REPORT

Waikaka Mine Geotechnical Assessment

Prepared for
Waikaia Gold Limited
Prepared by
Tonkin & Taylor Ltd

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1 Introduction

Waikaia Gold Limited (WGL) engaged Tonkin & Taylor Ltd (T+T) to provide advice on geotechnical aspects of a proposed alluvial gold mining operation located approximately 2 km south of Waikaka township, in the Waikaka Stream valley, Southland.

The aim of this assessment, which will form part of a resource consent application by WGL, is to consider the geotechnical feasibility of the proposed mine plan. The mine plan requires excavation to between 15 and 50 metres below the ground surface to reach the base of the gold bearing Waikaka Quartz Gravel (WQG) horizon.

The Waikaka Stream valley was modified by gold dredge operations in the late 19th and early 20th centuries. Investigation and trial mining of the WQG at this site was carried out by L&M Mining (L&M) in the 1990's and early 2000s. The current proposed mine extends northward from the footprint of the L&M operations.

1.1 Scope of work

The scope of work undertaken is commensurate with the assessment of mine feasibility for a resource consent application. The key geotechnical aspect is managing the likelihood of pit slope instability, with a focus on the potential for slope instability to encroach on site boundaries, and/or to have off site environmental effects. The information available for input to this assessment is relatively limited, resulting in uncertainty regarding slope performance in the proposed pit. The uncertainty is addressed by the proposed pit slope angles, configurations, and mining method, along with the recommendation for an observational approach to pit stability and adjustment to the mining method as indicated from assessment of the observation results.

The scope of work is summarised as follows:

- Review of WGL mining methodology for the proposed site.
- Review of published geological information of the surrounding area.
- Review of investigatory information for the site, including boreholes, soil samples, laboratory testing, piezometer readings, and hydrogeological testing.
- Development of a geotechnical ground model for the site.
- Development of recommended mine design parameters.
- Assessment of the geotechnical issues that may be encountered during mining and site rehabilitation works.

1.2 Site description

The proposed Waikaka Gold Mine (The Site) is located about 2 km south of the Waikaka township and 18 km north of Gore. The Site covers an area of approximately 150 hectares, with an approximate 100 hectare footprint currently proposed for mine pit. The location of the site and key geographic features are shown below in Figure 1.1 and in Figure A1 (Appendix A).

The Site is located on farmland on the generally flat (dipping <1° toward the southeast) valley floor of the northwest to southeast trending Waikaka Stream valley, with low-lying hills located to the east and west. The ground surface is modified by historic gold dredging, with poor drainage resulting in the construction of a network of open drains to improve farm pasture. The valley floor declines from 120 m Reduced Level (RL) to 113 mRL from north to south.

The Waikaka Stream crosses through the centre of the site, with the Shepherds Creek tributary connecting to the Waikaka Stream from the low-lying hills to the north. The proposed site extents are bounded to the west and north by Waikaka Road.

The southern extent of the site is bounded by an approximately 1 km wide terminal pond produced in the early 2000s by the L&M mining operation. A bathymetric survey[1] undertaken of the L&M pond by Ross Dungey Consulting Ltd in December 2021 recorded depths ranging from 1.1 and 8.29 m across the pond floor, with a mean depth of 5.58 m. A 100 m wide and 8 m high pile of dredge tailings is located along the southern edge of the L&M terminal pond.

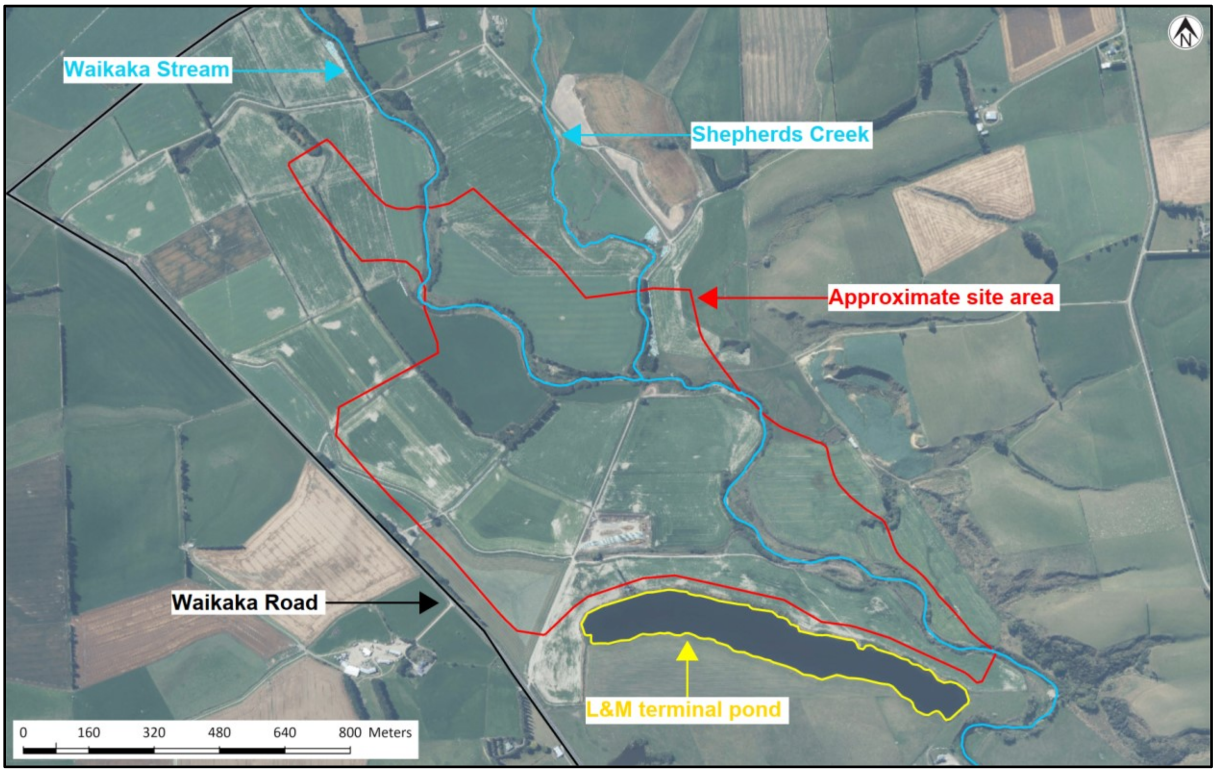

Figure 1.1: Proposed location of the Waikaka Gold Mine site.

1.3 Proposed development

Drawings prepared by WGL show the proposed Waikaka Gold Mine site comprised of 22 cells (including the starter pit) covering an area of approximately 100 hectares. Based on geological investigations, the WQG horizon has an approximately 1% fall down dip towards the north, with the mine expected to be 15 m deep at its shallowest in the south and reach depths of up to 50 m at its northern extent. The mine cells are sized to require 3 months to mine (a quarter) and the cell numbering relates to the quarterly advance down dip over 5 ½ years (see Figure 1.2).

[1]Ross Dungey Consulting Ltd, December 2021. Preliminary Pond Bathymetric Survey.

