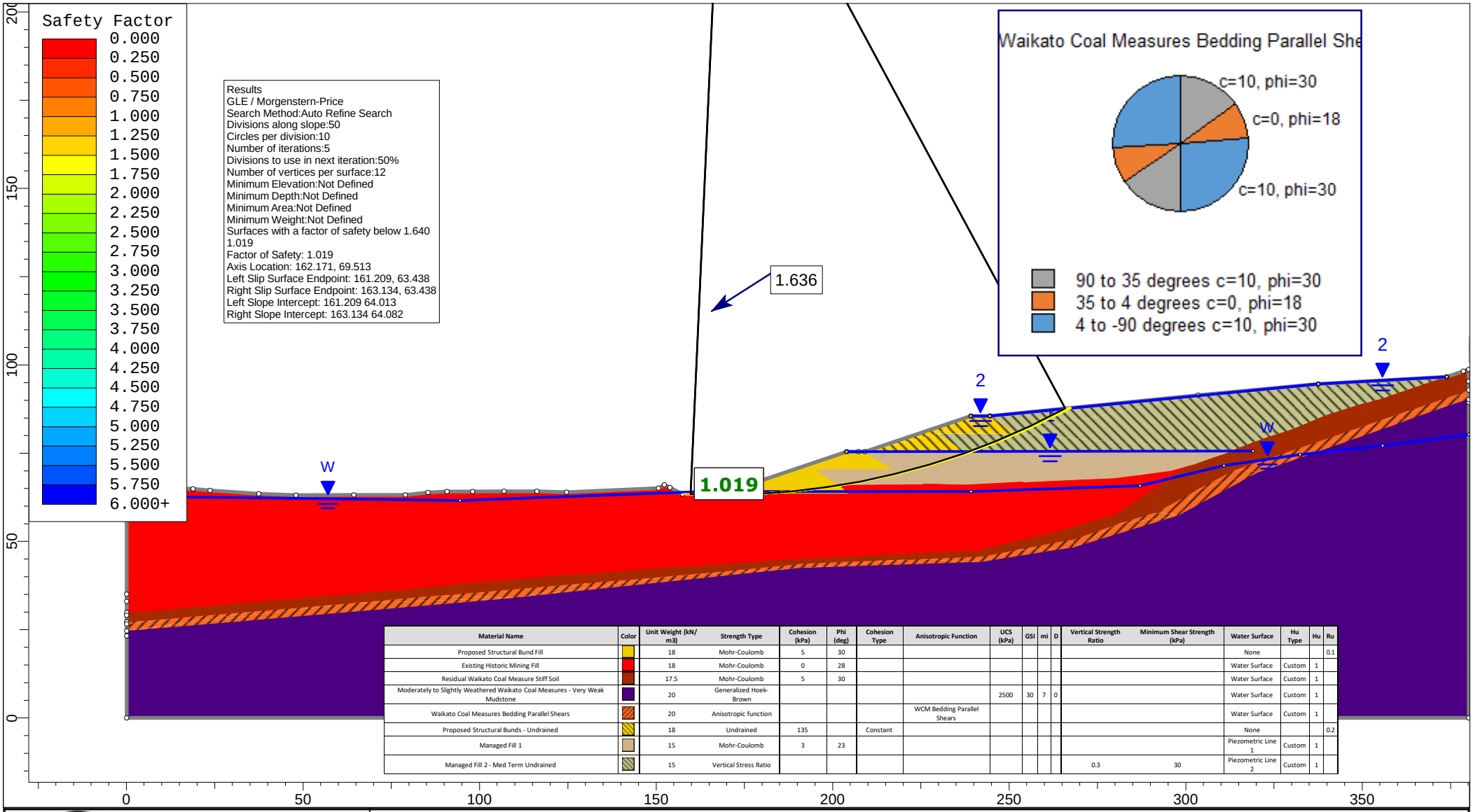



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Cohesion Type | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | | | | None | | | 0.1 |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Proposed Structural Bunds - Undrained | | 18 | Undrained | 135 | | Constant | | | | | | | | None | | | 0.1 |
| Managed Fill 2 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 2 | Custom | 1 | |
| Managed Fill 1 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 1 | Custom | 1 | |
| Historic Mining Fill - Undrained | | 18 | Vertical Stress Ratio | | | | | | | | | 0.3 | 40 | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 2 - Undrained w/ Deep Drainage | | |
| *Drawn By* | MK | *Scale* | 1:1500 |
| *Company* | Gaia Engineers | | |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

