April 2020

Gleeson Quarries Ltd

Huntly Quarry Disposal Sites

Fill Site 2 – Geotechnical Design Report

Revision B

Report Prepared By
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Revision History

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2325-23-51	GEOLOGICAL AND PROPOSED FILL SECTION 02	A
2325-23-52	GEOLOGICAL AND PROPOSED FILL SECTION 03	A
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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 2 located directly 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.: 2325-23-01 included in Appendix A. Our key findings and recommendations are presented in the following report:

- 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 2. The Fill Site 2 area is proposed to primarily accommodate imported managed fill material.

Test pit site investigations for Fill Site 2 were undertaken in two stages. The first stage involved the excavation of pits during June, 2019 in readily accessible areas. 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.

In support of the detailed design undertaken and presented in this report, additional test pits were excavated in October, 2019. The detailed design investigation focused on more difficult to reach areas near the toe of the proposed fill site in order to confirm the foundation conditions. It was discovered during the detailed design investigations that founding and toe conditions for the proposed fill were better than originally reported on at the concept stage. The toe of the fill area was originally thought to consist of Waikato Coal Measures material. Detailed design stage investigations confirmed that the toe material in fact belonged to the Newcastle Group greywacke unit.

Fill Site 2 is a broad gully that tapers sharply towards the toe in a westerly direction as shown in Figure 1. The broad eastern end of the gully is predominantly underlain by soil and rock of the Waikato Coal Measures group whilst the narrower and incised western end of the gully is underlain by weathered soil and rock of the Newcastle Group Greywackes.

The general design of the fill consists of:

- A 2m deep toe-key into the in-situ Newcastle Group Formation at the toe of the fill
- Inter-bench external batter angles of between 2H:1V and 4H:1V
- 5m wide external benches
- 0.4m thick drainage blankets every 10m vertical distance

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.

Displacement monitoring of the completed fill stages as well as the final profile will be necessary to monitor the stability of the fill both during and after construction.

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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 2 as shown in Figure 1 and Figure 2 as well as Drawing No.: 2325-23-01 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 additional test-pit investigation to assess foundation conditions under Fill Site 2 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 material referenced 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 2325-23-02 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 (Locations are shown on Drawing No.: 2325-23-01 in Appendix A and logs are presented in Appendix B) provide some information regarding the boundary between the Waikato Coal Measures and the Newcastle Group Greywacke. 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. The relevance of these measurements to the proposed development is discussed in Section 5.3.

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.

It is noted that the fill footprints presented in this report are conceptual and may be subject to geotechnical and civil specific design.

The concept fill footprint for Fill Site 2 has not been significantly changed and has been adopted in the final design of Fill Site 2. The proposed external batter angle, inter-bench height and bench widths have also been found to be suitable to the proposed site and adopted with minor variations primarily due to surrounding surficial drainage.

The conceptual quarry pit boundary provided in this report has also been used to assess the stability of the fill in relation to the final quarry pit. This assessment was carried out in a preliminary manner. This preliminary analysis was completed to test the impact of the proposed fill area on the conceptual quarry pit limit. Detailed investigation and design of the final quarry pit walls will need to be undertaken.

3 Site Description

3.1 Location

The location of Fill Site 2 and its relation to the quarry pit and surrounding proposed fill sites is presented in Figure 1 and Figure 2 as well as in Drawing No.: 2325-23-01. The site is accessed from the Huntly Quarry located at 300 Riverview Road in the northern Waikato township of Huntly.

3.2 Site Topography

Fill Site 2 is a broad gully being approximately 200m wide that trends in an east to west direction. The upper reaches of the gully exhibit sign of shallow instability in the form of small slump scarps as well as terracettes indicative of soil creep.

Two confined ephemeral watercourses run either side of a remnant ridge situated centrally within the gully, draining into an artificially dammed pond at the base of the remnant ridge. The pond drains into a more steeply incised main water course that follows a relatively straight path out of the gully. The watercourse was observed to be flowing downstream of the pond during all of our site visits. The ephemeral watercourses upstream of the pond however, were only observed to be flowing water beneath the surface within the layers of colluvial and alluvial material. These features are shown in Figure 1.

The steeply incised banks immediately rising from the water course exhibit slopes of between 1.5H:1V 2H:1V covering approximately 20m in vertical height. The upper slopes of the gully leading to the surrounding ridgelines average a gradient of approximately 2.5H:1V

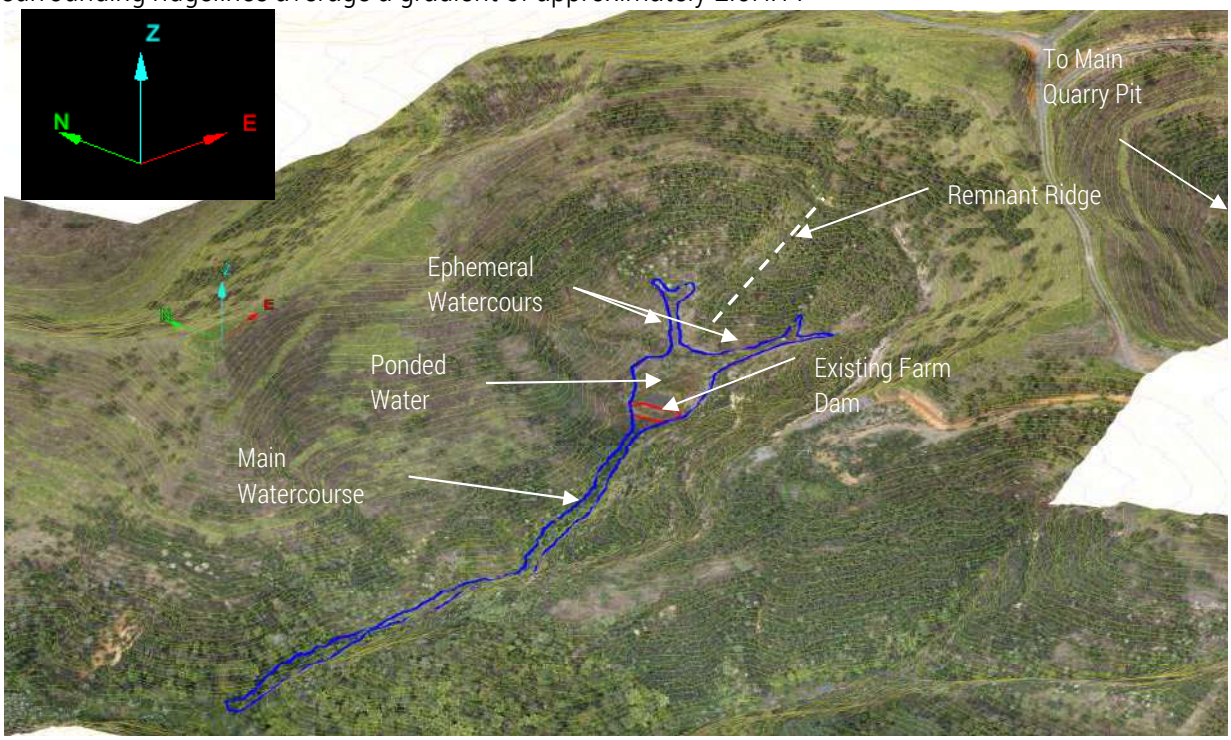


Figure 1: Oblique Image looking Northeast at Fill Site 2 Showing Topographic Features

3.3 Geomorphology

The geomorphology of the site is predominantly controlled by the underlying geology. The broader ridge area at the head of the Fill 2 gully exhibits evidence of historical shallow slumping and some evidence of creep terracettes. These 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. At the boundary between the younger soils and the weathered Newcastle Group Greywacke, the valley becomes noticeably narrower and steeper. The shape of the valley within this material is more controlled by erosion of the underlying weathered soils and is less affected by slumping and the soil creep depth is much shallower.

4 Test Pit Investigation

Test pit site investigations commenced on the 17th of June 2019 during the geotechnical appraisal and concept design stage. 7 (No's.) test pits were excavated within the Fill Site 2 area pits by means of a 30t excavator to a maximum depth of 4.5m deep at the time.

In preparation of this report, an additional 6 (No.) test pits were excavated to a maximum depth of 6.2m deep using the same plant during the detailed design investigations undertaken on the 7th of November 2019.

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.

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 locations of the test pits are shown on Drawing No.: 2325-23-01 included in Appendix A. Test Pit logs and relevant historical borehole logs are presented in Appendix B

The following table presents a summary of the measured field vane shear strengths in each geological unit:

Table 1: Summary of Measured Field Vane Shear Strength (Su)

Geological Unit	Minimum Measured Vane Shear Strength (kPa)	Maximum Measured Vane Shear Strength (kPa)
Recent Alluvium and Colluvium	41	140
Residually to Completely Weathered Waikato Coal Measures Material	>188	>188
Residually to Completely Weathered Newcastle Group Material	136	>188
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 flows into.

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

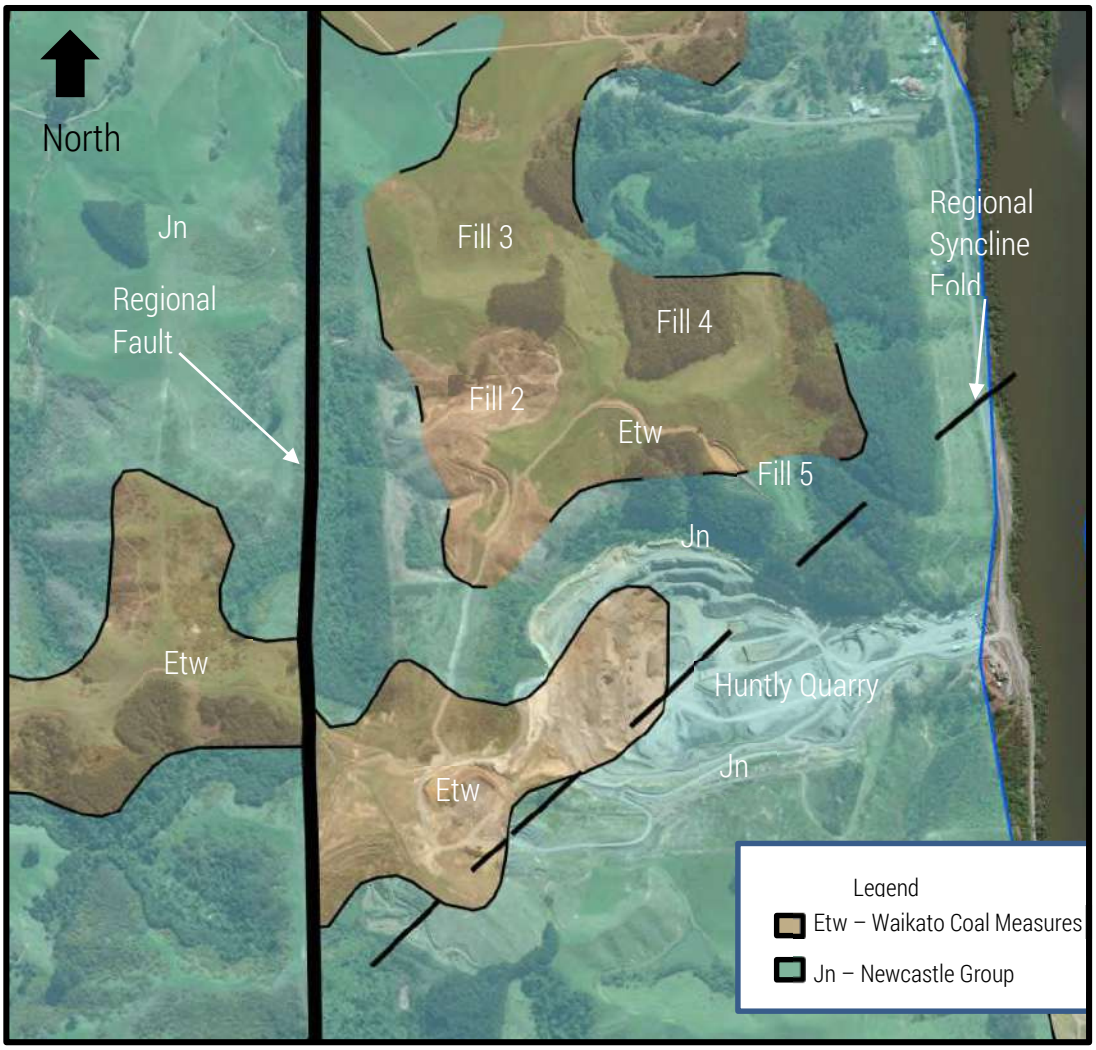


Figure 2: Published Geological Map of the Huntly Quarry and Fill Sites. *Modified from GNS Science Web Map Service Under Creative Commons Licence*

5.2 Local Stratigraphy

The following geological units have been observed or inferred within the Fill Site 2 area:

5.2.1 Holocene Alluvial/Colluvial Materials

The material is observed in the invert of the gully and within the watercourse. This material consists of texturally disturbed, firm silts and clays with varying organic content. It is typically saturated with active seepage and groundwater passage through this material visible in the near-surface.

5.2.2 Puketoka Formation

The material is inferred to be late Pleistocene to Holocene aged alluvial ash deposits. This material is present at the top of the highest ridges such as the ridge at the eastern extent of the Fill Site 2 as observed during walkover mapping. It consists of stiff to very stiff, predominantly white coloured pumiceous silts.

5.2.3 Waikato Coal Measures

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 nearer the ridges with weathering profiles being thinner towards the invert of the incised gully. The 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. Carbonaceous and Coal beds were encountered in test-pits approximately mid-way up the gully slopes. The carbonaceous beds were thin with organic material disseminated in a mudstone matrix.

5.2.4 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. This unit has deeply weathered to soils and weak rock as observed in the test pit investigation of Fill Site 2. 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 2, highly weathered to moderately weathered greywacke of this group was reached within the eroded invert of the existing gully. At this weathering grade the material exhibited a very weak rock strength. However, the rock mass is heavily jointed with heavy oxide staining present.

5.3 Geological Risks and Mitigation

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

5.3.1 Holocene Alluvial/Colluvial Materials

These materials are considered to be too weak and too wet to remain under the proposed fill. These materials will be removed during the gully muck-out stripping and drainage installation prior to the emplacement of any fill.

5.3.2 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. These planes are most commonly 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.

Bedding parallel weaknesses were not observed during the test pit investigation. Relatively uniform strength was observed within the residually weathered material followed by a gradual transition through weathering grades to moderately-slightly weathered material present in the base of the gullies.

However, sensitivity of the design to the presence of bedding parallel weaknesses will be checked for during the slope stability analysis as described in Section 7.2.

5.3.3 Newcastle Group Greywacke

Weathering:

The toe area of Fill 2 will be directly founded on the local basement material. The depth to the unweathered material has not been confirmed in this area. However, very weak to weak, highly to moderately weathered rock was observed within the test-pits located near the invert of the gully.

Within Fill 2, the unweathered component of the basement bedrock is overlain by variably thick weathered horizons. Due to the uncertain depth to unweathered material, the design will be undertaken based on a conservatively large thickness of weaker weathered material being present beneath the toe of the fill.

Structure:

Published GNS geological maps indicate that a large fault feature is running approximately in the north/south direction immediately at the west of the Fill Site 2 Gully. This fault feature is located at approximately 140m to the west of the toe of the proposed works. The fault is therefore not expected to be encountered during the construction of Fill Site 2. However, given the tectonic history of this geological unit, smaller scale fault structures related to the main faulting sequence are expected.

Whilst faults can cause zones of significant weakness as compared to surrounding unweathered material, this effect becomes less pronounced in the highly and completely weathered material where the proposed development is to be founded.

If fault weakened materials are observed within the subgrade during this stripping operations, undercuts and replacement with compacted granular fill will be required.

5.4 Groundwater

No information is available on the regional ground water tables. However, this water table is expected to be drawn down somewhat by the proximal quarry pit. It is therefore expected to be below the zone of influence expected to be imposed by the proposed fill material.

Perched groundwater in the surficial materials is expected to be of much higher significance to the stability of the proposed fill. This perched groundwater table is expected to seep continuously from the natural subgrade and concentrate at the location of the existing watercourse even after the area has been 'sealed' over by the proposed fill. It is for this reason the drainage structures and measures as well as specific construction considerations proposed in the later sections of this report will be adopted.

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 some of the batter and bench geometries to promote drainage.

The toe of the fill intersects the gully invert at approximately RL50 and the proposed fill rises to approximately RL115, just below the main ridgeline of the gully surrounding the fill.

Three external batter gradients have been adopted to allow the fill to more efficiently climb out of the incised lower gully, maximise the internal fill volume and finally stay below the surrounding gully ridge lines. External batters representing the first bench heights or approximately 10m in elevation will be 2H:1V. Intermediary external gradients above the first bench heights will be 3H:1V whilst the uppermost external batter angle will be 4H:1V.

The basal bund (Stage 1 Bund) must be constructed to the full 10m height and will be required to be keyed a minimum of 2m vertically into the underlying natural subgrade. All subsequent bunds above the Stage 1 bund should also be constructed to the designed height prior to managed fill being placed behind the bund. The height of the bunds above Stage 1may be split into 5m height to reduce the overall amount of structural fill required.

The general geometries for the proposed fill at Fill Site 2 are summarised in Table 2. A typical detail showing the proposed bund geometry is presented in Drawing No.: 2325-23-101 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
Lowest Bund – Stage 1	50 to 60	2H:1V	10m	1.5H:1V	5m
Secondary Bund – Stage 1	60 to 70	3H:1V	10m	1.5H:1V	5m
Bunds – Stage 2 to 3	70 to 80	3H:1V	10m	1.5H:1V	5m
Bunds – Stage 4	90 to 100	3H:1V	5m	1.5H:1V	5m
Upper Bund – Stage 5	100 to 110	4H:1V	5m	1.5H:1V	5m
Notes:	1) The top of the fill has a nominal a drainage gradient of approximately 5% and 10% to the south and north respectively.				

The proposed fill geometries result in a calculated total volume of approximately 717,000m^3. The proposed fill area has a footprint of approximately 45,000m^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 northern and southern 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

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.

Two 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 section through the centre of the proposed fill.
Cross Section 2	Design check to analyse stability of the back wall of the fill in proximity to the main quarry pit and the concept final pit extents.

The geological models used for analyses have been determined using the test pit site investigation data. Test pit investigations were able to confirm the presence of highly to moderately weathered greywacke bedrock material near the invert of the existing drainage channel.

The presence of the unweathered rock boundary was not confirmed during this investigation. 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	18 ~ 19	5	30	N/A	70
Waikato Coal Measures Bedding Parallel Shears	20	10 0 Note1	30 18 Note1	N/A	N/A
Residually and Completely Weathered Greywacke	18 ~ 19	8	30	N/A	100 ~ 150
Note	1) See Section 7.2 and Figure 3 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

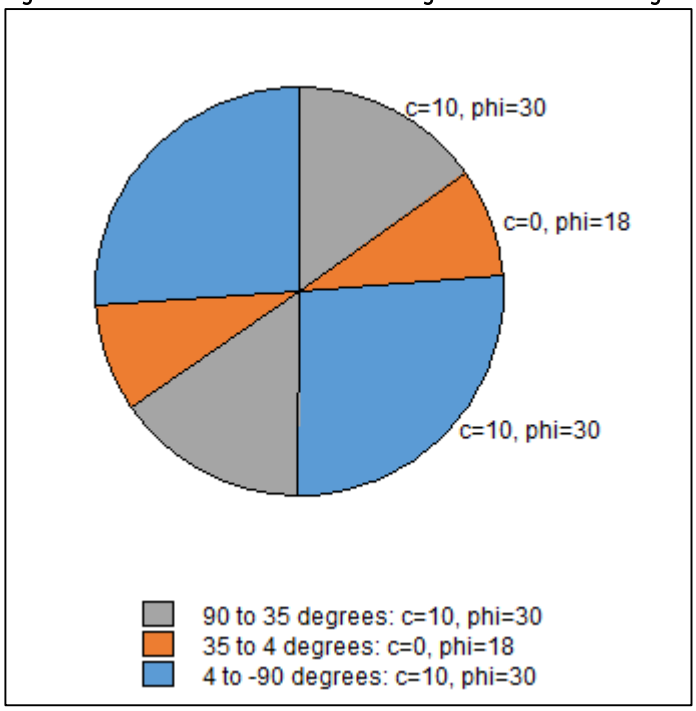
Fill Material	Mohr-Coulomb Parameters			Undrained Strength Parameters	
	Unit Weight (kN/m^3)	Cohesion - c' (kPa)	Angle of internal friction – Φ (°)	Vertical Stress Ratio	Undrained Shear Strength – Su (kPa)
Structural Fill	18	5	30	N/A	135
Managed Fill	15-16	3	23	0.3	30
Managed Fill – Material Strength Sensitivity	N/A	N/A	N/A	0.22	30

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.

During mapping of the area, bedding was observed but was not able to be mapped to a level of certainty suitable for modelling. As such, Waikato Coal Measures bedding has been modelled using a worst credible case anisotropic strength function. The worst-case strength function comprises a c'=0kPa and Φ=18° at an angular range of between 4° and 35° dipping out of the proposed slope. The anisotropic strength parameters are summarised in Figure 3: Waikato Coal Measures - Bedding Parallel Shears Strength Parameters below.

Figure 3: Waikato Coal Measures - Bedding Parallel Shears Strength Parameters



7.3 Fill Staging and Sensitivity Checks

Slope stability design checks using 5 "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. It was subsequently identified that the fill design was not sensitive to deep failure through the fill thickness. Instead, failure surfaces are all located closer to the underside of the structural bunds.

7.4 Pore-Water Pressure

It is believed that pore-water pressure within the proposed fill material 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. The Hu coefficient of the piezometric lines can then be altered to model both extreme and moderate groundwater conditions.

Control of pore-water pressure within the fill material is primarily achieved by the inclusion of 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.

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 2 – Cross Section 1	Existing Slope	0.915
	Completed Fill – Piezometric Moderate Groundwater	1.519
	Completed Fill – Piezometric Extreme Groundwater	1.308
	Completed Fill – Ru Pore-Water Pressure	1.547
	Completed Fill – Undrained Strength Case	1.326
	Stage 1 Filling – Long Term Strength	1.933
	Stage 1 Filling – Undrained Strength	2.169
	Stage 1 Filling – Material Variability	1.626
	Stage 2 Filling – Long Term Strength	1.775
	Stage 2 Filling – Material Variability	1.828
	Stage 2 Filling – Undrained Strength	1.800
	Stage 2 Filling – Medium Term Strength	1.845
	Stage 3 Filling – Long term strength	1.421
	Stage 3 Filling – Material Variability	1.562
	Stage 3 Filling – Undrained Strength	1.482
	Stage 3 Filling – Medium Term Strength	1.653
	Stage 4 Filling – Long term strength	1.322
	Stage 4 Filling – Material Variability	1.358
	Stage 4 Filling – Undrained Strength	1.225
	Stage 4 Filling – Medium Term Strength	1.410
	DCLS Seismic Loading	0.608
Fill 2 – Cross Section 2	Existing Slope	1.469
	Concept Quarry Pit Extents – No Managed Fill	1.273
	Concept Quarry Pit Extents – Completed Managed Fill	1.273

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 0.05g where the global FoS was ≈ 1.

Based on the above parameters the calculated seismic induced displacement with a 50% confidence level was determined to be 65mm. 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.

8 Proposed Fill Construction Recommendations

Based on our review of existing geological/geotechnical information, walk-over inspection/mapping test pit 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.: 2325-23-03. The location of this pond is not anticipated to adversely affect the stability of the proposed fill due to the ponds position at the base of the gully with a shallow depth to competent material. Changes to the proposed location of the sediment control pond location should be referred back to the geotechnical designer for review.

It should be noted that the 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

During the initial stages of the fill, it will be required to transport material to the working toe of the fill. Where possible existing forestry tracks should be utilised. If additional tracks are required, the location of these may affect ground stability and should be discussed with the geotechnical designer prior to undertaking the work as additional design may be required.

8.3 Stripping

Prior to commencement of filling – vegetation and topsoil along with soft and otherwise deleterious material should be removed to stockpile to expose subgrade conditions. Subgrade conditions should 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 43,900m^2. The average observed topsoil thickness is 0.3m which gives an estimated topsoil volume of approximately 13,000m^3. This topsoil volume does not include gully muck-out material and earthworks areas outside of the fill footprint such as the sediment control pond area.

8.4 Drainage

The drainage solutions required to generate the designed stability are discussed in the sections below:

8.4.1 Carrier Drain

A carrier drain is to be installed along the invert of the main watercourse channel. This drain will serve to convey the waterflows typically encountered within the main watercourse. It is anticipated that this drain will continue to relieve groundwater seepages expected from the surrounding subgrade even after the watercourse has been sealed off by the placement of fill.

The anticipated location of the carrier drain is shown in Drawing No.: 2325-23-04 included in Appendix A

The drain is to comprise an approximately 1.2m deep, 0.3m wide trench with three 160mm Φ punched drainage coils arranged with 200mm vertical spacing between the coils. The vertically spaced coil arrangement allows for variable capacity based on the amount of water received at the drain whilst also allowing 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 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 carrier drain is shown in Drawing No: 2325-23-102

It is anticipated that the carrier drain will be installed during the muck-out stripping of the gully material. Review of the drains suitability will be confirmed by observing water flows after the farm dam has been released.

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 watercourses or where soft and/or wet areas are discovered during stripping.

The anticipated locations of collector drains are shown in Drawing No.: 2325-23-04 included in Appendix A. 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.

The drain is 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% downslope. 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 main carrier drain network at the nearest suitable location and the positions of the drains are to be as-built surveyed.

8.4.3 Basal Drainage Blanket

All fill must be placed on a basal drainage blanket as generally indicated in Drawing No.: 2325-23-04 subject to field confirmation. The basal drainage layers serve to provide a preferential drainage path to convey any seepages from the natural subgrade beneath and excess pore-water from the fill material above to the carrier 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 nearest carrier drain at a minimum gradient of 1% to 3%.

The recommended aggregate is to have a nominal size of All Passing 150mm (AP150) 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.

Minor cuts and fills of less than 1m may be undertaken prior to placing the basal drainage blanket in order to grade localised areas to maintain the minimum gradient of 1% to 3%.

8.4.4 Internal Drainage Blankets

An internal drainage blanket is to be installed every 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 downslope 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 have a nominal size of All Passing 150mm (AP150) with less than 4% fines. 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.

Due to the incised nature of the central gully in the vicinity of the fill toe, the first bund representing 10m of elevation has a steeper external batter angle of 2H:1V and a top of bund width of 10m. The intermediary benches above adopt a 3H:1V external batter whilst the uppermost bund representing the final stage of the fill has a 4H:1V external batter angle.

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 drainage blankets.

The general details and layout of the structural bunds is shown on Drawing No.: 2325-23-101 shown in Appendix A.

8.5.1 Basal Bunds (Stage 1)

The basal bund will need to be constructed to the full dimensions of 10m height and 10m bench width. With external and internal batter angles of 2H:1V 1.5H:1V respectively. The anticipated thickness of the basal bund will be in the order of 70m at the base.

The basal bund will need to be keyed into competent underlying ground. This 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 and directed to the carrier drain which will daylight downslope of the fill. Drainage blanket material should not extend outside of the bund footprint.

8.5.2 Intermediary & Upper 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 (excluding the basal bund, see Section 8.5.1) may be 5m high instead of 10m high. 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 flume drains at the edges of the fill
2) To allow access maintenance machinery to maintain the swale drains and batter faces.

The benches have been designed with a crown to enable water to flow to both the northern and southern flanks of the fill. Benches are also 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 each valley are susceptible to slumping type failures. 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. Manged fill should not be placed at gradients steeper than 1H:6V during filling works.

8.7 Fill Control

Monitoring 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 – Cohesive Material

Fill Type	Criteria and Testing					
	Water content (NZS 4402: Test 2.1) Frequency of Testing	Water Content Acceptance Criteria	Pilcon Vane Shear Frequency of Testing	Shear vane Acceptance Criteria (NZGS 2001 Guideline for Hand Held	Maximum Dry Density and Air Void Frequency of Testing	Maximum Dry Density and Air Void Acceptance Criteria (NZS4407 Test 4.2.1)
Structural Fill	1 test per 500m³ of source material cut with a min of 2 tests for each area worked each day	± 4% of Optimum Water Content (NZS4402:1986 Test 4.1.1)	1 set (3 points) per 500m3 placed with a min of 2 tests for each area worked each day and no more than every 0.5m thick of fill placed	Avg Su= 135kPa No single value less than 110kPa	1 set (3 points) per 500m3 placed with a min of 2 tests for each area worked each day and no more than every 0.5m thick of fill placed	≤ 8% Air Voids

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

Fill Type	Grading Test Frequency & Acceptance Criteria	Proof Roll Frequency & Acceptance Criteria
Structural Fill	Visual check each day. No particles greater than 200mm. 1 test per 2000m³ of compacted fill (NZS4402:test 2.8.1) Of particle passing 65mm sieve: - No organic content; and - <4% passing 75µm sieve.	All layers. Visually confirm resultant impression at the surface shall be less than 5mm with a fully loaded ADT (min. 40 Tonne) or a standard axle vehicle (min. 10 Tonne). 1 calibration tests [2] per 5,000m³ of compacted fill and no more than every 1.5m thick of rock fill placed

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 - Non-Structural Fill

Fill Type	Proof Roll Frequency & Acceptance Criteria
Managed Fill	All placed soil fill shall be uniformly spread and track rolled by a bulldozer. The bulldozer should be able to track easily across the surface without sinking into the material. Material that is untrafficable by the bulldozer should be conditioned or blended before additional layers are spread.

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 ±4m 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.

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.: 2325-23-103

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 100mm net vertical displacement of structural fill
Notes:	1) The alert levels may be revised during construction in response to observed displacements	

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 will be determined by the supervising geotechnical engineer upon review of the displacement data.

8.8.2 Excess 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.

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9 Conclusions

This geotechnical design report covers the detailed investigation and design of Fill Site 2 undertaken by Gaia Engineers as part of the Huntly Quarry Fill Disposal Areas project.

The toe of proposed fill begins at RL 50 and the fill rises to RL 115. 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 lowest bund representing the first 10m of elevation will have external batters of 2H:1V in order for the fill to climb out of the steeply incised portion of the gully. Above the first bench, external batter gradients will transition into 3H:1V with the final external bund being 4H: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 will be sufficiently stable. Stability of the fill is reliant on the correct implementation of the design including installation of the drainage blankets, control of external batter angles and adherence to the appropriate fill specifications.

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 is the property of our client – Gleeson Quarries Ltd.

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 5 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

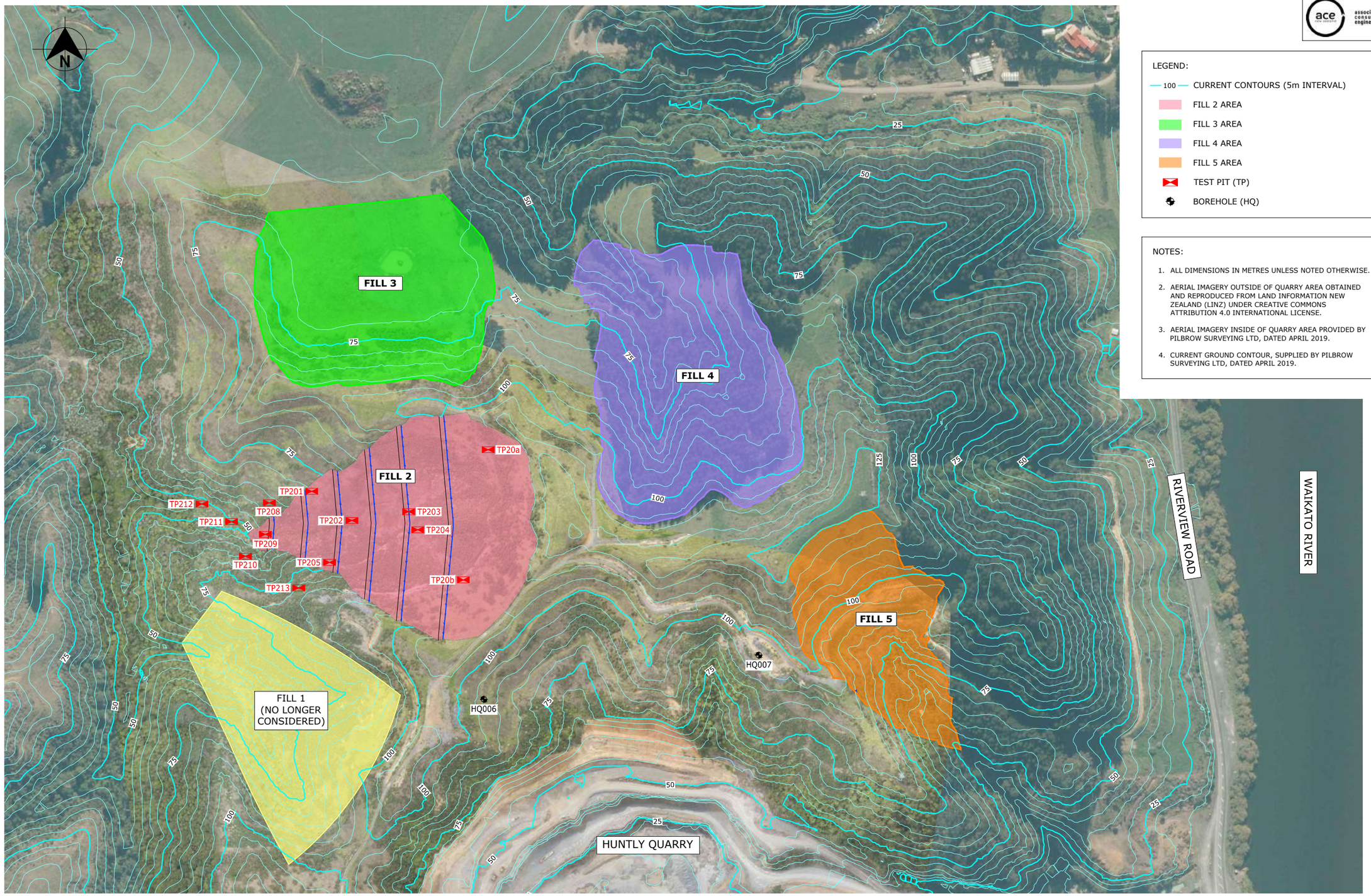
Likely Risk	Mitigation Strategy
Ground Conditions: Position of Geological/Geotechnical Unit boundaries differs from design. Worse conditions than those designed for could lead to slope instability Presence of Bedding Parallel Shears and Weaknesses within the Waikato Coal Measures are encountered	Specific design of toe-keys to cut-off bedding parallel weaknesses. No permanent cuts that daylight bedding parallel weaknesses.
Groundwater Conditions: Groundwater table is higher than observed and/or groundwater springs are encountered.	Sufficient contingency in construction budget for additional drainage measures.
Land Slips: 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. Maintaining positive drainage across all active earthworks sites and shaping of finished ground. Not directing catchment stormwater flows onto active earthworks areas and conveying water to a safe discharge point
Displacement Monitoring: Excessive Fill Displacements Measured	Install stand-pipe piezometers to monitor pore-water pressures Installation of sub-horizontal bored drains Remove material causing deformation and replace with compacted hard-fill or soft-pit-run
Seismically induced displacement: Displacement causing sloughing of material from external batters	Reinstate drainage capacity of swale drains if blocked by slip material Remove remnant displaced material and replace with compacted structural fill.

12 Safety in Design (SiD) Considerations

A Safety in Design matrix is included in Appendix D. It is anticipated that prior to construction the document will be finalised with the contractor.