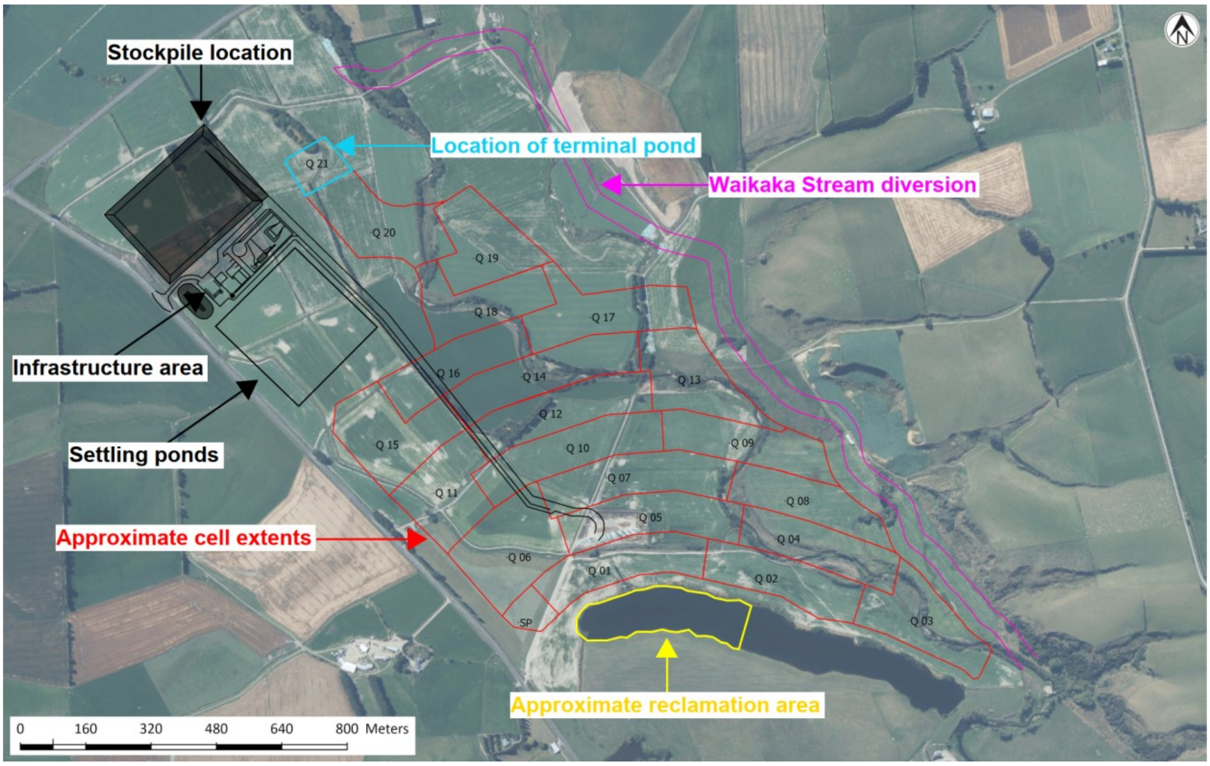

Figure 1.2: Proposed location of key aspects of the mining development.

A summary of the key aspects of the proposed Waikaka Gold Mine development[2] is described below in Table 1.1. The proposed layout is shown in Figure A1 in Appendix A.

Table 1.1: Key aspects of the proposed Waikaka Gold Mine

Mining methodology	WGL's preferred mining methodology includes the use of large excavators (180 – 360 T) and rigid dump trucks (100 T) to undertake the mining works, involving excavation, transportation, and processing of materials. Mining is proposed to commence in the southwestern corner of the site at the starter pit (SP) and progress in a northward direction via several eastward and westward traverses (cells Q1 to Q21). During early mining operations in the starter pit, the backfill is intended to be placed within the L&M pond and on the proposed stockpile (SP1), due to limited pit void capacity. Subsequently, backfill will then be placed in 5 m lifts into the pit void, creating a V-shaped void between the backfill batter and the cut northern face, or highwall of the pit.
Reclamation of L&M Pond	WGL plan to utilise an approximately 400 m length of the western portion of the L&M pond to place overburden backfill sourced from the starter pit. WGL intend to construct a low temporary bund 100 m beyond the proposed reclamation area, which will support construction of the main permanent bund at the eastern edge of the proposed reclamation area. The area will then be dewatered by pumping the pond water to the remnant L&M pond to the east. Upon completion of dewatering, the material sourced from the starter pit will be end-tipped into the reclamation area, advancing toward the east. WGL estimate that upon filling to a nominal

[2] Hogan Mining Services Ltd., April 2022. Mining Methodology Report for the Waikaka Gold Mining Project, Rev 6 Draft for information.

	elevation of 115 mRL, the reclaimed area will contain approximately 400,000 m^3 of overburden backfill.
Diversion of Waikaka Stream	Approximately 2.4 km of the Waikaka Stream crosses the proposed site and will need to be diverted permanently to allow mining operations to be undertaken. The stream diversion[3] is proposed to be located at the eastern extent of the mining operation and adjacent to the low-lying hills. WGL intend to construct the stream bed using an excavator and rear dump trucks to advance cutting and progressively form the stream bed. Where possible, spoil will be used to construct bunds and flood levees along the stream edge.
Stockpile	The proposed stockpile (SP1) is located at the northwest corner of the site and will eventually cover an area of 585 m by 320 m, with a maximum height of 10 m. SP1 is intended to be used for stockpiling of overburden during periods of limited pit void capacity and/or separating overburden materials (clay, sand, and gravel) to be reutilised on site as required. The remaining material at the completion of mining will be placed in the remaining pit void.
Infrastructure area	The infrastructure area is located immediately south of SP1 and includes the Gold Recovery Plant (GRP), settling ponds, workshop, heavy equipment layout area, offices, parking, and other amenities. The GRP is the floating plant used at WGL's Freshford mine. The 26 m by 12 m flat bottomed pontoons will rest on a prepared gravel hardstand.
Terminal pond	A terminal void will remain (subject to landowner agreement) on completion of mining and return of the material from SP1. The volume of the terminal void is expected to be approximately 400,000 cubic metres, being equivalent to the amount of overburden going to the reclamation of the L&M pond area from the starter pit. The footprint of the terminal void is expected to be significantly less than that of the starter pit (3.4 hectares) due to being about twice the depth. The void walls will require recontouring to reduce slope angles for long term stability, and to create a riparian margin. The void will then fill with groundwater and surface runoff to leave a permanent pond.

2 Site investigations

2.1 Previous trial pits by L&M

Mining trial works were undertaken at the site during the early stages of the L&M mining operations, and are outlined in the following reports:

- Riddolls & Grocott Ltd, June 1999. Waikaka Gold Prospect: Trial Pit Dewatering and Spoil Handling Trials. RGL project reference, 168.
- McDougall, T. August 2000. Waikaka Trial Mine: June – July 2000.

The key geotechnical aspects pertaining to the 1998 – 1999 and the June – July 2000 mining trial are summarised below in Section 2.1.1 and 2.2.2 respectively.