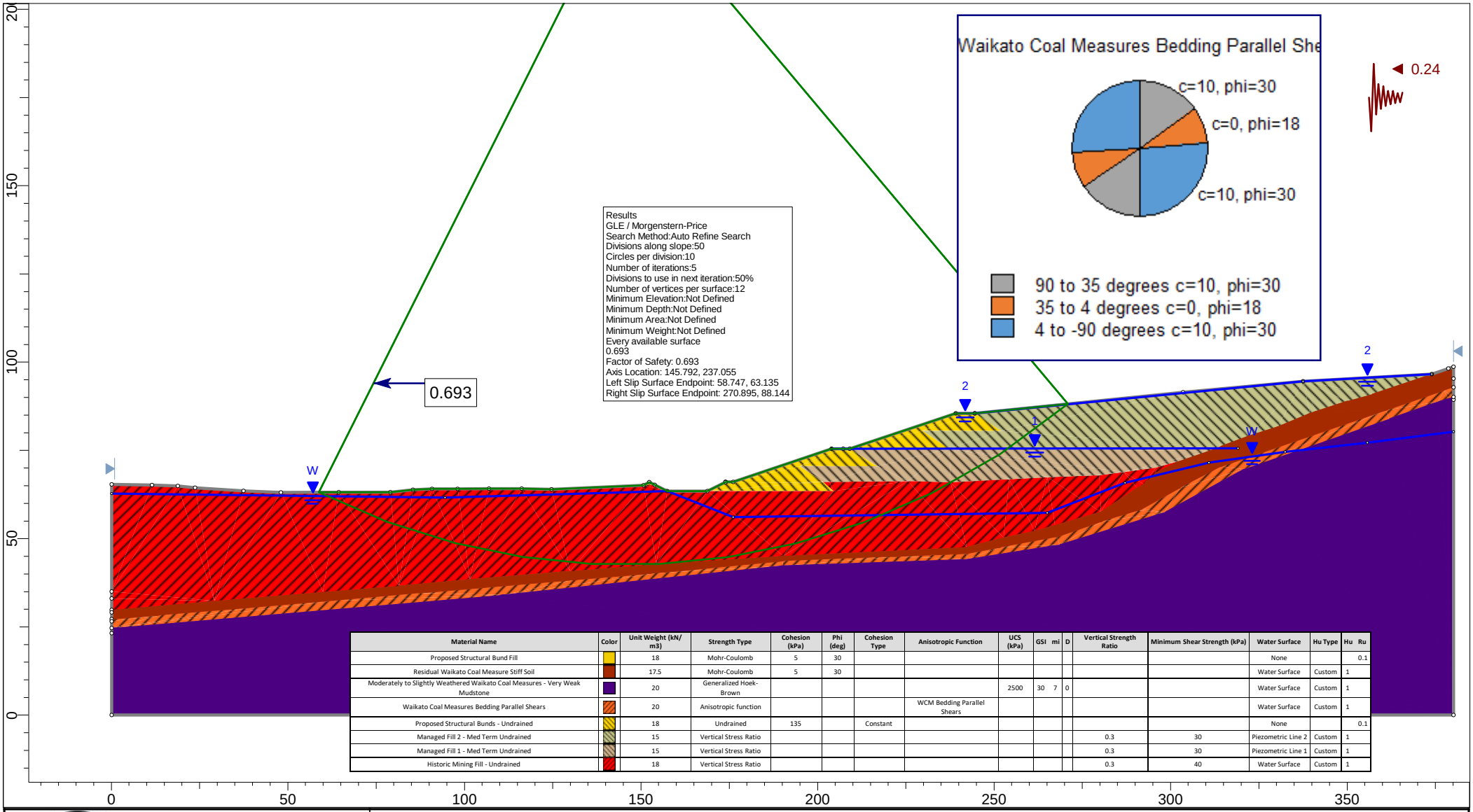



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Cohesion Type | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | | | | None | | | 0.1 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Proposed Structural Bunds - Undrained | | 18 | Undrained | 135 | | Constant | | | | | | | | None | | | 0.2 |
| Managed Fill 1 | | 15 | Mohr-Coulomb | 3 | 23 | | | | | | | | | Piezometric Line 1 | Custom | 1 | |
| Managed Fill 2 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 2 | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 2 - Medium Term Strength | | |
| *Drawn By* | MK | *Scale* | 1:1500 |
| *Company* | Gaia Engineers | | |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

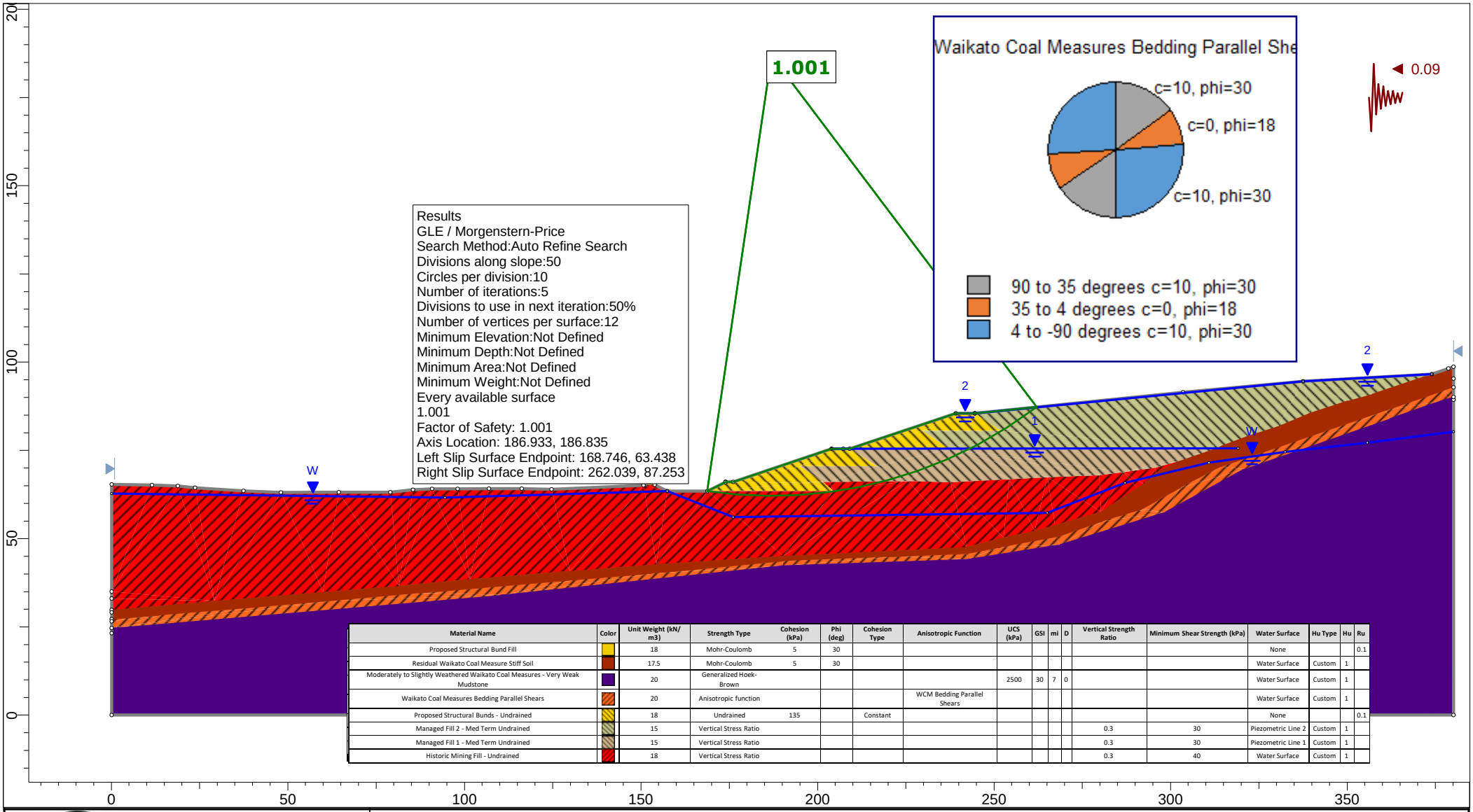



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Cohesion Type | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | | | | None | | | 0.1 |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Proposed Structural Bunds - Undrained | | 18 | Undrained | 135 | | Constant | | | | | | | | None | | | 0.1 |
| Managed Fill 2 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 2 | Custom | 1 | |
| Managed Fill 1 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 1 | Custom | 1 | |
| Historic Mining Fill - Undrained | | 18 | Vertical Stress Ratio | | | | | | | | | 0.3 | 40 | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 2 - Seismic Loading w/ Deep Drainage | | |
| *Drawn By* | MK | *Scale* | 1:1500 |
| *Company* | Gaia Engineers | | |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