APPENDIX A – Design Drawings

DRAWING NO:	DRAWING TITLE:	REVISION:
2325-23-01	OVERALL PROJECT LAYOUT WITH CURRENT CONTOURS	A
2325-23-02	OVERALL PROJECT GEOLOGICAL MAP	A
2325-23-03	PROPOSED FILL SITE 2 FINAL SURFACE AND DRAINAGE	B
2325-23-04	MUUCKOUT AREA AND UNDERFILL DRAINAGE PLAN	A
2325-23-10	STAGE 1 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	B
2325-23-11	STAGE 2.1 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	A
2325-23-12	STAGE 2.2 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	B
2325-23-13	STAGE 3.1 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	A
2325-23-14	STAGE 3.2 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	B
2325-23-15	STAGE 4.1 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	B
2325-23-16	STAGE 4.2 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	B
2325-23-17	STAGE 5.1 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	B
2325-23-18	STAGE 5.2 LAYOUT – BUND AND MANAGED FILL ARRANGEMENT	B
2325-23-50	GEOLOGICAL AND PROPOSED FILL SECTION 01	A
2325-23-51	GEOLOGICAL AND PROPOSED FILL SECTION 02	A
2325-23-52	GEOLOGICAL AND PROPOSED FILL SECTION 03	A
2325-23-101	TYPICAL BUND AND MANAGED FILL – ARRANGEMENT AND DETAIL	B
2325-23-102	TYPICAL DRAINAGE DETAILS	A
2325-23-103	DISPLACEMENT MONITORING LAYOUT	B



LEGEND:

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

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 QUARRY AREA PROVIDED BY PILBROW SURVEYING LTD, DATED APRIL 2019.
4. CURRENT GROUND CONTOUR, SUPPLIED BY PILBROW SURVEYING LTD, DATED APRIL 2019.

OVERALL PROJECT LAYOUT WITH CURRENT 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	12/03/20	ISSUED FOR INFORMATION

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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 2 AREA

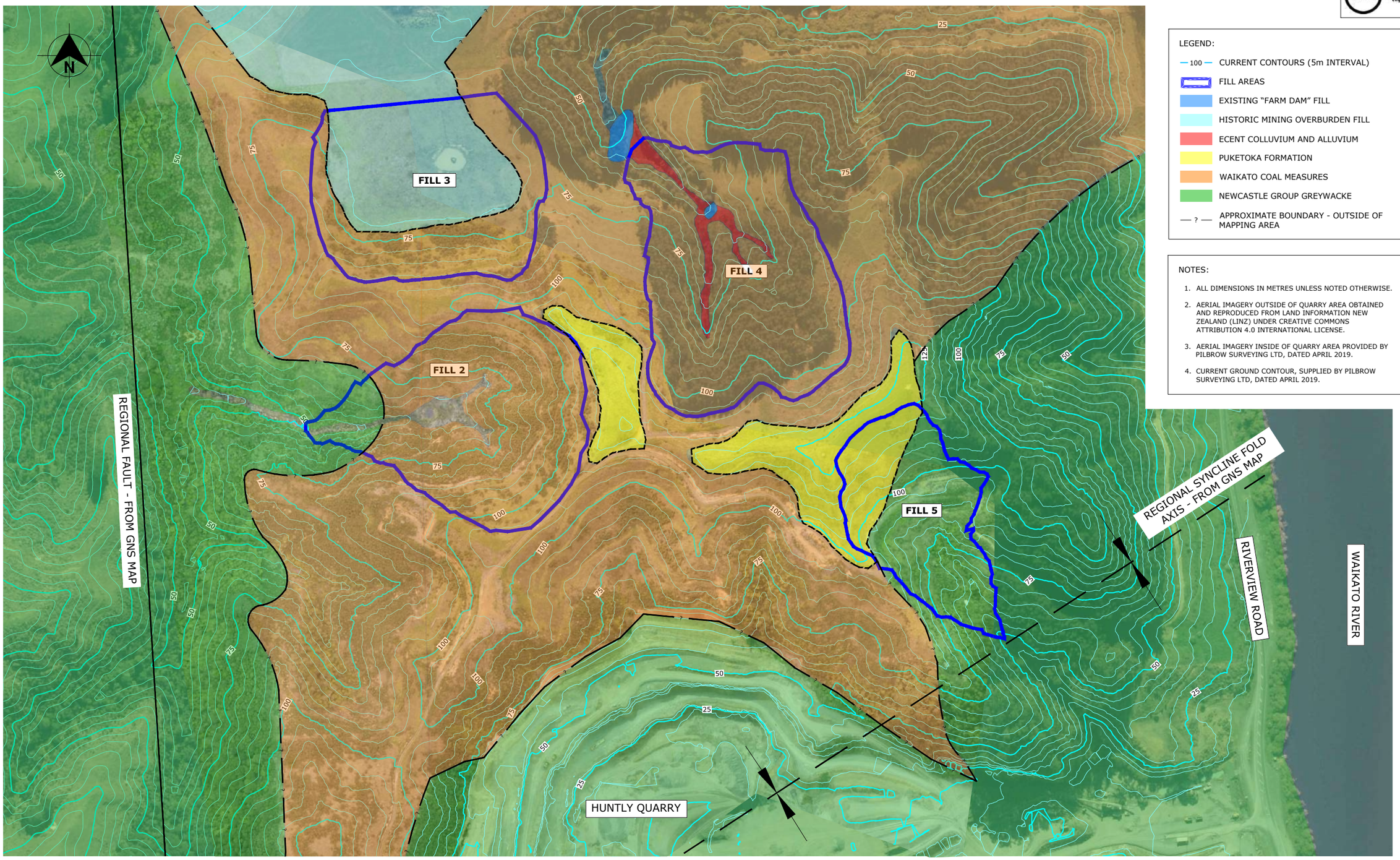
Drawing Title: OVERALL PROJECT LAYOUT WITH CURRENT CONTOURS

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-01 Rev. A

FILE LOCATION: I:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2325-23-01.dwg
PLOT DATE: 2020-05-12



LEGEND:

- 100 — CURRENT CONTOURS (5m INTERVAL)
- FILL AREAS
- EXISTING "FARM DAM" FILL
- HISTORIC MINING OVERBURDEN FILL
- ECENT 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 QUARRY 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)

INFORMATION

ORIGINAL IN COLOUR

Rev.	Date	Revision Details
A	12/03/20	ISSUED FOR INFORMATION

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Design Review: K. C. CHEUNG		
Drawn: S. CHEN		
Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 2 AREA

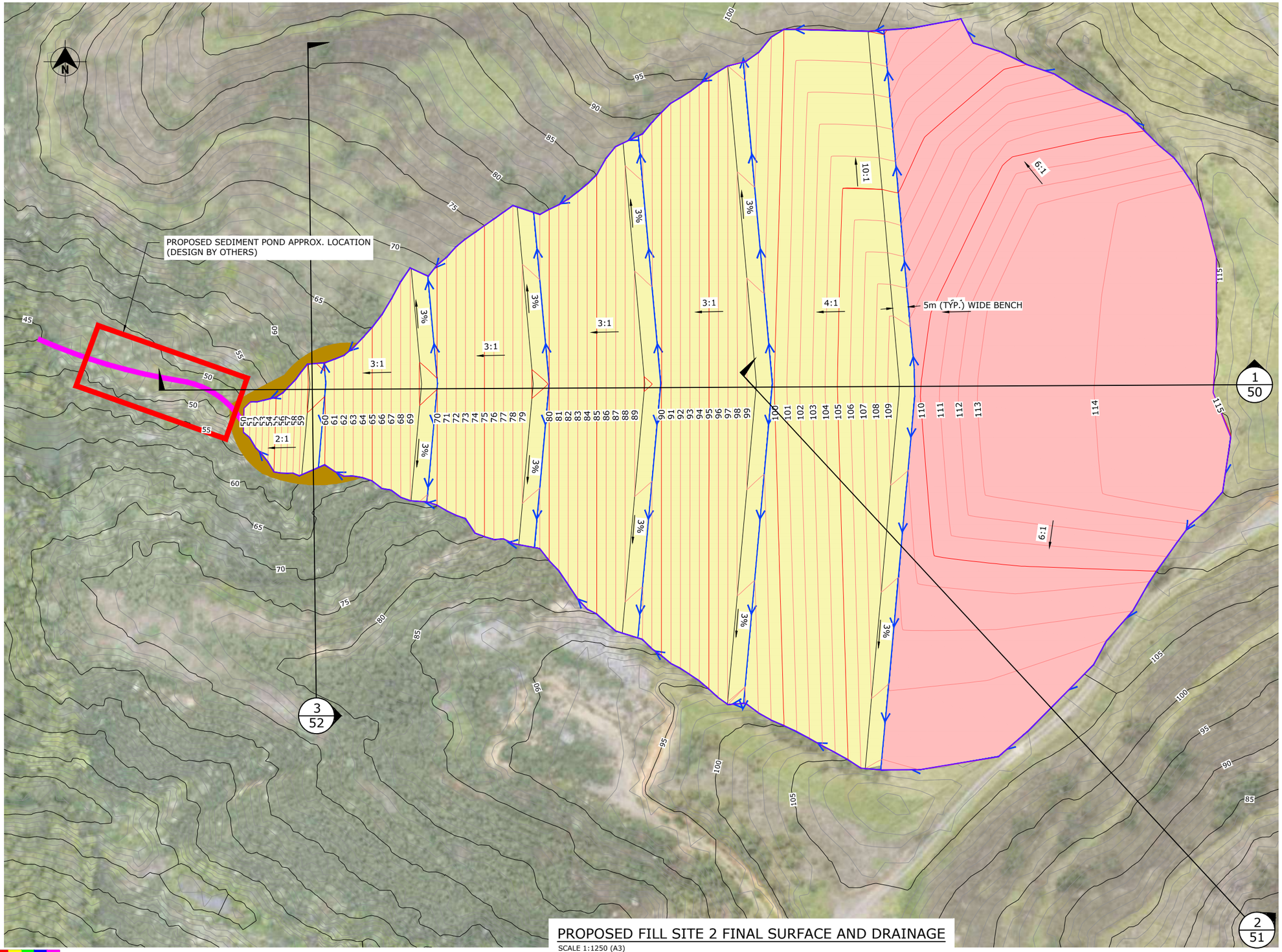
Drawing Title: OVERALL PROJECT GEOLOGICAL MAP

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-02 Rev. A

FILE LOCATION: I:\2325_Huntly Quarry_Disposal Sites\50_Drawings\23\2325-23-02.dwg
PLOT DATE: 2020-03-12



PROPOSED FILL SITE 2 FINAL SURFACE AND DRAINAGE

SCALE 1:1250 (A3)

ORIGINAL IN COLOUR

LEGEND:

- 100 EXISTING CONTOURS (1m INTERVAL)
- 100 PROPOSED FILL CONTOURS (1m INTERVAL)
- STRUCTURAL FILL (BUND)
- MANAGED FILL (NON STRUCTURAL FILL)
- UNDERCUT
- WATER FLOW DIRECTION
- CARRIER DRAINS

NOTES:

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3. AERIAL IMAGERY INSIDE OF QUARRY AREA PROVIDED BY PILBROW SURVEYING LTD, DATED APRIL 2019.
4. CURRENT 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. COLLECTOR DRAINS TO BE INSTALLED IN DEPRESSIONS AND SEEPAGE LOCATIONS AND TO BE CONFIRMED ON SITE BY THE ENGINEER.
8. ALL SWALE DRAINS, SCOUR PROTECTION AND OUTLET CHANNEL TO BE DESIGN AND SPECIFIED BY STORMWATER DESIGN SPECIALIST.

VOLUME:

SITE AREA	**45,290 m²**
ESTIMATED TOPSOIL STRIPPING	**13,580 m³**
DRAINAGE BLANKET	**25,635 m³**
STRUCTURAL FILL (BUND)	**113,090 m³**
MANAGED FILL	**577,915 m³**
TOTAL FILL MATERIAL	**716,640 m³**

INFORMATION

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B	14/04/20	REVISED FOR INFORMATION
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Design Review: K. C. CHEUNG		
Drawn: S. CHEN		
Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 2 AREA

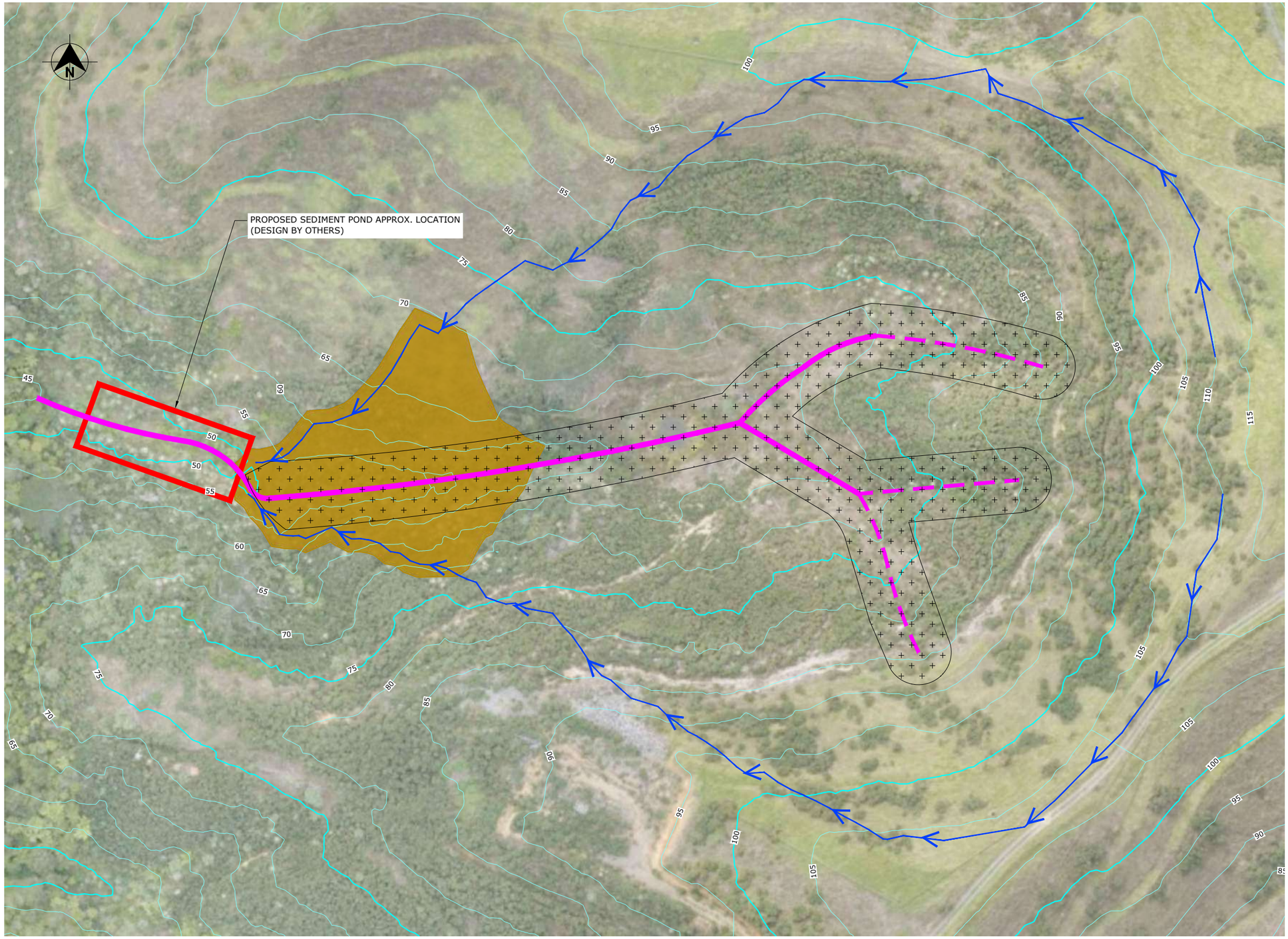
Drawing Title: PROPOSED FILL SITE 2
FINAL SURFACE AND DRAINAGE

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-03 Rev. B

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2325-23-03.dwg
PLOT DATE:2020-04-09



LEGEND:

- 120 EXISTING CONTOURS (5m INTERVAL)
- DRAINAGE BLANKET
- UNDERCUT FOR TOE KEY
- SWALE DRAINS & WATER FLOW DIRECTION (DESIGN BY OTHERS, REFER NOTE 7)
- CARRIER DRAINS
- COLLECTOR DRAINS

NOTES:

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6. MUCKOUT OF ENTIRE STAGE 1 GENERAL FILL FOOTPRINT TO BE COMPLETED TO THE SATISFACTION OF THE INSPECTING ENGINEER.
7. COLLECTOR DRAINS TO BE INSTALLED IN DEPRESSIONS AND SEEPAGE LOCATIONS AND TO BE CONFIRMED ON SITE BY THE ENGINEER.
8. ALL SWALE DRAINS, SCOUR PROTECTION AND OUTLET CHANNEL TO BE DESIGN AND SPECIFIED BY STORMWATER DESIGN SPECIALIST.

MUCKOUT AREA AND UNDERFILL DRAINAGE PLAN

SCALE 1:1250 (A3)

ORIGINAL IN COLOUR

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Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES FILL 2 AREA

Drawing Title: MUCKOUT AREA AND UNDERFILL DRAINAGE PLAN

Project No. 2325/23

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-04 Rev. A

FILE LOCATION: I:\2325_Huntly Quarry_Disposal Sites\55_Drawings\2325-23-04.dwg

PLOT DATE: 2020-03-12

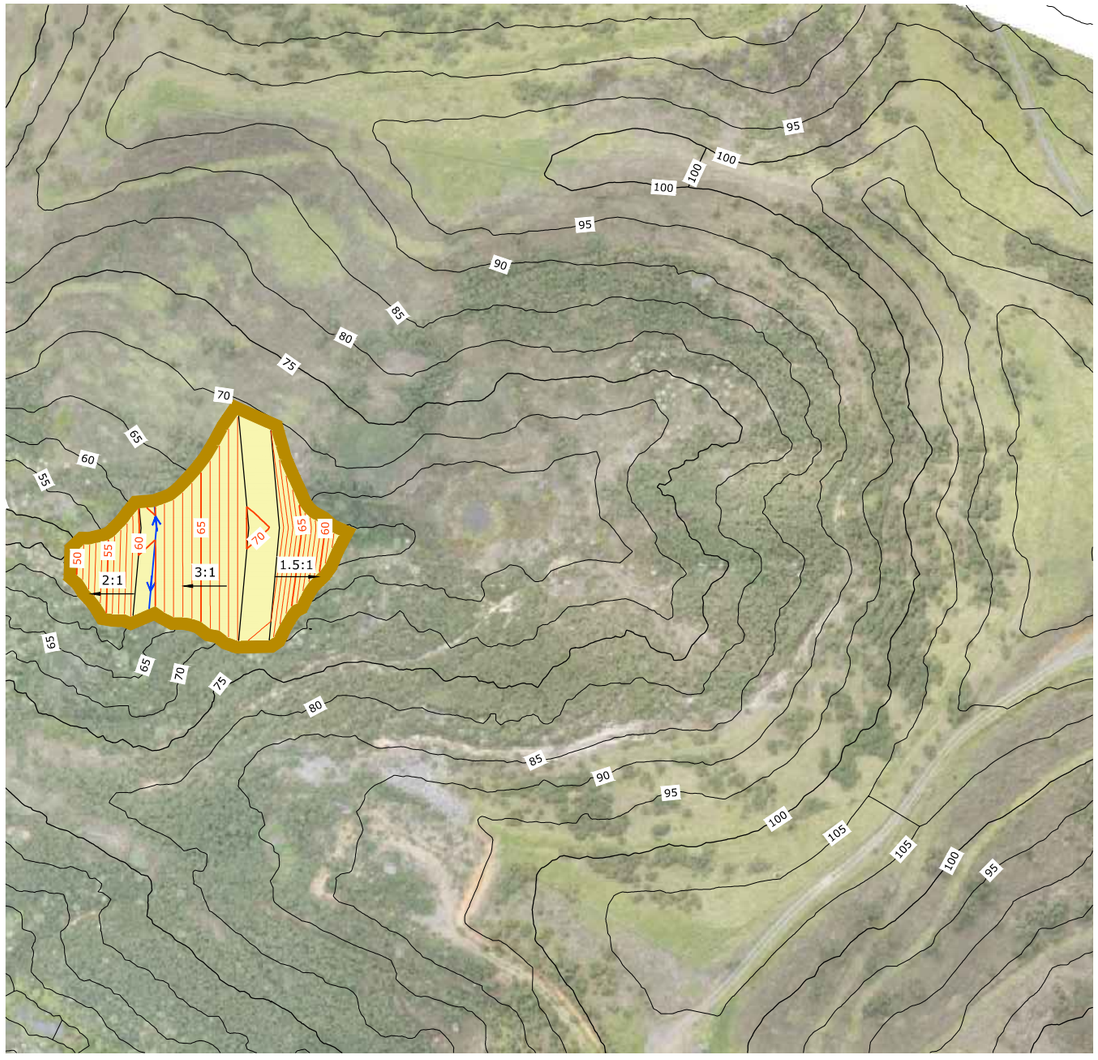
BUND VOLUME: 18,525m³

LEGEND:

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

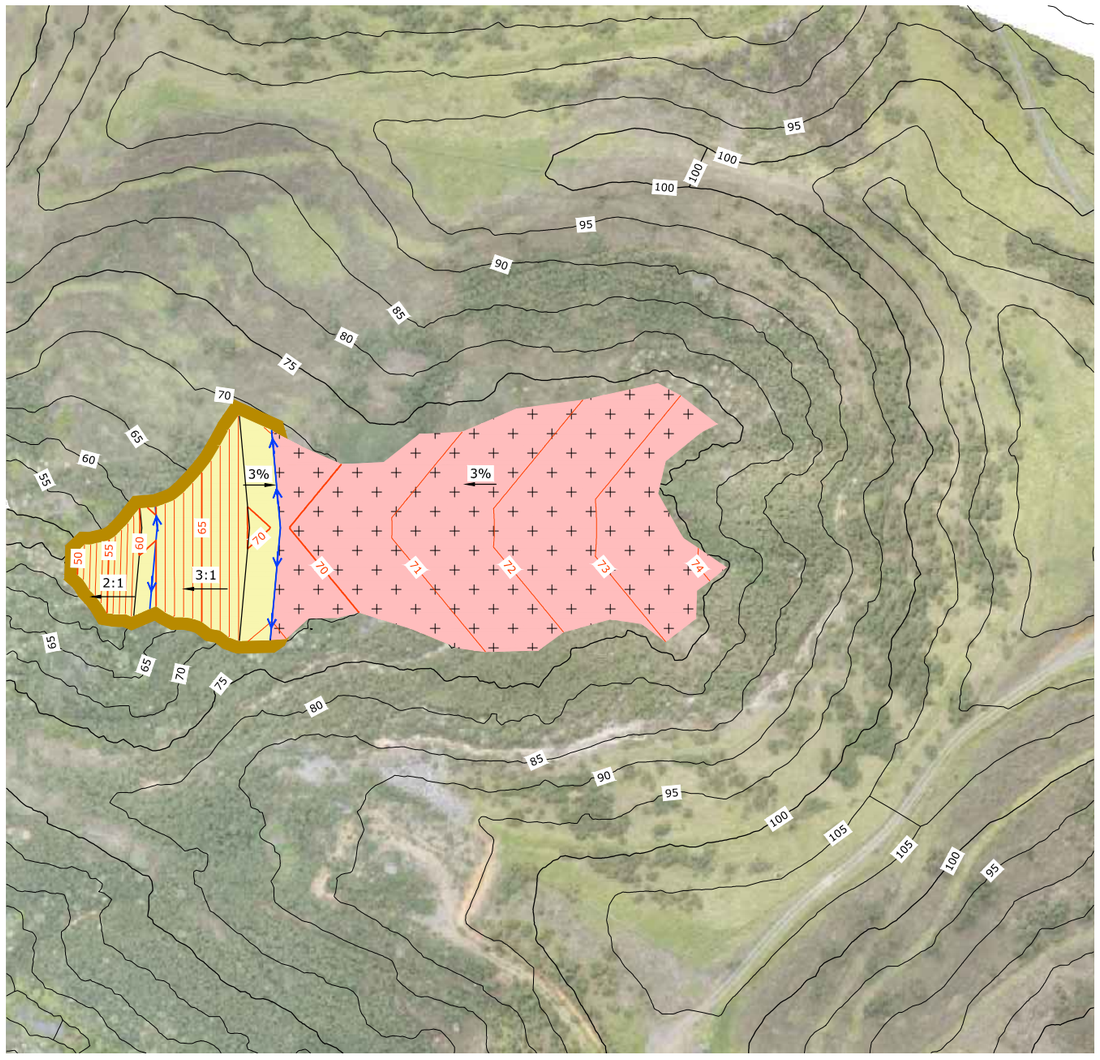
MANAGED FILL VOLUME: 46,805m³

DRAINAGE BLANKET VOLUME: 3,660m³



STAGE 1: STRUCTURAL FILL (BUND) LAYOUT

SCALE 1:2000



STAGE 1: MANAGED FILL LAYOUT

SCALE 1:2000

ORIGINAL IN COLOUR

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Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 2 AREA

Drawing Title: STAGE 1 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-10 Rev. B

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2325-23-10.dwg
PLOT DATE: 2020-04-09

BUND VOLUME: 8,050m³

LEGEND:

- EXISTING CONTOURS (5m INTERVAL)
- PROPOSED FILL CONTOURS (1m INTERVAL)
- STRUCTURAL FILL (BUND)
- MANAGED FILL
- DRAINAGE BLANKET
- MUCK OUT FOOTPRINT
- WATER FLOW DIRECTION

MANAGED FILL VOLUME: 51,575m³

DRAINAGE BLANKET VOLUME: 6,025m³

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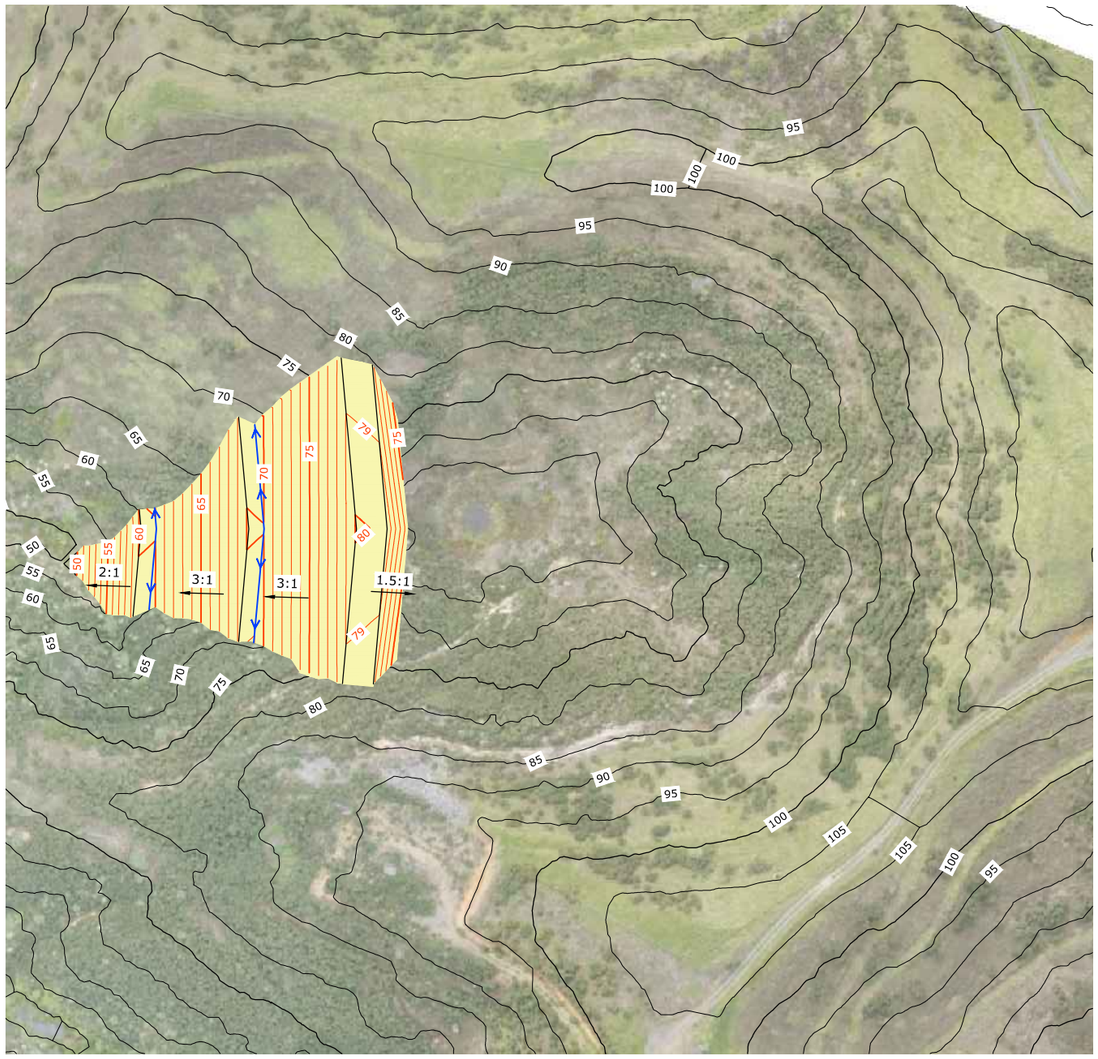
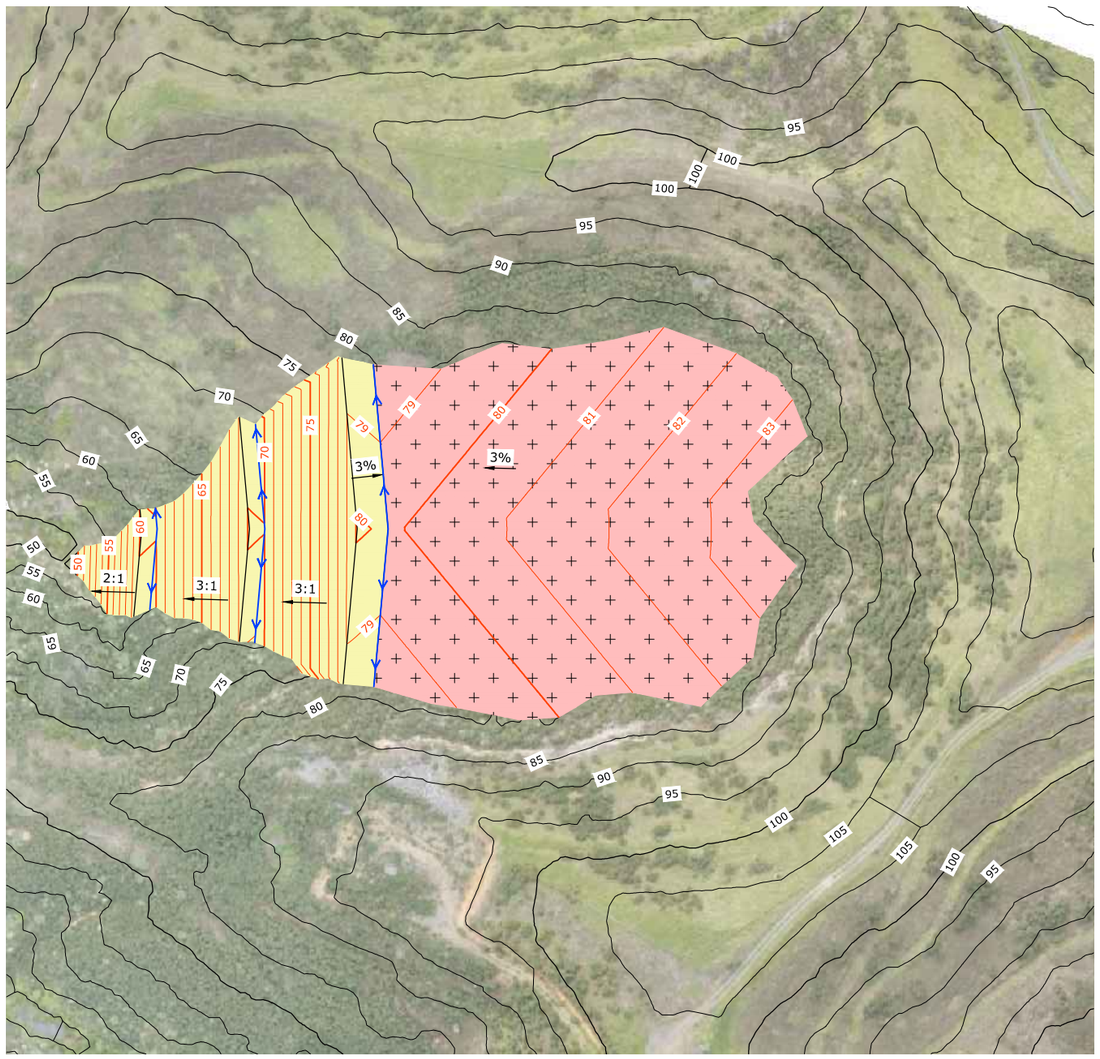


STAGE 2.2: STRUCTURAL FILL (BUND) LAYOUT

SCALE 1:2000



STAGE 2.2: MANAGED FILL LAYOUT

SCALE 1:2000

ORIGINAL IN COLOUR

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Drawn: S. CHEN		
Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 2 AREA

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

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-12 Rev. B

PLOT DATE: 2020-04-09

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\05_Drawings\23\2325-23-12.dwg

BUND VOLUME: 14,170m³

LEGEND:

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

MANAGED FILL VOLUME: 65,430m³

DRAINAGE BLANKET VOLUME: 7,590m³

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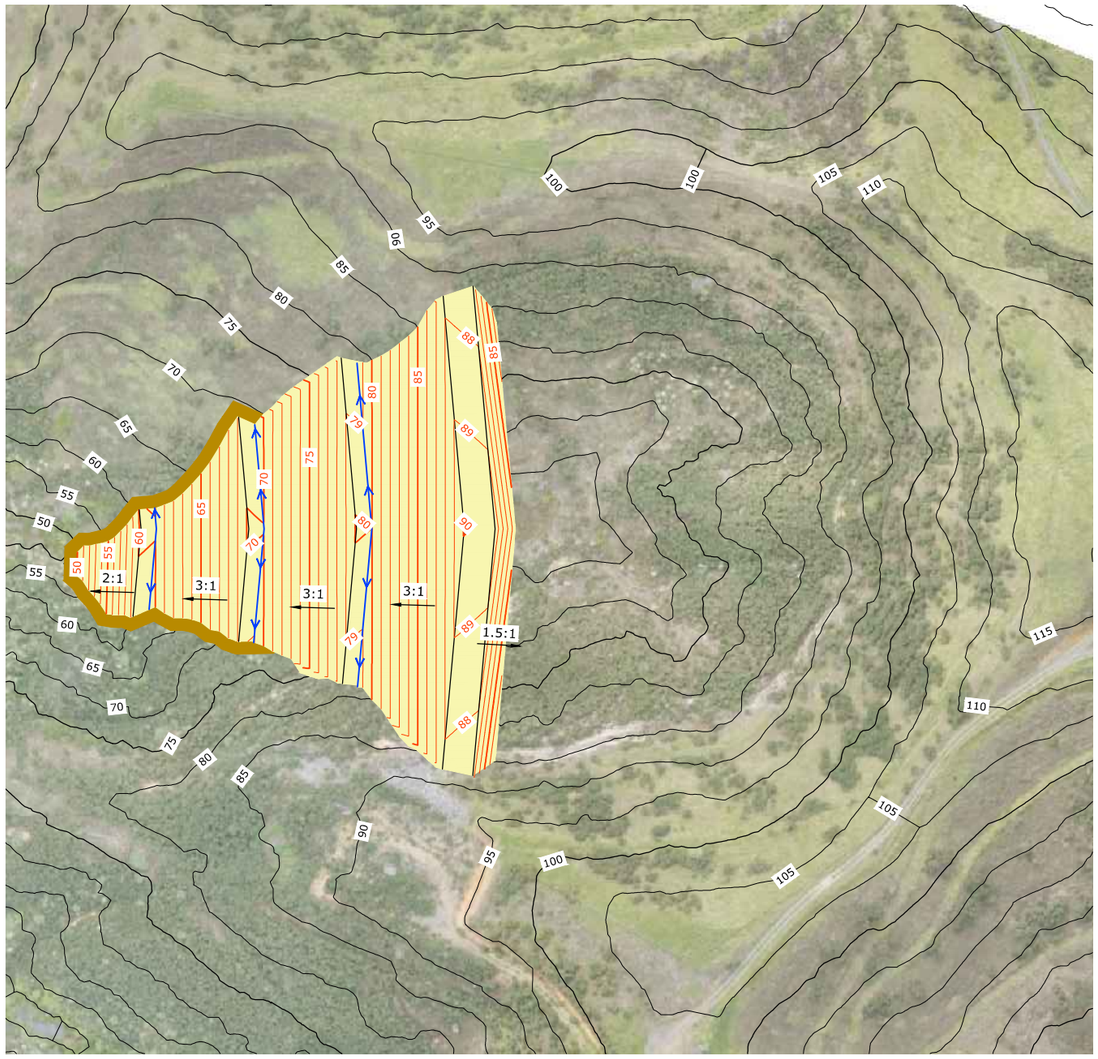
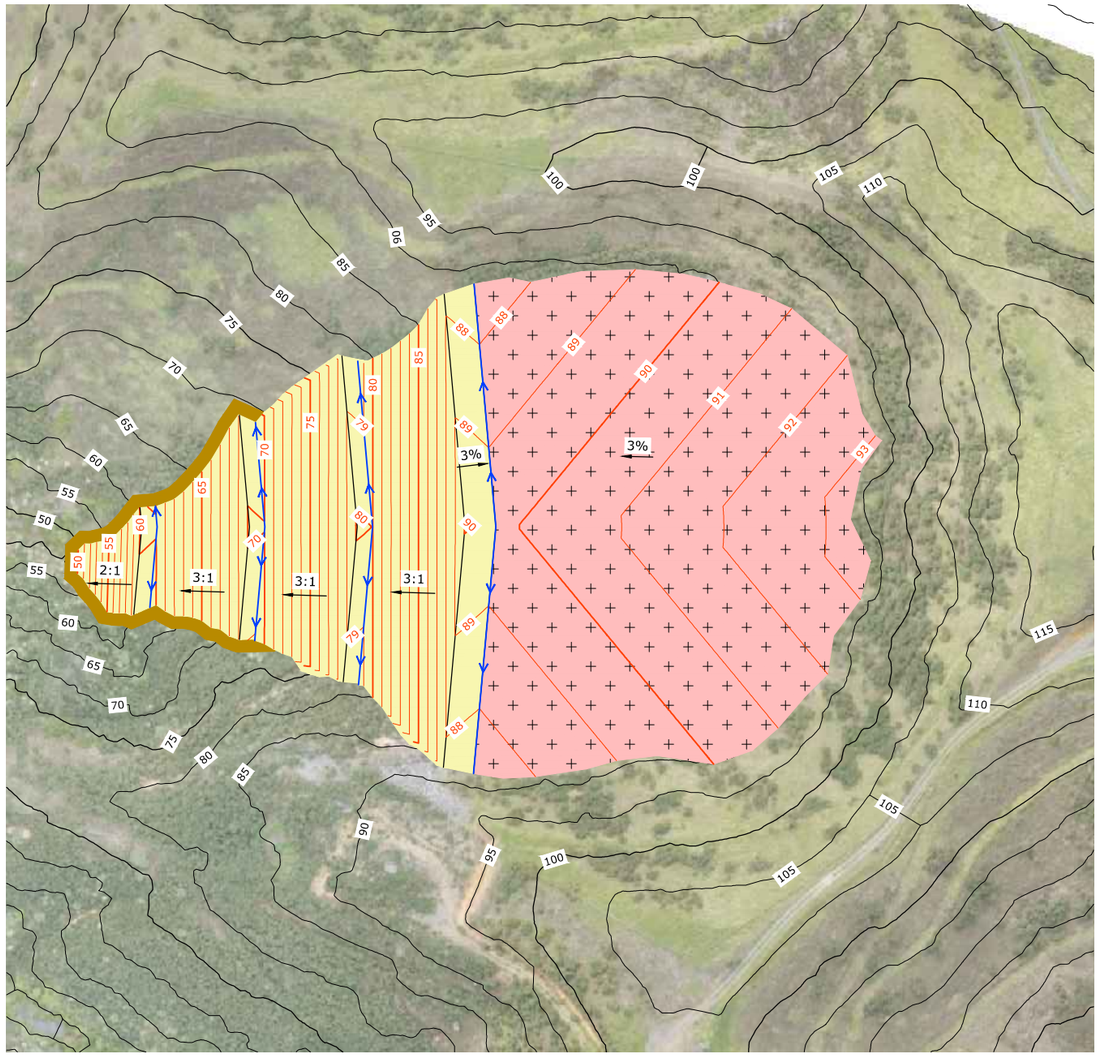


STAGE 3.2: STRUCTURAL FILL (BUND) LAYOUT

SCALE 1:2000



STAGE 3.2: MANAGED FILL LAYOUT

SCALE 1:2000

ORIGINAL IN COLOUR

INFORMATION

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Design Review: K. C. CHEUNG		
Drawn: S. CHEN		
Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 2 AREA

Drawing Title: STAGE 3.2 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-14 Rev. B

PLOT DATE:2020-04-09

FILE LOCATION:\\2325_Huntly Quarry_Disposal Sites\50_Drawings\2325235-23-14.dwg

LEGEND:

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

BUND VOLUME: 12,890m³

MANAGED FILL VOLUME: 77,490m³

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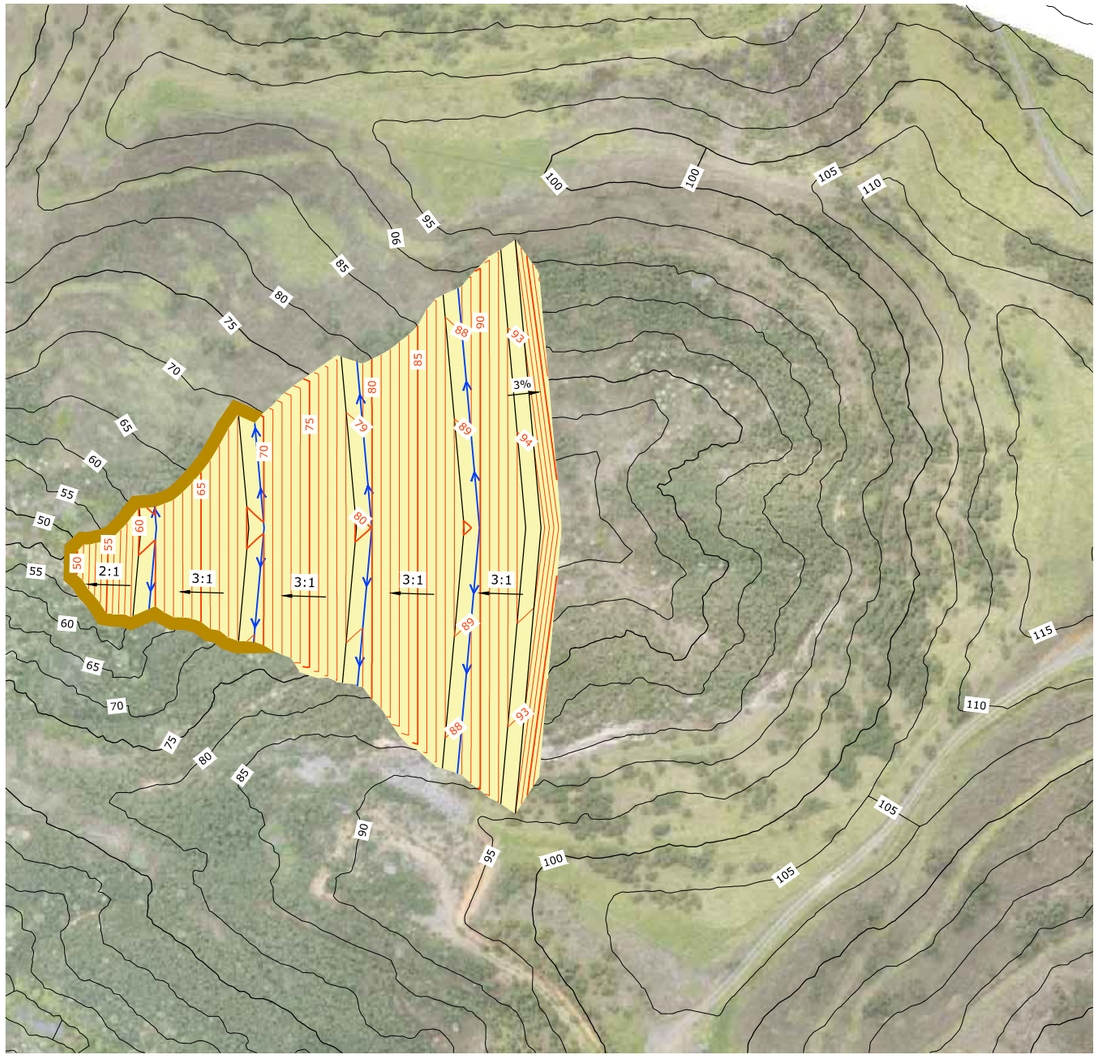

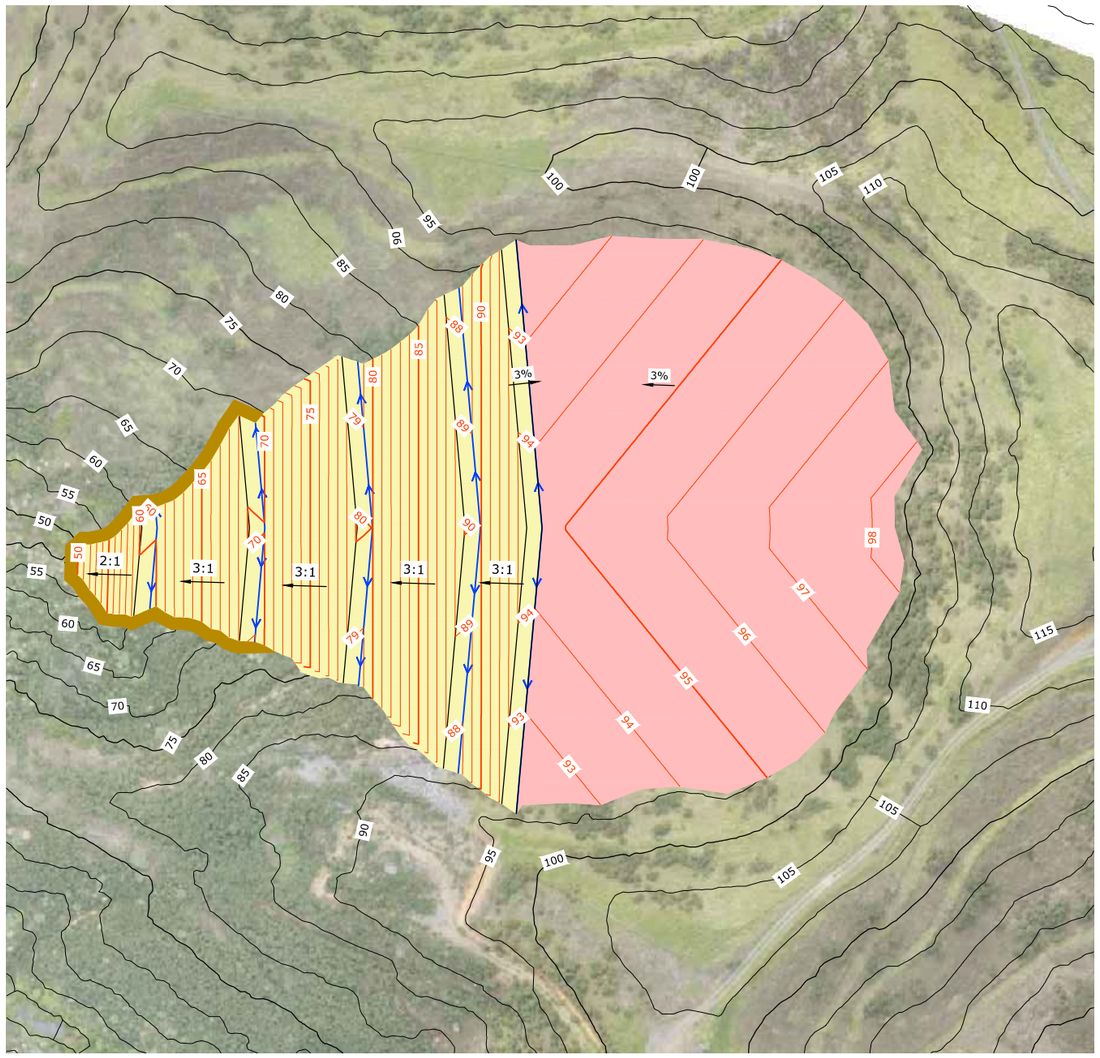

STAGE 4.1: STRUCTURAL FILL (BUND) LAYOUT

SCALE 1:2000

STAGE 4.1: MANAGED FILL LAYOUT

SCALE 1:2000

ORIGINAL IN COLOUR

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Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 2 AREA

Drawing Title: STAGE 4.1 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-15 Rev. B

PLOT DATE:2020-04-09

FILE LOCATION J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2325-23-15.dwg

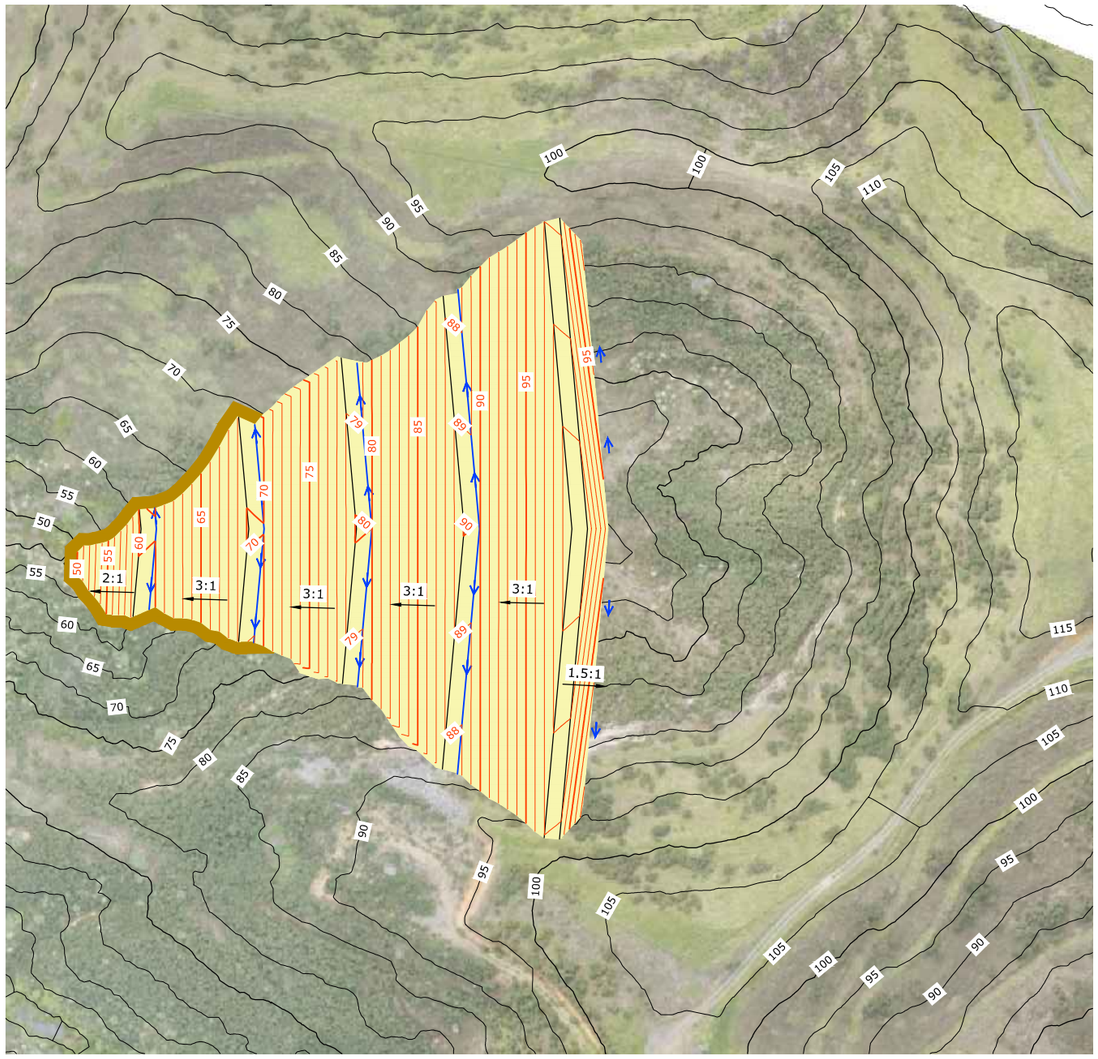
BUND VOLUME: 14,100m³

LEGEND:

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

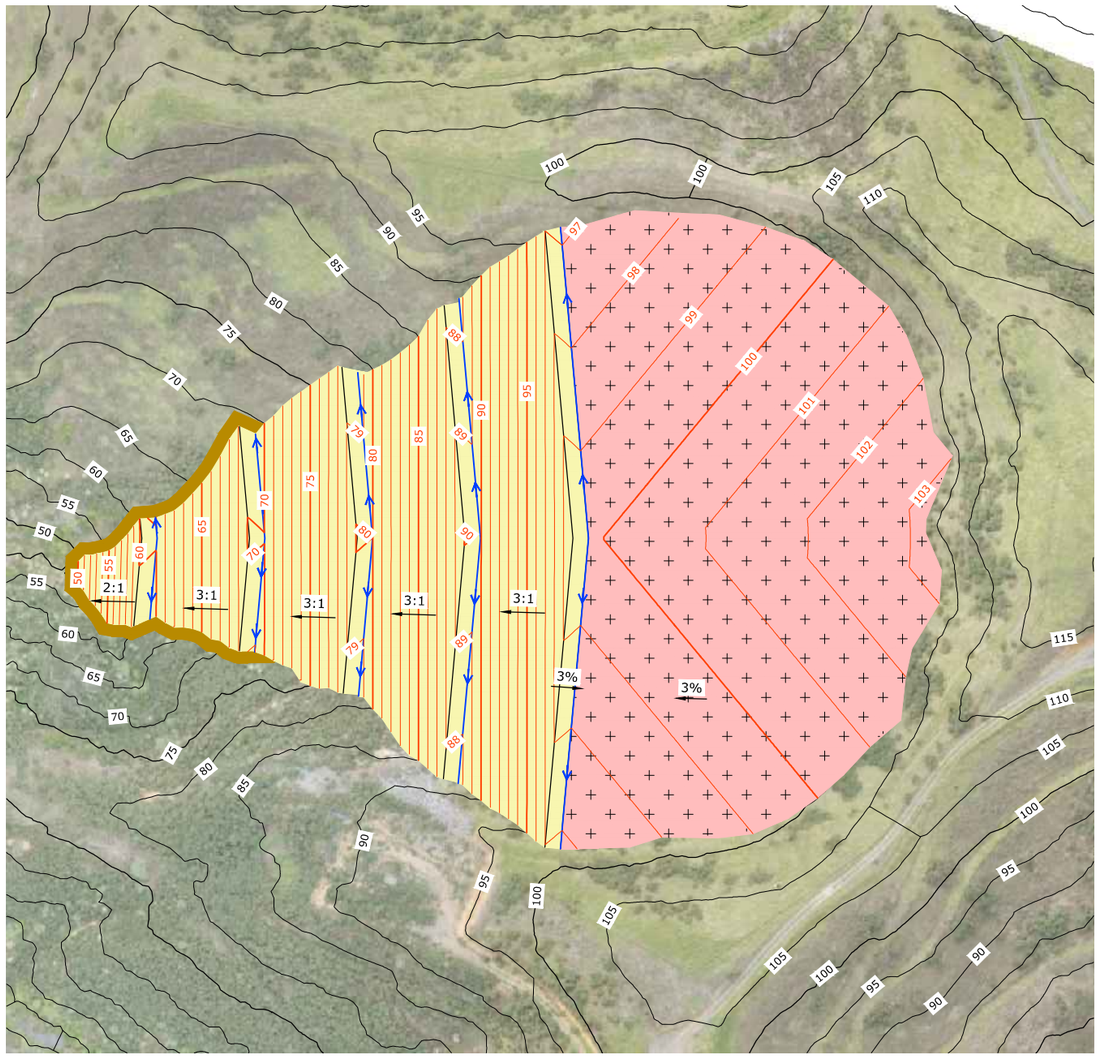
MANAGED FILL VOLUME: 76,410m³

DRAINAGE BLANKET VOLUME: 8,360m³



STAGE 4.2: STRUCTURAL FILL (BUND) LAYOUT

SCALE 1:2000



STAGE 4.2: MANAGED FILL LAYOUT

SCALE 1:2000

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Design Review: K. C. CHEUNG		
Drawn: S. CHEN		
Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 2 AREA

Drawing Title: STAGE 4.2 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-16 Rev. B

PLOT DATE:2020-04-09

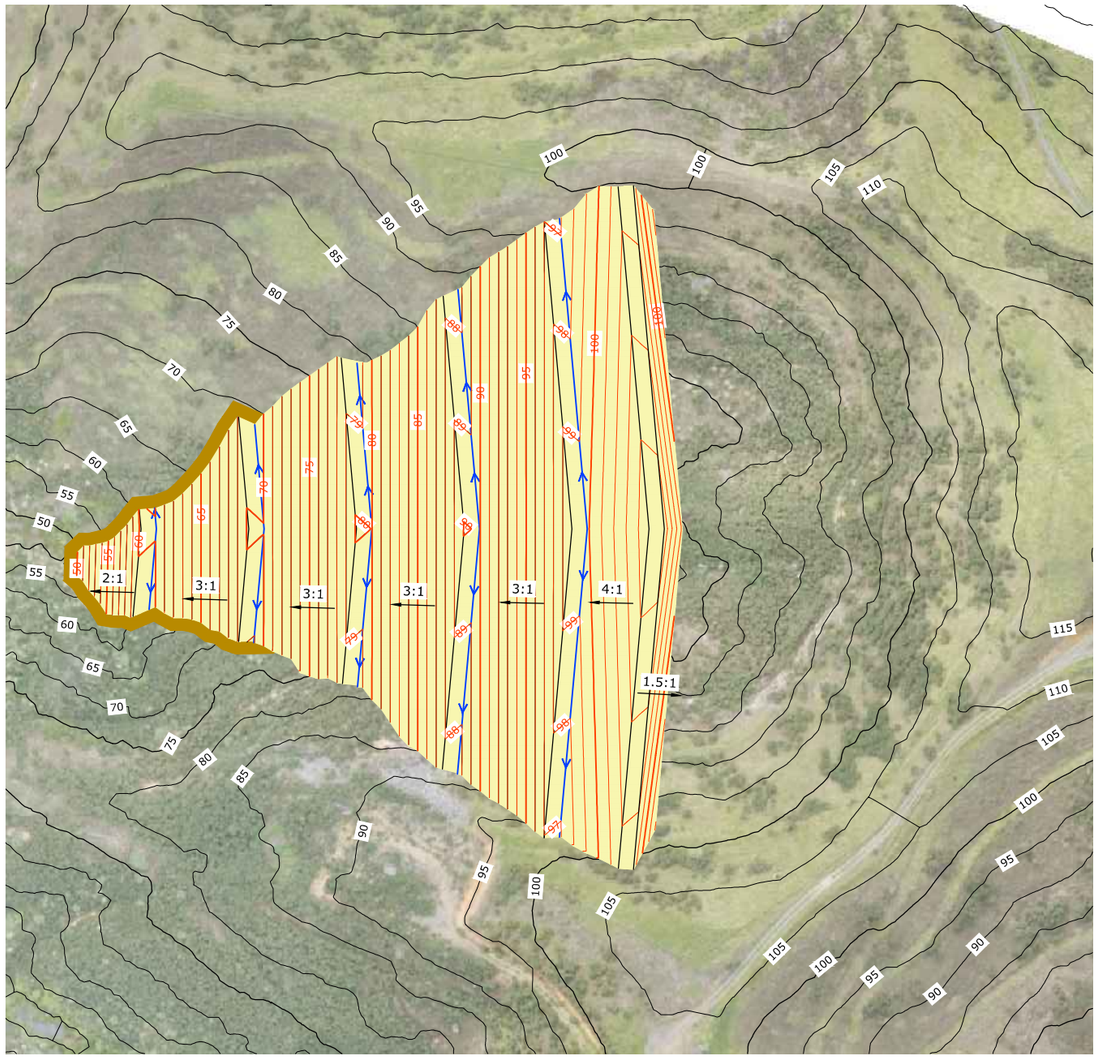
FILE LOCATION:J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\2325-23-16.dwg

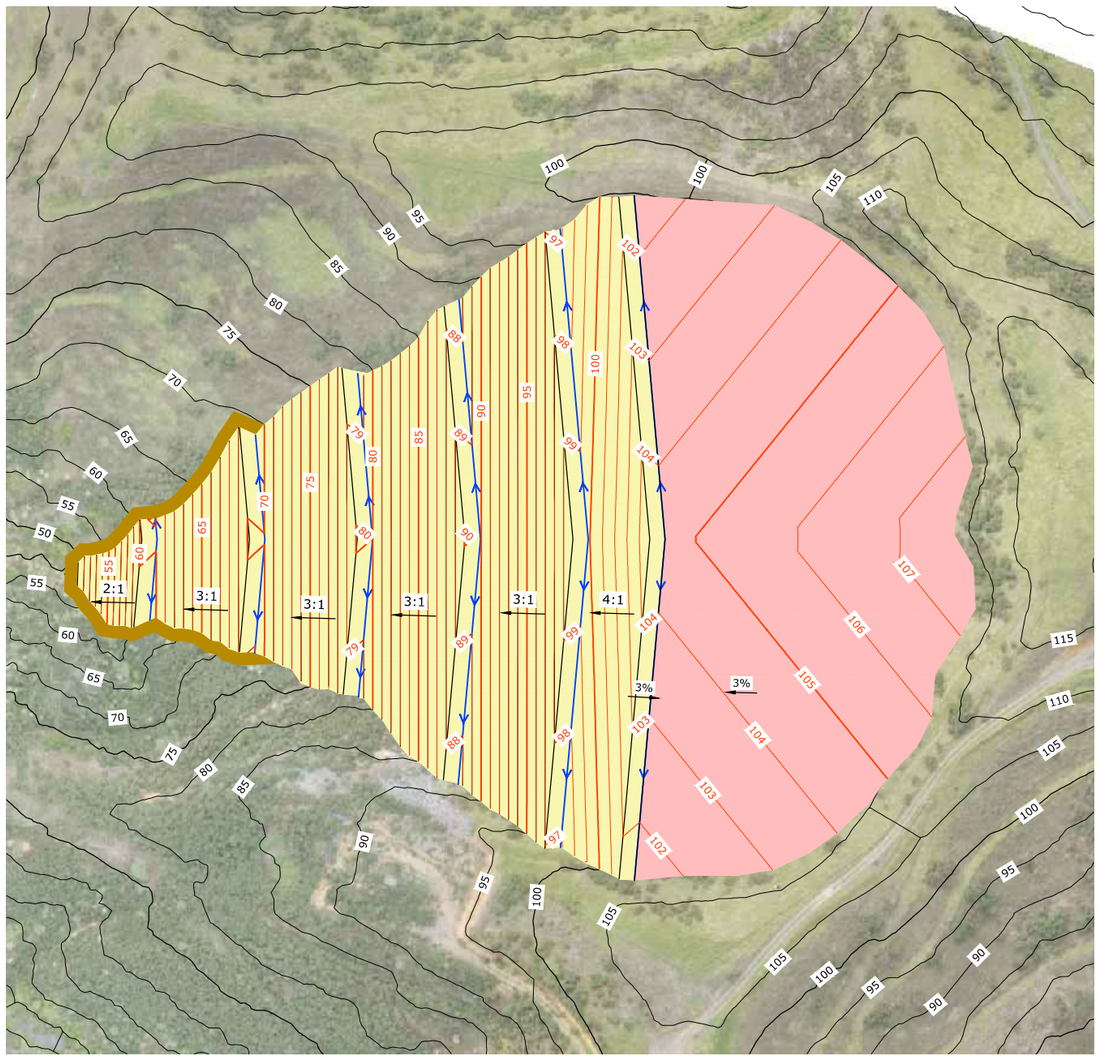
BUND VOLUME: 15,640m³

LEGEND:

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

MANAGED FILL VOLUME: 70,340m³





STAGE 5.1: STRUCTURAL FILL (BUND) LAYOUT
SCALE 1:2000

STAGE 5.1: MANAGED FILL LAYOUT
SCALE 1:2000

ORIGINAL IN COLOUR

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Designed: M. KERNOT		
Design Review: K. C. CHEUNG		
Drawn: S. CHEN		
Drafting Check: M. KERNOT		

Project: HUNTLY QUARRY DISPOSAL SITES
FILL 2 AREA

Drawing Title: STAGE 5.1 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/23
Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3
Drawing No. 2325-23-17 Rev. B

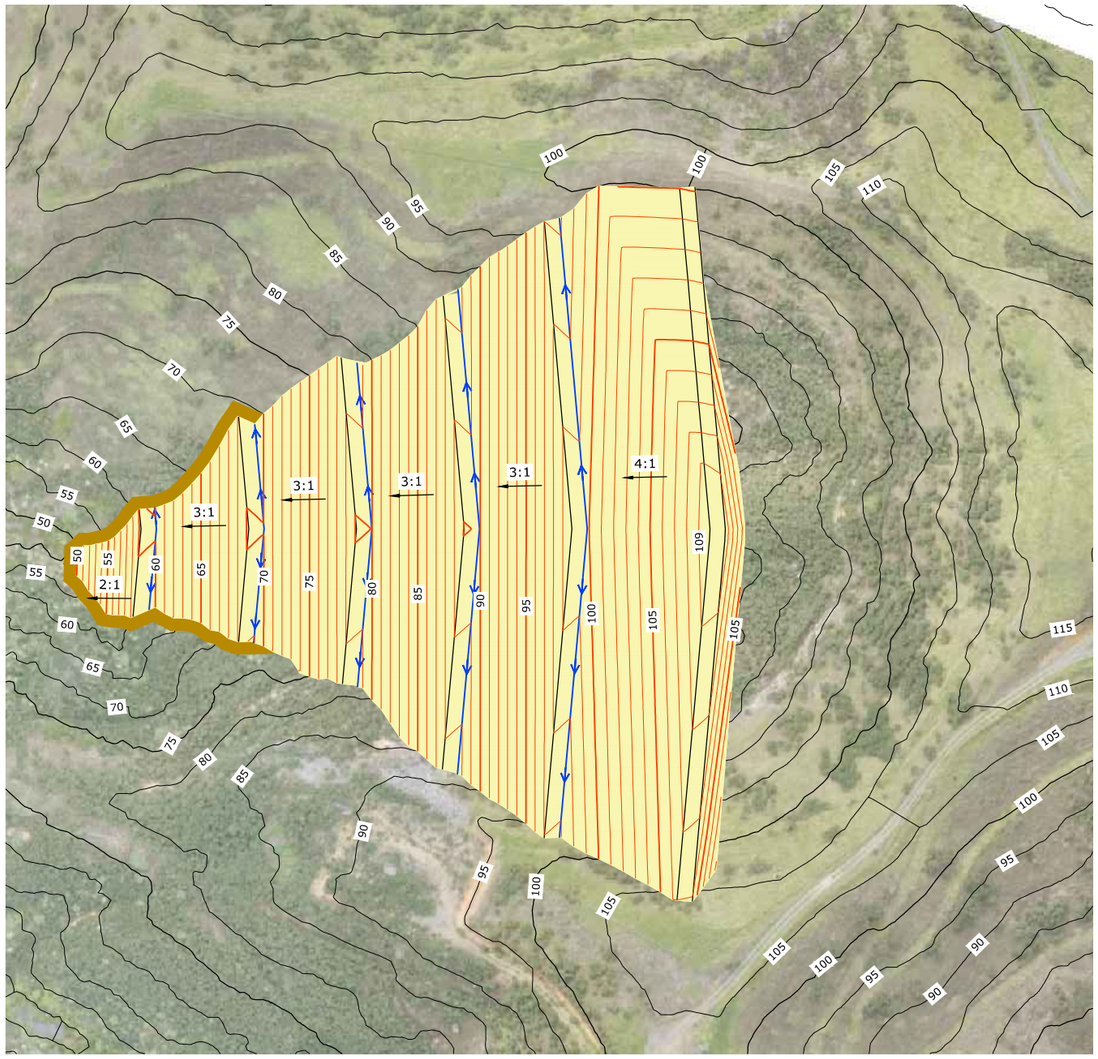
PLOT DATE:2020-04-09
FILE LOCATION:\\2325_Huntly_Quarry_Disposal Sites\50_Drawings\2325-23-17.dwg

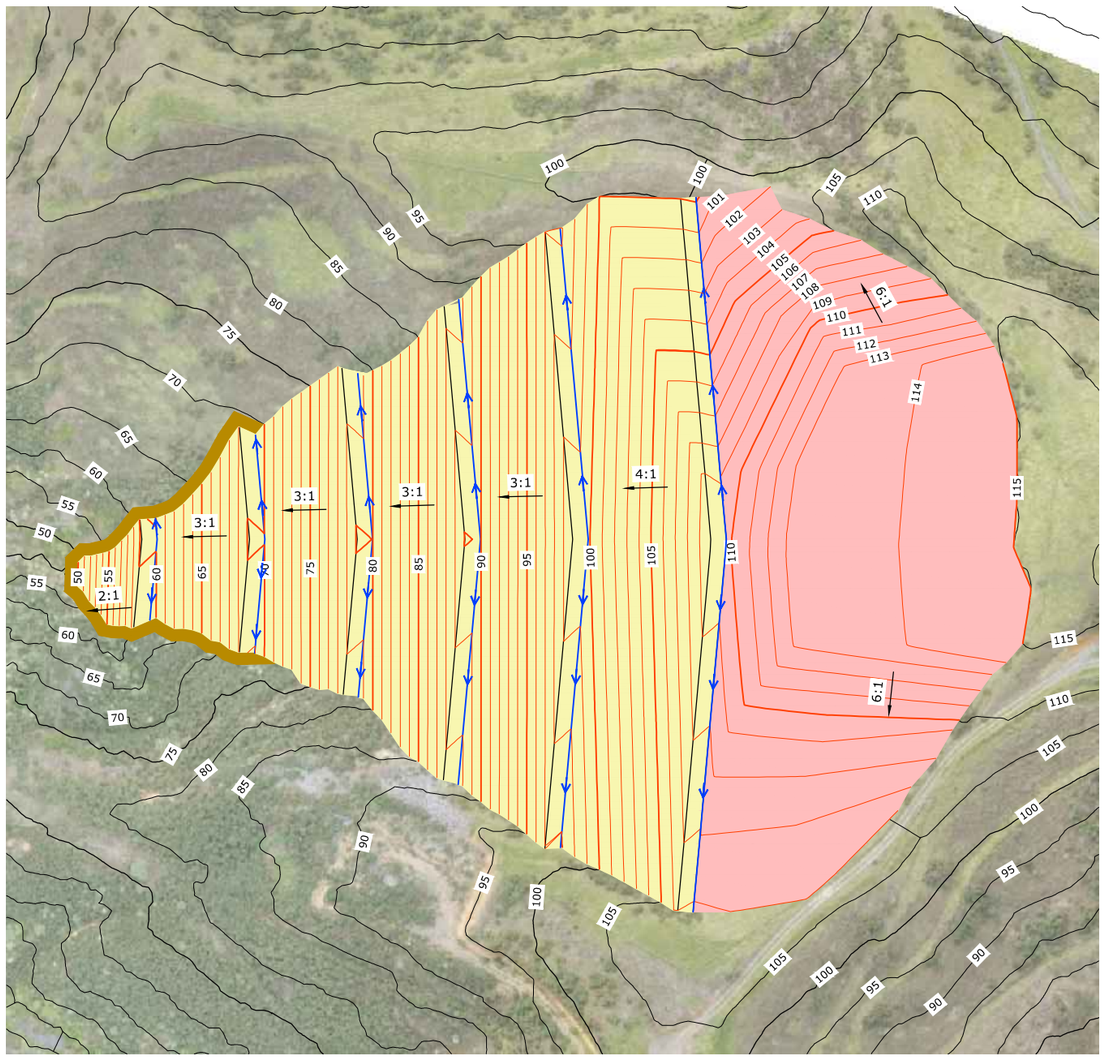
BUND VOLUME: 14,435m³

LEGEND:

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

MANAGED FILL VOLUME: 87,605m³





STAGE 5.2: STRUCTURAL FILL (BUND) LAYOUT

SCALE 1:2000

STAGE 5.2: MANAGED FILL LAYOUT

SCALE 1:2000

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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 2 AREA

Drawing Title: STAGE 5.2 - LAYOUT
BUND AND MANAGED FILL ARRANGEMENT

Project No. 2325/23

Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

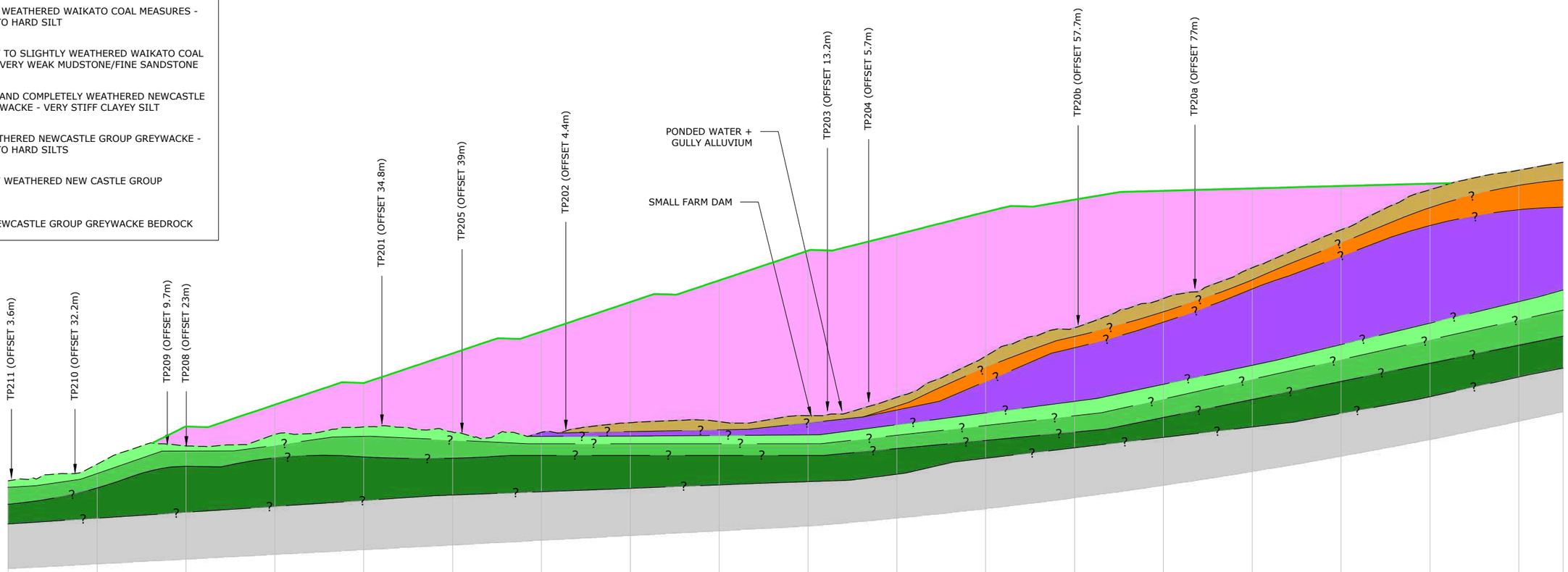
Drawing No. 2325-23-18 Rev. B

PLOT DATE: 2020-04-09

FILE LOCATION: I:\2325_Huntly Quarry_Disposal Sites\55_Drawings\2325-23-18.dwg

LEGEND:

- PROPOSED 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
- RESIDUALLY AND COMPLETELY WEATHERED NEWCASTLE GROUP GREYWACKE - VERY STIFF CLAYEY SILT
- HIGHLY WEATHERED NEWCASTLE GROUP GREYWACKE - VERY STIFF TO HARD SILTS
- MODERATELY WEATHERED NEW CASTLE GROUP GREYWACKE
- INFERRED NEWCASTLE GROUP GREYWACKE BEDROCK



DATUM: 0.00m

PROPOSED LEVELS F2 UP TO RL110																		
CURRENT LEVELS	48.00	51.74	55.83	58.43	60.15	58.98	58.90	61.08	61.32	62.66	66.80	76.05	82.42	89.00	95.97	104.50	113.51	117.92	119.71
CHAINAGE	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	350

SECTION 1/03

SCALE 1:1000 (A3)

ORIGINAL IN COLOUR

INFORMATION

Rev.	Date	Revision Details
B	14/04/20	REVISED FOR INFORMATION
A	12/03/20	ISSUED FOR INFORMATION

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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 2 AREA

Drawing Title: GEOLOGICAL AND PROPOSED FILL CROSS SECTION 1

Project No. 2325/23

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

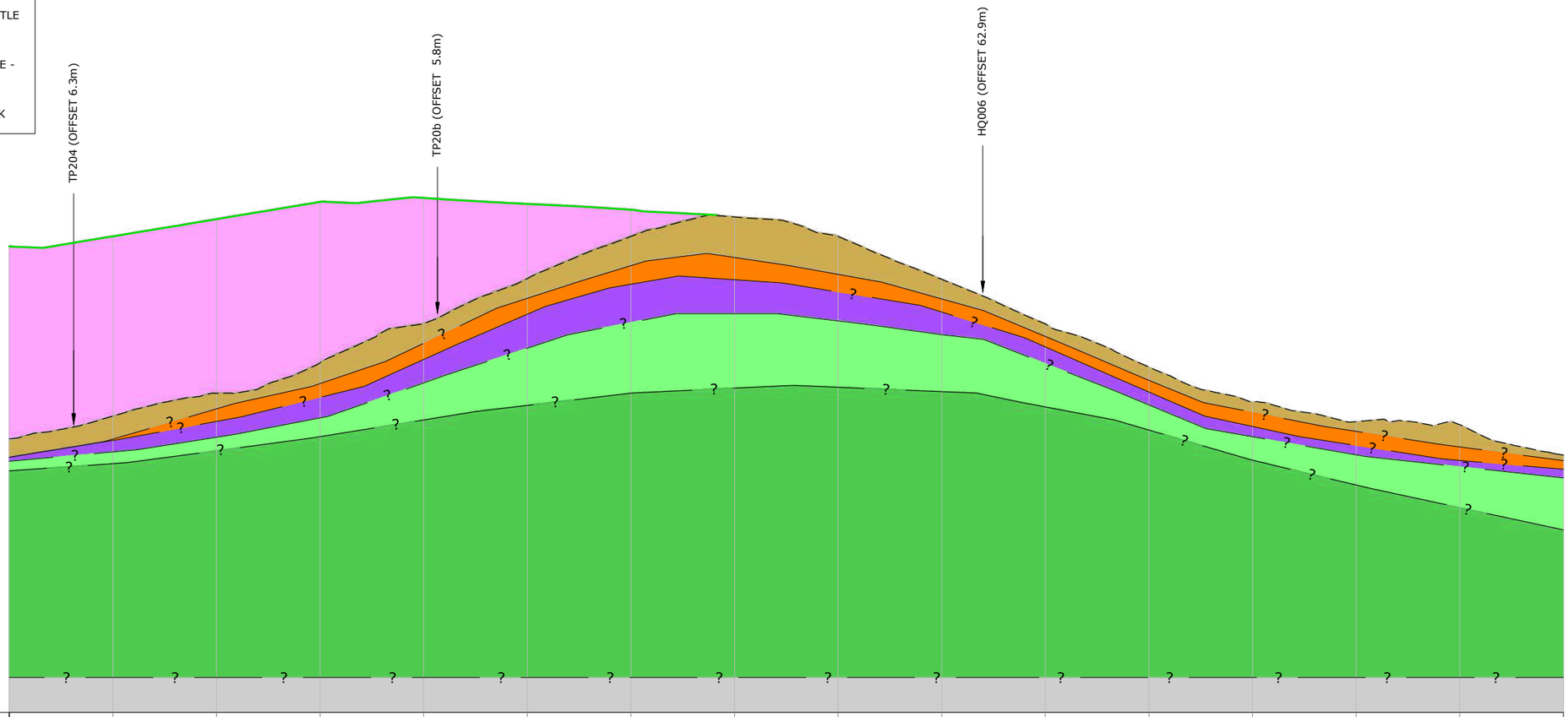
Drawing No. 2325-23-50 Rev. B

PLOT DATE: 2020-04-14

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\50_Drawings\23\2325+23+50_S2.dwg

LEGEND:

- PROPOSED 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
- RESIDUALLY AND COMPLETELY WEATHERED NEWCASTLE GROUP GREYWACKE - VERY STIFF CLAYEY SILT
- HIGHLY WEATHERED NEWCASTLE GROUP GREYWACKE - VERY STIFF TO HARD SILTS
- INFERRED NEWCASTLE GROUP GREYWACKE BEDROCK



DATUM: 10.00m

PROPOSED LEVELS F2 UP TO RL110															
CURRENT LEVELS	62.78	67.20	71.61	77.49	85.04	93.74	101.85	105.62	101.86	93.60	84.99	76.66	70.00	66.12	65.51	59.68
CHAINAGE	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300

SECTION 2/03

SCALE 1:1000 (A3)

ORIGINAL IN COLOUR

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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 2 AREA

Drawing Title: GEOLOGICAL AND PROPOSED FILL CROSS SECTION 2

Project No. 2325/23

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

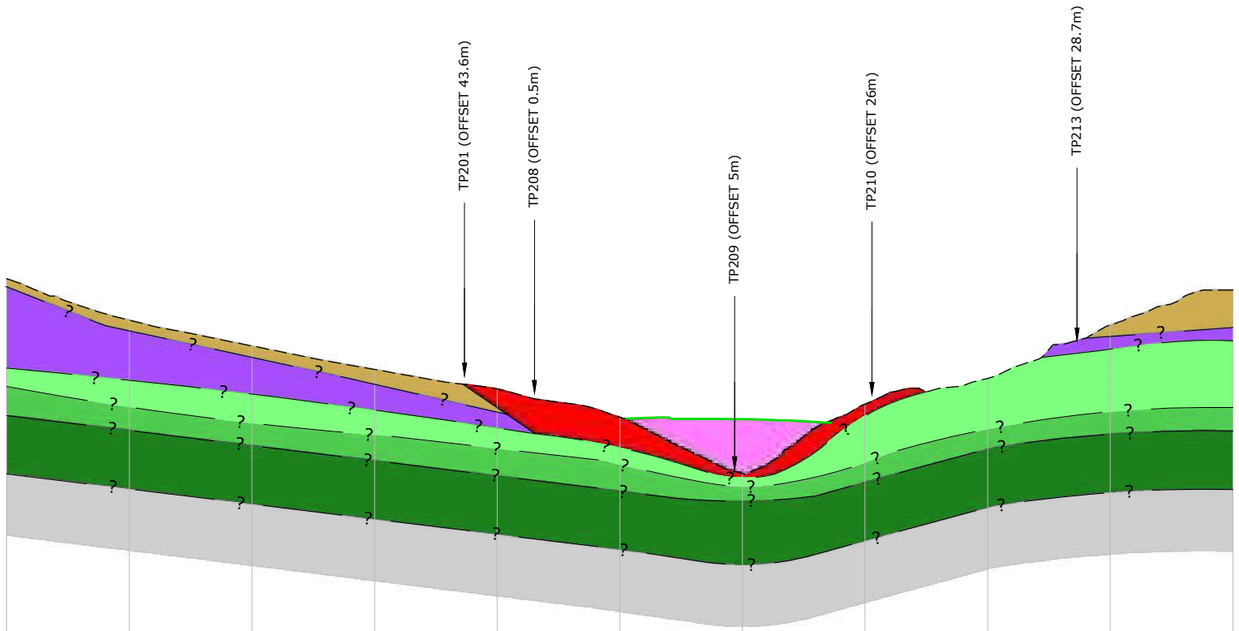
Drawing No. 2325-23-51 Rev. B

FILE LOCATION: I:\2325_Huntly Quarry_Disposal Sites\05_Drawings\2312325-23-05_51.dwg

PLOT DATE: 2020-04-14

LEGEND:

- PROPOSED FILL
- RECENT COLLUVIUM AND ALLUVIUM - SOFT TO FIRM CLAY WITH VARYING ORGANIC CONTENT
- RESIDUALLY WEATHERED WAIKATO COAL MEASURES - STIFF TO VERY STIFF CLAY/SILT
- MODERATELY TO SLIGHTLY WEATHERED WAIKATO COAL MEASURES - VERY WEAK MUDSTONE/FINE SANDSTONE
- RESIDUALLY AND COMPLETELY WEATHERED NEWCASTLE GROUP GREYWACKE - VERY STIFF CLAYEY SILT
- HIGHLY WEATHERED NEWCASTLE GROUP GREYWACKE - VERY STIFF TO HARD SILTS
- MODERATELY WEATHERED NEW CASTLE GROUP GREYWACKE
- INFERRED NEWCASTLE GROUP GREYWACKE BEDROCK



DATUM: 10.00m

PROPOSED LEVELS F2 UP TO RL110						59.95				
CURRENT LEVELS	82.86	76.08	71.89	68.05	64.90	60.32	51.12	62.42	66.58	75.29	81.00
CHAINAGE	0	20	40	60	80	100	120	140	160	180	200

SECTION 3
SCALE 1:1000 (A3) 03

ORIGINAL IN COLOUR

INFORMATION

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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 2 AREA

Drawing Title: GEOLOGICAL AND PROPOSED FILL CROSS SECTION 3

Project No. 2325/23

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-52 Rev. A

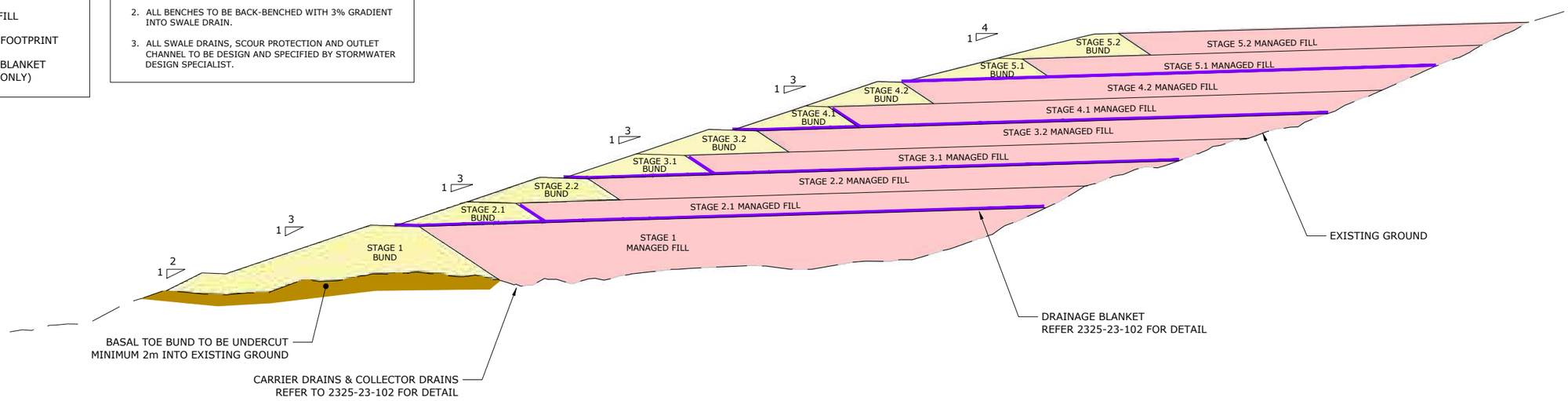
FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\90_Drawings\23\2325+23+50_S3.dwg PLOT DATE: 2020+03+13

LEGEND:

- STRUCTURAL FILL (BUND)
- MANAGED FILL
- MUCK OUT FOOTPRINT
- DRAINAGE BLANKET (INDICATE ONLY)

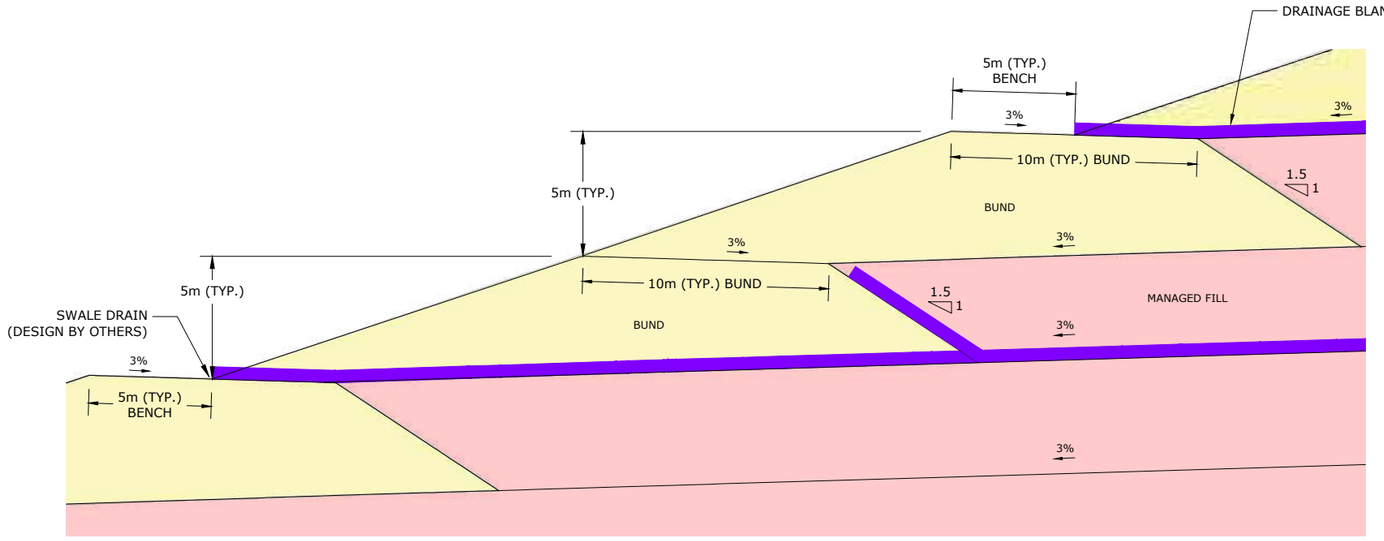
NOTES:

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.



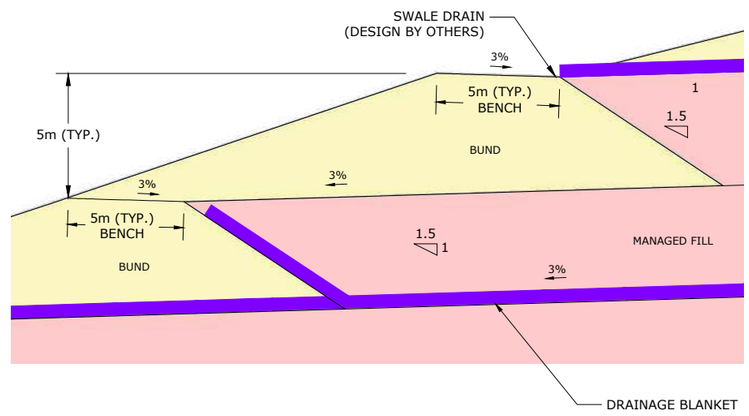
TYPICAL BUND AND MANAGED FILL ARRANGEMENT

SCALE 1:1000



TYPICAL BUND AND MANAGED FILL DETAIL (STAGE 1 TO STAGE 3.2)

SCALE 1:250



TYPICAL BUND AND MANAGED FILL DETAIL (STAGE 4.1 TO STAGE 5.2)

SCALE 1:250

ORIGINAL IN COLOUR

INFORMATION

Rev.	Date	Revision Details
B	14/04/20	REVISED FOR INFORMATION
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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 2 AREA

Drawing Title: TYPICAL BUND AND MANAGED FILL ARRANGEMENT AND DETAIL

Project No. 2325/23

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

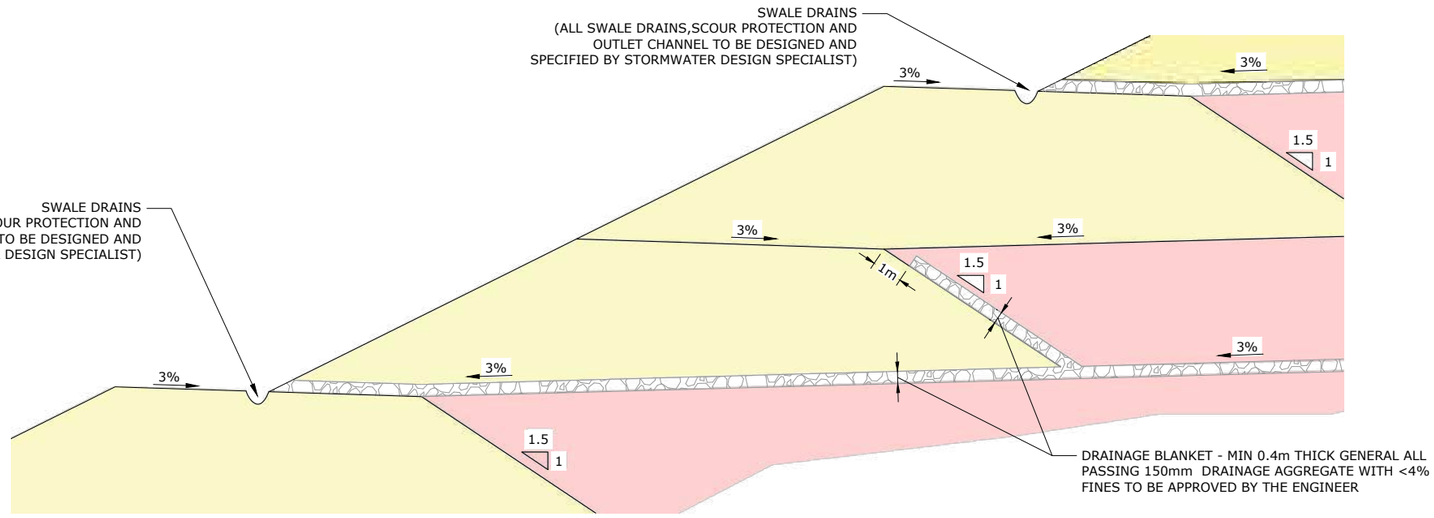
Drawing No. 2325-23-101 Rev. B

PLOT DATE: 2020-04-09

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\90_Drawings\23\2325-23-101_102.dwg

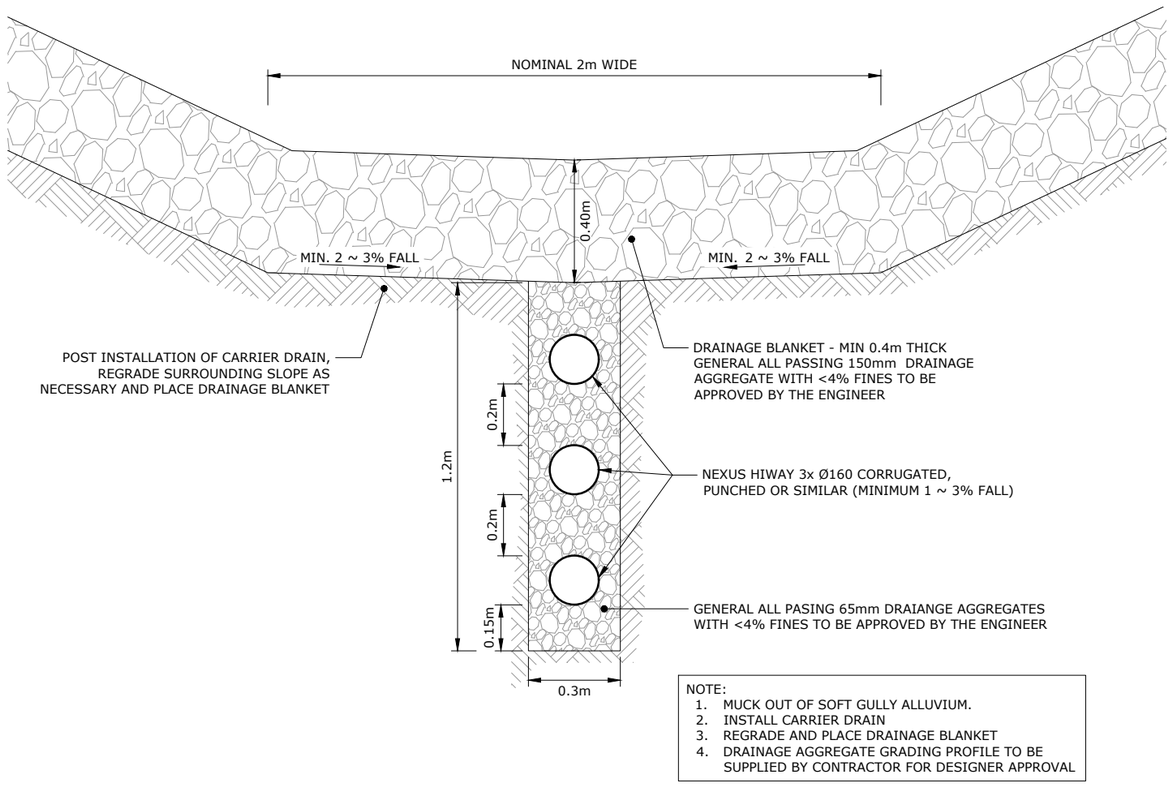
LEGEND:

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



TYPICAL DRAINAGE BLANKET DETAIL

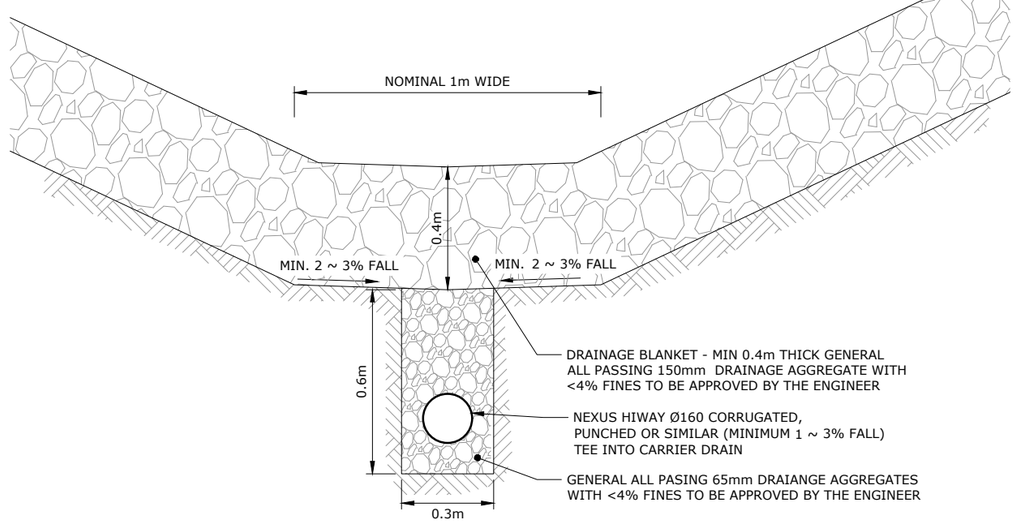
SCALE 1: 200



NOTE:
1. MUCK OUT OF SOFT GULLY ALLUVIUM.
2. INSTALL CARRIER DRAIN
3. REGRADE AND PLACE DRAINAGE BLANKET
4. DRAINAGE AGGREGATE GRADING PROFILE TO BE SUPPLIED BY CONTRACTOR FOR DESIGNER APPROVAL

TYPICAL DRAIANGE DETAIL: UNDERFILL DRAIN - MAIN CARRIER DRAIN

SCALE 1: 20



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

TYPICAL DRAIANGE DETAIL: COLLECTOR DRAINS

SCALE 1: 20

ORIGINAL IN COLOUR

INFORMATION

Rev.	Date	Revision Details
B	14/04/20	REVISED FOR INFORMATION
A	12/03/20	ISSUED FOR INFORMATION

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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 2 AREA

Drawing Title: TYPICAL DRAINAGE DETAIL

Project No. 2325/23

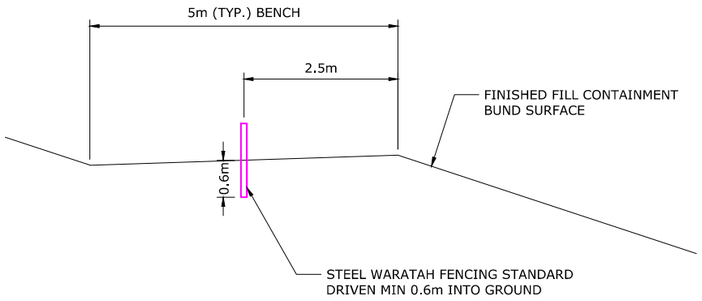
Scale: AS SHOWN
ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-102 Rev. B

PLOT DATE: 2020-04-14

FILE LOCATION: J:\2325_Huntly Quarry_Disposal Sites\GIS_Drawings\23\2325-23-101_102.dwg

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 OF STRUCTURAL FILL
		100mm NET VERTICAL DISPLACEMENT OF STRUCTURAL FILL
NOTE: THE ALERT LEVELS MAYBE REVISED DURING CONSTRUCTION IN RESPONSE TO OBSERVED DISPLACEMENTS		

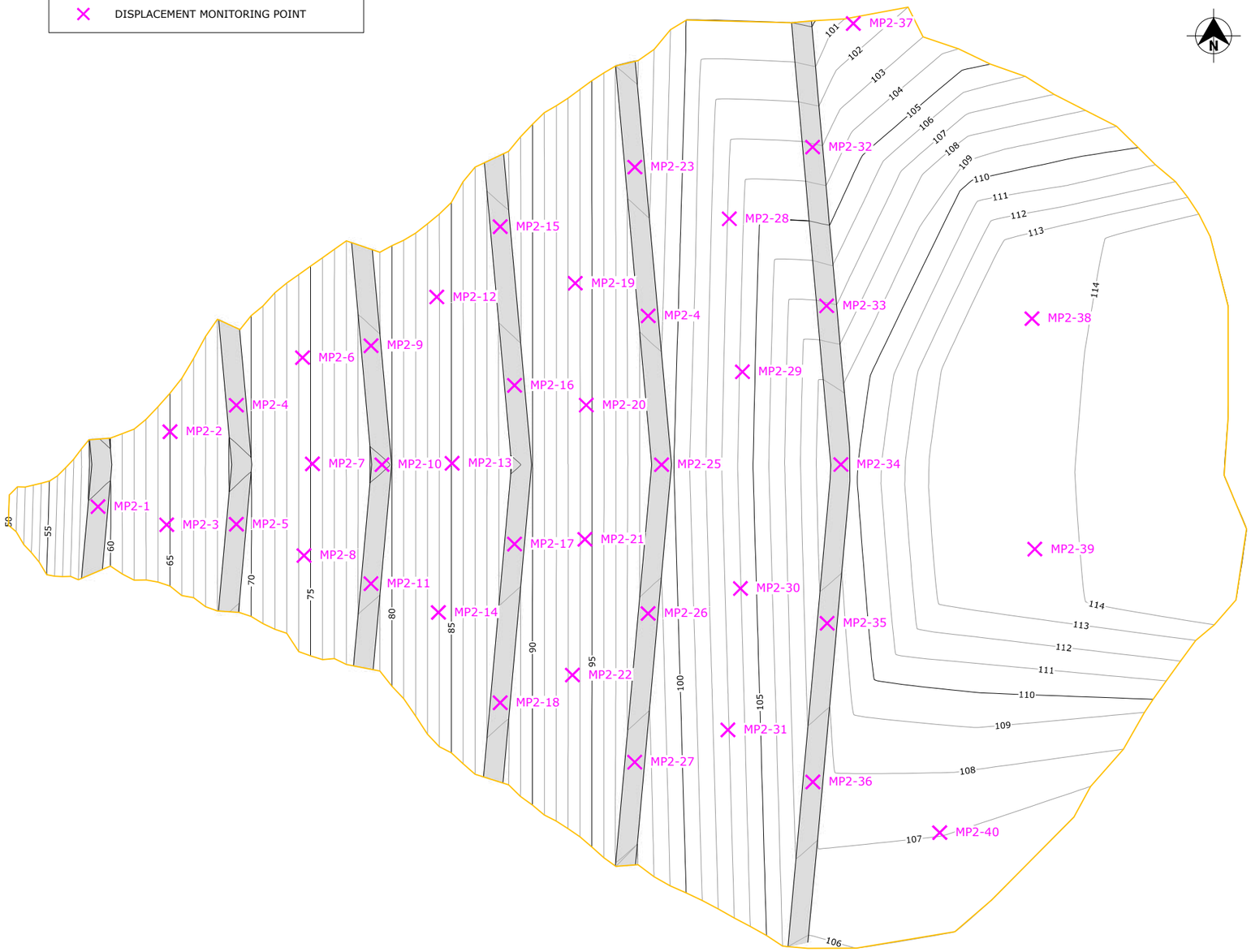


TYPICAL DISPLACEMENT MONITORING DETAIL

SCALE 1:100 (A3)

LEGEND:

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



PROPOSED MONITORING POINTS					
ID	EASTING (m)	NORTHING (m)	ID	EASTING (m)	NORTHING (m)
MP2-1	433555.34	721312.43	MP2-21	433677.60	721304.23
MP2-2	433573.42	721331.24	MP2-22	433674.48	721270.15
MP2-3	433572.59	721307.87	MP2-23	433690.13	721397.67
MP2-4	433590.09	721337.89	MP2-24	433693.49	721360.31
MP2-5	433590.08	721308.02	MP2-25	433696.86	721322.96
MP2-6	433606.69	721349.83	MP2-26	433693.49	721285.61
MP2-7	433609.19	721323.16	MP2-27	433690.11	721248.28
MP2-8	433607.05	721300.15	MP2-28	433713.87	721384.68
MP2-9	433623.88	721352.83	MP2-29	433717.16	721346.27
MP2-10	433626.66	721322.96	MP2-30	433716.67	721291.87
MP2-11	433623.88	721293.09	MP2-31	433713.50	721256.36
MP2-12	433640.41	721365.05	MP2-32	433734.78	721402.68
MP2-13	433644.27	721323.30	MP2-33	433738.31	721362.83
MP2-14	433640.81	721285.87	MP2-34	433741.87	721322.99
MP2-15	433656.33	721382.72	MP2-35	433738.43	721283.14
MP2-16	433659.92	721342.88	MP2-36	433734.85	721243.30
MP2-17	433659.92	721303.04	MP2-37	433745.02	721433.72
MP2-18	433656.32	721263.20	MP2-38	433789.87	721359.62
MP2-19	433675.19	721368.51	MP2-39	433790.58	721301.76
MP2-20	433677.95	721337.91	MP2-40	433766.69	721230.58

DISPLACEMENT MONITORING LAYOUT

SCALE 1:1250 (A3)

ORIGINAL IN COLOUR

INFORMATION

Rev.	Date	Revision Details
B	14/04/20	REVISED FOR INFORMATION
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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 2 AREA

Drawing Title: DISPLACEMENT MONITORING LAYOUT

Project No. 2325/23

Scale: AS SHOWN ORIGINAL SHEET SIZE: A3

Drawing No. 2325-23-103 Rev. B

PLOT DATE: 2020-04-09

FILE LOCATION: I:\2325_Huntly Quarry_Disposal Sites\55_Drawings\2325-23-103.dwg

B

APPENDIX B – Test Pit & Historic Borehole Logs

Description	No. Sheets:
Test Pit Log Report Sheets	25
Historic Borehole Logs Sheets	12

5 Carmont Place, Mt Wellington, Auckland 1060, New Zealand
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www.gaia-engineers.co.nz

TEST PIT LOG

TEST PIT ID. TP201

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:	19/06/2019
COORDINATES:	E.433597.7m	GROUND R.L (m):	69.60m	PIT FINISHED:	19/06/2019
	N.721356.3m	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 TOPSOIL										
0.20-1.50 m Silty CLAY; light grey and orange. Very stiff, moist, low to moderate plasticity, insensitive.	1				134 188+	68				69.0
1.50-4.50 m Completely weathered, light grey with orange streaks, MUDSTONE; extremely weak [clayey SILT; Hard, moist, non plastic].	2		Waikato Coal Measures		188+ 188+					68.0 67.0
End of Pit @ 4.5 m	3 4 5 6									66.0 65.0 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	TP201	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP202

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:	19/06/2019
COORDINATES:	E.433639.2m	GROUND R.L (m):	60.20m	PIT FINISHED:	19/06/2019
	N.721326.0m	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)	Sample ID	Sample Type	R.L (m)
0.00-1.00 m Completely weathered, light grey with orange streaks, MUDSTONE; extremely weak [clayey SILT; Hard, moist, non plastic].	1		Waikato Coal Measures		188+					60.0
1.00-4.50 m Highly weathered, light grey and orange with red streaks, sandy MUDSTONE; extremely weak, limonite and MnO staining on defects [clayey SILT; hard, moist, low plasticity]. @ 1.0m - becoming completely weathered to highly weathered, light grey and orange with red streaks. Limonite and MnO staining on joint surfaces.	2				188+					59.0
	3				188+					58.0
	4				188+					57.0
	5				188+					56.0
End of Pit @ 4.5 m	6				188+					55.0

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	TP202	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP203

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:	19/06/2019
COORDINATES:	E.433698.1m	GROUND R.L (m):	63.70m	PIT FINISHED:	19/06/2019
	N.721335.1m	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)
0.00-1.00 m Clayey SILT; brown-grey with orange streaks. Very stiff, moist, low plasticity, moderately sensitive [disturbed texture].					129	41				
1.00-1.50 m Completely to highly weathered, light grey with orange streaks, MUDSTONE; extremely weak [clayey SILT; Very stiff, moist, low plasticity].	1				143	52				63.0
1.50-3.00 m Moderately weathered, light grey, sandy MUDSTONE; very weak; sheared fabric.	2		Waikato Coal Measures		UTP					62.0
End of Pit @ 3.0 m	3									61.0
	4									60.0
	5									59.0
	6									58.0

Scala (blows/100mm): 2 4 6 8 10 12

Contractor:	Gleeson Civil Ltd.	Remarks:	Groundwater notes:
Plant:	Hitatch 30t Excavator	SV readings corrected to BS1377 - Dial No. 1872	Groundwater Not Encountered
Logged:	MK	Terminated Due to Hard Digging	
Checked:	KCC		
Approved:	KCC		

Logged in accordance with NZ Geotechnical Society (2005) guidelines

GAIA ENGINEERS	Test Pit Photographs	TP203	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP204

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:	19/06/2019
COORDINATES:	E.433707.4m	GROUND R.L (m):	64.00m	PIT FINISHED:	19/06/2019
	N.721316.3m	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 TOPSOIL 0.10-0.50 m Silty CLAY; grey and orange. Firm, moist, low plasticity.	0		Colluvium		188+					64.0
0.50-3.00 m Silty CLAY with some fibrous organics; grey-brown with black mottles; Firm, wet to saturated, low plasticity, moderately sensistive.	1		Alluvium		45	16				63.0
	2				41	14				62.0
3.00-4.00 m Moderately weathered, light grey, massive, sandy MUDSTONE; very weak; sheared fabric.	3		Waikato Coal Measures							61.0
End of Pit @ 4.0 m	4									60.0
	5									59.0
	6									58.0

Scala (blows/100mm): 2 4 6 8 10 12

Contractor:	Gleeson Civil Ltd.	Remarks:	Groundwater notes:
Plant:	Hitatch 30t Excavator	SV readings corrected to BS1377 - Dial No. 1872	Groundwater Not Encountered
Logged:	MK	Terminated Due to Hard Digging	
Checked:	KCC		
Approved:	KCC		

Logged in accordance with NZ Geotechnical Society (2005) guidelines

GAIA ENGINEERS	Test Pit Photographs	TP204	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP205

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:	19/06/2019
COORDINATES:	E.433616.0m	GROUND R.L (m):	73.70m	PIT FINISHED:	19/06/2019
	N.721282.6m	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)
0.00-1.50 m Clayey SILT; light grey, orange and brown. Very stiff, moist, low plasticity.	1		FILL		188+		2 4 6 8 10 12			73.0
1.50-3.50 m Clayey SILT; light grey and dark orange. Very stiff, moist, low plasticity.	2		Waikato Coal Measures		188+					72.0
@3.0m - becoming light grey and orange with pink streaks	3				188+					71.0
End of Pit @ 3.5 m	4				188+					70.0
	5									69.0
	6									68.0

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	TP205	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP20a (206)

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:	20/06/2019
COORDINATES:	E.433780.5m	GROUND R.L (m):	96.00m	PIT FINISHED:	20/06/2019
	N.721399.4m	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)
0.00-0.10 m TOPSOIL										
0.10-0.50 m Clayey SILT; brown. Firm, moist, moderate plasticity, finely fissured.					UTP					
0.50-1.10 m Clayey SILT; light grey, Stiff, moist, moderately plastic, fissured.	1				UTP					95.0
1.10-1.40 m Carbonaceous SILT; black and purple-brown. Stiff with hard black inclusions, moist.										
1.40-2.30 m Highly weathered, light brown, SILTSTONE; very weak; highly fissured, extremely closely spaced joints.	2		Waikato Coal Measures		UTP					94.0
2.30-2.70 m Highly weatherd, black and dark grey, COAL with interbedded carbonaceous SILT; weak, dry, sub-horizontally bedded, relict leaf impressions.					UTP					
2.70-3.50 m Moderately weathered, light grey, SILTSTONE; very weak, dry, widely spaced joints, sub-horizontally bedded.	3				UTP					93.0
End of Pit @ 3.5 m					UTP					
	4									92.0
	5									91.0
	6									90.0

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

GAIA ENGINEERS	Test Pit Photographs	TP20a (206)	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP20b (207)

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:	20/06/2019
COORDINATES:	E.433754.8m	GROUND R.L (m):	87.00m	PIT FINISHED:	20/06/2019
	N.721264.5m	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)
0.00-0.20 m TOPSOIL										
0.20-0.50 m Clayey SILT; brown. Very stiff, moist, moderate plasticity, finely fissured.					UTP					
0.50-1.90 m Clayey SILT; light grey and minor grey-brown mottles; Very stiff, moderate plasticity, moist, highly fissured.	1				UTP					86.0
					UTP					
1.90-2.10 m Highly weathered, grey-brown/black carbonaceous SILTSTONE/LIGNITE; very weak; dry, sub-horizontal bedding.	2		Waikato Coal Measures		UTP					85.0
2.10-4.15 m Highly weathered, light grey SILTSTONE; very weak; moist, some Fe staining on closely spaced joints					UTP					
3.4 to 3.7m - carbonaceous SILTSTONE beds common	3				UTP					84.0
					UTP					
4.15-4.30 m Highly weathered, light brown, slightly carbonaceous SILTSTONE; weak; dry.	4				UTP					83.0
End of Pit @ 4.3 m										
	5									82.0
	6									81.0

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

GAIA ENGINEERS	Test Pit Photographs	TP20b (207)	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP208

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:	07/11/2019
COORDINATES:	E.433553.7m	GROUND R.L (m):	63.20m	PIT FINISHED:	07/11/2019
	N.721344.3m	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)
0.00-0.30 m TOPSOIL										63.0
0.30-1.00 m Clayey SILT; orange-brown mottles. Stiff, moist, moderate plasticity, fissured texture.					140	30				
1.00-3.50 m Clayey SILT with some completely weathered medium gravels; yellow and orange-brown with light grey inclusions. Gravels are extremely weak and friable	1		Colluvium		109	37				62.0
	2									61.0
	3									60.0
3.50-5.70 m SILT; yellow-brown and light grey mottles. Hard, low plasticity, moist [inferred completely weathered greywacke, limonite and MnO staining on relict fractures]	4		Newcastle Group Greywacke							59.0
	5									58.0
End of Pit @ 5.7 m	6									

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

TEST PIT LOG

TEST PIT ID. TP209

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:	07/11/2019
COORDINATES:	E.433549.6m	GROUND R.L (m):	51.30m	PIT FINISHED:	07/11/2019
	N.721311.6m	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)
0.00-0.30 m TOPSOIL										
0.30-0.80 m Clayey SILT; yellow-brown. Stiff, moist, moderate plasticity, slightly fissured texture.			Colluvium							51.0
0.80-1.50 m Clayey SILT with some sand; yellow-brown and light grey mottles. Hard, low plasticity, moist [inferred completely weathered greywacke, limonite and MnO staining on relict fractures]	1		Newcastle Group Material							50.0
1.50-2.00 m Highly weatherd, grey, brown and orange, SANDSTONE; Very weak, very closely spaced joints with limonite and MnO staining, rare moderately weathered core stones										
End of Pit @ 2.0 m	2									49.0
	3									48.0
	4									47.0
	5									46.0
	6									

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

GAIA ENGINEERS	Test Pit Photographs	TP209	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP210

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:	07/11/2019
COORDINATES:	E.433528.9m	GROUND R.L (m):	61.70m	PIT FINISHED:	07/11/2019
	N.721288.9m	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 TOPSOIL			Colluvium				2 4 6 8 10 12			
0.30-0.60 m Clayey SILT; orange-brown; Stiff, low plasticity, moist, fissured										
0.60-4.70 m Sandy SILT; light grey and orange. Hard, non plastic, moist [inferred completely weathered greywacke, very closely jointed, with limonite and MnO staining]. From 2.4 - 2.8m: pink streaks	1 2 3 4		Newcastle Group Material							61.0 60.0 59.0 58.0
4.70-5.70 m Completely weathered, grey, brown and orange, SANDSTONE; Very weak, very closely spaced joints with limonite and MnO staining, some highly weathered core stones	5									57.0
End of Pit @ 5.7 m	6									56.0

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

GAIA ENGINEERS	Test Pit Photographs	TP210	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP211

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:	07/11/2019
COORDINATES:	E.433514.4m	GROUND R.L (m):	48.20m	PIT FINISHED:	07/11/2019
	N.721324.7m	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) 2 4 6 8 10 12	Sample ID	Sample Type	R.L (m)
0.00-0.20 m TOPSOIL										
0.20-0.60 m Sandy SILT with some clay; light grey and yellow-brown. Hard, non plastic, moist [inferred completely weathered greywacke].										
0.60-1.60 m Highly weathered, grey, brown and orange, SANDSTONE; Very weak, very closely spaced, smooth, planar joints with limonite and MnO staining, rare moderately weathered core stones	1		Newcastle Group Material							48.0
End of Pit @ 1.6 m	2									47.0
	3									46.0
	4									45.0
	5									44.0
	6									43.0

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

TEST PIT LOG

TEST PIT ID. TP212

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:	07/11/2019
COORDINATES:	E.433483.7m	GROUND R.L (m):	47.70m	PIT FINISHED:	07/11/2019
	N.721343.1m	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)
0.00-0.30 m TOPSOIL										
0.30-1.10 m Clayey SILT with trace sand; yellow-brown and orange-brown mottles. Very stiff, moist, moderate plasticity, fissured	1				113	45				47.0
1.10-3.20 m Sandy SILT; light grey and orange. Hard, non plastic, moist [inferred completely weathered greywacke].	2		Newcastle Group Material							46.0
From 3.0m - becoming very weak rock strength	3									45.0
End of Pit @ 3.2 m	4									44.0
	5									43.0
	6									42.0

Scala (blows/100mm): 2 4 6 8 10 12

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

GAIA ENGINEERS	Test Pit Photographs	TP212	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

TEST PIT LOG

TEST PIT ID. TP213

1:30 Sheet 1 of 2

PROJECT:	Huntly Quarry Disposal Sites	CLIENT:	Gleeson Quarries Ltd.	JOB No:	2325
LOCATION:	Huntly Quarry	SURVEY CIRCUIT:	NZGD2000 Mt Eden Circuit	PIT STARTED:	07/11/2019
COORDINATES:	E.433584.1m	GROUND R.L (m):	81.10m	PIT FINISHED:	07/11/2019
	N.721256.2m	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)
0.00-0.50 m TOPSOIL & Track Fill										81.0
0.50-3.50 m Silty CLAY; yellow-brown. Stiff to very stiff, moist, moderate plasticity	1		Newcastle Group Material		177	27				80.0
	2				164	63				79.0
	3									78.0
3.50-5.40 m Clayey SILT; light grey and yellow-brown mottles with pink veining. Very stiff, moderate plasticity, moist [inferred completely weathered greywacke].	4									77.0
	5									76.0
5.40-6.20 m SILT with trace clay; light grey and fine orange veining. Hard, moist, low plasticity, limonite and MnO present on very closely spaced relict jointing [inferred completely weathered greywacke].	6									

Scala (blows/100mm): 2 4 6 8 10 12

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

TEST PIT LOG

TEST PIT ID. TP213

1:30 Sheet 2 of 2

PROJECT:	Huntly Quarry Disposal Sites	CLIENT:	Gleeson Quarries Ltd.	JOB No:	2325
LOCATION:	Huntly Quarry	SURVEY CIRCUIT:	NZGD2000 Mt Eden Circuit	PIT STARTED:	07/11/2019
COORDINATES:	E.433584.1m	GROUND R.L (m):	81.10m	PIT FINISHED:	07/11/2019
	N.721256.2m	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) 2 4 6 8 10 12	Sample ID	Sample Type	R.L (m)
SILT with trace clay; light grey and fine orange veining. Hard, moist, low plasticity, limonite and MnO present on very closely spaced relict jointing [inferred completely weathered greywacke].	7									75.0
End of Pit @ 6.2 m	8									74.0
	9									73.0
	10									72.0
	11									71.0
	12									70.0

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

GAIA ENGINEERS	Test Pit Photographs	TP213	
		PROJECT: Huntly Quarry Disposal Sites	JOB No: 2325

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ006	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2699807.00	Collar Y :6399179.00	Collar Z :99.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :0.00	Segment End Depth :19.31	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
	cl	OB	Topsoil, moist, very stiff, brown clay, grading to orange-brown sandy clay below 1.5m.	
		OB	Moist to wet, firm, orange-grey clay w some subang med sand.	
2.5		OB		97.1
		OB		
	wcs	OB	Ext weak, black and purple-grey coal and carbonaceous mdst/szst, of waikato coal measures. In places decomposed and/or crushed.	
5.0		OB		94.7
		OB		
	Gs	OB	GS, ext weak, highly leached and altered, decomposed to moist, very stiff, yellow-grey clay, w many small red nodules, 1-2mm (Fe-ox).	
7.5		OB		92.3
		OB		
		OB		
10.0		OB		89.8
		OB		
	Gs	BR	Ext weak to weak, highly leached and clay altered, banded yellow-brown and yellow-white, fine to med GS. Many small red nodules, 1-2mm (Fe-ox), and occ vns of white + green (smectite) clay + Fe-ox.	
12.5		BR		87.4
		BR		
		BR		
15.0		BR		85.0
		BR		
	Gs	BR	GS, ext weak, highly leached. Fine to med grained with fine bands of green-grey, silty CLAY weathered yellow-green grey & whitesh grey, fine clayey silt. Occ nodules of Fe oxide, rarely along defects. Defects com coated w clay.	
17.5		BR		82.6
		BR	Ext weak, highly leached. Banded with alternating layers of fine to med grained, com clay alt. Nod of Fe oxide com. Defects com coated in bottle green, semi translucent clay with straitated surfaces may indicate shearing.	
	Gs	BR		

Huntly - Geology Legend

Core Loss/Washout	Clay/Ash	Fill	Tertiary Carbonaceous Mudstone	Tertiary Carbonaceous Sandstone	Greywacke Argillite	
Greywacke Conglomerate	Greywacke Chipwacke	Greywacke Sandstone	Greywacke Siltstone	Fault/Fault Zone	Shear Zone	

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ006	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2699807.00	Collar Y :6399179.00	Collar Z :99.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :19.31	Segment End Depth :38.61	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
20.0	Gs	BR	Ext weak, highly leached. Banded with alternating layers of fine to med grained, com clay alt. Nod of Fe oxide com. Defects com coated in bottle green, semi translucent clay with straitated surfaces may indicate shearing.	80.2
22.5	Gs	BR	GS, extremely weak, highly leached & clay altered. Banded with irregular layers of fine to med grained,var cl alt. Bands tend to lense or pinch out. Nod of Fe oxide com. Def coated in bottle green, semi trans cl. Sme soft, white clay vn	77.8
	Gs	BR		
25.0		BB	GS str veined with several white-grey veins. Vn mat is soft to hard with sme crystalline calcite & other mineral. Vn up to 3cm wide. Cl alt with green clay. Hw red-brwn, Fe ox thrhout. Vn hosted in fine-med grained GS, v weak, Mw & cl alt.	75.4
		BB		
		BB		
27.5		BB		72.9
	Gs	BL		
30.0		BL	Bedded GS. Bed thickness varies, with sections of greenish-grey, v fine to fine silty-sand & dark greenish-grey beds of very fine sandy-silt. Mod strong with some variation in strength bwt beds. Variably cl altered & leached. Mod veined with v fine veinle	70.5
		BL		
		BL		
32.5		BL		68.1
		BL		
35.0		BL		65.7
	Gs	BL	Bedded Gs. Alternating sequence of green-grey, v.fine-fine silty-sandstone & dk-grey sandy-silt. Bed thickness varies with some fine beds discont, lensing out. Cl altered & variably leached. Fine green min com. Minor py on defect surf. Abundant v.fine-fin	
37.5		BL		63.3
		BL		

Huntly - Geology Legend

Core Loss/Washout	Clay/Ash	Fill	Tertiary Carbonaceous Mudstone	Tertiary Carbonaceous Sandstone	Greywacke Argillite	
Greywacke Conglomerate	Greywacke Chipwacke	Greywacke Sandstone	Greywacke Siltstone	Fault/Fault Zone	Shear Zone	

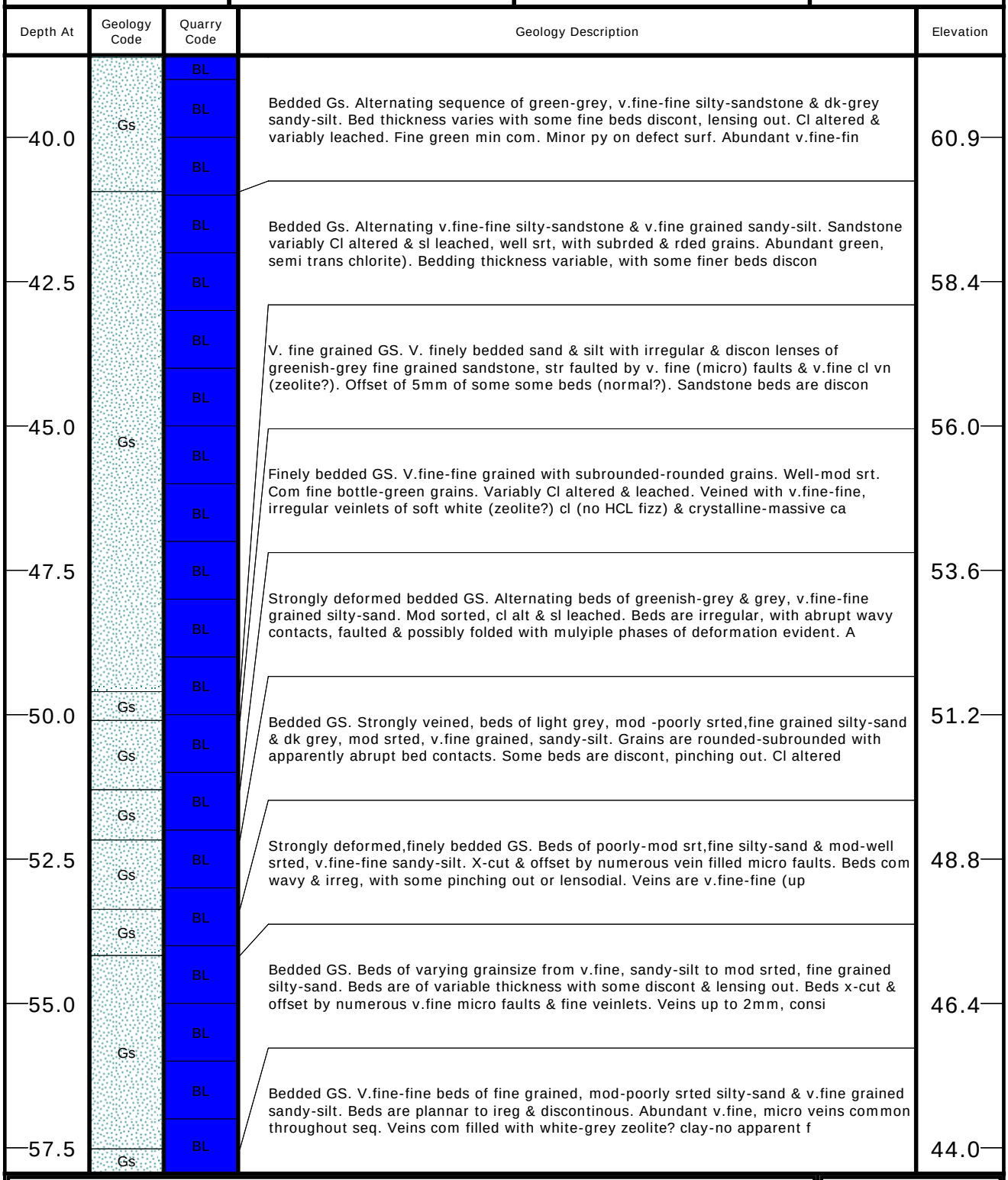
Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ006	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2699807.00	Collar Y :6399179.00	Collar Z :99.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :38.61	Segment End Depth :57.92	Scale 1:100



Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ006	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2699807.00	Collar Y :6399179.00	Collar Z :99.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :57.92	Segment End Depth :77.22	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
	Gs	BL	Bedded GS. V.fine-fine beds of fine grained, mod-poorly srted silty-sand & v.fine grained sandy-silt. Beds are plannar to ireg & discontinous. Abundant v.fine, micro veins common throughout seq. Veins com filled with white-grey zeolite? clay-no apparent f	
		BL	Crush zone with highly fragmented, bedded GS. Cr surfaces coated in dk grey, silty-clay. GS fragmented into pebble-cobble sized fragments. Coarse-fine py dissim in mod sized clusters on frag surfaces. a angle of cr zone approx 40°.	
60.0	Sz			41.5
	Gs	BL	Bedded GS. Beds of v.fine grained sandy-silt & fine grained silty-sand. Coarser grained beds tend to be poor-mod sorted with rounded-subrounded opaque & greenish-grey grains. Beds are planar or often discont & lensodial. Variable Cl altered. Strongly fra	
		BL	Bedded GS. GS fragmented into cobble-pebble sized fragments of v.fine-fine, finely bedded silty sand & sandy-silt. Some surfaces finely veined with milky-white, slightly discoloured pinkish-brown quartz & poss some softer zeolite (no HCL fizz). Minor py o	
62.5		BL	Bedded GS. Beds of varying grainsize, thickness & colour from v.fine grained, dark grey sandy-silt & fine-v.fine, greenish-grey,silty -sand, mod-poorly sorted. Grains com rounded-subrounded. Variably cl alt. V.fine-fine micro faults & iregular veinlets th	39.1
	Gs	BL	Clay, non-plastic, silty-clay with fine grains of pyrite dissimented throughout. Zone x-cuts bedded GS at alpha angle of approx 40°.Some poss core loss GS fragmented into angular-subangular peeble-sized frag.	
		BL	Bedded GS. Fine beds of alternating v.fine grained, sandy-silt & fine-v.fine grained, silty-sand. Mod srted. Variably Cl altered. V.fine micro faults x-cut & offset GS. Some filled with v.fine. white, soft cl (zeolite). Rare fine py grains. Core fragmente	
65.0		BL		36.7
	Gs	BL	Bedded GS, intensely fragmented into cobble-sized, angular fragments. GS fragmented along fine veinlet (1mm) at alpha angle of approx 50°. Vein consists of white, soft (zeolite?) clay & coarse crystalline, milky white-transparent qz. GS fraGS have sw (Fe	
		BL	Bedded GS. Beds of v.fine grained, sandy-silt & fine, silty sand. Highly fragmented into angular sections along alpha angles of 05, 10 & 40°. Fract surfaces coated in very fine green-grey & white, silty clay, sw pinkish -brown	
67.5	Sz	BL	Bedded GS, intensely fragmented into sub-angular, peeble-sized fragments. Coated in fine, soft, silty white clay with fine soft, cl (zeolite) veins throughout. Minor py inclusions along vein margins.	34.3
		BL	Bedded GS. Fine interbedded layers of v.fine grained, sandy-silt & v.fine -fine, silty sand. Mod srt with some sbround-rounded opaque grains. Bedding varies-reg-ireg with some beds lensing out, others x-cut & offset by micro faults. V.fine faults & veins	
	Gs	BL	Bedded GS, intensely fragmented into pebble-cobble sized, angular fragments. GS v.fine-fine grained, interbedded, poor-mod sorted silty-sand. Grains are subrounded-rounded with opaque grains com & rare clusters of fine py. Veined with numerous SW, pinkish	
70.0	Sz			31.9
	Gs	BL	Finely bedded, v.fine grained GS. Well-mod sorted, fine beds of sandy-silt. X-cut with numerous micro faults & fractures with v.fine (<1mm), white-grey ireg veinlets discoloured pinkish-brown. Minor weathering of fracture surfaces pinkish-brown. GS com fr	
	Sz			
		BL	Bedded GS, intensely fragmented into gravel-pebble-cobble sized, angular fragments. Fragments com coated in fine, white-grey silty clay (zeolite?) & minor calcite. Minor fine pyrite & dark green, semi trans mineral (chlorite?). Surfaces com smooth, & weak	
	Gs			
72.5		BL	Finely bedded GS. Interbedded sandy-silt. Highly veined & fract/faulted. Veins are v.fine, soft white-grey (zeolite?) discoloured pinkish-white (Fe oxides) & mineralised with clusters of fine py. GS cl altered and highly fract, com along fine veinlets. GS	29.5
		BL	Intensely fragmented grey, bedded, v.fine grained GS. Completely fragmented/crushed into gravel-cobbled sized, angular fragments. Coated in white-grey, fine clay & com mineralised with dark green chlorite with visible cleavage; rare clusters of fine pyrit	
	Gs			
	Sz	BL	Finely bedded GS. Interbedded v.fine grained,sandy-silt. Intensely veined & faulted. Veins up to 3mm, consisting of white soft clay (zeolite?) & calcite. Minor py. GS clay alt	
75.0	Gs			27.1
	Sz			
	Gs	BL	Intensely fragmented v. fine grained interbedded GS, crushed into gravel-cobble sized angular frag. Cl veined with minor py & pinkish-brown, Fe oxide nodules. Crush zone downhole contact at 24 & 10°. Up hole contact at 70°, cl coated.	
		BL	Finely-ireg bedded GS. Interbedded v.fine grained, sandy-silt & clayey-silt. Variably cl alt. Intensely veined and faulted with ireg, x-cuuting v.fine network of white-grey, soft clay (zeolite?) & white, soft, crystalline calcite veins. Occ sw pinkish-bro	

Huntly - Geology Legend

Core Loss/Washout	Clay/Ash	Fill	Tertiary Carbonaceous Mudstone	Tertiary Carbonaceous Sandstone	Greywacke Argillite	
Greywacke Conglomerate	Greywacke Chipwacke	Greywacke Sandstone	Greywacke Siltstone	Fault/Fault Zone	Shear Zone	

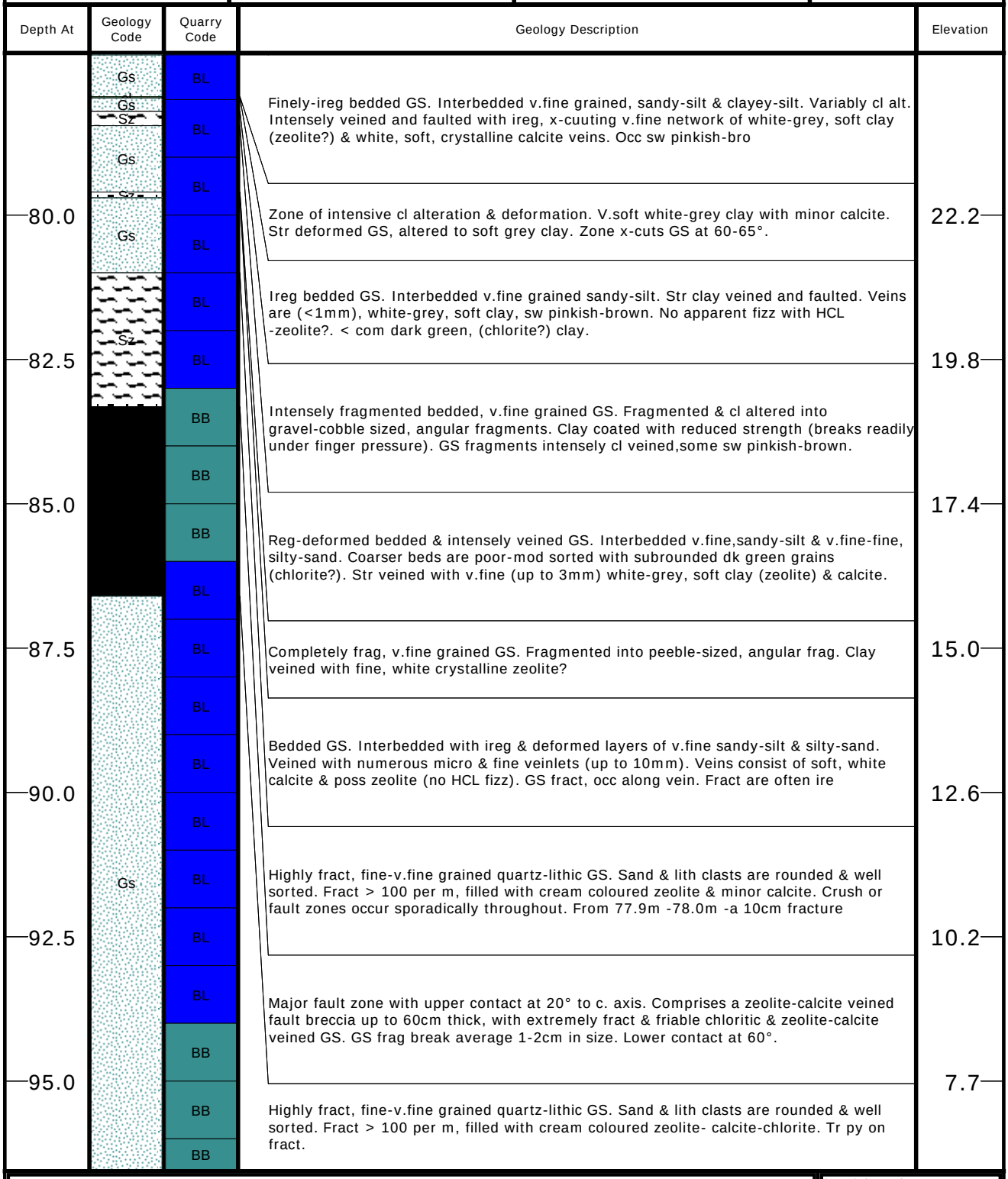
Quarry Code Legend

Overburden
Brown/Soft Pit Run
Blue Brown
Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ006	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2699807.00	Collar Y :6399179.00	Collar Z :99.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :77.22	Segment End Depth :96.53	Scale 1:100



Huntly - Geology Legend

Core Loss/Washout | Clay/Ash | Fill | Tertiary Carbonaceous Mudstone | Tertiary Carbonaceous Sandstone | Greywacke Argillite

Greywacke Conglomerate | Greywacke Chipwacke | Greywacke Sandstone | Greywacke Siltstone | Fault/Fault Zone | Shear Zone

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ006	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2699807.00	Collar Y :6399179.00	Collar Z :99.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :96.53	Segment End Depth :115.84	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
97.5	Gs	BB / BL / BL / BL	Highly fract, fine-v.fine grained quartz-lithic GS. Sand & lith clasts are rounded & well sorted. Fract > 100 per m, filled with cream coloured zeolite- calcite-chlorite. Tr py on fract.	5.3
100.0				2.9
102.5				0.5
105.0				-1.9
107.5				-4.3
110.0				-6.8
112.5				-9.2
115.0				-11.6

Huntly - Geology Legend

- Core Loss/Washout
- Clay/Ash
- Fill
- Tertiary Carbonaceous Mudstone
- Tertiary Carbonaceous Sandstone
- Greywacke Argillite
- Greywacke Conglomerate
- Greywacke Chipwacke
- Greywacke Sandstone
- Greywacke Siltstone
- Fault/Fault Zone
- Shear Zone

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ007	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2700093.00	Collar Y :6399219.00	Collar Z :107.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :0.00	Segment End Depth :19.31	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
	cl	OB	Orange-brown, dark brown silty-sandy clay, soft, moist.	
2.5				105.1
		OB	Light yellow-pinkish, HW grey v.fine-fine clayey sand & silt. V.stiff, Dry & friable	
5.0				102.7
7.5	Gs	OB	GS. Approx half weathered to clayey, soft soil. Ext weak, friable. Some rock fragments are jointed with limonite & Fe ox staining.	100.3
10.0				97.8
12.5				95.4
15.0	Gs	OB	GS. Sections completely weathered to clayey-silty soil. Very weak. Remenant bedding textures of interbedded fine-v.fine GS. Str jointed with Fe oxide & limonite alt.	93.0
17.5				90.6