2.1.1 1998 – 1999 mining trial

An approximately 50 m by 50 m square and 15 m deep trial pit (dimensions based on historic drawings) was excavated between 21 October and 5 November 1998. Dewatering of this pit was discontinued on 11 November 1998 to allow recovery of the groundwater to original levels. The purpose of this trial pit was to observe material behaviour when excavated and spoiled to develop

[3]Environmental Management Associates, December 1999. Waikaka Stream Diversion.

mining parameters, and to monitor the groundwater response to dewatering of the trial pit. Notable findings of this report included:

- Four nested piezometers were installed in October 1998 to monitor levels in silty clay overburden materials of the Upper Waikaka Sequence (UWS) and the “wash” gravel of the Waikaka Quartz Gravel (WQG). These piezometers were located at varying distances from the trial pit to identify the groundwater response to dewatering of the trial pit. Two piezometers (G-001/G-002) were located within 60 m, while the remaining two piezometers were located 350 m (G-003) and 680 m (G-004) away respectively.
- Dewatering of the trial pit by pumping from a sump at the base of the excavation commenced in late January 1999 and continued through to September 1999. During this time, the groundwater response in G-001 and G-002 indicated a relatively flat cone of depression within 60 m of the trial pit and appeared to be closely related to the pond level during dewatering. No significant groundwater response was observed within G-003 and G-004, which were located 350 m and 680 m respectively.
- The gravel lenses within the UWS flowed water during dewatering which resulted in washout of some gravel and sand creating overhanging faces of silty clay. Cessation of flow in these gravel lenses was used as a proxy to declare dewatering complete.
- A key inference from the dewatering trial is that the gravel lenses encountered are horizontally continuous for >50 m, but <350 m. The pore pressures in the low permeability silt/clay units would have been expected to change over time, but this would not have been measured by the piezometer system installed.
- At the end of the 8 month dewatering period there was no observable instability on 68^{o} degree slopes in the silty clay materials of the UWS.
- Local instability was observed within UWS silty clay materials that were overlying gravel lenses e.g., minor slabbing due to localised undermining. However, no overall (crest to toe) instability was observed in the highwall of the UWS.
- Materials from each geological unit were separated and placed in spoil piles to estimate their angle of repose. The height of each spoil pile and their respective angle of repose are summarised below in Table 2.1.

Table 2.1: Angle of repose for spoil piles of each overburden material

Overburden material	Spoil pile height	Angle of repose
Tailings – Gravel	4 m	36°
Tailings – silty SAND	4 m	20°
UWS – Sandy Gravel	5.1 m	34°
UWS – silty CLAY	3.5 m	43°
UWS – saturated	3.9 m	26°

2.1.2 June – July 2000 mining trial

An approximately 3600 m^2 trial pit was excavated between June and July 2000 to depths of up to 14 m below ground level. The purpose of this trial pit was primarily to check that gold grades were consistent with the results from exploratory investigations. However, the mining trial also provided supplementary knowledge on the geotechnical and handling characteristics of the overburden and wash materials. Notable findings of this report included:

1 The observed geological profile within the trial pit was summarised as follows:

a 0 m: Topsoil.

b 0.2 m: Silt.

c 1.2 m: Sandy gravel with some clay.

d 3.0 m: Interbedded carbonaceous siltstone and claystone and gravel (UWS).

e 11.0 m: Top of WQG wash.

2 Most of the thick Silt/Clay intervals were observed to be capped with up to 0.5 m of black carbonaceous silt and sometimes lignite.

3 The trial pit was originally intended to be battered at 60°, however actual batter angles within the overburden materials were approximately 80°.

4 With the batter angle of 80° there were no significant block failures in the thick clay intervals, despite erosion and undermining taking place due to groundwater drainage through gravel lenses. The report makes no mention of any global instability over the two month period the pit was monitored.

5 The in situ, 4 m thick WQG wash materials stood sub-vertically (80° – 90°) without observations of instability.

6 A minor circular failure was observed within gravel-dominated tailings and involved approximately 3 – 4 m^3 of loose material. Based on observations during the mining trial, a batter angle of 35° was recommended in the near surface historic tailings materials.

7 Overburden materials were observed to transport well when kept dry, particularly the Silt/Clay materials which usually remained blocky while being transported. The gravels were observed to become problematic if they were not completely dewatered, as they would become ‘thixotropic’ when agitated during transportation. This resulted in wet material sticking to the tray of the dump trucks, which required regular scraping to remove.

8 The trafficability of all overburden materials was very good, provided thorough dewatering was undertaken where necessary. There were no concerns regarding the ability of any overburden materials to support heavy equipment.

9 There were no issues trafficking or stockpiling the overburden materials when they were kept dry. However, saturated materials were noted to be problematic. In particular, the ‘thixotropic’ behaviour of the saturated gravel materials meant some materials were difficult to handle once they reached the stockpile. The Silt/Clay materials were also noted to be difficult to handle when wet during transport, and the stockpile surface could become sticky and soft such that dump trucks could not drive on the materials. The average angle of repose of stockpile materials was approximately 30°.

10 Based on comparison between the surveyed volume of the trial pit and the volume of the compacted overburden stockpile, the material appears to have increased in volume by approximately 9%. Although, it is noted this did not include consideration of mining tailing’s, which is suggested may account for an additional 5%.

2.2 Boreholes and bulk sample shafts

Investigation boreholes were drilled across the site by L&M to assess gold grades in the WQG, but the overburden materials were not logged. The top and base of the WQG inferred from these holes has been incorporated in development of the 3D geology model surfaces that bound the WQG.

WGL has been logging overburden lithology from chips recovered during RC drilling that has been conducted as part of their mine feasibility study. To date, the logs from approximately 200 WGL exploratory investigations have been supplied to T+T by WGL across the proposed Waikaka Gold Mine site. Bulk samples of the overburden materials were obtained from several 1200 mm bulk gold sample holes/shafts excavated by WGL. T+T selected typical overburden samples from the WGL logs to support geotechnical classification of the overburden materials at the site. Classification of these materials included description by a senior engineering geologist from T+T and geotechnical laboratory testing of selected samples.

The findings are summarised below in Section 2.2.1 and 2.2.2.

2.2.1 Logged samples

WGL supplied 4 No. samples to T+T for geotechnical logging to be completed by a senior Engineering Geologist, in general accordance with the NZGS 'Field Description of Soil and Rock' guidelines[4]. The materials provided were extracted from the UWS, and predominantly comprised of hard clay material, with occasional interbeds of gravel. The samples had been stored in double wrap plastic bags for approximately 1 year. Logged descriptions of these materials are provided below in Table 2.2.

Table 2.2: Samples logged by T+T

Borehole name	Sample depth (m)	Geological unit	Soil description
BSJ2	18.9 – 21.9	Upper Waikaka Sequence	Silty CLAY with minor organics; brown to dark brown. Hard, dry to moist, medium plasticity; organics, amorphous Interbedded with: CLAY with trace sand; pale brownish white. Hard, dry, high plasticity.
BSJ3	22.4 – 25.6		Silty CLAY with trace of sand and gravel; grey. Hard, moist, medium plasticity; sand, coarse; gravel, fine.
BSJ4[1]	17.5 – 21.7		Silty CLAY; grey. Firm, wet, medium plasticity. Interbedded with: Fine to coarse GRAVEL with some sand; light brownish grey. Wet, poorly graded; sand, medium to coarse; gravel, subrounded, quartz.
BSC4	5.9 – 12.0		CLAY with trace sand; pale brownish white. Hard, dry, high plasticity. Interbedded with: Fine to coarse GRAVEL with some sand; light brownish grey. Wet, poorly graded; sand, medium to coarse; gravel, subrounded, quartz.

Notes: [1]Water expelled from the gravel material mixed with clay in the sample bag has resulted in disturbance and softening of the silty CLAY material in the sample.

[4]NZ Geotechnical Society Inc. (December 2005). Field description of soil and rock – Guideline for the field classification and description of soil and rock for engineering purposes.

2.2.2 Laboratory testing

T+T recommended that 10 No. bulk samples from the material recovered during drilling be submitted for laboratory testing at Central Testing Services in Alexandra. The samples tested are bulk samples that cover several metres of retrieved core sample. An attempt was made to select samples that were predominately clay, or sand and gravel, but most samples contain some mixed /interbedded units. The tests undertaken on the soil samples included the following:

- Particle Size Distribution (NZS 4402:1986, Test 2.8.1).
- Atterberg Limits and Water Content (NZS 4402:1986, Test 2.1, 2.2, 2.3, and 2.4).