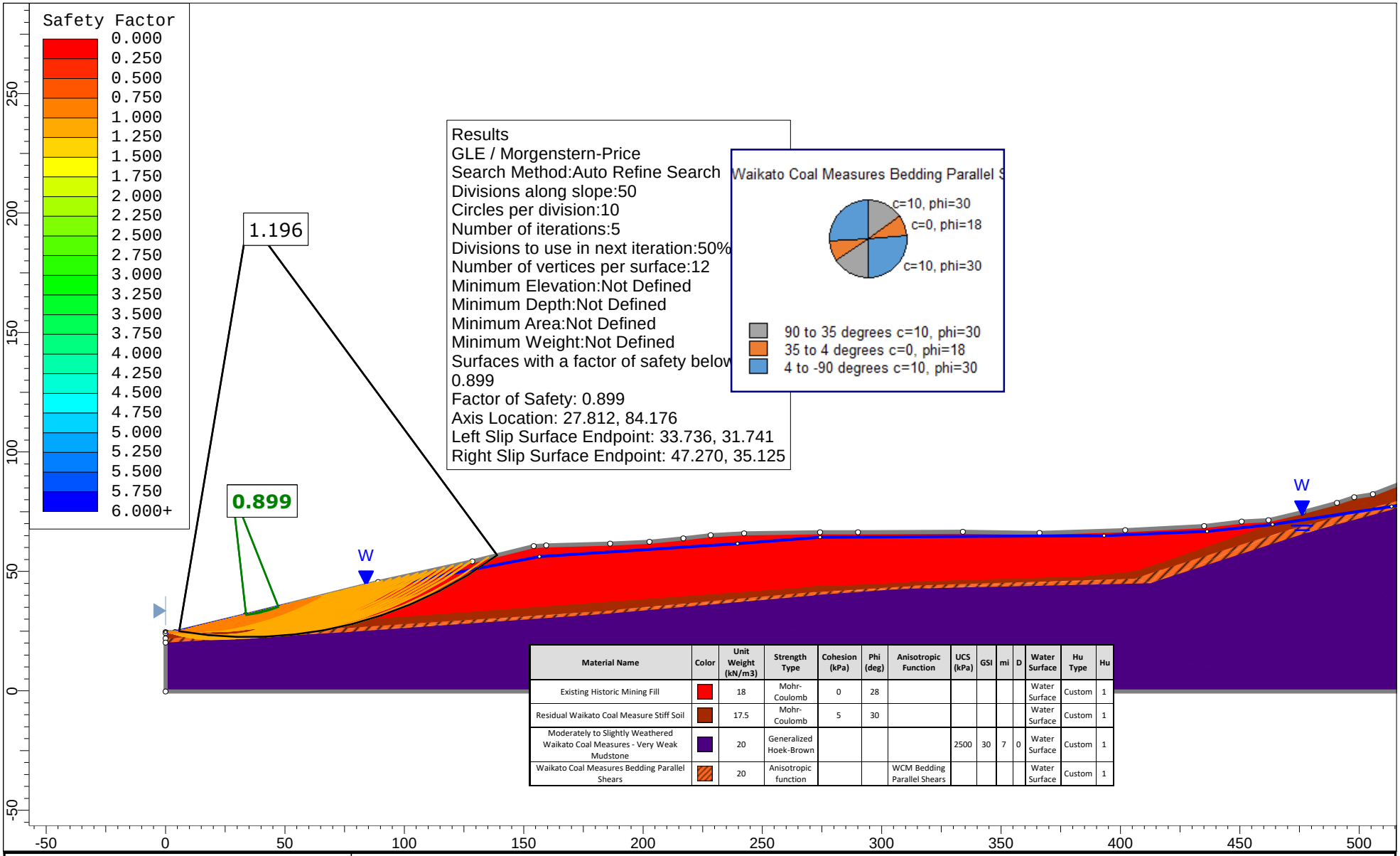



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Cohesion Type | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | | | | None | | | 0.1 |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Proposed Structural Bunds - Undrained | | 18 | Undrained | 135 | | Constant | | | | | | | | None | | | 0.1 |
| Managed Fill 2 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 2 | Custom | 1 | |
| Managed Fill 1 - Med Term Undrained | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Piezometric Line 1 | Custom | 1 | |
| Historic Mining Fill - Undrained | | 18 | Vertical Stress Ratio | | | | | | | | | 0.3 | 40 | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 1, Proposed Fill - Stage 2 - Critical Seismic w/ Deep Drainage | | |
| *Drawn By* | MK | *Scale* | 1:1500 |
| *Company* | Gaia Engineers | | |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_1 - Piezometric Lines.slmd |

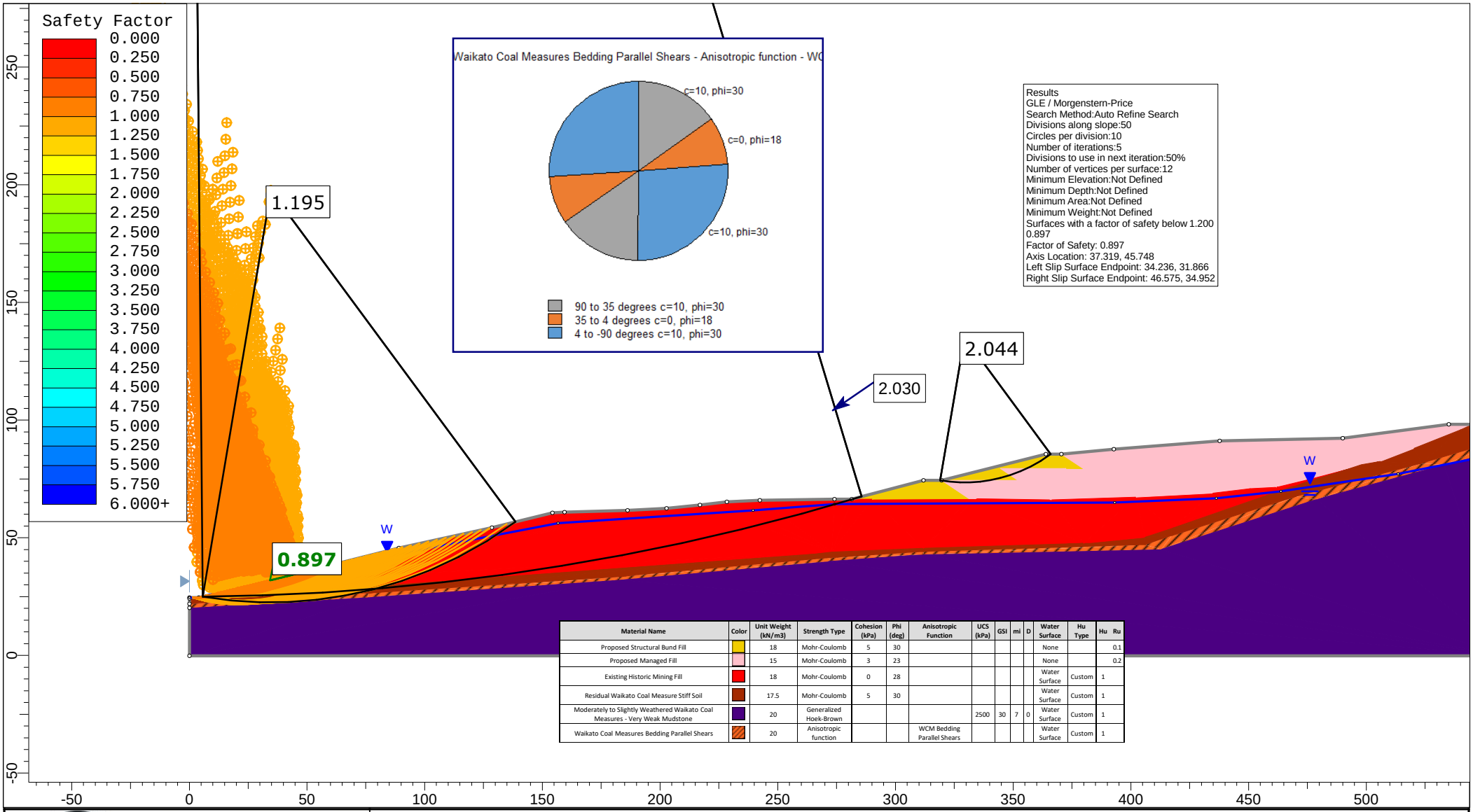



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 2, Existing Slope - Master Scenario | | |
| *Drawn By* | MK | *Scale* 1:2250 | *Company* Gaia Engineers |
| *Date* | March 2021 | | *File Name* Fill Site 3 Cross Section_2.slmd |