Huntly - Geology Legend

Core Loss/Washout	Clay/Ash	Fill	Tertiary Carbonaceous Mudstone	Tertiary Carbonaceous Sandstone	Greywacke Argillite	
Greywacke Conglomerate	Greywacke Chipwacke	Greywacke Sandstone	Greywacke Siltstone	Fault/Fault Zone	Shear Zone	

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ007	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2700093.00	Collar Y :6399219.00	Collar Z :107.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :19.31	Segment End Depth :38.61	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
20.0	Gs	OB	GS. Sections completely weathered to clayey-silty soil. Very weak. Remenant bedding textures of interbedded fine-v.fine GS. Str jointed with Fe oxide & limonite alt.	88.2
		OB		
		BR		
22.5	Gs	BR	Bedded, v.weak-weak, GS. Str jointed with Fe oxide & limonite alteration. GS highly fragmented.	85.8
		BR		
		BR		
25.0		BB		83.4
		BB		
		BB		
27.5		BL		80.9
		BL		
30.0		BL		78.5
	Gs	BL	Bedded, fine -v.fine grained GS. Interbedded quartz-lithic,fine-v fine sands and v.fine grained, silt (poss argillite), in discont pod like beds. Laminated. Str jointed with Fe ox & limonite alt. Minor fine white zeol veins & minor calcite.	
32.5		BL		76.1
		BL		
		BL		
35.0		BL		73.7
		BL		
		BL		
37.5		BL		71.3
		BL		

Huntly - Geology Legend

Core Loss/Washout	Clay/Ash	Fill	Tertiary Carbonaceous Mudstone	Tertiary Carbonaceous Sandstone	Greywacke Argillite	
Greywacke Conglomerate	Greywacke Chipwacke	Greywacke Sandstone	Greywacke Siltstone	Fault/Fault Zone	Shear Zone	

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ007	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2700093.00	Collar Y :6399219.00	Collar Z :107.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :38.61	Segment End Depth :57.92	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
	Gs	BL		
40.0		BL	Bedded, fine -v.fine grained GS. Interbedded quartz-lithic,fine-v fine sands and v.fine grained, silt (poss argillite), in discont pod like beds. Laminated. Str jointed with Fe ox & limonite alt. Minor fine white zeol veins & minor calcite.	68.9
		BL		
		BL		
42.5	Gs	BL		66.4
		BL	V.fine-fine grained GS. Laminated interbedded sequence of mod-well sorted, quartz -lithic GS and v.fine grained, clayey-silt. Fine GS beds up to 190mm. Beds com offset on v.fine micro faults. Jointed & x-cut by fine calcite & zeol veins	
		BL		
45.0		BL		64.0
		BL		
47.5	Gs	BL	Bedded v.fine-fine GS. Laminated interbedded fine-med, mod-well sorted qz lithic GS & v.fine clayey-silt. Beds are often discont. GS str fragmented with joint surfaces thinely coated with cal,zeol & coarse py clusters.	61.6
		BL		
		BL		
50.0		BL		59.2
		BL		
		BL		
52.5	Gs	BL	V.fine-fine GS. Laminated, interbedded v.fine-fine, mod-well sorted qz-lithic GS & v.fine grained clayey-silt, (possibly argillite). Beds are offset by fine micro faults, com jointed & x-cut by fine calcite & zeo veins, often with fine py. Some sections s	56.8
		BL		
		BL		
55.0		BL		54.4
		BL		
		BL		
57.5		BL		52.0

Huntly - Geology Legend

Core Loss/Washout	Clay/Ash	Fill	Tertiary Carbonaceous Mudstone	Tertiary Carbonaceous Sandstone	Greywacke Argillite	
Greywacke Conglomerate	Greywacke Chipwacke	Greywacke Sandstone	Greywacke Siltstone	Fault/Fault Zone	Shear Zone	

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ007	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2700093.00	Collar Y :6399219.00	Collar Z :107.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :57.92	Segment End Depth :77.22	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
60.0	Gs	BL	V.fine-fine GS. Laminated, interbedded v.fine-fine, mod-well sorted qz-lithic GS & v.fine grained clayey-silt, (possibly argillite). Beds are offset by fine micro faults, com jointed & x-cut by fine calcite & zeo veins, often with fine py. Some sections s	49.5
62.5				47.1
65.0	Gs	BL	Bedded GS, mod-highly fractured, interbedded v.fine-fine grained, mod srted GS and v.fine, clayey-silt (possibly argillite) in fine or discont & pod like beds (flaser bedding?). Veined with fine (1mm) white-pink calcite (siderite?), zeolite. Vein surfaces	44.7
67.5				42.3
70.0	Gs	BL	Finely bedded GS. Laminated interbedded v.fine-fine, mod-well sorted, qz-lithic GS & v.fine grained, clayey-silt (possibly argillite), occassionaly as fine, discont & pod like beds (flaser bedding?). Occ fractured & veined with v.fine (1mm), white-grey &	39.9
72.5				37.5
75.0				35.1

Huntly - Geology Legend

Core Loss/Washout	Clay/Ash	Fill	Tertiary Carbonaceous Mudstone	Tertiary Carbonaceous Sandstone	Greywacke Argillite	
Greywacke Conglomerate	Greywacke Chipwacke	Greywacke Sandstone	Greywacke Siltstone	Fault/Fault Zone	Shear Zone	

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ007	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2700093.00	Collar Y :6399219.00	Collar Z :107.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :77.22	Segment End Depth :96.53	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
	Gs	BL	Finely bedded GS. Laminated interbedded v.fine-fine, mod-well sorted, qz-lithic GS & v.fine grained, clayey-silt (possibly argillite), occassionaly as fine, discont & pod like beds (flaser bedding?). Occ fractured & veined with v.fine (1mm), white-grey &	
80.0				30.2
82.5	Gs		Bedded GS, v.fine - fine grained, clayey-sandy-silt with minor v.fine white flecks (poss zeolite) diss within GS. Laminated & finely interbedded, well-mod sorted. Occ veined with v.fine white-grey zeolite-calcite veinlets. Occ fract.	27.8
85.0				25.4
87.5	Gs		Finely bed GS. Mod fract. Laminated interbedded v.fine-fine, mod-well sorted, qz-lithic GS & v.fine grained, clayey-silt (possibly argillite), occ as fine, discont & pod like beds (flaser bedding?). Occ fractured & veined with v.fine (1mm), discont & pod	23.0
90.0	Gs		Zone of intensive fracturing, faulting & veining of v.fine-fine grained, qz lithic GS interbedded with clayey-silt (possibly argillite). Veins (up to 25mm) of white-grey, soft zeolite & calcite. Some minor pyrite.	20.6
92.5	Gs		Bedded fine grained GS. Laminated, interbedded qz-lithic, well-mod sorted GS, and v.fine clayey-silt, poss argillite. Bedded laminanited to flaser like with some clay-silt in pod like beds. Some sections highly fractured with fracturing less com after 97m	18.2
95.0				15.7

Huntly - Geology Legend

Core Loss/Washout	Clay/Ash	Fill	Tertiary Carbonaceous Mudstone	Tertiary Carbonaceous Sandstone	Greywacke Argillite	
Greywacke Conglomerate	Greywacke Chipwacke	Greywacke Sandstone	Greywacke Siltstone	Fault/Fault Zone	Shear Zone	

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

Drill Hole Log

Project Name: Resource Drilling - Huntly (Dec-Mar 2006)

Hole Name :HQ007	Client: Stevensons Resources Limited		
Collar Coordinates (Mt. Eden Circuit):	Collar X :2700093.00	Collar Y :6399219.00	Collar Z :107.50
Drilling Company: Brown Brothers Ltd.	Drilled By: Kerry Brown	Logged By:	A Spargo
Hole Length :100.00	Segment Start Depth :96.53	Segment End Depth :115.84	Scale 1:100

Depth At	Geology Code	Quarry Code	Geology Description	Elevation
97.5	Gs	BL	Bedded fine grained GS. Laminated, interbedded qz-lithic, well-mod sorted GS, and v.fine clayey-silt, poss argillite. Bedded laminanited to flaser like with some clay-silt in pod like beds. Some sections highly fractured with fracturing less com after 97m	13.3
100.0				10.9
102.5				8.5
105.0				6.1
107.5				3.7
110.0				1.2
112.5				-1.2
115.0				-3.6

Huntly - Geology Legend

- Core Loss/Washout
- Clay/Ash
- Fill
- Tertiary Carbonaceous Mudstone
- Tertiary Carbonaceous Sandstone
- Greywacke Argillite
- Greywacke Conglomerate
- Greywacke Chipwacke
- Greywacke Sandstone
- Greywacke Siltstone
- Fault/Fault Zone
- Shear Zone

Quarry Code Legend

- Overburden
- Brown/Soft Pit Run
- Blue Brown
- Blue

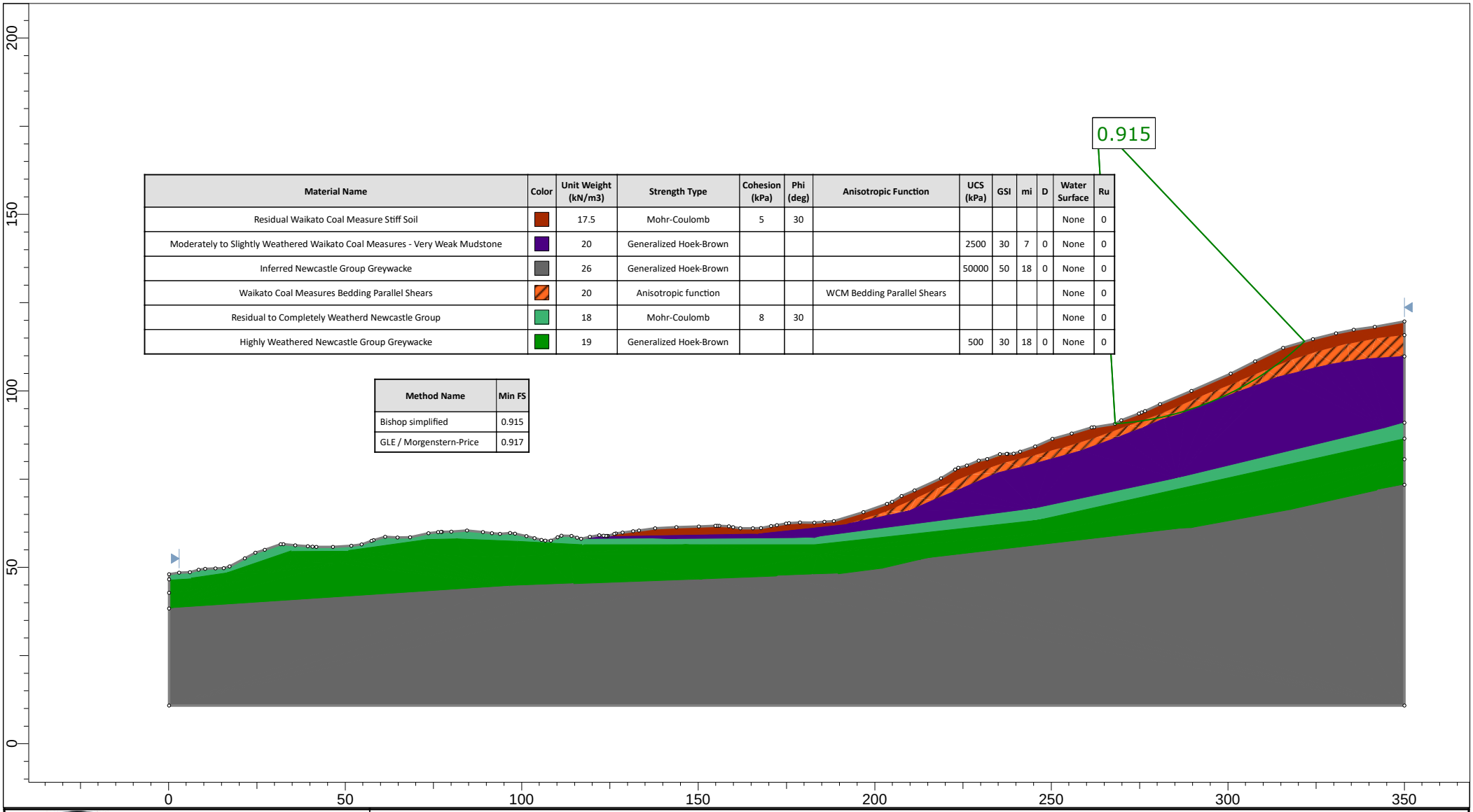
APPENDIX C – Slope Stability Analysis Outputs

Description	No. Sheets:
Slope Stability Analysis Outputs	25

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

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Anisotropic Function	UCS (kPa)	GSI	mi	D	Water Surface	Ru
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				2500	30	7	0	None	0
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0	None	0
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears					None	0
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30						None	0
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0	None	0

Method Name	Min FS
Bishop simplified	0.915
GLE / Morgenstern-Price	0.917



GAIA ENGINEERS

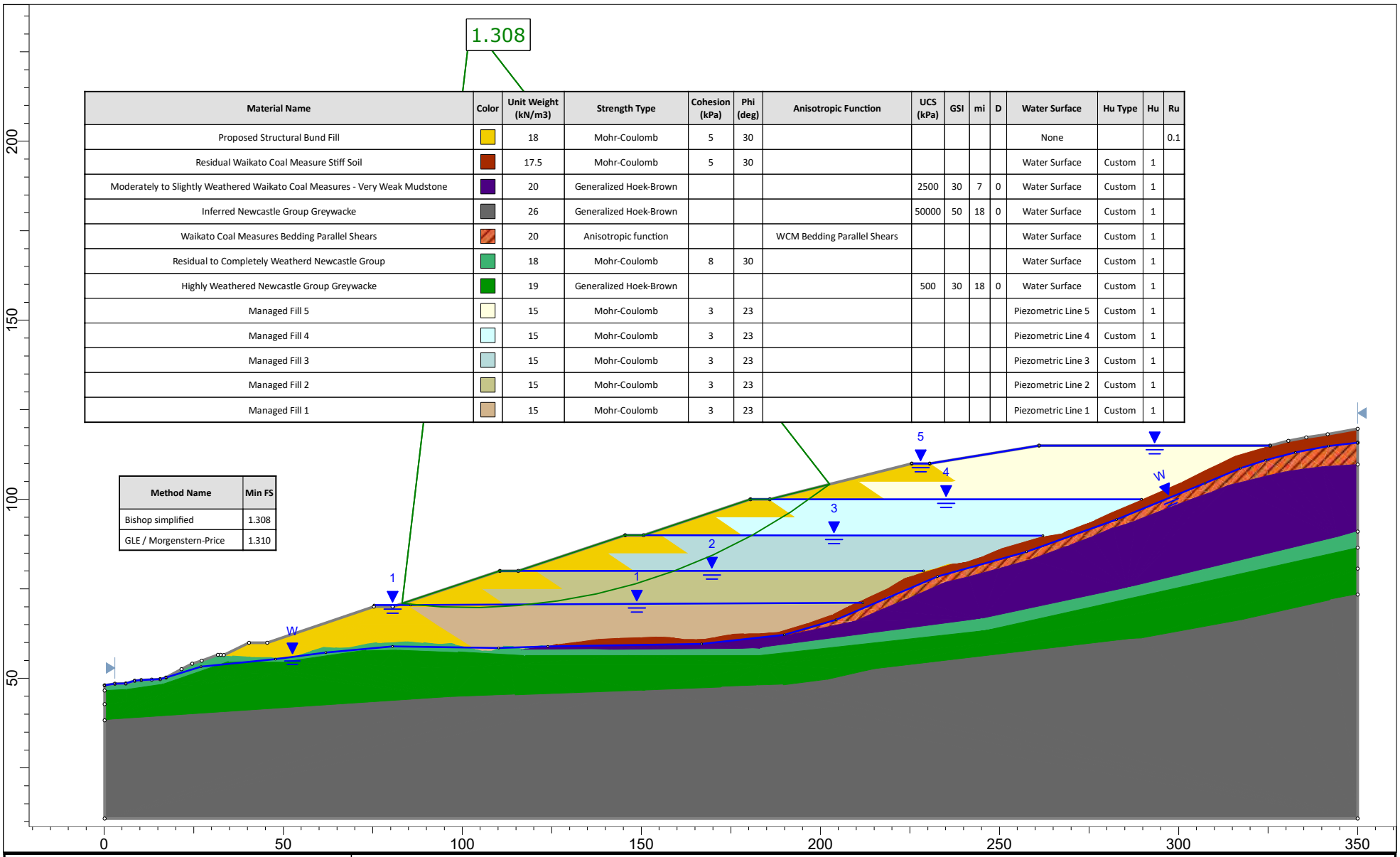
SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Existing Slope - Master Scenario		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Bulk Pore Pressure.slmd

1.308

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
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0	Water Surface	Custom	1	
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears					Water Surface	Custom	1	
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30						Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0	Water Surface	Custom	1	
Managed Fill 5		15	Mohr-Coulomb	3	23						Piezometric Line 5	Custom	1	
Managed Fill 4		15	Mohr-Coulomb	3	23						Piezometric Line 4	Custom	1	
Managed Fill 3		15	Mohr-Coulomb	3	23						Piezometric Line 3	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	

Method Name	Min FS
Bishop simplified	1.308
GLE / Morgenstern-Price	1.310



GAIA ENGINEERS

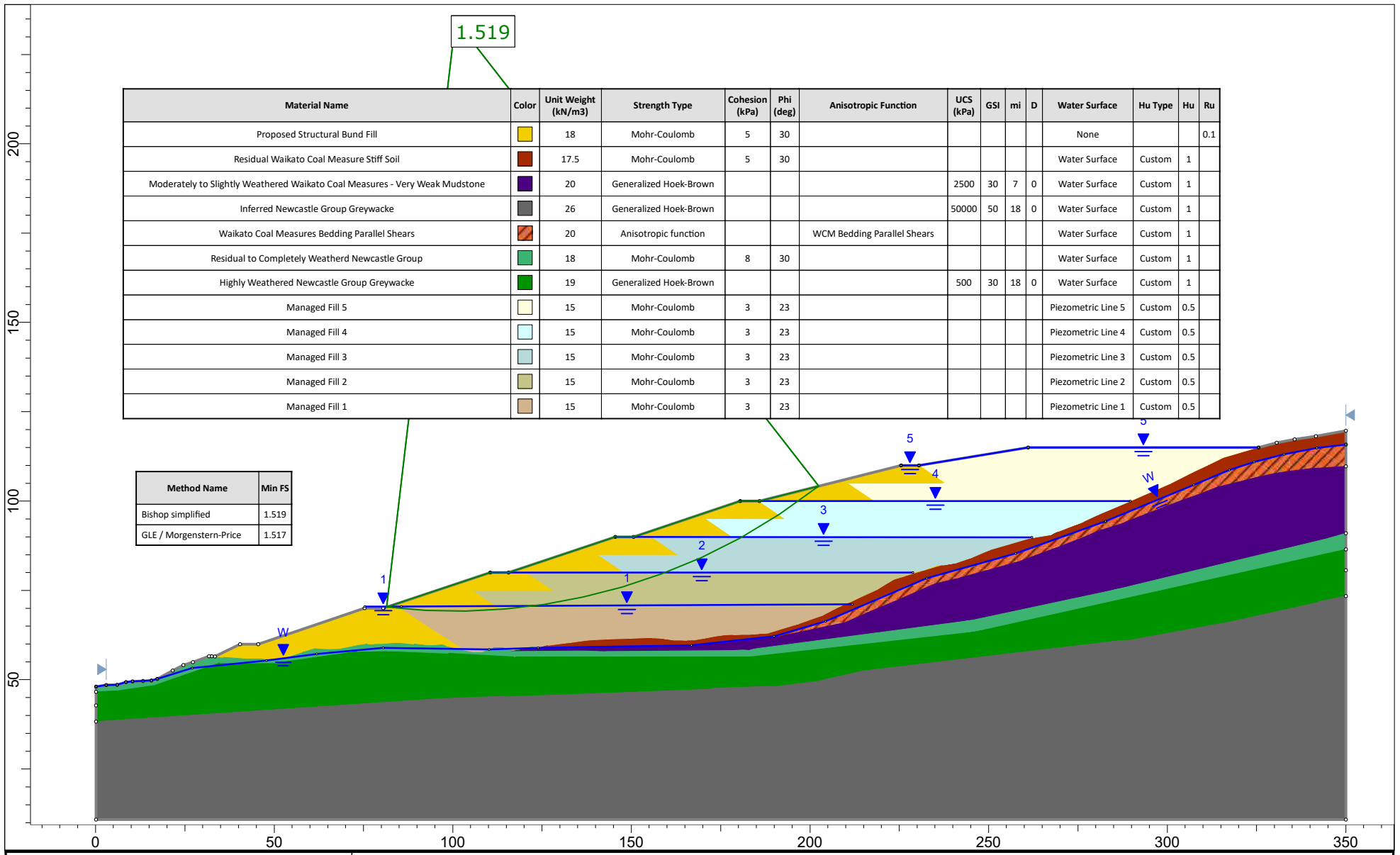
SLIDEINTERPRET 8.032

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Longterm, High Groundwater		
Drawn By MK	*Scale* 1:1500	*Company*	Gaia Engineers Ltd.
Date April. 2020		*File Name*	Fill Site 2 - Piezometric Lines Analysis.slmd

1.519

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
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0	Water Surface	Custom	1	
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears					Water Surface	Custom	1	
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30						Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0	Water Surface	Custom	1	
Managed Fill 5		15	Mohr-Coulomb	3	23						Piezometric Line 5	Custom	0.5	
Managed Fill 4		15	Mohr-Coulomb	3	23						Piezometric Line 4	Custom	0.5	
Managed Fill 3		15	Mohr-Coulomb	3	23						Piezometric Line 3	Custom	0.5	
Managed Fill 2		15	Mohr-Coulomb	3	23						Piezometric Line 2	Custom	0.5	
Managed Fill 1		15	Mohr-Coulomb	3	23						Piezometric Line 1	Custom	0.5	

Method Name	Min FS
Bishop simplified	1.519
GLE / Morgenstern-Price	1.517

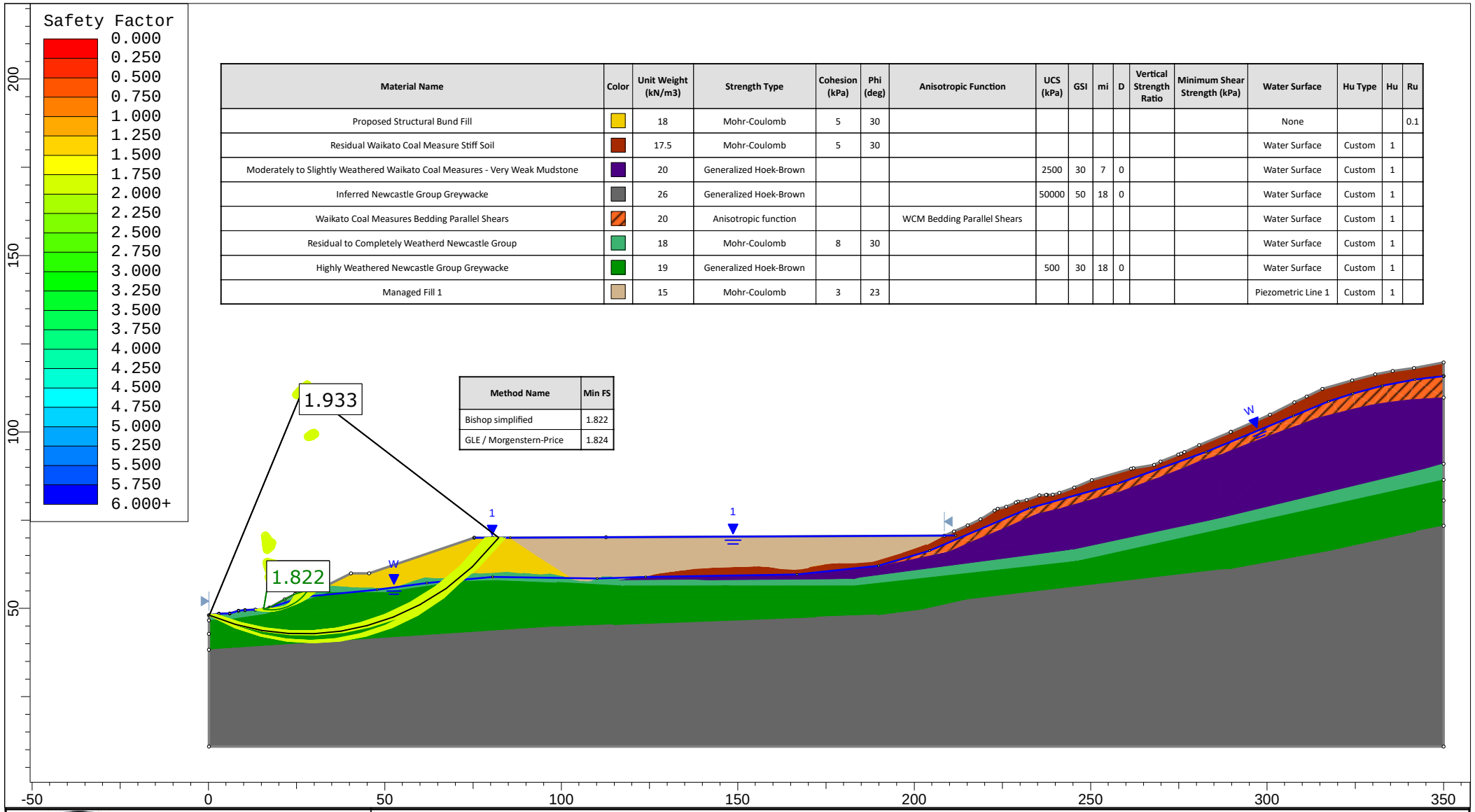


GAIA ENGINEERS

SLIDEINTERPRET 8.032

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Longterm, Moderate Groundwater		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	April. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0			Water Surface	Custom	1	
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears							Water Surface	Custom	1	
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30								Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0			Water Surface	Custom	1	
Managed Fill 1		15	Mohr-Coulomb	3	23								Piezometric Line 1	Custom	1	

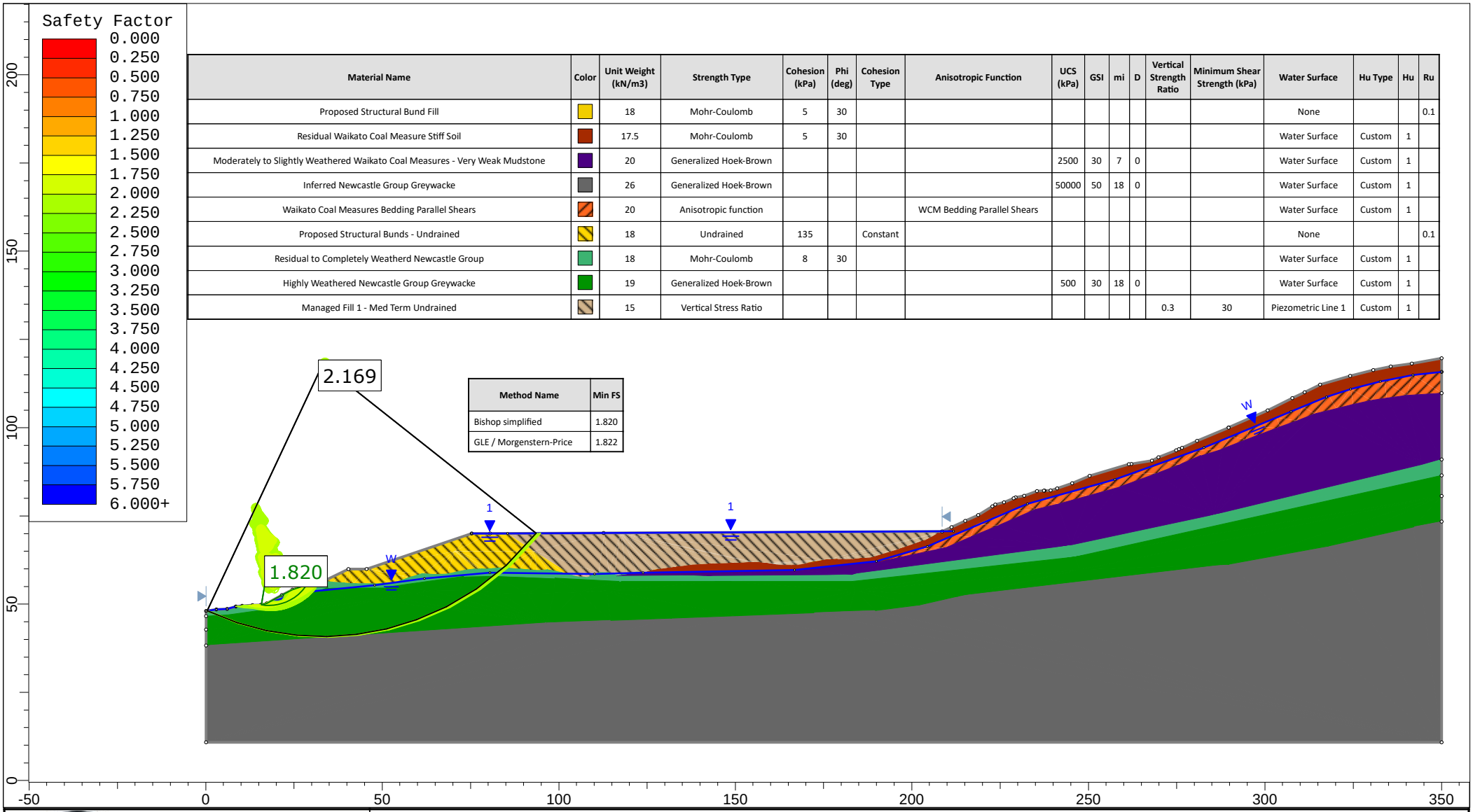


GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 1 - Master Scenario		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	1	
Managed Fill 1 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 1	Custom	1	



GAIA ENGINEERS

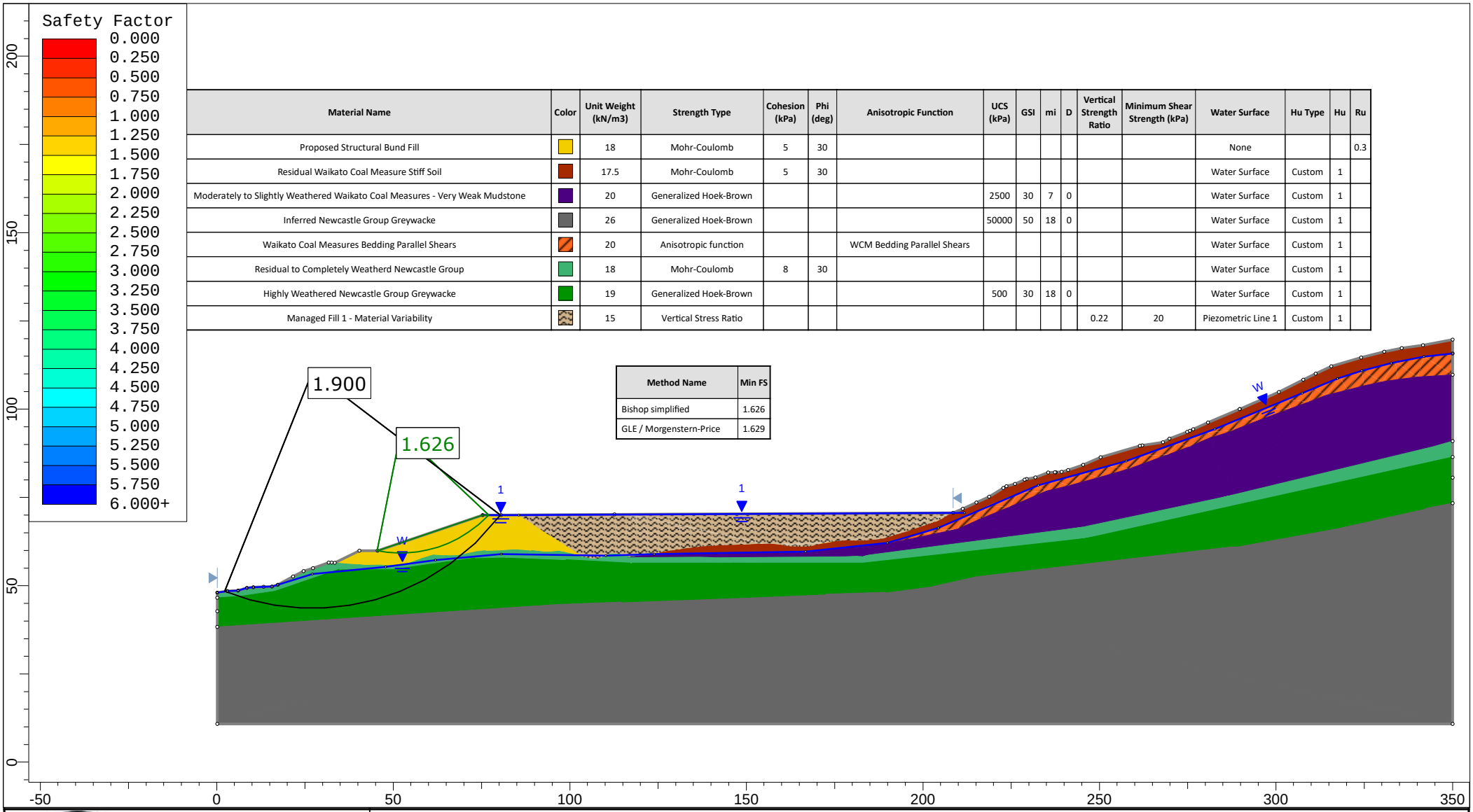
SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 1 - Undrained Strength		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.slmd

Safety Factor
0.000
0.250
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+

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
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0			Water Surface	Custom	1	
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears							Water Surface	Custom	1	
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30								Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0			Water Surface	Custom	1	
Managed Fill 1 - Material Variability		15	Vertical Stress Ratio								0.22	20	Piezometric Line 1	Custom	1	