The results from the completed tests are summarised below in Table 2.3. The laboratory test result sheets are included in Appendix C.

Table 2.3: Laboratory test results

BH No.	Sample depth (m)	Geological Unit	Logged description	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Fines (<63 micron)	Sand (<2 mm)	Gravel (<60 mm)
BSC1	0 – 5	Tailings	Silty GRAVEL with some clay and sand.	15.2	29	21	8	25	20	55
BSC1	5 – 10.4	UWS	Sandy GRAVEL with some silt and trace of clay.	12.1	24	19	5	14	25	61
BSC1	27.4 – 33	UWS	Sandy GRAVEL with minor silt.	10.7	N/A	NP	NP	11	35	54
BSC1	33 – 40.4	UWS	Silty SAND and GRAVEL with trace of clay.	10.6	22	18	14	24	36	40
BSC2	33.1 – 38.8	UWS	Gravelly sandy silty CLAY.	13.6	31	17	14	48	30	22
BSC4	24.4 – 30.3	UWS	Sandy silty CLAY with some gravel.	20.1	34	17	17	48	30	22
BSC4	30.3 – 35.2	UWS	Sandy GRAVEL with some silt.	20.4	22	NP	NP	18	32	50
BSJ1	17.8 – 21.5	UWS	Sandy silty CLAY with some gravel.	6.1	30	16	14	50	37	13
BSJ3	0 – 6.1	Tailings	Sandy silty CLAY with some gravel.	25.4	30	20	10	56	32	12
BSJ3	6.1 – 11.7	UWS	Sandy silty CLAY with some gravel.	15.5	43	21	22	61	21	18

3 Published geology

Two geological maps cover The Site and surrounds, Wood 1956[5] and Turnball 2003[6]. The maps are similar, but map detail (1:63,360 vs 1:250,000), the nomenclature and the assigned age of units vary. Key aspects that relate to The Site follow:

- Gore Lignite Measures (GLM) are mapped and described in similar areas on Wood 1956 and Turnbull 2003 (Figure 3.1). An outcrop is noted on the true right of the valley beside The Site. GLM are assigned to Oligocene to Miocene age (~7 – 34 Mya), deposited over an approximately 23 Mya range.
- Waikaka Quartz Gravel (WQG) is shown on Wood 1956 outcropping along the true left side of the valley beside the site. WQG is grouped with other units as Pebbly Hills Gravel on Turnbull 2003 (Figure 3.1). An unconformity is mapped between GLM and PHG. The age of PHG is bracketed as Late Miocene to Pliocene (~1.8 – 7 Mya) on both maps, covering an approximately 5 Mya range.
- PHG is described in Turnbull 2003 as up to 150 m of quartz gravel and conglomerate with a clay matrix, and rare claystone, quartz sand and lignite.
- Gore Piedmont Gravel (GPG) was classified as Pliocene in age on Wood 1956, and reclassified as Early Quaternary (~1.0 – 1.8 Mya) by Turnbull 2003 (Figure 3.1).
- The PHG and GPG are described as alluvial and fan deposits accumulating in actively growing intermontane basins formed by Late Miocene to Pliocene uplift that continued into the Early Quaternary and formed the main ranges in Southland. According to Turnbull 2003 "most of the present day topography was probably formed by the end of the Pliocene".
- The northwest to southeast trending Livingstone Fault is inferred to be 300 m east of the site and is mapped on Turnbull 2003 as a concealed and inactive fault. The Livingstone Fault is a major regional fault contact between the Caples terrane and Murihiku Supergroup basement rocks.
- The floor of the Waikaka Stream valley, including The Site is immediately underlain by Holocene-age unconsolidated sand and gravel from historic dredge tailings (Q1n).
- An aerial photo in Turnbull 2003 shows the L&M pond at end of mining (photo CN43866/17: D.L. Homer) and describes "working Late Miocene to Pliocene and Early Quaternary quartz gravel".

Based on the above, the site specific units (See Section 2.1 above) of Waikaka Quartz Gravel (WQG) and Upper Waikaka Sequence (UWS) are interpreted as Pebbly Hills Gravel (PHG) described on Turnbull 2003. This geological relationship, or correlation is not discussed in any of the reports or information that we have available to us for this study. The reason for conducting this assessment of the published geology relates to the geotechnical characteristics of the UWS overburden in cut slopes and backfill. PHG is geological rock, but an engineering soil, possibly straddling the engineering soil to engineering rock boundary. The UWS and WQG are >1.8 Mya old and have been buried under approximately 100 to 200 m of accumulated sediments. Therefore, they are over consolidated soils, but have not undergone the depth of burial, induration and cementation typically associated with rock formation.

[5] Wood, B. L., 1956. *The Geology of the Core Subdivision – Gore Sheet District (S170)*. New Zealand Geological Survey.
[6] Turnbull, I.M.; Allibone, A.H. (compilers) 2003: *Geology of the Murihiku area*. Institute of Geological & Nuclear Sciences 1:250,000 geological map 20. 1 sheet + 74 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.

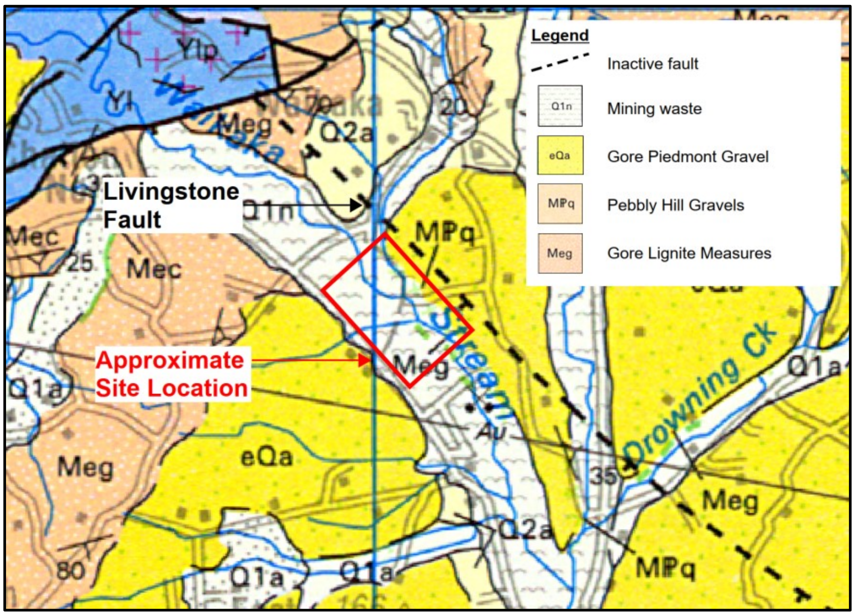

Figure 3.1: Geological setting of the area (obtained from QMAP – Turnbull 2003).

4 Geological model

The geological model presented in this report and in associated appendices is based on information obtained by recent and historic investigations, undertaken by others, at point locations. The nature and continuity of the stratigraphy away from borehole locations may vary from those assumed in this report.

Due to the size of the site and discontinuous nature of the deposits, it must be appreciated that there is significant variation within each of the geological units.

4.1 3D ground model

A 3D ground model has been developed of the proposed Waikaka Gold Mine area, using the software package 'Leapfrog' (produced by Seequent Limited). This involved interpretation of available ground investigation data supplied by WGL, including approximately 200 No. exploratory investigations to depths between approximately 15 and 55 mbgl, LiDAR terrestrial survey, and bathymetric survey profiles of the L&M pond.