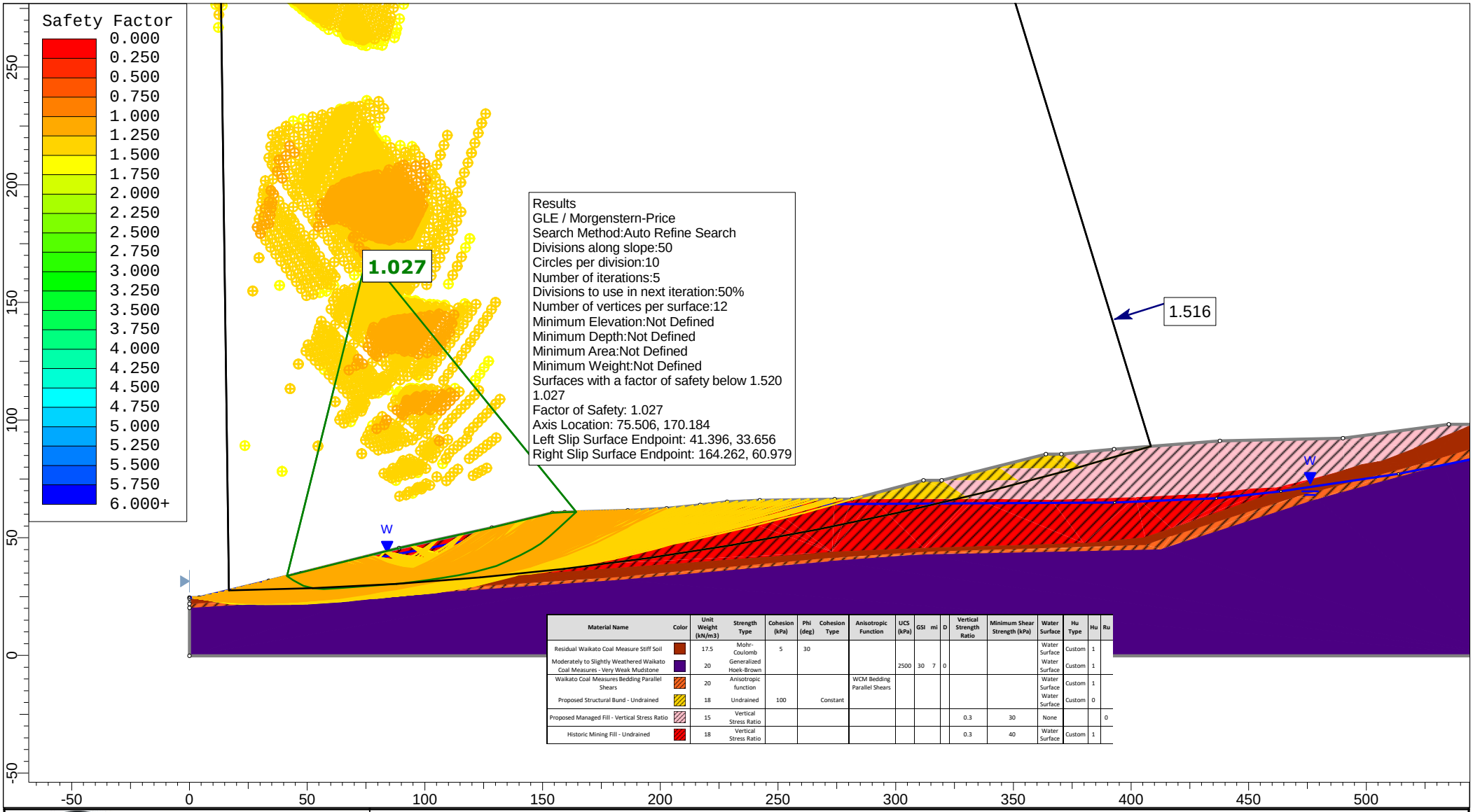



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | None | | | 0.1 |
| Proposed Managed Fill | | 15 | Mohr-Coulomb | 3 | 23 | | | | | | None | | | 0.2 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 2, Proposed Fill - Master Scenario | | |
| *Drawn By* | MK | *Scale* 1:2250 | *Company* Gaia Engineers |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_2.slmd |

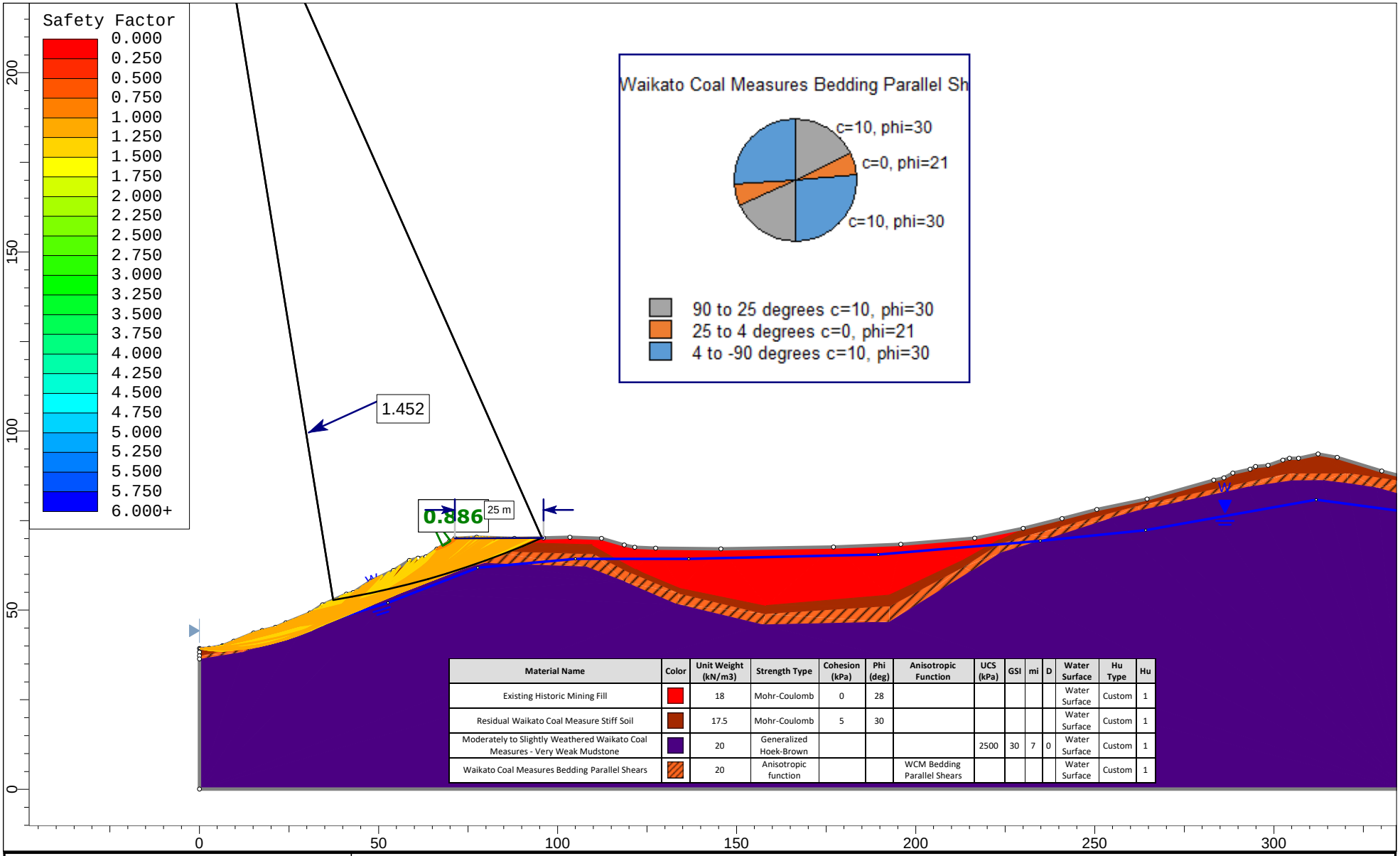



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Cohesion Type | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 | |
| Proposed Structural Bund - Undrained | | 18 | Undrained | 100 | | Constant | | | | | | | | Water Surface | Custom | 0 | |
| Proposed Managed Fill - Vertical Stress Ratio | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | None | | | 0 |
| Historic Mining Fill - Undrained | | 18 | Vertical Stress Ratio | | | | | | | | | 0.3 | 40 | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 2, Proposed Fill - Undrained | | |
| *Drawn By* | MK | *Scale* | 1:2250 |
| *Company* | Gaia Engineers | | |
| *Date* | March 2021 | *File Name* | Fill Site 3 Cross Section_2.slmd |