Method Name	Min FS
Bishop simplified	1.626
GLE / Morgenstern-Price	1.629

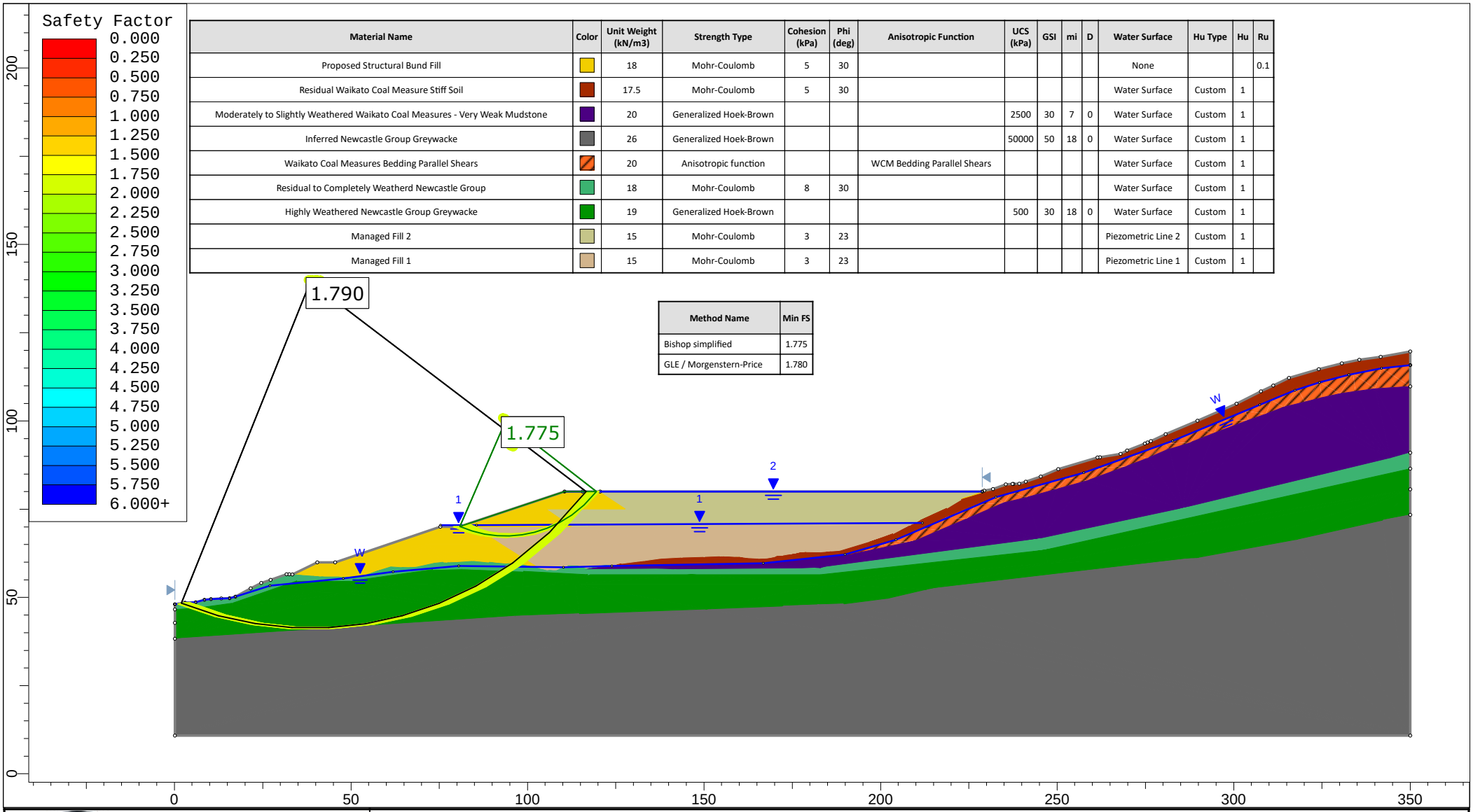


GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 1 - Material Variability		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0	Water Surface	Custom	1	
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears					Water Surface	Custom	1	
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30						Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0	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	



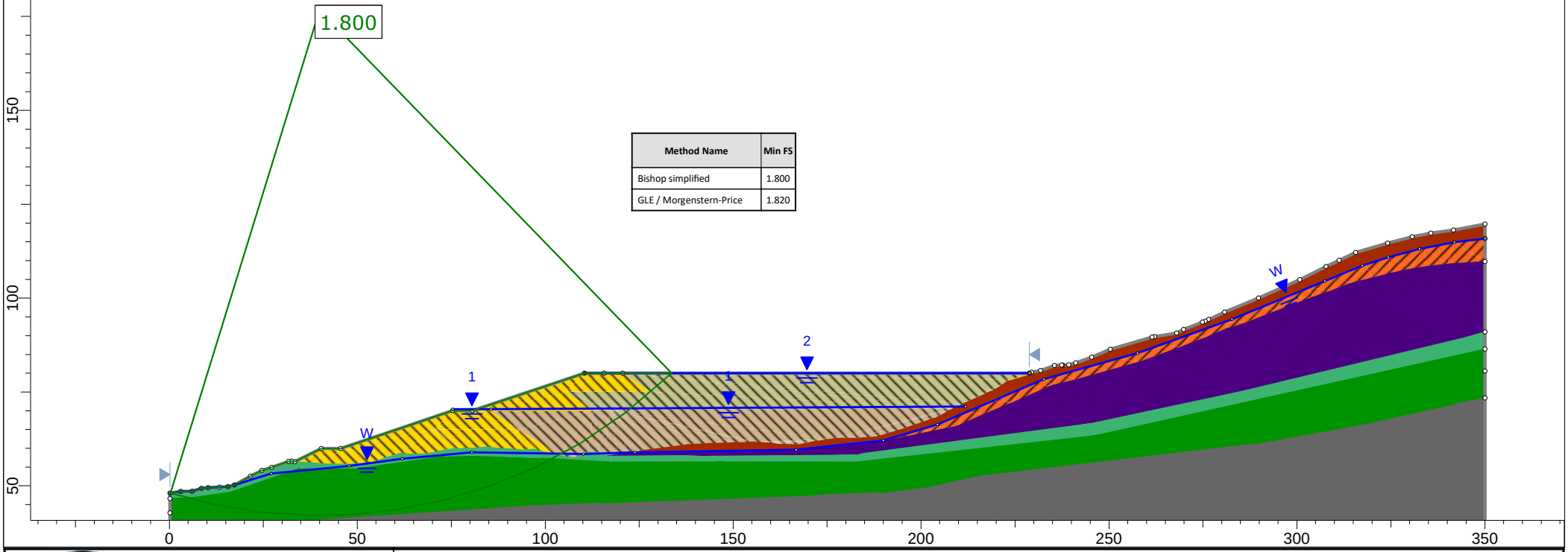
Method Name	Min FS
Bishop simplified	1.775
GLE / Morgenstern-Price	1.780

GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 2 - Master Scenario		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	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	



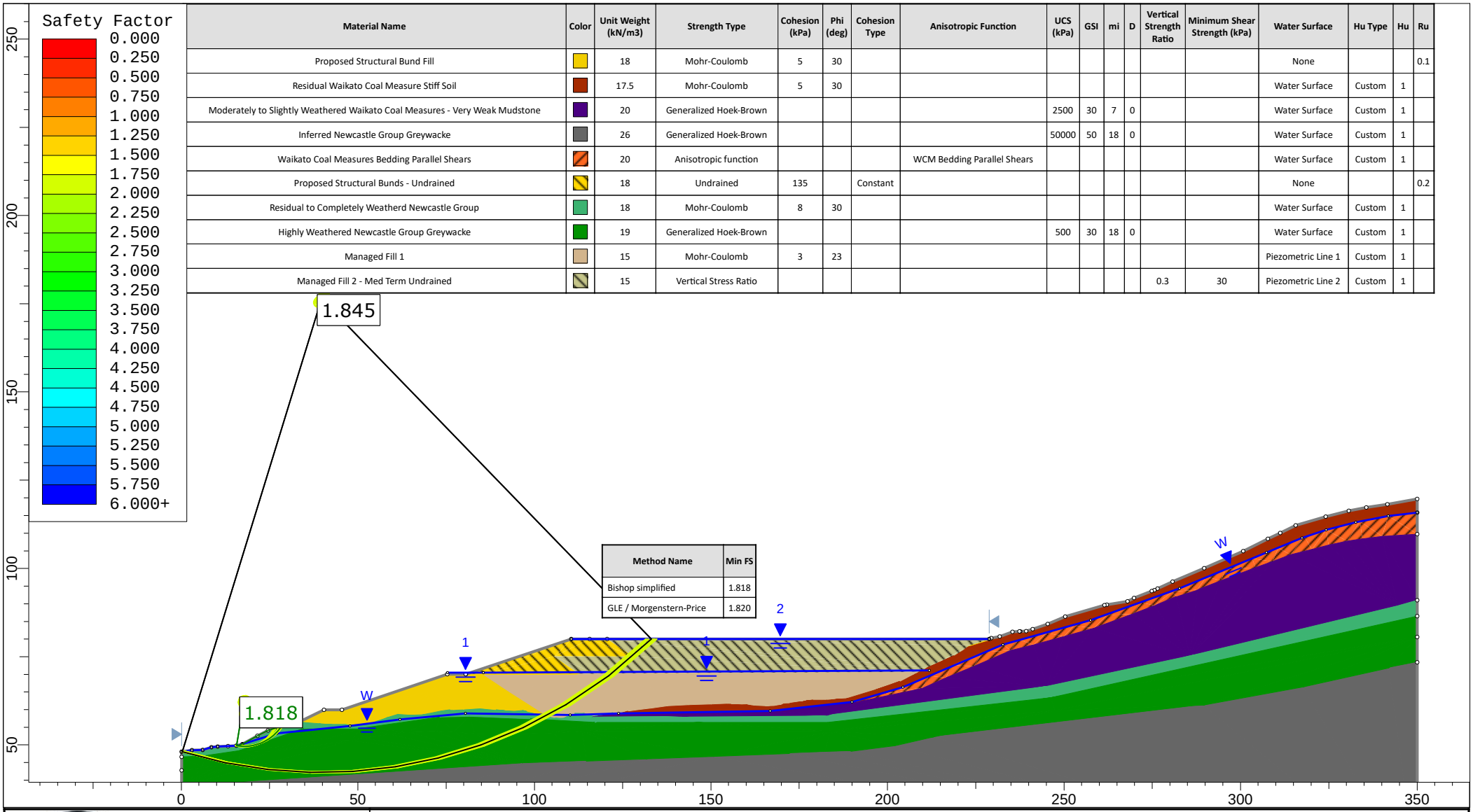
Method Name	Min FS
Bishop simplified	1.800
GLE / Morgenstern-Price	1.820

GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 2 - Undrained Strength		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	1	
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	

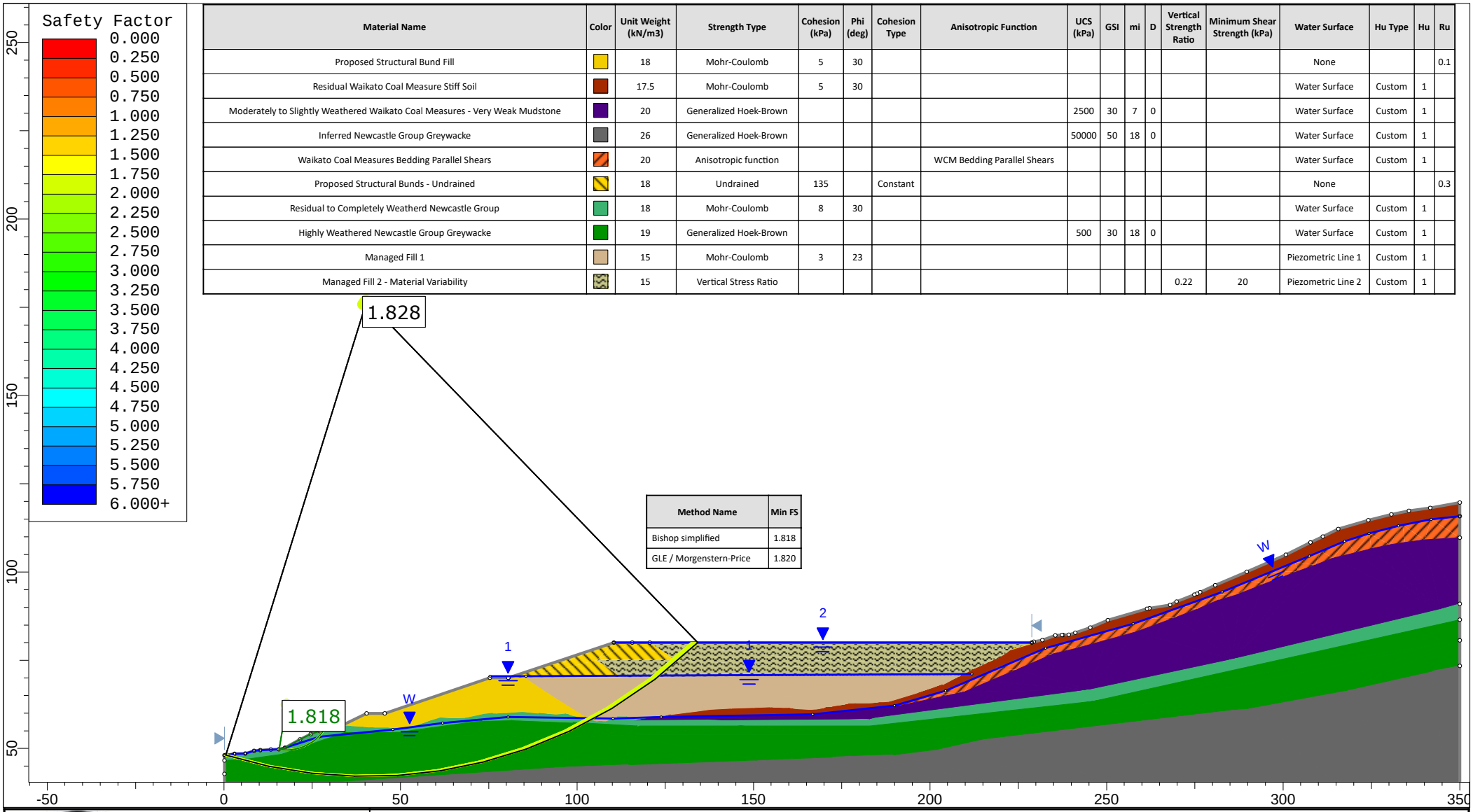


GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 2 - Medium Term Strength		
Drawn By	MK	Scale	1:1500
Company	Gaia Engineers Ltd.		
Date	Feb. 2020	File Name	Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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			0.3
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			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	

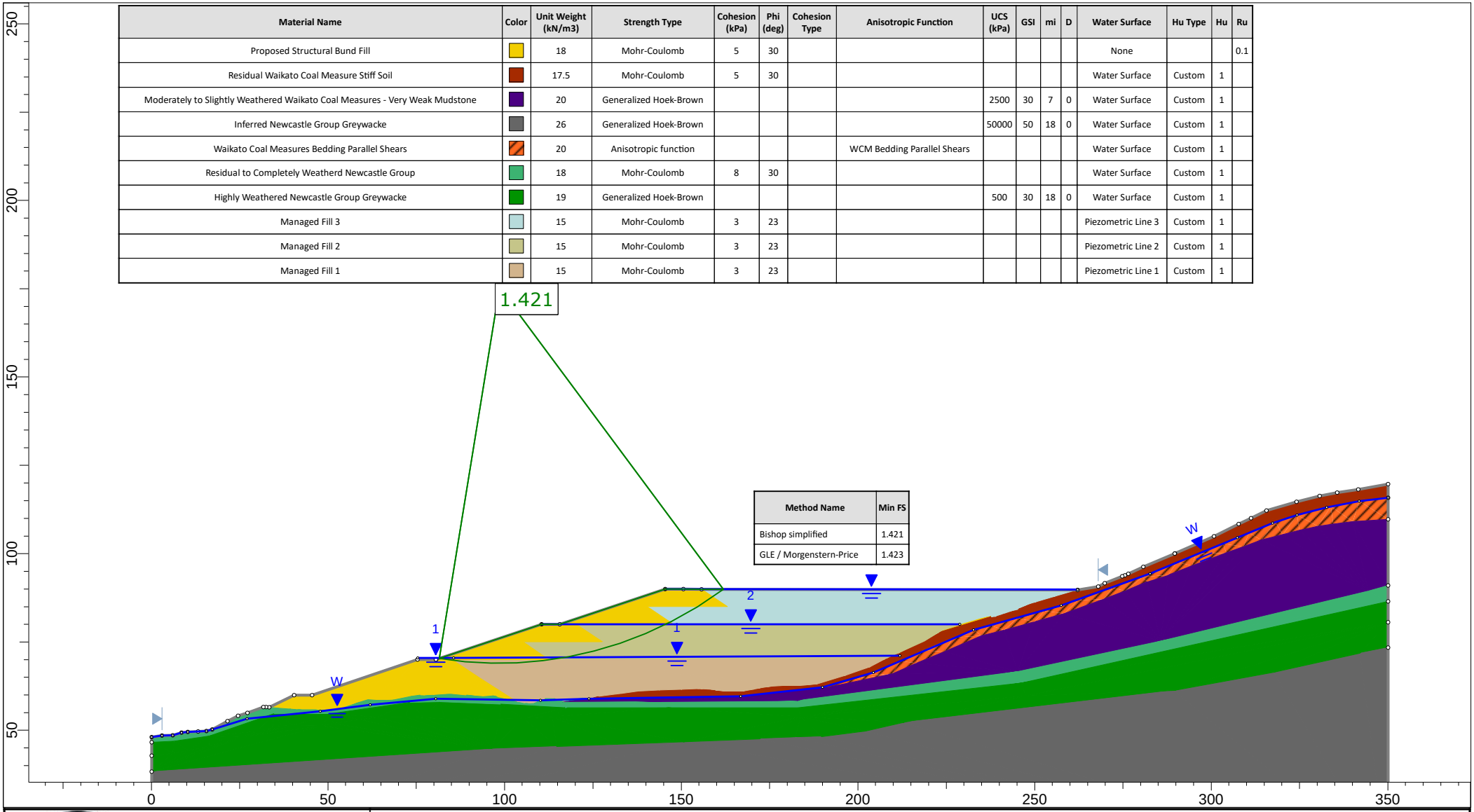


GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 2 - Material Variability		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.slmd

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Cohesion Type	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
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	0	Water Surface	Custom	1	
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function				WCM Bedding Parallel Shears					Water Surface	Custom	1	
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30							Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0	Water Surface	Custom	1	
Managed Fill 3		15	Mohr-Coulomb	3	23							Piezometric Line 3	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	

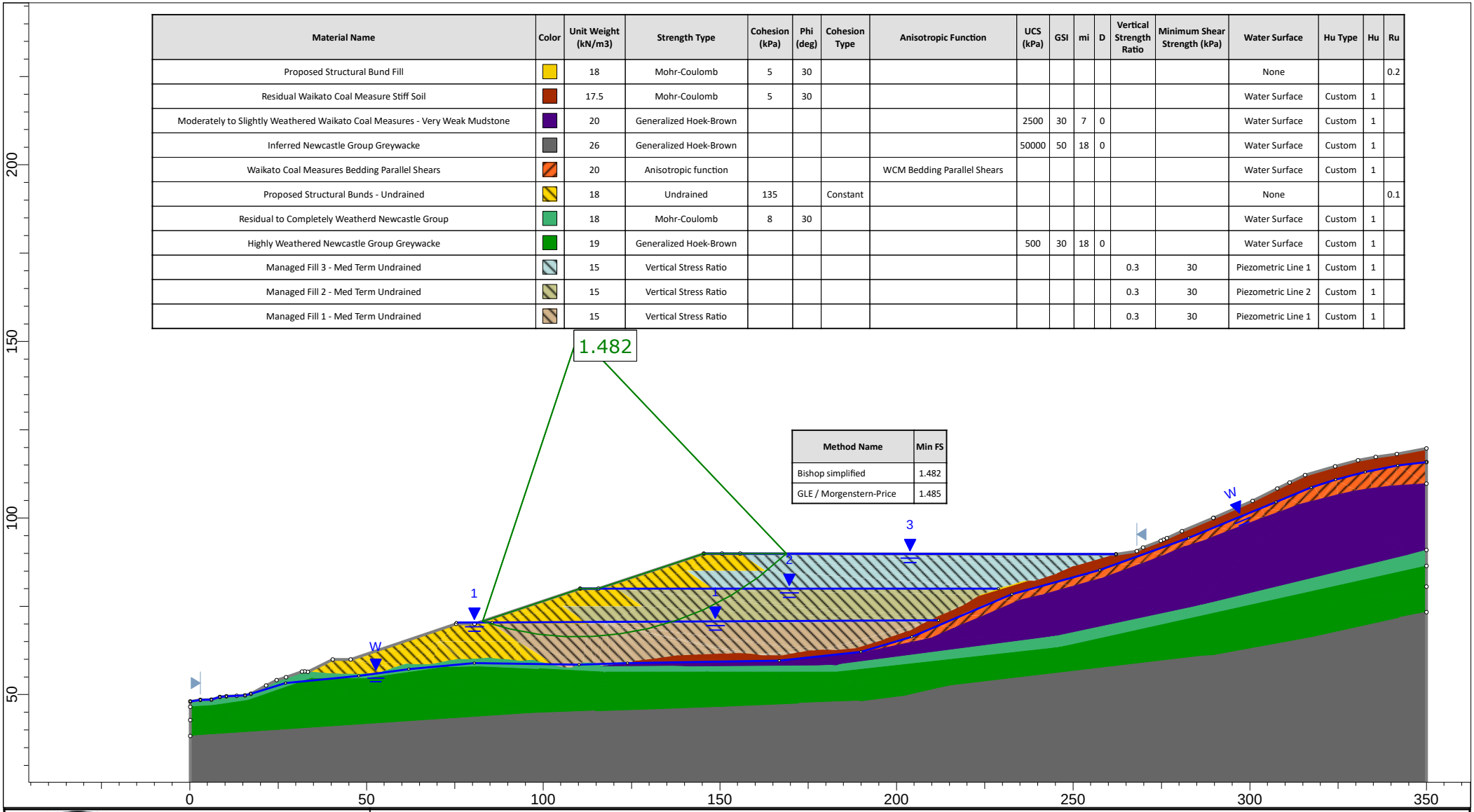


GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 3 - Master Scenario		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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			0.2
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	1	
Managed Fill 3 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 1	Custom	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	



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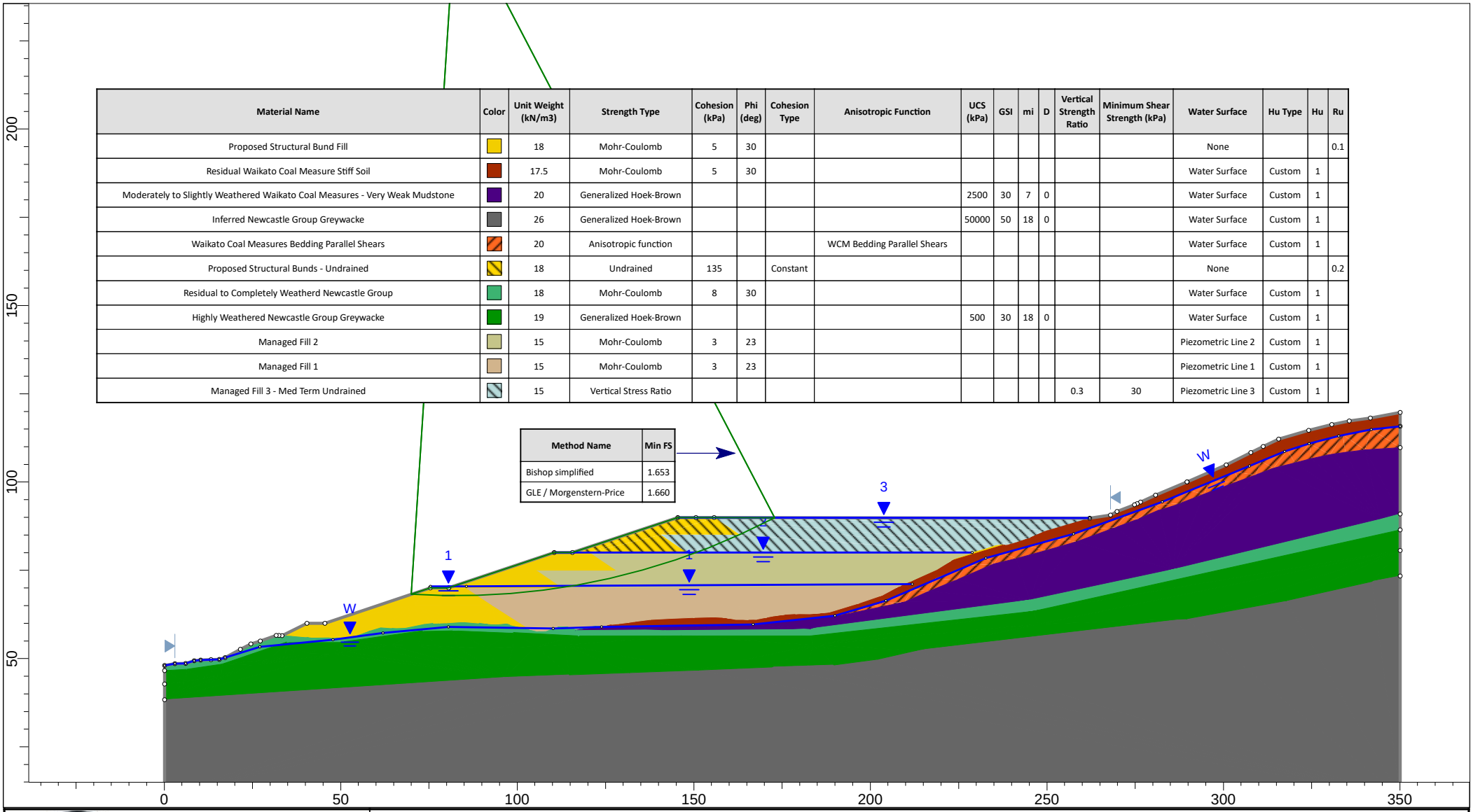
SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 3 - Undrained Strength		
Drawn By	MK	Scale	1:1500
Company	Gaia Engineers Ltd.		
Date	Feb. 2020	File Name	Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			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	
Managed Fill 3 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 3	Custom	1	

Method Name	Min FS
Bishop simplified	1.653
GLE / Morgenstern-Price	1.660



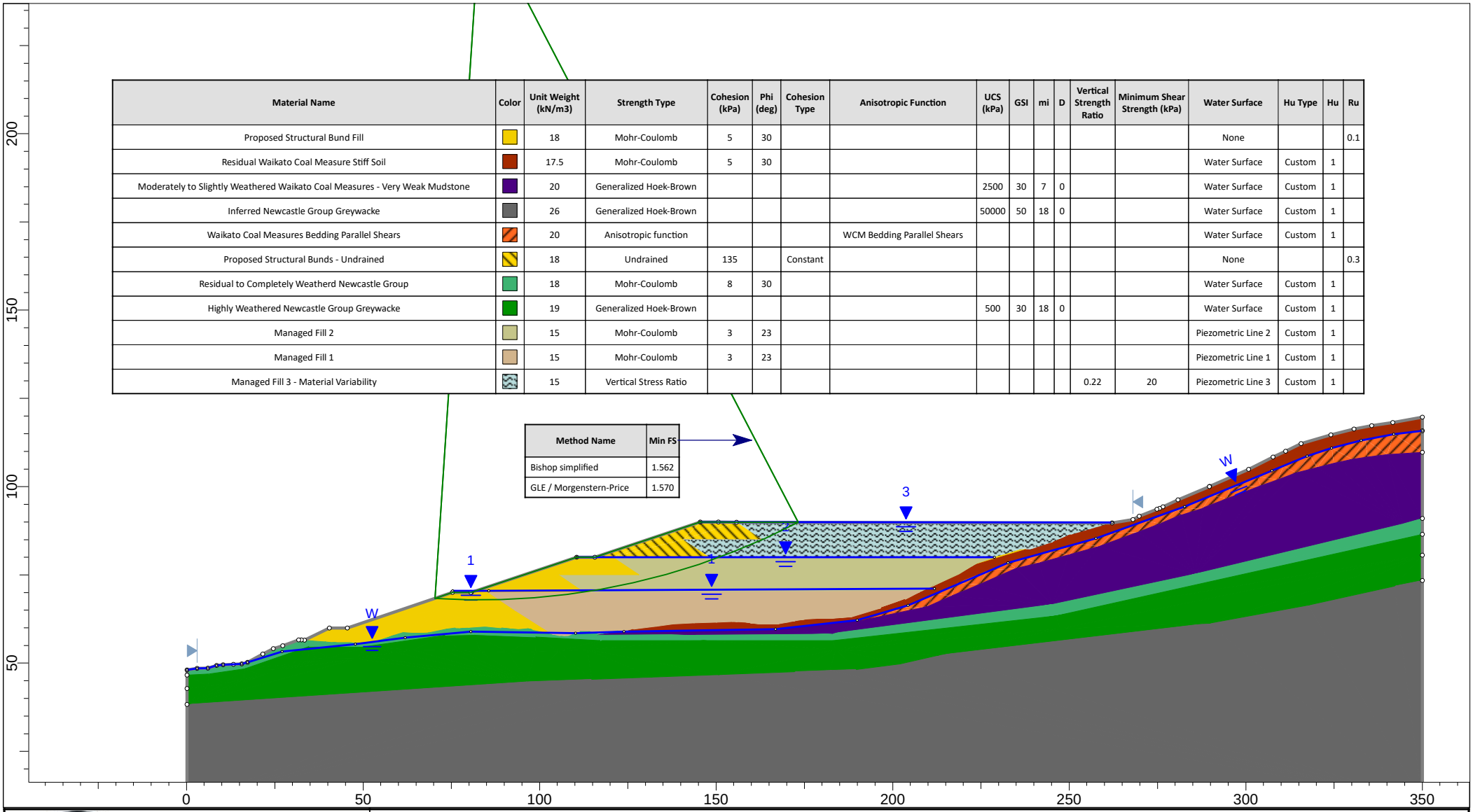
GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 3 - Medium Term Strength		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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			0.3
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			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	
Managed Fill 3 - Material Variability		15	Vertical Stress Ratio									0.22	20	Piezometric Line 3	Custom	1	

Method Name	Min FS
Bishop simplified	1.562
GLE / Morgenstern-Price	1.570



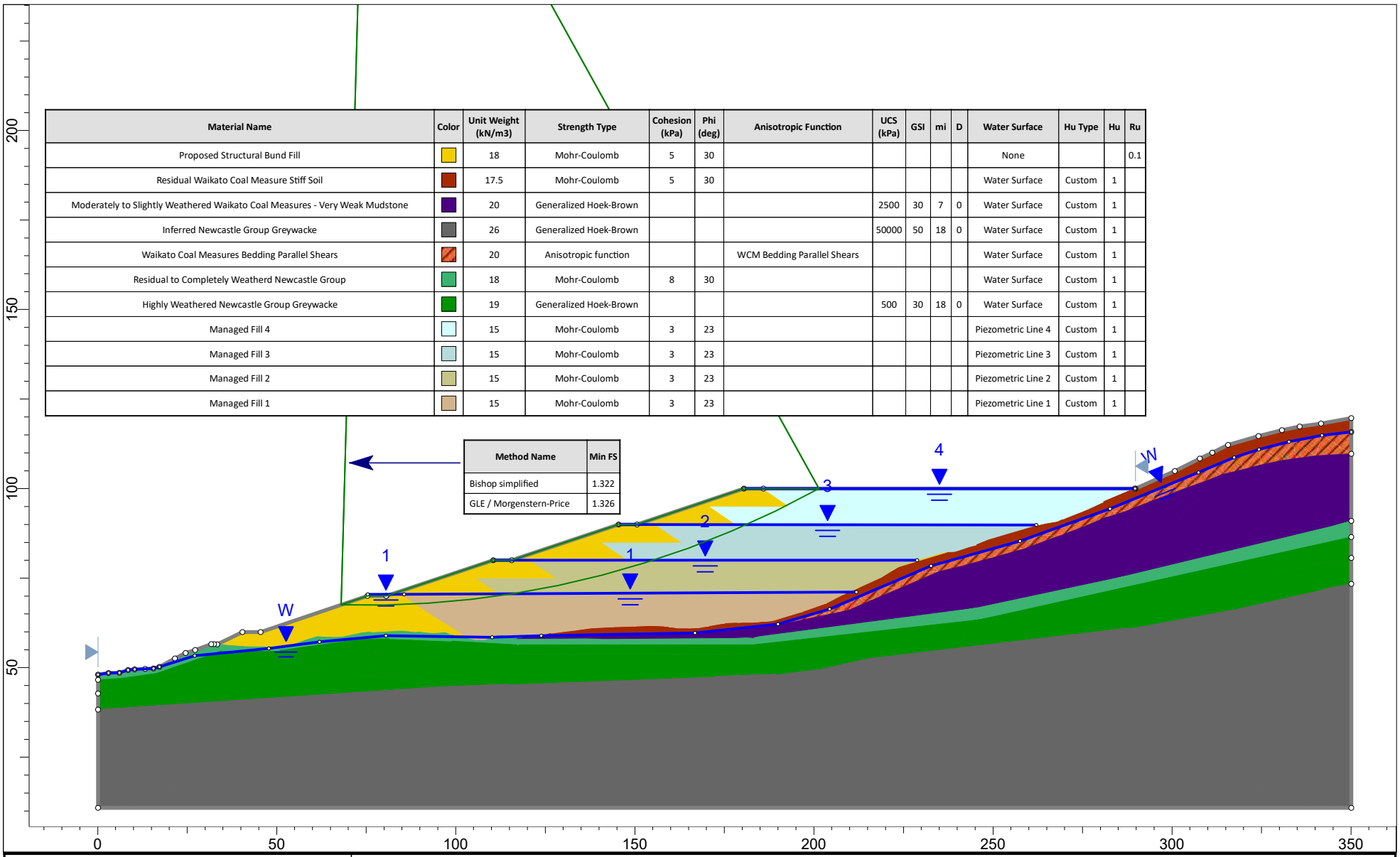
GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 3 - Material Variability		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	Feb. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0	Water Surface	Custom	1	
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears					Water Surface	Custom	1	
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30						Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0	Water Surface	Custom	1	
Managed Fill 4		15	Mohr-Coulomb	3	23						Piezometric Line 4	Custom	1	
Managed Fill 3		15	Mohr-Coulomb	3	23						Piezometric Line 3	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	

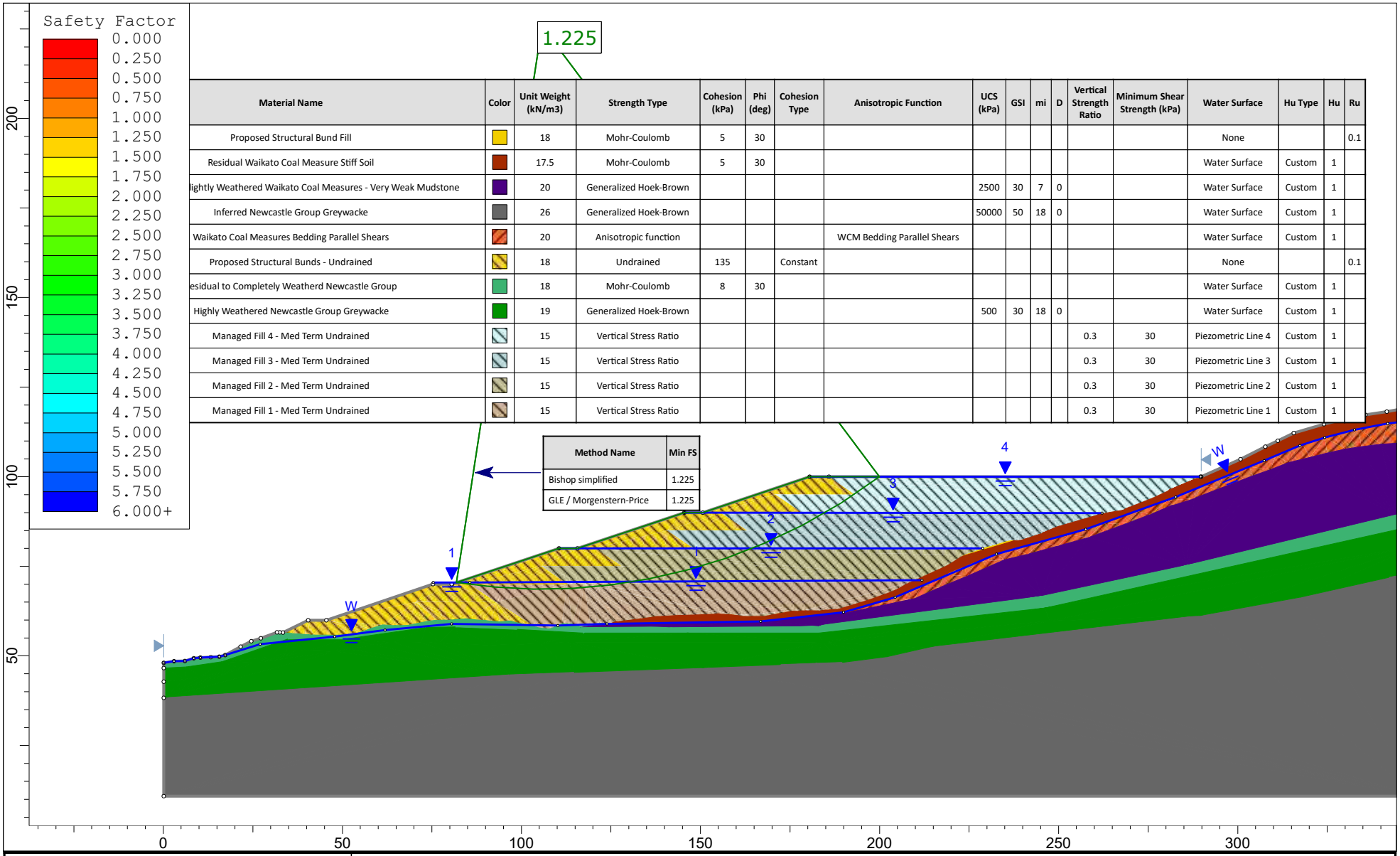
Method Name	Min FS
Bishop simplified	1.322
GLE / Morgenstern-Price	1.326