To develop the geological model, it was necessary to include user generated points and lines to guide the geological surfaces. Where possible, the points and lines were used away from investigation data to keep the model as true to the raw data as possible.

An overview of the developed geological model is presented below in Figure 4.1. Representative geological cross sections (Figure A2, A3 and A4, Appendix A) have been produced at six locations across the proposed site (see Figure A1, Appendix A) using the 3D geological model. The model divides the UWS overburden into silt/clay units, horizons where significant organics have been recorded, and lenses of gravel, or units of predominantly gravel with some clay interbeds.

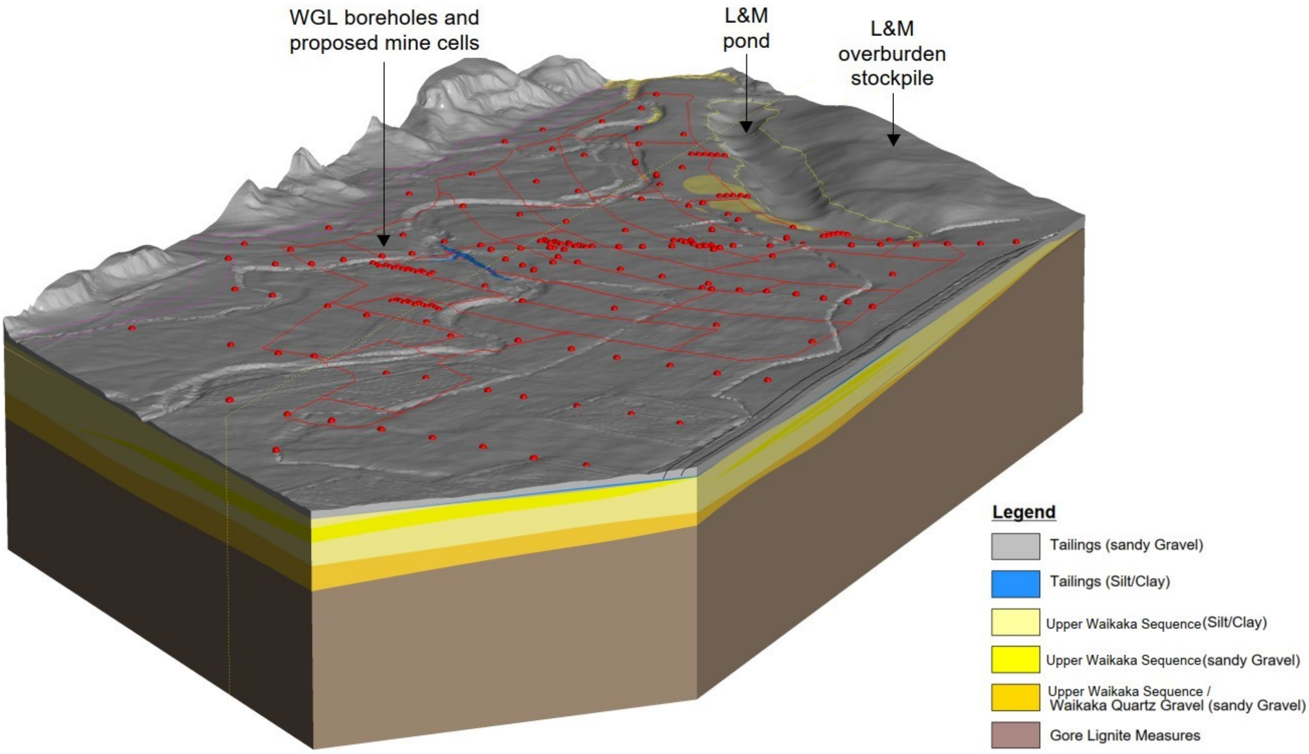

Figure 4.1: 3D Geological Mode view from northeast towards the southeast l.

4.2 Geological profile

A summary of representative geological profiles inferred from the WGL investigations and developed in our ground model is presented below in Table 4.1.

Table 4.1: Summary of the geological profile

Geological unit	Typical depth to top of layer below ground level (mbgl)		
	Starter pit (SW corner)	Cell 10 (centre)	Cell 21 (NW corner)
Silty /sandy gravel tailings	0	0	0
Silt/clay tailings (Waikaka Blue)	-	2	-
Upper Waikaka Sequence[1]	5	4	4
Waikaka Quartz Gravel	18	29	47
Gore Lignite Measures	20	32	49

Note: [1]The Upper Waikaka Sequence comprises Silt/Clay dominated layers often 'capped' by organic horizons that are interbedded with laterally discontinuous lenses of sandy gravel.

4.3 Groundwater

4.3.1 Piezometer water levels

5 No. standpipe piezometers were installed during investigations to enable groundwater monitoring of the Waikaka Mine site. The piezometer screens have targeted three zones across the site. Screened installation details and groundwater readings for the piezometers are presented below in Table 4.2.

Table 4.2: Summary of groundwater monitoring

Piezometer ID	Screen depth (m)	Screened geological unit	Depth to groundwater (m)	
			1/12/2021	18/02/2022
Piezo 1	1 – 4	Tailings	1.71	1.76
Piezo 2	3 – 6	Tailings	1.98	2.23
Piezo 3	13.5 – 17.5	Upper Waikaka Sequence	1.42	1.70
Piezo 4	11.1 – 12.1	Upper Waikaka Sequence	1.19	3.06
Piezo 6	16.6 – 22.6	Waikaka Quartz Gravel	-	1.24

In general, the groundwater levels recorded within the site area have been in the order of 1.5 – 2.0 m below the ground surface and generally decrease in elevation to the southeast with the topographic profile. The relative consistency in depth to groundwater and response over summer is similar for the Tailings and UWS gravel units. The WQG is potentially confined, with shallower depth to groundwater.

The continuity of UWS gravel lenses is demonstrated by the trial pit dewatering described in Section 2.1.1. A key inference from the dewatering trial is that the gravel lenses encountered are horizontally continuous for >50 m, but <350 m. The pore pressures in the low permeability silt/clay units would have been expected to change over time, but this would not have been measured by the piezometer system installed.

4.3.2 Preliminary results from hydrogeology study

Test pumping from 11 groundwater test wells has been carried out to assess the inflows and dewatering rates applicable to aspects of the mine design, particularly the capacity required for sump pumping, settling ponds, and rates of discharge back to the Waikaka Stream.

Notes from a hydrogeological assessment[7] were provided to assist in the consideration of groundwater levels in slope stability models. Key aspects of the hydrogeological assessment include:

- The lower, or bottom confined aquifer is the WQG, the mid confined aquifer is the UWS, the upper unconfined aquifer is the tailings.
- “The test data does not show any interaction of the bottom and mid confined aquifers upon each other or the top unconfined layer.” Hence inflows were “separately modelled inflows with excavation from each of the saturated thicknesses for the 3-zones.”
- Modelled dewatering inflows, assuming mining progressing from south to north were an average of approximately 16 L/s and a maximum of 27 L/s.
- Stream depletion, calculated from the top (Tailings) layer, was low at 2.6 L/s to 3.3 L/s.
- “The stream depletion is also applicable to potential (L&M) pond inflows when working in that area or otherwise when 50 m from the river.”
- For the stream realignment “there needs to be discussion of how the current in-situ hydraulic connection (or lack of it) will be maintained. This is in terms of lateral depletion rates and bed losses.”