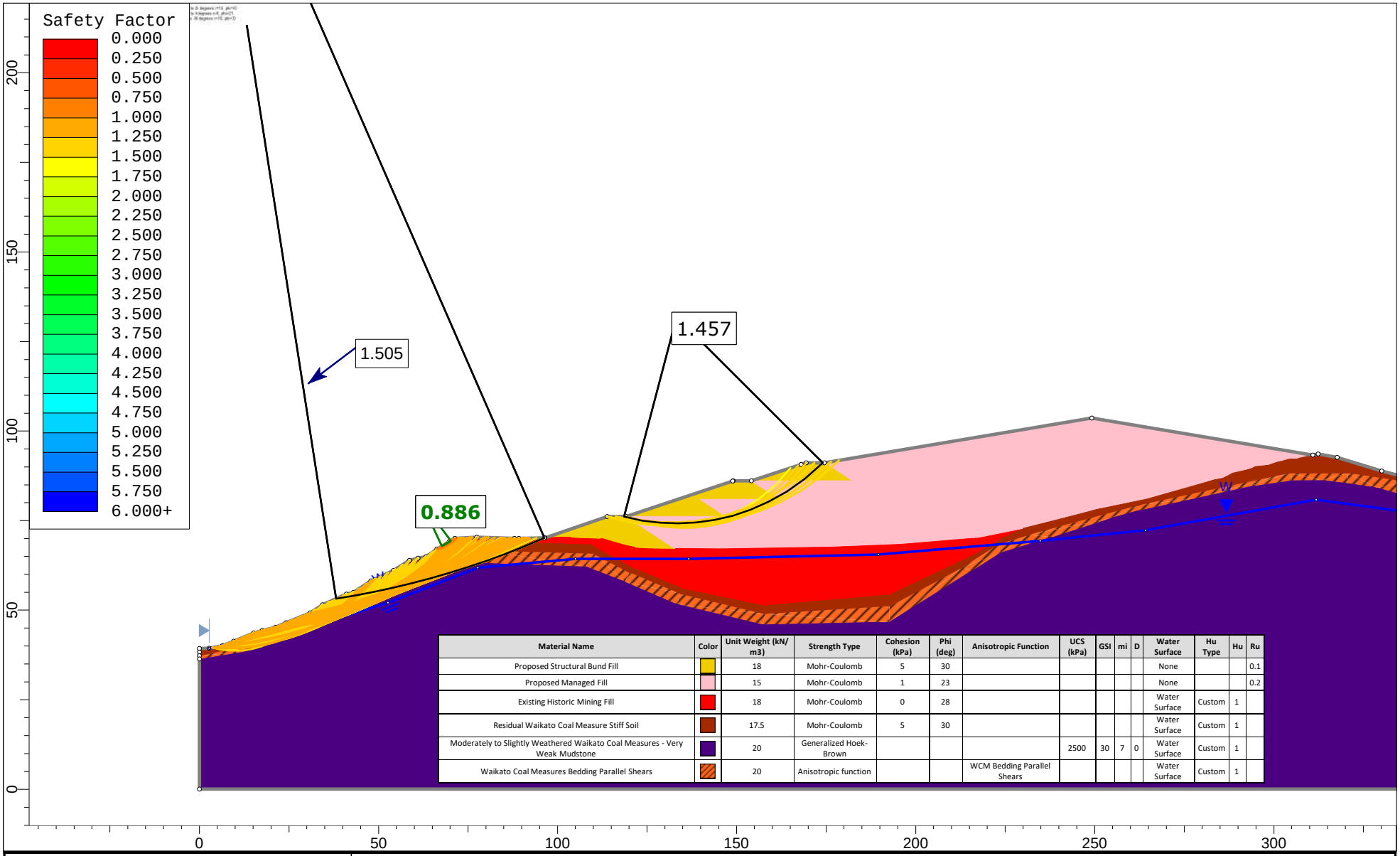



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 3, Existing Slope - Master Scenario | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | | *File Name* Fill Site 3 Cross Section_3.slmd |

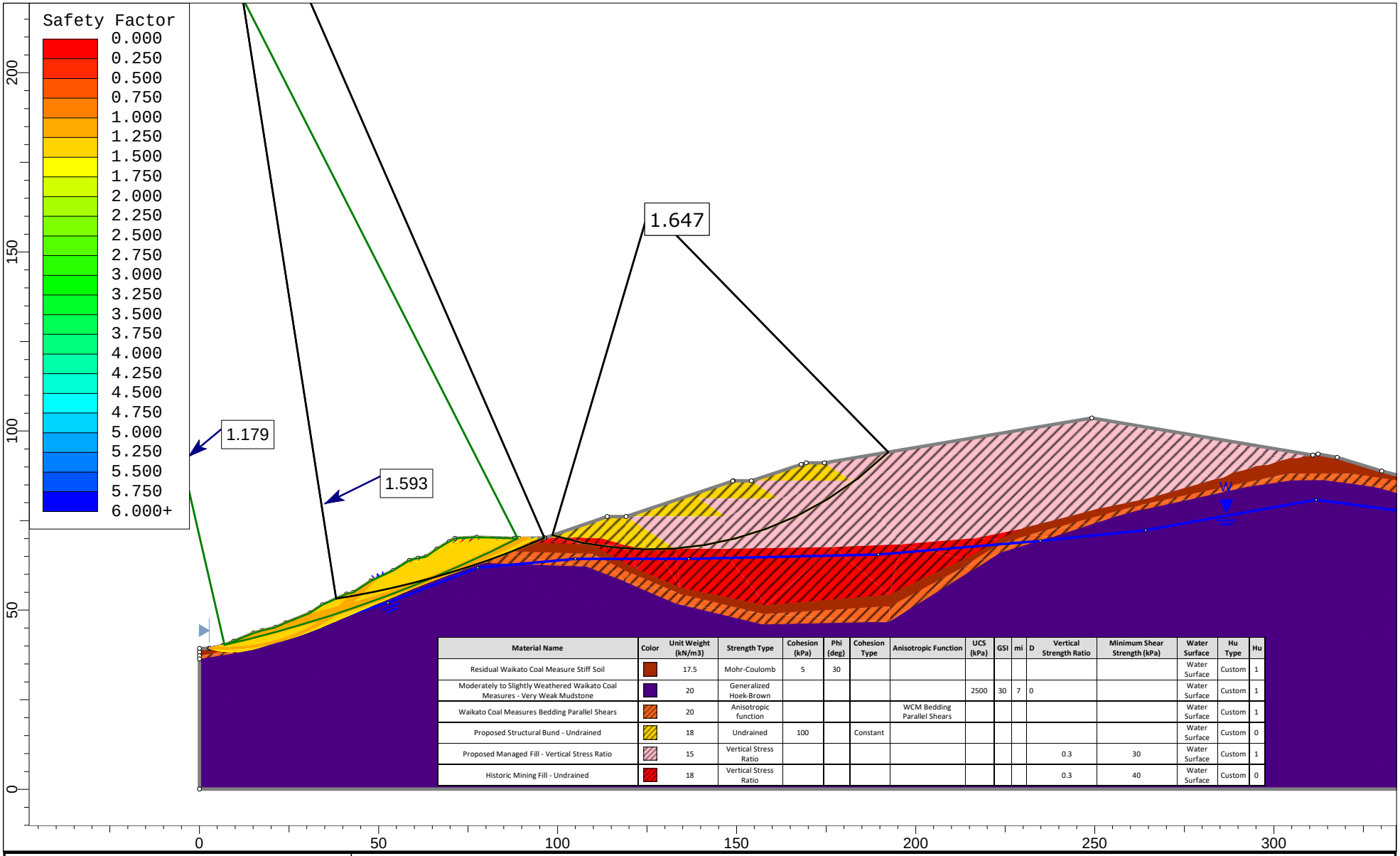



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | None | | | 0.1 |
| Proposed Managed Fill | | 15 | Mohr-Coulomb | 1 | 23 | | | | | | None | | | 0.2 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 3, Proposed Slope - Master Scenario | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | | *File Name* Fill Site 3 Cross Section_3.slmd |