GAIA ENGINEERS

SLIDEINTERPRET 8.032

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 4 - Master Scenario		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	April. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
ightly Weathered Waikato Coal Measures - Very Weak Mudstone		20	Generalized Hoek-Brown					2500	30	7	0			Water Surface	Custom	1	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
esidual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	1	
Managed Fill 4 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 4	Custom	1	
Managed Fill 3 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 3	Custom	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	

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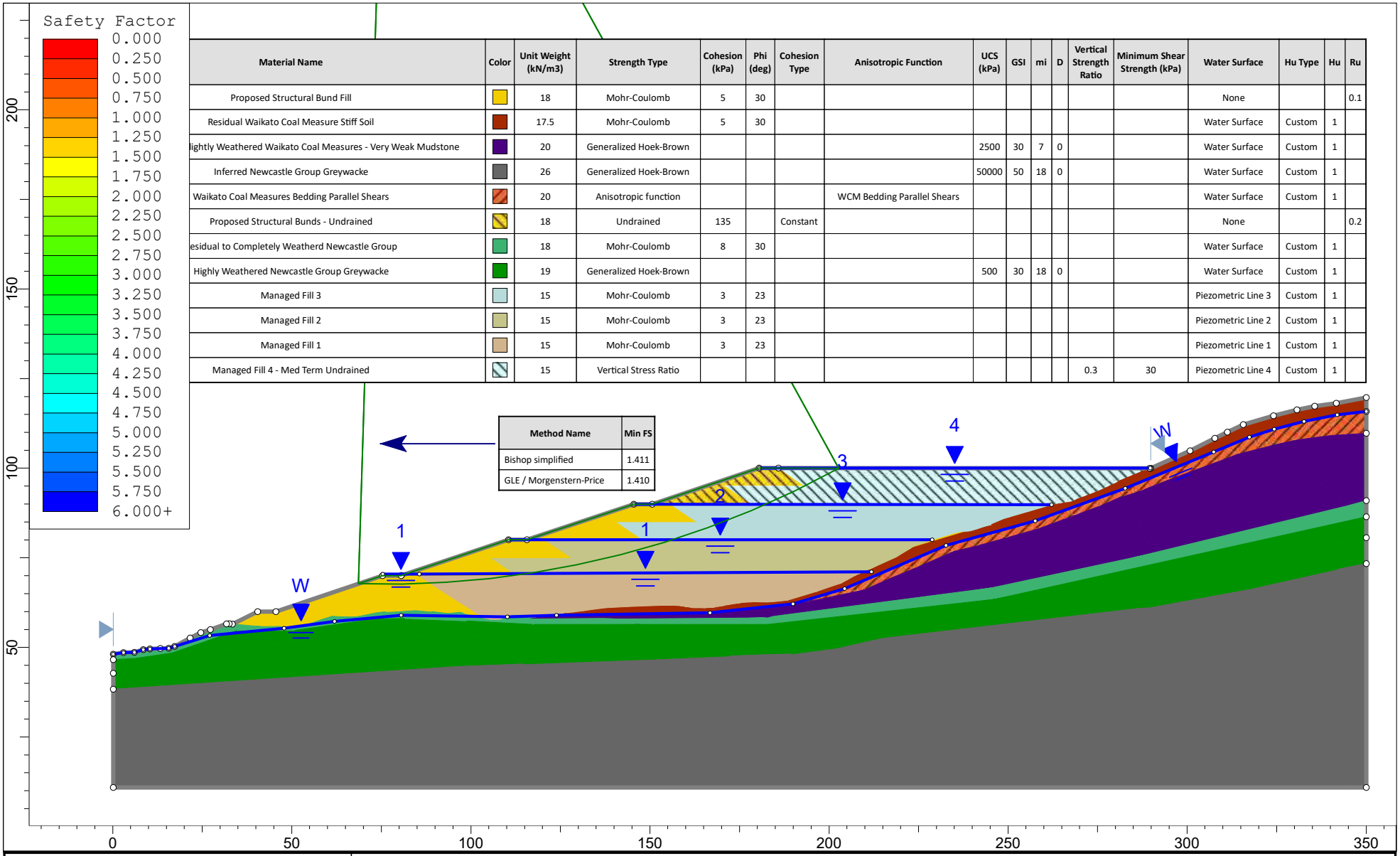
SLIDEINTERPRET 8.032

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 4 - Undrained Strength		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	April. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
ightly Weathered Waikato Coal Measures - Very Weak Mudstone		20	Generalized Hoek-Brown					2500	30	7	0			Water Surface	Custom	1	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
esidual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	1	
Managed Fill 3		15	Mohr-Coulomb	3	23									Piezometric Line 3	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	
Managed Fill 4 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 4	Custom	1	

Method Name	Min FS
Bishop simplified	1.411
GLE / Morgenstern-Price	1.410

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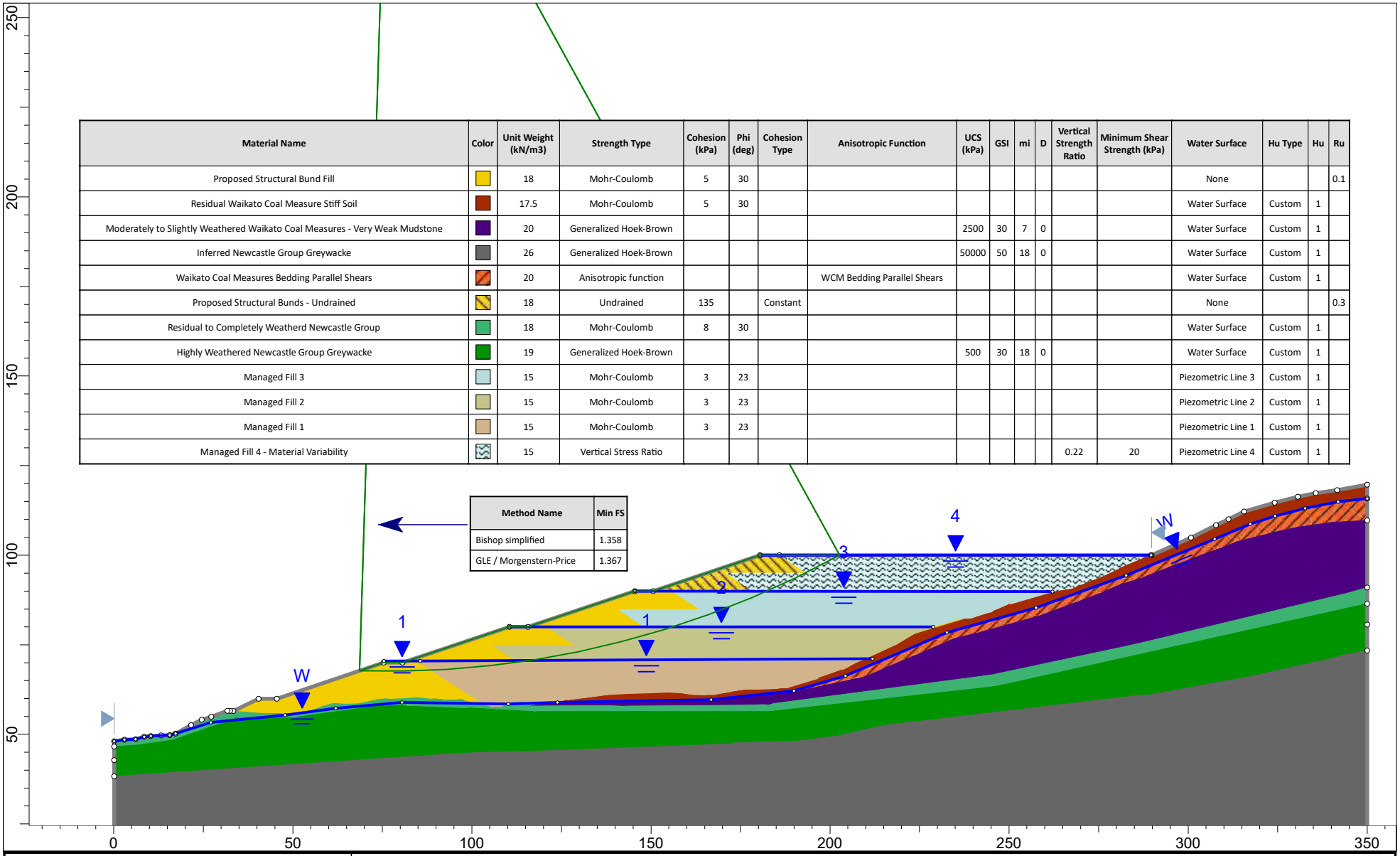
SLIDEINTERPRET 8.032

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 4 - Medium Term Strength		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	April. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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			0.3
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	1	
Managed Fill 3		15	Mohr-Coulomb	3	23									Piezometric Line 3	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	
Managed Fill 4 - Material Variability		15	Vertical Stress Ratio									0.22	20	Piezometric Line 4	Custom	1	

Method Name	Min FS
Bishop simplified	1.358
GLE / Morgenstern-Price	1.367



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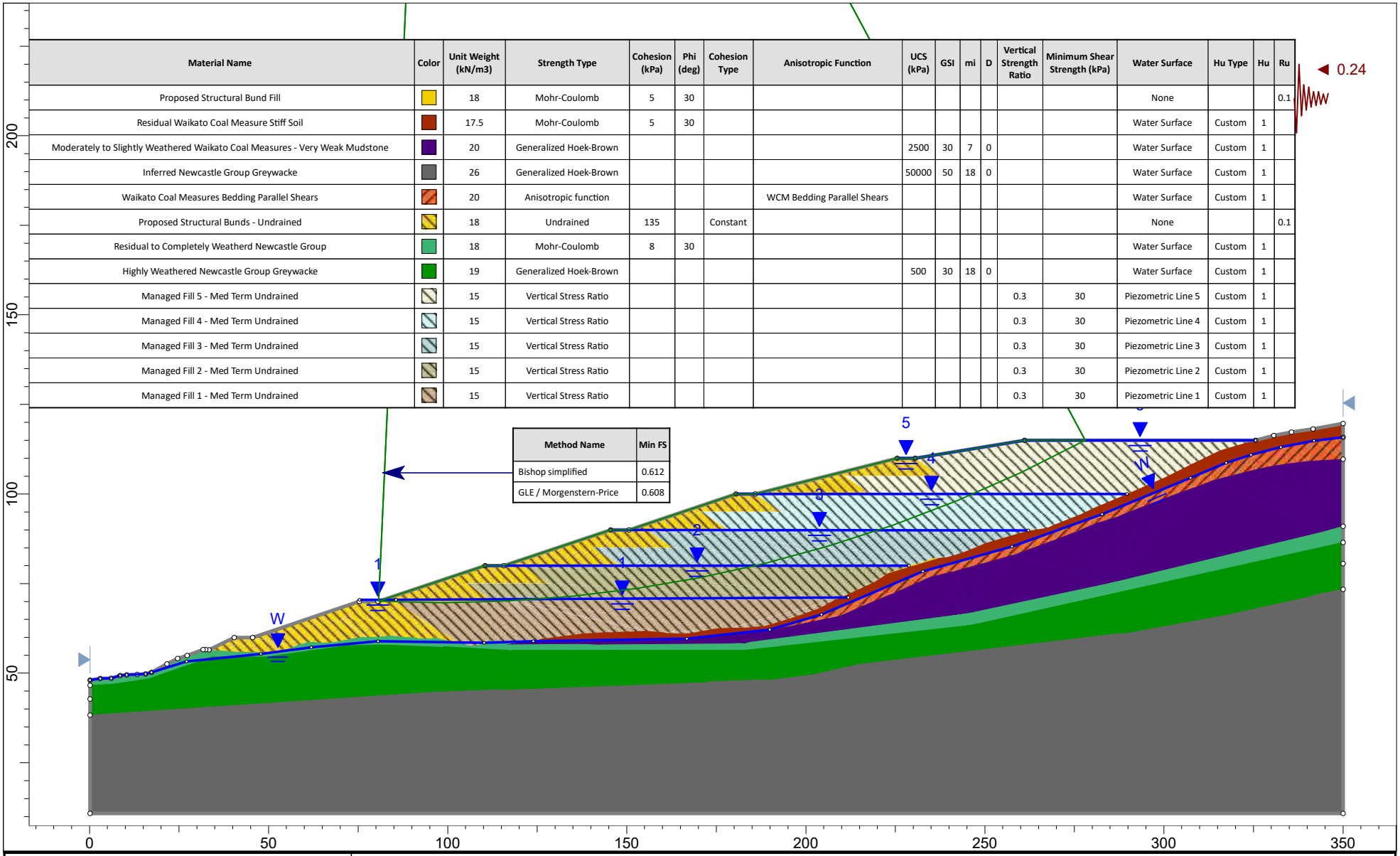
SLIDEINTERPRET 8.032

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Proposed Fill - Stage 4 - Material Variability		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	April. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	1	
Managed Fill 5 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 5	Custom	1	
Managed Fill 4 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 4	Custom	1	
Managed Fill 3 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 3	Custom	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	

◄ 0.24

Method Name	Min FS
Bishop simplified	0.612
GLE / Morgenstern-Price	0.608



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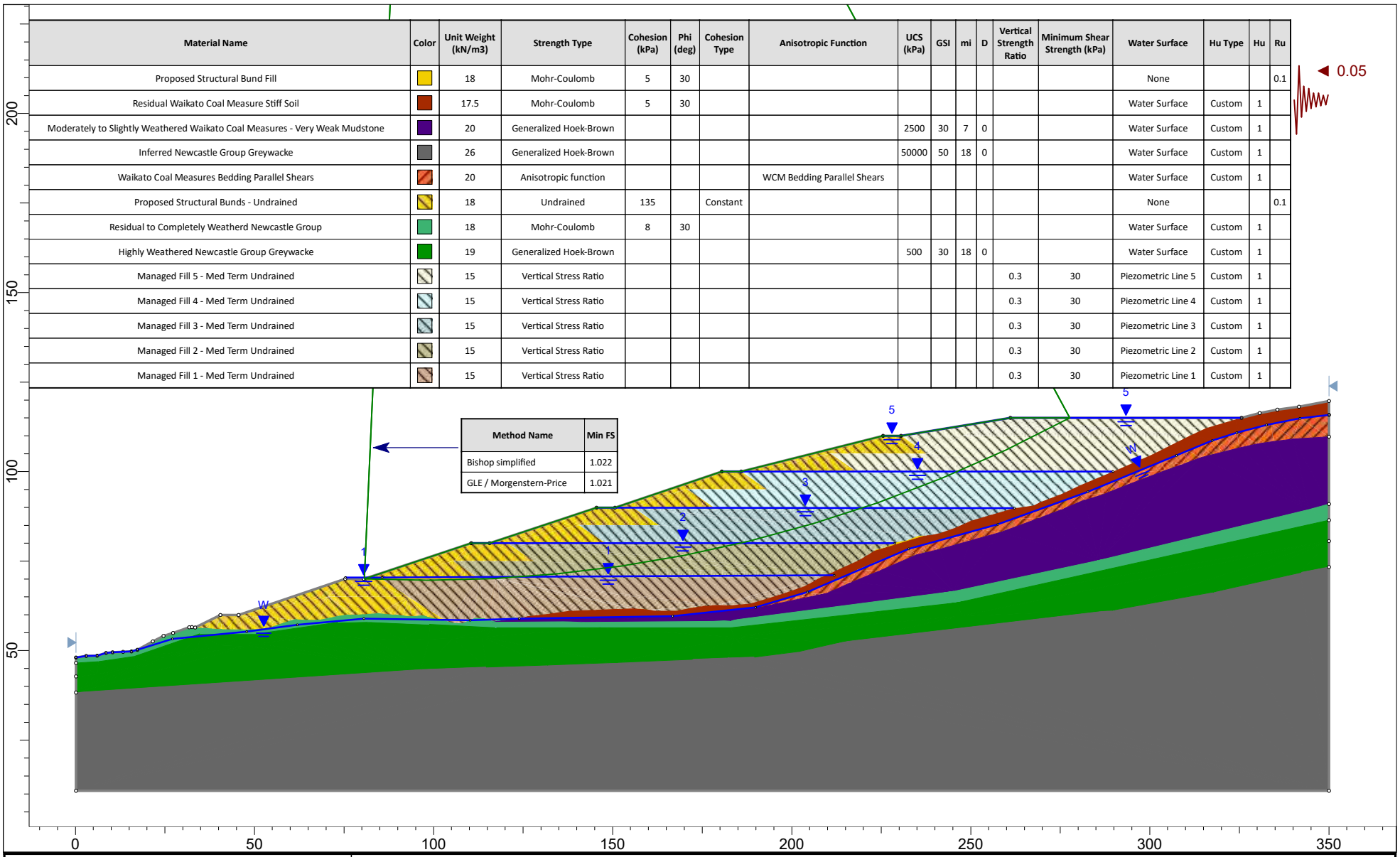
SLIDEINTERPRET 8.032

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Seismic Loadings - Proposed Fill, Design Seismic Loading		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	April. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown					50000	50	18	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
Residual to Completely Weatherd Newcastle Group		18	Mohr-Coulomb	8	30									Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown					500	30	18	0			Water Surface	Custom	1	
Managed Fill 5 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 5	Custom	1	
Managed Fill 4 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 4	Custom	1	
Managed Fill 3 - Med Term Undrained		15	Vertical Stress Ratio									0.3	30	Piezometric Line 3	Custom	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	

0.05

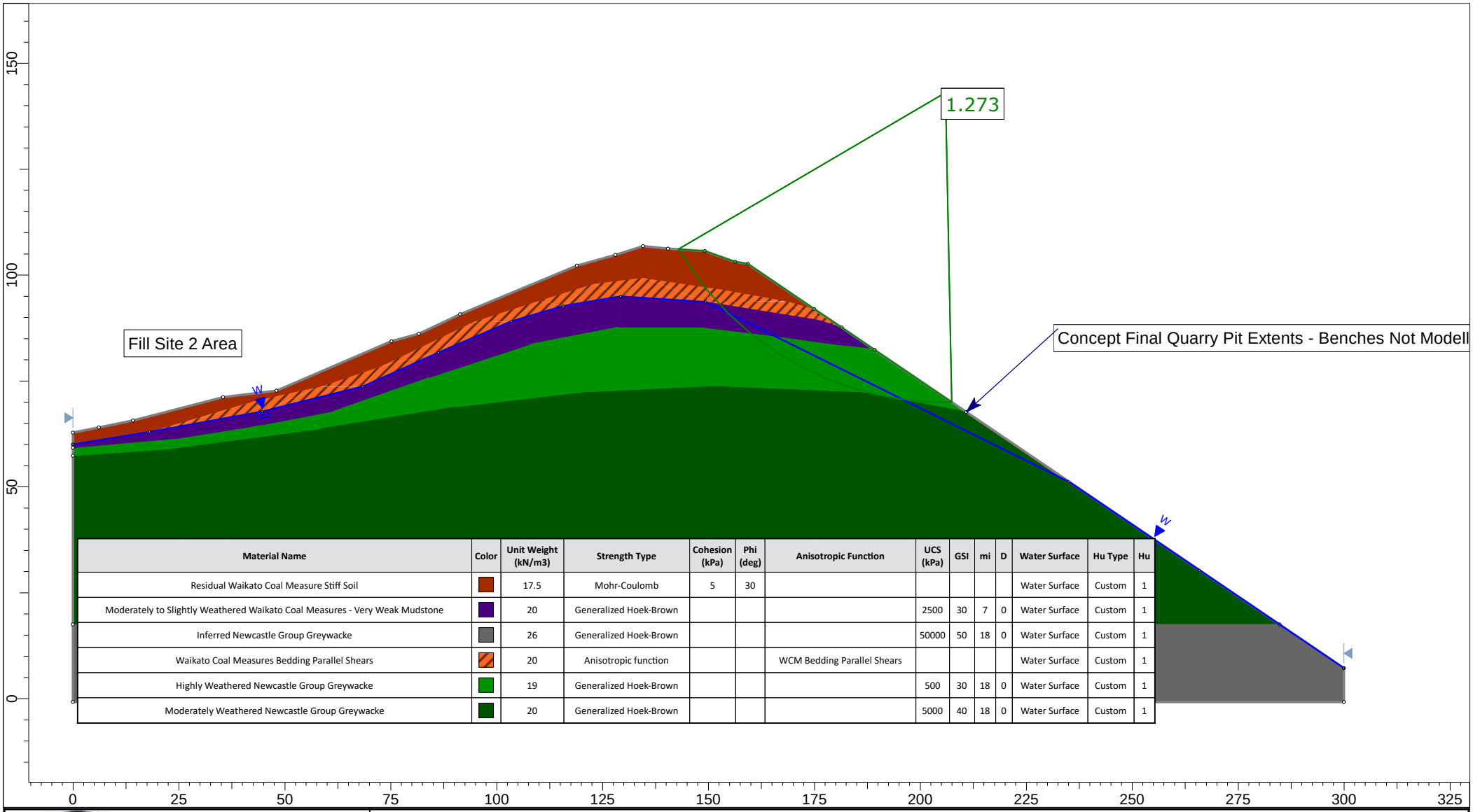
Method Name	Min FS
Bishop simplified	1.022
GLE / Morgenstern-Price	1.021



GAIA ENGINEERS

SLIDEINTERPRET 8.032

Project	Huntly Quarry - Fill Disposal Sites		
Analysis Description	Fill Site 2, Seismic Loadings - Proposed Fill, Critical Seismic PGA		
Drawn By	MK	*Scale* 1:1500	*Company* Gaia Engineers Ltd.
Date	April. 2020		*File Name* Fill Site 2 - Piezometric Lines Analysis.slmd

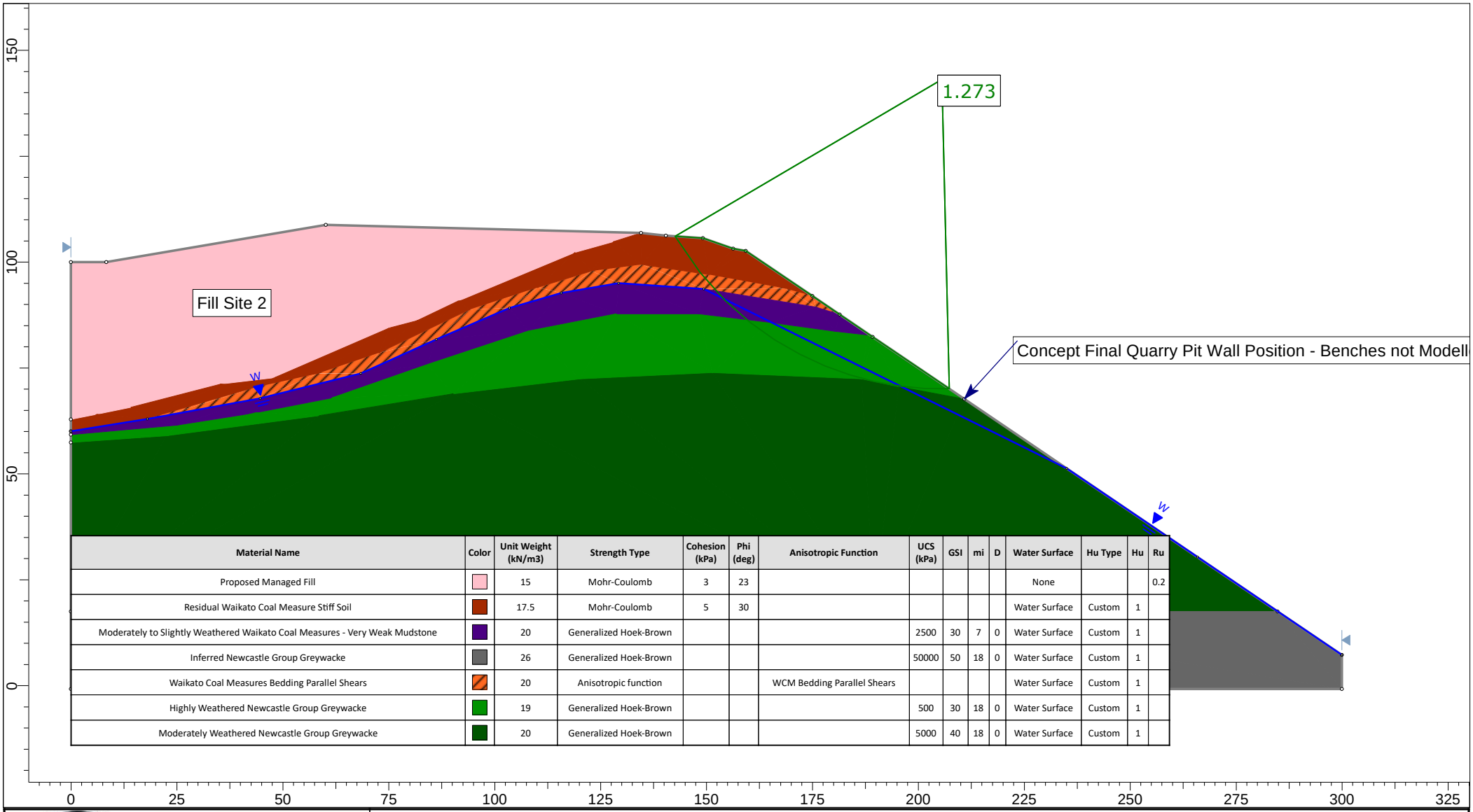


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Anisotropic Function	UCS (kPa)	GSI	mi	D	Water Surface	Hu Type	Hu
Residual Waikato Coal Measure Stiff Soil		17.5	Mohr-Coulomb	5	30						Water Surface	Custom	1
Moderately to Slightly Weathered Waikato Coal Measures - Very Weak Mudstone		20	Generalized Hoek-Brown				2500	30	7	0	Water Surface	Custom	1
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0	Water Surface	Custom	1
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears					Water Surface	Custom	1
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0	Water Surface	Custom	1
Moderately Weathered Newcastle Group Greywacke		20	Generalized Hoek-Brown				5000	40	18	0	Water Surface	Custom	1

GAIA ENGINEERS

SLIDEINTERPRET 8.029

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	, Concept Quarry Pit Extents, No Managed Fill - Master Scenario		
Drawn By		*Scale* 1:1250	*Company*
Date	25/02/2020, 4:27:51 PM		*File Name* Fill Site 2 - Concept Quarry Pit Check.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 Managed Fill		15	Mohr-Coulomb	3	23						None			0.2
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	
Inferred Newcastle Group Greywacke		26	Generalized Hoek-Brown				50000	50	18	0	Water Surface	Custom	1	
Waikato Coal Measures Bedding Parallel Shears		20	Anisotropic function			WCM Bedding Parallel Shears					Water Surface	Custom	1	
Highly Weathered Newcastle Group Greywacke		19	Generalized Hoek-Brown				500	30	18	0	Water Surface	Custom	1	
Moderately Weathered Newcastle Group Greywacke		20	Generalized Hoek-Brown				5000	40	18	0	Water Surface	Custom	1	

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SLIDEINTERPRET 8.029

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	, Concept Quarry Pit Extents - Master Scenario		
Drawn By		*Scale* 1:1250	*Company*
Date	25/02/2020, 4:27:51 PM		*File Name* Fill Site 2 - Concept Quarry Pit Check.slmd

D

Appendix D – Safety in Design (SiD) Table

5 Carmont Place, Mt Wellington, Auckland 1060, New Zealand
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Risk Assessment Matrix		Consequence (Impact)				
		Negligible	Minor	Moderate	Major	Severe
Probability of Occurance (Likelihood)	Very Likely	High (11)	High (16)	Extreme (20)	Extreme (23)	Extreme (25)
	Likely	Moderate (7)	High (12)	High (17)	Extreme (21)	Extreme (24)
	Possible	Low (4)	Moderate (8)	High (13)	Extreme (18)	Extreme (22)
	Unlikely	Low (2)	Low (5)	Moderate (9)	High (15)	Extreme (19)
	Rare	Low (1)	Low (3)	Moderate (6)	High (14)	High (16)

Consequence (Impact) Table					
Description					
Impact	Negligible	Minor	Moderate	Major	Severe
Safety	Would cause minor injuries that are able to be treated on site with no long-term effects	Would cause minor casualties that require medical attention off-site with no long-term effects	Would cause casualties that require hospitalisation with no long-term effects	Would cause serious casualties resulting in the long-term physical impairment of personnel	Would cause loss of life
Environment & Heritage	Would cause limited short term damage. Little resourses required to rectify	Would cause limited medium term damage. Rectification occurs from within budget	Would cause some environmental damage requiring the allocation of some resources to rectify	Would cause extensive environmental damage requiring significant resources to rectify	Would cause catastrophic environmental damage leading to significant fines and resources to rectify or unable to rectify
Reputation	Negligible damage to reputation	External reputation minimally damaged. Little effort or expense required to recover	External reputation damaged: some effort and expense required to recover	External reputation severely damaged: considerable effort and expense required to recover	External reputation irrevocably destroyed or damaged

Probability (Likelihood) Table		
Probability	Description	
Very Likely	Probability of occurance > 75%	More than 1 event per month
Likely	Probability of occurance ~ 50% - 75%	More than 1 event per year
Possible	Probability of occurance ~ 25% - 50%	1 event per 1 to 10 years
Unlikely	Probability of occurance ~ 10% - 25%	1 event per 10 to 100 years
Rare	Probability of occurance < 10%	Less than 1 event per 100 years

Risk Status	Definition
Open	Safety risk identified. Treatments yet to be fully considered.
Open - Managed	Treatments have been identified but not yet specified by the Designer.
Open - Specified	Treatments have been specified within design documents.
Closed - Eliminated	Treatments have been specified and have eliminated the risk.
Closed - Transferred	Treatments have been specified. Risk transfered to the Builder.
Cancelled	Risk cancelled. Situation no longer exists.

Hazard ID	Raised By	Hazard Description	Potential Cause	Potential Consequence	Consequence (A)	Likelihood (A)	RISK (A)	Controls Incorporated in Design	Consequence (R)	Likelihood (R)	RISK (R)	Status	*Construction Controls*	*Operation and Maintenance Controls*

Huntly Quarry - Fill Site 2

DATE PRINTED: 15-November-2019

***Note:** Reasonable steps have been taken to identify unusual and significant risks and hazards as part of the Safety in Design Process. Safety in Design aims to identify hazards and risks relevant to the design that arise in the construction, operation and maintenance of the asset, and where reasonably practicable, to eliminate or mitigate and/or communicate these risks. The Builder is responsible for managing the usual hazards and risks normally associated with the process of construction, operation and maintenance of the asset.*

Hazard ID	Raised By	Hazard Description	Potential Cause	Potential Consequence	Assessed Risk			Controls Incorporated in Design Gaia Engineers Design Scope only	Residual Risk			Design Status	Construction Controls	Operation and Maintenance Controls
									Consequence	Likelihood	RISK			
1	Gaia	Earth Moving Machinery, Public Vehicles, Pedestrians	Collisions between large earth moving machinery, pedestrians and public vehicles.	Injury or possible death. Damage to plant.	Severe	Possible	Extreme (22)	Nil	Severe	Rare	High (16)	Closed - Transferred	Site specific hazard identification plan developed and implemented by Contractor during construction and filling stages (issued and communicated to staff and outside users at site inductions and weekly tool box meetings.	N/A
2	Gaia	Dust	High wind, dry conditions and movement of earth moving machinery	Nuisance to workers and surrounding quarry neighbours	Negligible	Very Likely	High (11)	Nil	Negligible	Unlikely	Low (2)	Open - Managed	Develop dust mitigation plan. Appropriate PPE worn. Water carts for dust control. Consider sprinkler system for more sensitive areas.	N/A
3	Gaia	Poor Access	Access to areas not currently served by haul roads	Becoming stuck	Negligible	Possible	Low (4)	Nil	Negligible	Possible	Low (4)	Closed - Transferred	Access and haul road design to be addressed by Contractor in discussion with the Supervising Geotechnical Engineer.	N/A
4	Gaia	Unauthorised civilian access to Fill area.	Inadequate measures to warn or prevent people from entering managed fill works area.	Injury or Death	Severe	Possible	Extreme (22)	Nil	Severe	Rare	High (16)	Closed - Transferred	Provide fencing and warning signage. Restrict access to construction areas. Site specific hazard identification plan developed and implemented by Contractor.	
5	Gaia	Machine roll or damage	Trafficability of ground where over-wet soil at or near the surface, and/or ground uneven	Injury to personnel Damage to equipment	Moderate	Possible	High (13)	Fill specfications provided to assist with improved trafficability	Moderate	Possible	High (13)	Open - Managed	Trained and competent operators under the appropriate supervision operating machinery at all times.	N/A
6	Gaia	Working at edges of steep embankments. Plant or person working at crest of embankment.	Plant or person falling down embankment slope and/or injury to personnel	Injury to personnel Damage to equipment	Major	Possible	Extreme (18)	Slopes designed with conservative configurations.	Major	Unlikely	High (15)	Open - Managed	Trained and competent operators under supervision of experienced managers Establishment of fall protection barriers at the crest of steep slopes	N/A
7	Gaia	Failure of Embankments/Toe Buttress/Bund	Adverse ground conditions, adverse groundwater conditions and seismic events post construction.	Failed material impacts person or plant causing serious injury or possibly death. Failed material impacts surrounding environment.	Major	Possible	Extreme (18)	Slope stability, groundwater analyses and sensitivity analysis. Embankments/to buttresses designed with suitably conservative parameters and configurations. Monitoring of ground conditions during construction.	Major	Rare	High (14)	Open - Specified	Request regular inspections by Supervising Geotechnical Engineers	Monitoring of ground conditions after construction to confirm stability.
8	Gaia	Adverse/unforeseen ground conditions	May cause slope instability if high steep slopes formed in adverse ground.	Injury or possible death	Severe	Possible	Extreme (22)	Excavation of high steep slopes not anticipated during construction. Reviewed ground conditions as stripping progresses through regular monitoring.	Severe	Rare	High (16)	Open - Specified	Regular request inspections by Supervising Geotechnical Engineers	N/A
9	Gaia	Contaminated soil encountered during excavation.	Workers may encounter contaminated soil during excavation.	Sickness/Health Impact	Moderate	Likely	High (17)	Provide records of where excavation of contaminated soil occurs Waste is to be disposed of appropriately. All plant and equipment shall be cleaned and decontaminated.	Moderate	Rare	Moderate (6)	Open - Managed	Site Specific contamination control plan. Appropriate PPE worn at all times.	N/A