[7] Environmental Associates Ltd, February 2022. Email correspondence T. Heller to N Becker.

4.3.3 Discussion

While the geological units have similar groundwater levels, they are anticipated to have different hydrogeological features. These features are summarised below:

- Tailings – Near surface groundwater within the dredge tailings is expected to be perched on top of the low permeability Silt/Clay of the UWS, which likely limits vertical transmissivity and mixing with the lower aquifer systems.
- Upper Waikaka Sequence – Groundwater located within the laterally discontinuous gravel lenses will drain after excavation of pit walls, as noted during L&M pit excavations described in Section 2.1. The Silt/Clay layers are also saturated but will drain at much slower rate and not contribute significantly to inflows to the mine pit. The rate of drainage of the Silt/Clay units will control the shape of the drawn down groundwater surface in the cut walls of the mine pit.
- Waikaka Quartz Gravel – Groundwater is confined by the overlying low permeability Silt/Clay of the UWS and the underlying clay-dominated Gore Lignite Measures. This aquifer system is expected to be laterally continuous due to the homogenous, granular nature of this unit.

5 Geotechnical assessments

5.1 General

This section presents geotechnical analysis and assessments for the design and construction of the proposed Waikaka Mine, including:

- Slope stability.
- Trafficability.
- Transportation, backfilling, and stockpiling.
- Bearing capacity.
- Other geotechnical hazards.

Assessments and opinions in this report are primarily based on investigations and trials undertaken by others. The nature and continuity of the subsoils away from the investigation locations is inferred, but it must be appreciated that actual conditions could vary from the assumed model.

5.2 Slope stability analysis

5.2.1 Inputs and assumptions

5.2.1.1 Engineering materials

The assessment of the age and condition of the UWS overburden units has a significant bearing on the analysis of cut slopes in the pit, and the assessment of slope performance over the time that they are exposed, prior to having backfill placed against the slope. The time of cut slope exposure varies from months to 1 to 2 years and is controlled by the proposed mine path indicated by the Q1 to Q21 mine cells shown on Figure 1.2.

The WQG and UWS units are interpreted as the Pebbly Hills Gravel (see discussion in Section 3). This implies over consolidated materials that may straddle the engineering soil to rock boundary (unconfined compressive strength of 1MPa). A change in strength of Silt/Clay units from undrained to drained conditions following initial excavation is unlikely due to the over consolidated condition.

The limited amount of geotechnical observation and testing available for this study means that there is uncertainty in the behaviour of the Silt/Clay units in the proposed cut slopes. Of note are observations of 10 to 15 m high cut slopes standing at angles of 60 to 80^o for several months following excavation in L&M pits (Section 2.1). While this is encouraging from a slope stability viewpoint, there is uncertainty in translating this stability from an observed 10 m slope to a proposed 40 m slope in Silt/Clay units.

To establish a defendable feasibility slope design, that will allow the management of uncertainty during pit slope excavation, we have assumed that the Silt/Clay units will behave like normally consolidated soils and have considered slope stability cases for initial short term undrained conditions and long term drained conditions. The difference between short term and long term cases is a loss of effective shear strength as pore pressures dissipate over time in Silt/Clay units. Pore pressure dissipation is likely to occur over months to years.

5.2.1.2 Geological structure

As discussed above the WQG and UWS are likely to behave as over consolidated engineering soils. Bedding within the deposits has a very gentle dip to the north, and regional scale tectonic deformation is limited to broad uplift and tilting. There are no known defect sets and bedding partings were not observed as planes of differential weakness in the L&M pits.

The implication for slope instability in the proposed pit is an absence of structure controlled instability, such as translational sliding, wedge or toppling movements.

5.2.1.3 Groundwater

Groundwater will drain into the pit and be pumped out from sumps as excavation progresses. Based on the discussion in Section 4.3 groundwater will drain relatively freely from the surficial tailings deposits, gravel lenses in the UWS and the WQG. The Silt/Clay units are expected to drain very slowly and contribute a small proportion of groundwater to be pumped from the pit.

Groundwater profiles in analysed slopes were arrived at primarily by judgement and precedent. Seepage analysis was conducted to help visualise stages of drainage with time and differences observed by altering hydraulic parameters. Due to the limited groundwater/aquifer information the analyses could not be used with any confidence, but they did confirm the overall shape of the judgement based groundwater surfaces, illustrate the drainage of gravel lenses over time while the Silt/Clay units remained relatively undrained. The seepage analyses also obtained similar orders of inflow to the pit as the hydrogeology study (Section 4.3.2).

A general groundwater piezometric surface was adopted for the slope stability analysis, with well drained surficial tailings, a curved profile over the UWS, and the lower part of the UWS and the WQG remaining saturated to the surface of the excavated pit slope.

5.2.1.4 Parameters for slope stability analysis

Table 5.1 presents the adopted material geotechnical design parameters. The parameters are based on the recorded observations of the mine trials, samples logged by T+T, laboratory testing, our previous experience and precedent with similar materials.

The adopted shear strength parameters for the UWS Silt/Clay are important to the modelled performance of cut slopes in the pit. The undrained (short term) shear strength of Silt/Clay is the lower limit for a hard cohesive soil (200 kPa). The drained (long term) Silt/Clay shear strength is the minimum required to support observed 10 m high faces that stood for 9 months in the L&M pit, assuming those faces had developed into a drained condition.

The shear strength for Gore Lignite Measures is set relatively low for 'basement' rock, but this unit is similar in character to the UWS, albeit another 5 to 10 Mya older. The adopted shear strength allows for circular failures to propagate through the base of the slope, which is considered a feasible mechanism.

Table 5.1: Adopted design parameters for stability analysis

Geological unit		Unit weight, γ (kN/m^3)	Drained shear strength		Undrained shear strength, S_u (kPa)
			Effective friction angle, Φ' (°)	Effective cohesion, c' (kPa)	
Tailings	Silty / sandy gravel	18	32	0	-
	Silt/Clay (Waikaka Blue)	18	22	0	25
Upper Waikaka Sequence	Silt/Clay	18	30	10	200
	Sandy Gravel	19	45	3	-
Waikaka Quartz Gravel		19	45	3	-
Gore Lignite Measures		18	40	10	-

5.2.2 Methodology and slope cases

The geotechnical modelling software package GeoStudio (Slope/W), published by Geo-Slope international Ltd, has been used to analyse the pit wall stability for short term and long term conditions at the proposed Waikaka mine site. The primary output of the stability analysis is a calculated factor of safety (FoS) for a given set of inputs (e.g. pit wall geometry, soil strength parameters, groundwater levels, and the short term (undrained) and long term (drained) loading conditions).

Six locations (Cross section 1 to 6 on Figure A1, Appendix A) have been selected for slope stability analysis to represent the range of slope conditions expected across the proposed mine footprint. These are:

- Cross Section 1 – Starter Pit, Road boundary.
- Cross Section 2 – L&M Pond boundary.
- Cross Section 3 – Internal pit slope and backfill slope.
- Cross Section 4 – Stream diversion boundary.
- Cross Section 5 – Road boundary.
- Cross Section 6 – Final void, highest pit slopes.

Several slope configurations have been analysed at each of these locations in an iterative process to identify suitable pit wall geometries that can be adopted for mine design across the site at the resource consent stage of development.