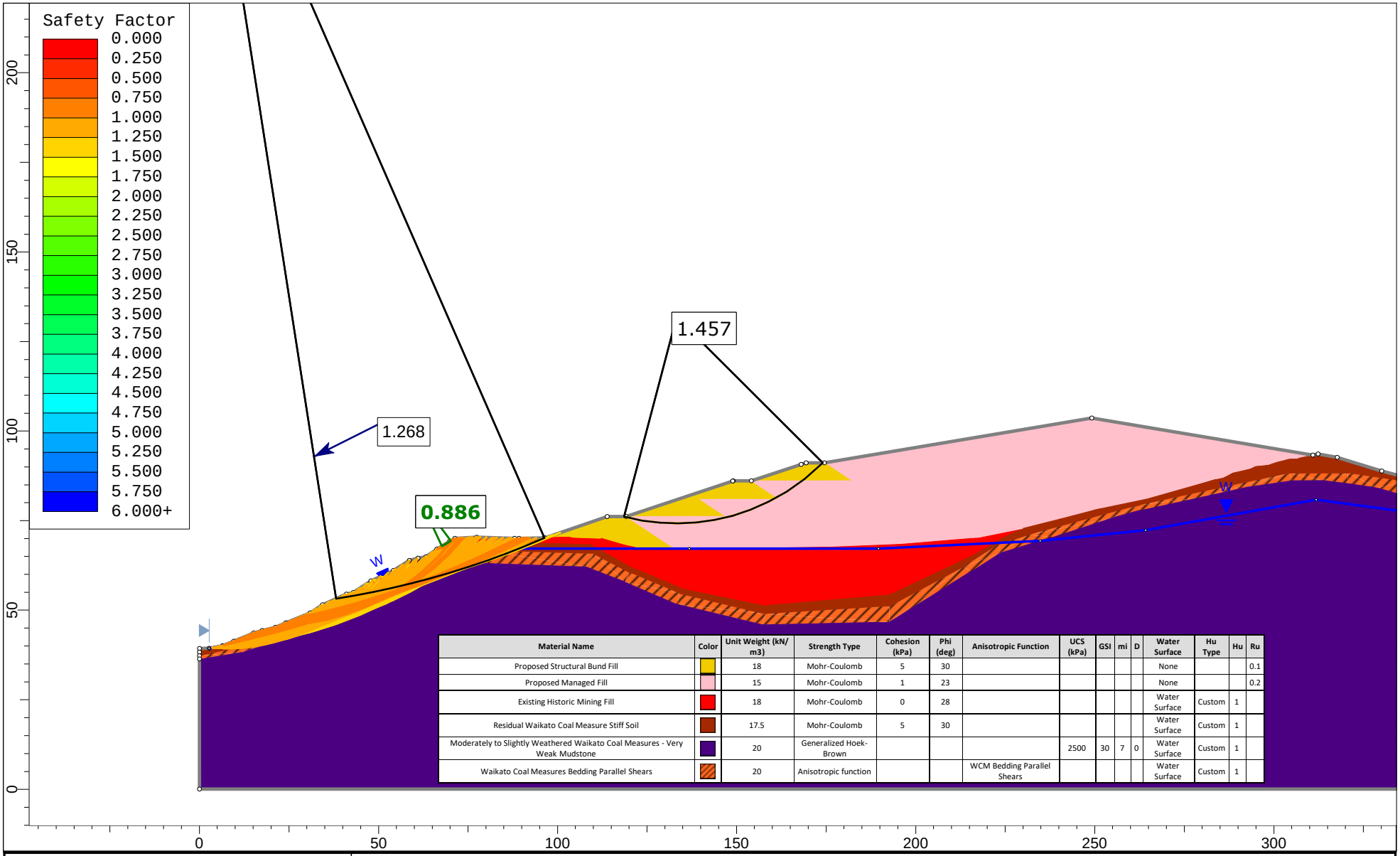



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Cohesion Type | Anisotropic Function | UCS (kPa) | GSI | mi | D | Vertical Strength Ratio | Minimum Shear Strength (kPa) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | | | | Water Surface | Custom | 1 |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | | 2500 | 30 | 7 | 0 | | | Water Surface | Custom | 1 |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | | WCM Bedding Parallel Shears | | | | | | | Water Surface | Custom | 1 |
| Proposed Structural Bund - Undrained | | 18 | Undrained | 100 | | Constant | | | | | | | | Water Surface | Custom | 0 |
| Proposed Managed Fill - Vertical Stress Ratio | | 15 | Vertical Stress Ratio | | | | | | | | | 0.3 | 30 | Water Surface | Custom | 1 |
| Historic Mining Fill - Undrained | | 18 | Vertical Stress Ratio | | | | | | | | | 0.3 | 40 | Water Surface | Custom | 0 |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 3, Proposed Slope - Undrained | | |
| *Drawn By* | MK | *Scale* 1:1500 | *Company* Gaia Engineers |
| *Date* | March 2021 | | *File Name* Fill Site 3 Cross Section_3.slmd |