Aspects that have been considered in analysis include:

- <u>Uncertainty in analysis and slope failure mechanism, along with tolerance to, or consequence of failure can be reflected in the target FoS adopted</u> – The slopes at Waikaka mine can be separated into two classes:
  - Internal Slopes – Slope failure is limited within the mine footprint. A minimum target FoS of 1.2 has been adopted.
  - Boundary slopes – Slope failure is not necessarily limited to the mine footprint and may adversely affect infrastructure, neighbouring land, or the environment, and/or could have significant implications on the mining operations. These boundaries include the

Waikaka Stream diversion, Waikaka Road, and the L&M pond. A minimum target FoS of 1.3 has been adopted at the location of the boundary. Accordingly, a FoS of less than 1.3 may be considered acceptable if the crest of the slip circle does not extend across the boundary.

- Duration of slope exposure – The UWS Silt/Clay materials may behave differently in the short term (undrained condition) compared to the long term (drained condition), due to dissipation of pore pressures. For this assessment, we have conservatively assumed these soils may behave in a short term condition for 4 months before transitioning to a long term condition. However, the length of time could potentially be extended to years following appropriate mining trials.
- Height of slopes – The overburden at the Waikaka Gold Mine site includes significant intervals of hard Silt/Clay materials, which have been observed to maintain steep batter angles in the trial pits. However, these cohesive materials may become less stable with increasing slope height as the shear stresses in the ground overcome the shear strength of the soil. This effect is less pronounced in granular materials as the shear strength increases, to a point, with increasing overburden depth and confinement.

The slope cases analysed for each of the 6 cross sections are:

1. Short term (undrained) shear strength, steeper cut batter angles.
2. Long term (drained) shear strength, steeper cut batter angles.
3. Long term (drained) shear strength, fill buttress placed steeper cut batter angles.
4. Long term (drained) shear strength, flatter cut batter angles (results in sterilisation of WQG in proposed mine footprint).

Backfill slopes of 2(H):1(V) with a short term dewatered groundwater profile and 3(H):1(V) with long term recovering groundwater profile were analysed on Cross Section 3.

Examples of Slope W printouts for cases 1, 3, and 4 are presented in Appendix B.

5.2.3 Slope configurations and stability results

The proposed pit wall configurations have been arrived at by iterations of the stability analysis. Different locations require different slope configurations to meet the proposed stability criteria. Table 5.2 provides a summary of the slopes divided by internal and boundary slopes, long term and short term cases, and slope height. An example of the application of the slope configurations is provided on Figure A5 (Appendix A).

There are several features that are consistent between the analysed configurations, including:

- Tailings are battered at a gradient of 1.5H:1V.
- A berm is located at the base of the tailings, with a width equal to at least half of the thickness of the tailings. The berm is intended to:
  - Contain (catch) localised failures of the batter slope, which may be induced due to pockets of soft material and/or groundwater inflows.
  - Convey groundwater seepage flows and surface groundwater to vertical drain or drop structures, or local on bench pumping sumps.
- 5 m wide berms spaced at 10 m vertical intervals throughout the remainder of the slope profile.

Table 5.2: Slope configurations

Slope type	Length of time	Overall slope gradient	Max. slope height (m)	Config. No.	Configuration description[5]
Internal (FoS>1.2)	Short-term	1H:1V	40	1	10 m high cut batter slope gradients of 0.5H:1V (excluding tailings).
		1.5H:1V[1]	50	2	10 m high cut batter slope gradients of 1H:1V (excluding tailings).
	Long term	2H:1V	50	3	10 m high cut batter slope gradients of 1.5H:1V (excluding tailings).
Boundary (FoS>1.3)	Short-term	1H:1V	40	4	10 m high cut batter slope gradients of 0.5H:1V (excluding tailings), with a 1.5H:1V buffer between the boundary and base of the slope. Buttressing of the slope is required a short period after exposure to limit the likelihood of larger scale movement developing.
	Long-term with buttress	2H:1V Overall comprising 1H:1V cut slope and 2H:1V buttress	40	5	• 10 m high cut batter slope gradients of 0.5H:1V (excluding tailings), with a buffer between the crest of the pit slope and site boundary calculated by projecting a 2.5H:1v line from the toe of the pit slope to the ground surface[2]. • Buttress geometry comprising of the following: – The height of the buttress is equal to half the total slope height. – The width of the crest of the buttress is equal to a third of the total slope height. – The fill batter gradient will be no steeper than 2H:1V.
	Long term (no buttress)[4]	2H:1V[3]	40	6	Cut Batter slope gradients of 1.5H:1V (excluding tailings), with a buffer between the crest of the pit slope and site boundary calculated by projecting a 2.5H:1v line from the toe of the pit slope to the ground surface[2]. To achieve this buffer zone, the currently proposed toe of slope will need to be adjusted inwards in some locations and this may sterilise a section of the WQG.

Table notes:

1. For slopes between 40 and 50 m high (cells Q19, 20, and 21) an overall slope gradient of 1H:1V has a FoS between 1.1 and 1.2 and is potentially acceptable provided that the proposed infrastructure along the western boundary of the pit can be protected from the risk of slope failure. Noting that mine closure stage slopes around a terminal void pond will likely require gentler gradients in the order of 3H:1V.
2. See Figure A5, Appendix A where the equivalent buffer is shown as a setback of 1/2H from the boundary to the crest of the cut slope.
3. A long term slope cut at 2H:1V will encroach on the proposed mining cell limits, thus sterilising part of the WQG currently proposed for recovery. Appendix B Slope W examples illustrate this.
4. Long term slopes cut at 1H:1V have a FoS <1 due to the decrease in shear strength of the Silt/Clay unit over time. Hence the adoption of a design cut at 1H:1V with addition of a fill buttress, or a cut at 2H:1V.
5. An example of the design slope configuration is shown on Figure A5, Appendix A.

The slope angles and configurations described are considered to provide a slope design that is defendable at feasibility design and consenting stage. They also allow for the management of the current uncertainty by allowing sufficient space (and time) to react to any observed instability by applying measures such as flattening slope angles, buttressing slopes, and dewatering slopes.

5.2.4 Further slope stability considerations

Additional slope stability considerations include the following:

- It should be noted that our slope stability analysis considers the stability of the overall slope and does not consider local instability that may develop on individual batters due to slope degradation, e.g. undermining by groundwater seepage erosion, desiccation etc.
- Localised instability of the UWS, comprising of block failures of Silt/Clay materials that overly gravel lenses was noted during the 1999 and 2000 mining trial. Water inflows from gravel lenses within the UWS were observed to cause erosion and undermining of the overlying Silt/Clay units. Blocks of up to 12 m^3 were observed to slab from above gravel lenses following rapid dewatering in the 1999 mining trial, however no significant block failures occurred during the 2000 mining trial. This may be due to differing rates of dewatering or seasonality resulting in further degradation of the slope e.g. desiccation cracking.
- It is possible that gravel lenses may promote hydraulic connection from either the L&M pond or Waikaka Stream diversion into the mine pit. Depending on the proximity to the pond or stream, hydraulic connectivity could result in significant piping erosion of the pit wall and potential for deep-seated failure causing a breach to the pit wall. We consider the following:
  - L&M Terminal Pond – Based on comparison of the L&M bathymetric survey and the 2021 bathymetric survey, it appears that the base of the L&M pond is covered in a layer of accumulated tailings and backfill mud. Due to this and the discontinuous nature of the gravel lenses, the potential for groundwater inflows to result in uncontrollable piping erosion is considered low. Excavation works in this area could be staged around the L&M terminal pond, with monitoring of groundwater inflows. If groundwater flows are observed to cause accelerating erosion and muddy seepage water, excavation works should be stopped with backfilling works undertaken to mitigate further erosion of the pit wall.
  - Waikaka Stream diversion – Based on review of the investigation data, it appears there is the potential for hydraulic connection between the stream diversion and the mine pit. This potential issue could be mitigated during construction of the stream channel by laying a low permeability Silt/Clay liner underneath and adjacent to the stream bed, preventing inflows into the underlying materials.