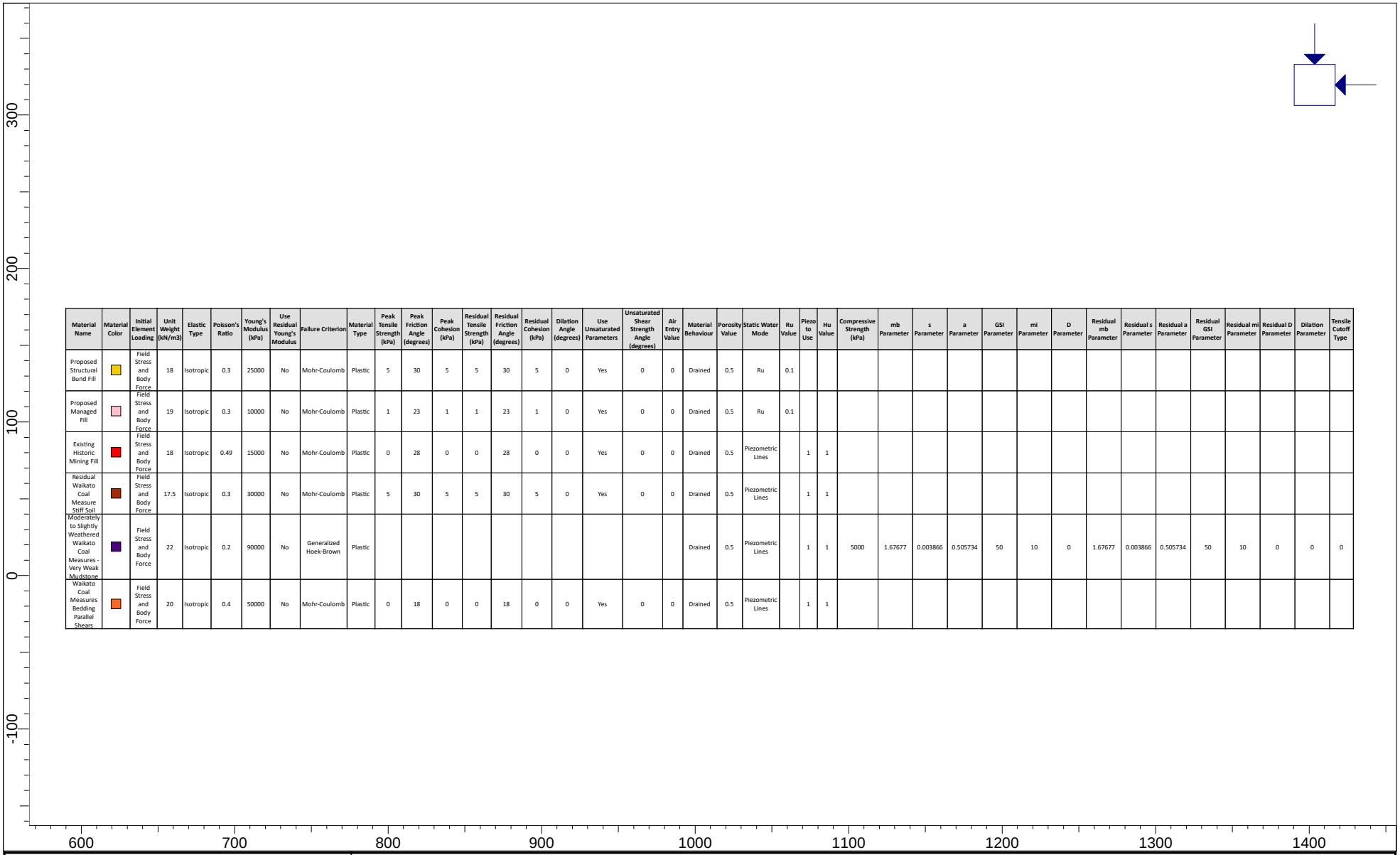



| Material Name | Color | Unit Weight (kN/m3) | Strength Type | Cohesion (kPa) | Phi (deg) | Anisotropic Function | UCS (kPa) | GSI | mi | D | Water Surface | Hu Type | Hu | Ru |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | 18 | Mohr-Coulomb | 5 | 30 | | | | | | None | | | 0.1 |
| Proposed Managed Fill | | 15 | Mohr-Coulomb | 1 | 23 | | | | | | None | | | 0.2 |
| Existing Historic Mining Fill | | 18 | Mohr-Coulomb | 0 | 28 | | | | | | Water Surface | Custom | 1 | |
| Residual Waikato Coal Measure Stiff Soil | | 17.5 | Mohr-Coulomb | 5 | 30 | | | | | | Water Surface | Custom | 1 | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | 20 | Generalized Hoek-Brown | | | | 2500 | 30 | 7 | 0 | Water Surface | Custom | 1 | |
| Waikato Coal Measures Bedding Parallel Shears | | 20 | Anisotropic function | | | WCM Bedding Parallel Shears | | | | | Water Surface | Custom | 1 | |

GAIA ENGINEERS

SLIDEINTERPRET 9.010

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Disposal Sites | | |
| *Analysis Description* | Fill Site 3 - Cross Section 3, Proposed Slope - High GWL | | |
| *Drawn By* MK | *Scale* 1:1500 | *Company* Gaia Engineers | |
| *Date* March 2021 | | *File Name* Fill Site 3 Cross Section_3.slmd | |

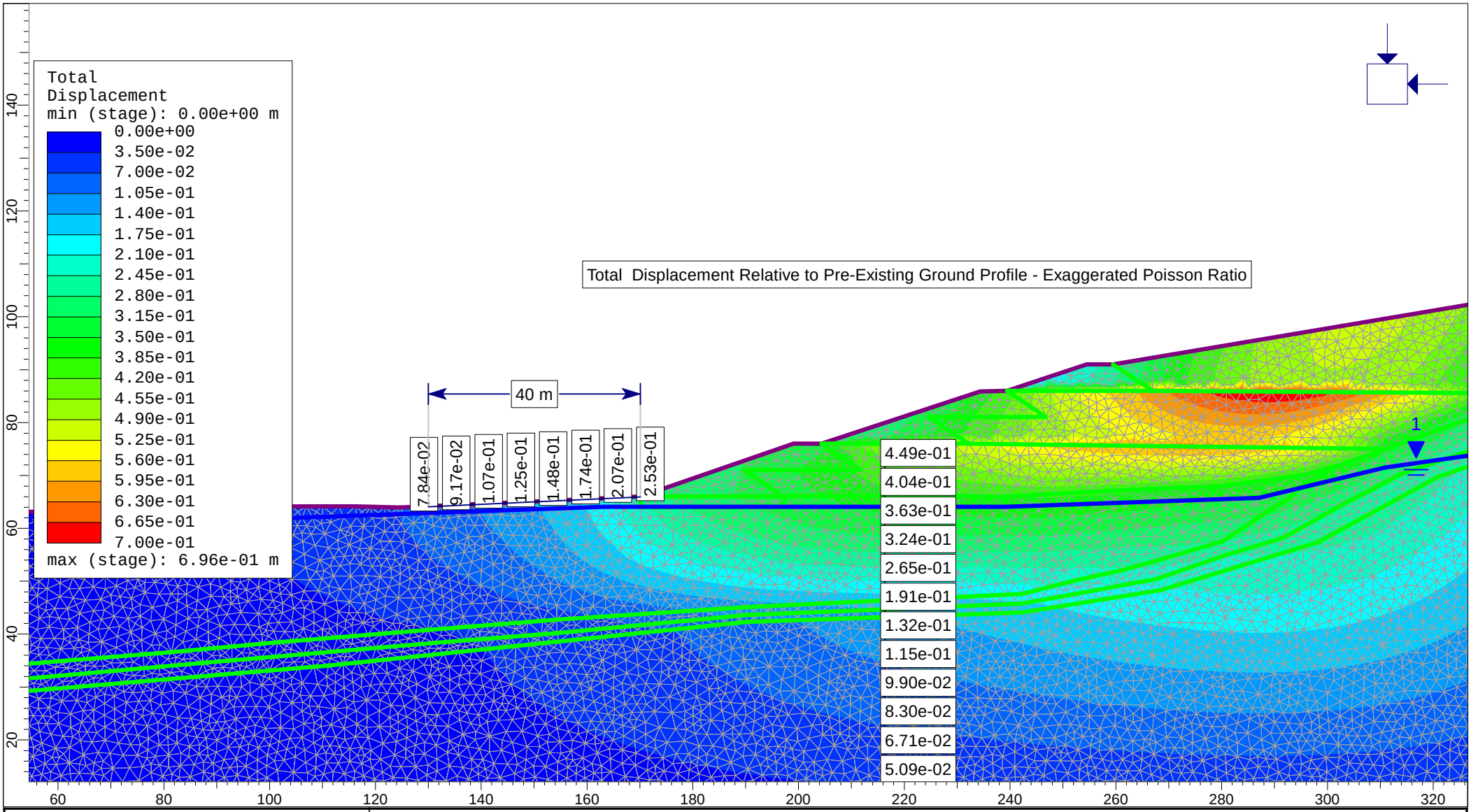



| Material Name | Material Color | Initial Element Loading | Unit Weight (kN/m3) | Elastic Type | Poisson's Ratio | Young's Modulus (kPa) | Use Residual Young's Modulus | Failure Criterion | Material Type | Peak Tensile Strength (kPa) | Peak Friction Angle (degrees) | Peak Cohesion (kPa) | Residual Tensile Strength (kPa) | Residual Friction Angle (degrees) | Residual Cohesion (kPa) | Dilation Angle (degrees) | Use Unsaturated Parameters | Unsaturated Shear Strength Angle (degrees) | Air Entry Value | Material Behaviour | Porosity Value | Static Water Mode | Ru Value | Piezo to Use | Hu Value | Compressive Strength (kPa) | mb Parameter | s Parameter | a Parameter | GSI Parameter | mi Parameter | D Parameter | Residual mb Parameter | Residual s Parameter | Residual a Parameter | Residual GSI Parameter | Residual mi Parameter | Residual D Parameter | Dilation Parameter | Tensile Cutoff Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed Structural Bund Fill | | Field Stress and Body Force | 18 | Isotropic | 0.3 | 25000 | No | Mohr-Coulomb | Plastic | 5 | 30 | 5 | 5 | 30 | 5 | 0 | Yes | 0 | 0 | Drained | 0.5 | Ru | 0.1 | | | | | | | | | | | | | | | | |
| Proposed Managed Fill | | Field Stress and Body Force | 19 | Isotropic | 0.3 | 10000 | No | Mohr-Coulomb | Plastic | 1 | 23 | 1 | 1 | 23 | 1 | 0 | Yes | 0 | 0 | Drained | 0.5 | Ru | 0.1 | | | | | | | | | | | | | | | | |
| Existing Historic Mining Fill | | Field Stress and Body Force | 18 | Isotropic | 0.49 | 15000 | No | Mohr-Coulomb | Plastic | 0 | 28 | 0 | 0 | 28 | 0 | 0 | Yes | 0 | 0 | Drained | 0.5 | Piezometric Lines | | 1 | 1 | | | | | | | | | | | | | | |
| Residual Waikato Coal Measure Stiff Soil | | Field Stress and Body Force | 17.5 | Isotropic | 0.3 | 30000 | No | Mohr-Coulomb | Plastic | 5 | 30 | 5 | 5 | 30 | 5 | 0 | Yes | 0 | 0 | Drained | 0.5 | Piezometric Lines | | 1 | 1 | | | | | | | | | | | | | | |
| Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone | | Field Stress and Body Force | 22 | Isotropic | 0.2 | 90000 | No | Generalized Hoek-Brown | Plastic | | | | | | | | | | | Drained | 0.5 | Piezometric Lines | | 1 | 1 | 5000 | 1.67677 | 0.003866 | 0.505734 | 50 | 10 | 0 | 1.67677 | 0.003866 | 0.505734 | 50 | 10 | 0 | 0 | 0 |
| Waikato Coal Measures Bedding Parallel Shears | | Field Stress and Body Force | 20 | Isotropic | 0.4 | 50000 | No | Mohr-Coulomb | Plastic | 0 | 18 | 0 | 0 | 18 | 0 | 0 | Yes | 0 | 0 | Drained | 0.5 | Piezometric Lines | | 1 | 1 | | | | | | | | | | | | | | |

rocscience

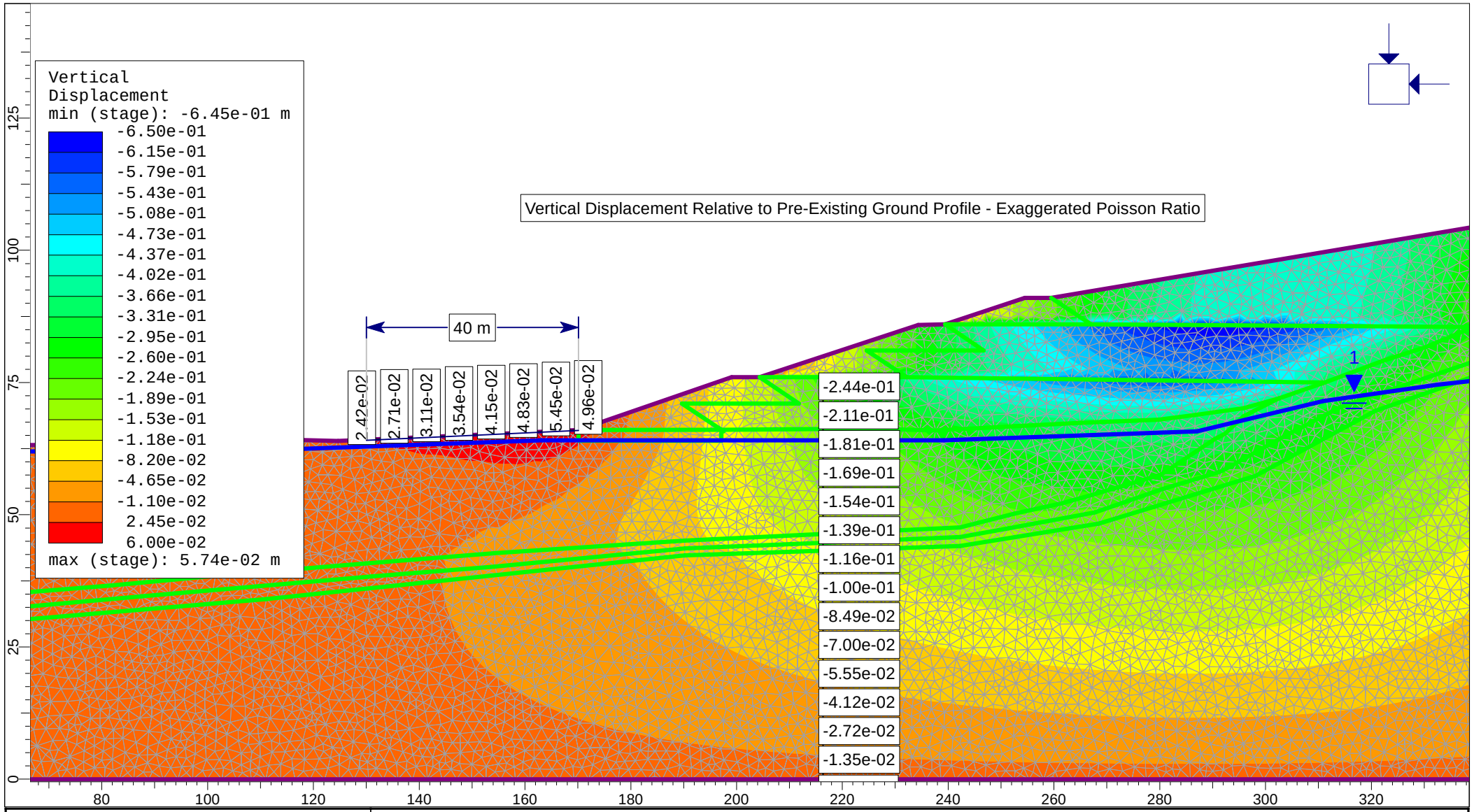
RS2 10.012

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Site 3 | | |
| *Analysis Description* | Cross Section 1 - Displacement Analysis | | |
| *Drawn By* | MK | *Scale* 1:3500 | *Company* Gaia Engineers |
| *Date* | June 2021 | | *File Name* Fill Site 3 Cross Section_1 - FEM.fez |




| | | | |
|---|---|---|---|
| rocscience | Project: Huntly Quarry - Fill Site 3 | | |
| | Analysis Description: Cross Section 1 - Displacement Analysis | | |
| | Drawn By: MK | Scale: 1:1000 | Company: Gaia Engineers |
| | Date: June 2021 | | File Name: Fill Site 3 Cross Section_1 - FEM.fez |

INTERPRET 10.012




rocscience

INTERPRET 10.012

| | | | |
|---|---|---|---|
| *Project* | Huntly Quarry - Fill Site 3 | | |
| *Analysis Description* | Cross Section 1 - Displacement Analysis | | |
| *Drawn By* | MK | *Scale* 1:1000 | *Company* Gaia Engineers |
| *Date* | June 2021 | *File Name* | Fill Site 3 Cross Section_1 - FEM.fez |