5.3 Trafficability

The draft mining methodology report (Hogan Mining, April 2022) provides discussion and methods for control groundwater seepage and surface runoff during the mining cycle of each quarterly cell. A summary of the expected trafficability from a geotechnical perspective is provided below in Table 5.3.

Table 5.3: Summary of factors affecting trafficability

Geotechnical unit	Trafficability	Mitigation of poor trafficability
Backfill	L&M trials observed good trafficking on blocky, 'dry' excavated Slit/Clay. Saturated gravel, sticky and soft wet clay backfill were difficult to traffic. Likely that thinly interbedded gravel and Silt/Clay will cause problems as the seepage from the gravel	Separation of materials as much as possible during excavation has the potential to improve productivity This may require customising of flitch levels to suit the bedding within the UWS. Preferential use of 6 wheel articulated dumpers for hauling and dumping wet

Geotechnical unit	Trafficability	Mitigation of poor trafficability
	will wet the clay resulting in the sticky and wet material described by L&M.	materials and rigid dump trucks for 'dry' Silt/Clay may limit trafficking issues on the backfill. Dumping of saturated and wet materials in specific areas on the backfill or stockpile will reduce the potential for bogging of wheeled vehicles.
Silty / sandy gravel tailings	Generally trafficable by all plant, while dry. Localised fine-grained layers may be un-trafficable when wet and undrained.	Local 'soft spots' comprising of sand and silt may require boxing out of the soft subgrade and backfill with sandy gravel. Typically boxing out to 0.5 to 1 m depth. Deep contour drains penetrating down to the UWS can be utilised where required to collect and dispose of perched groundwater flows.
Silt/clay tailings (Waikaka Blue)	Expected to be wet and generally will not be trafficable. Tracked plant may become bogged.	Where encountered, excavation of this unit will be required. Replacement with approximately 1 m of sandy gravel may be required to traffic across excavated areas. Geotextiles could be considered to 'strengthen' fill in critical areas.
Upper Waikaka Sequence	Based on the mining trials, the Silt/Clay materials trafficked well with both wheeled and tracked machinery, provided sufficient dewatering. There is potential for rutting and bogging in locations where ramps and roads traverse saturated gravel lenses due to seepage flows loosening gravel and wetting the Silt/Clay units adjacent to the seepage.	Ensure good drainage of gravel seepage zones to prevent softening and rutting of Silt/Clay. Maintain a high crown and deep table drains on ramps. Use cut off drains comprising a slot trench backfilled with geofabric wrapped drainage gravel as required. Sandy gravel sheeting, 0.5 to 1 m thick may be required in wet seepage zones to allow trafficking by wheeled plant.
Waikaka Quartz Gravel	Based on the mining trials, these materials are expected to traffic well, due to free draining nature of the dense gravels.	Occasional pockets of silt/clay material may require excavation to allow trafficking on insitu gravel.
Gore Lignite Measures	Expected to traffic well, while dry. During L&M mining trials, degradation of these materials was observed following prolonged submersion. This resulted in a 50 – 100 mm thick layer of soft, wet material across the mine floor.	Maintain good drainage of the pit floor with deep swales and tables falling to sumps to prevent significant disturbance of underlying materials.

5.4 Transportation, stockpiling, backfilling

Based on review of the mining trial, and existing investigation data, we consider the following:

- As outlined in Section 2.1.2, there were no issues trafficking or stockpiling the overburden materials when they were kept dry, in particular the Silt/Clay which remained blocky while in transit. However, the saturated gravel layers were noted to be problematic, as they would liquefy in the dump trucks and could also cause Silt/Clay materials disaggregate and become sticky and soft, and therefore difficult to handle. These Silt/Clay materials were also un-trafficable for dump trucks when sticky and soft. If this is a common issue, this could be managed by transporting the saturated gravel soils separately to prevent wetting and loss of strength of the hard Silt/Clay materials.

- As outlined in Section 1.3, the stockpile is proposed to eventually cover a 585 m by 320 m area, with a maximum height of 10 m. Site preparation works including stripping of topsoil and sub-excavation of any localised 'soft spots' will be required prior to stockpiling. We also recommend that adequate surface drainage (i.e. perimeter drain) is installed to capture surface run-off and allow appropriate settling / treatment to be undertaken. Provided adequate tracked compaction, we consider a 1.5H:1V slope gradient to be appropriate within stockpiled materials no more than 10 m in height.
- We understand that WGL intend to place returned backfill material in 5 m vertical intervals. An overall slope gradient of 2H:1V should be appropriate across the proposed mine site, assuming slow recovery of groundwater due to the low permeability of the excavated materials. Observation of local instability on the backfill should be a continuous exercise, with adjustment to truck haul routes and dumping positions set back from the crest of the slope as required. It is possible that instability of the backfill may occur if the groundwater recovers faster than anticipated and/or development of the mine progresses slower than proposed. Deep-seated instability will likely be preceded by an increase in seepage across the lower batter and development of tension cracks greater than 5 m back from the crest. If this occurs and is an issue for mining activity at the toe of the slope then unweighting of the backfill crest and adjustment to a slope gradient of 3H:1V is recommended. Geotechnical advice should be sought.

5.5 Backfill bulking factors

As outlined in Section 2.1.2, a bulking factor of approximately 1.09 was observed for the 'compacted' overburden stockpile during the 2000 mining trial, with an estimate of an additional 1.05 bulking if wash plant slimes were to be included in overburden stockpiles.

There is uncertainty in estimating a bulking factor for the proposed mine that will use excavators and trucks dumping and tracking in 5 m lifts. The 2000 mine trial used bucket wheel excavator and conveyors to the overburden stockpile. We understand that wash plant slimes for this project will require dewatering and thickening prior to placement with overburden backfill, which will reduce the potential bulking of this material.

At this stage we recommend adopting a design bulking factor of 1.1, which is consistent with the observations made during the mining trial and allows for bulking in the blocky excavated Silt/Clay materials. Bulking in gravel materials may be less than 1.1 based on recent experience of gravel backfill at Waikaia Mine.

In practice the bulking factor of backfill will relate to the method of placement adopted, being susceptible variation due to depth of fill lifts and degree of compaction by tracked and wheeled vehicles.

The actual bulking factor should be established by monitoring and surveying the placed volumes (and any settlement) in early mining cells. This is an important activity as it allows the arrangement of interim and final ex-pit dumps and pit voids to be adjusted accordingly.

5.6 Bearing capacity and settlement

The foundation for the Gold Recovery Plant (GRP) will consist of stripping of organic topsoil, local excavation and replacement of soft spots to 1 m depth in the tailings, and placement of a 0.5 m compacted gravel hardstand. The GRP pontoons (26 m by 12 m) will rest directly on the hardstand. The ground pressure of the GRP spread over the pontoon base will be approximately 15 kPa.

Based on the drilling undertaken the historic tailings under the site may comprise up to 6 m of gravel tailings. Waikaka Blue slimes at the base of the tailings could be locally up to 2 m thick. The Upper Waikaka Sequence includes dense gravel lenses and hard clay/silt beds.

Foundation design of the GRP is governed by settlement rather than the bearing capacity of the underlying soils, due to the large surface area of the structure (~250 m^2) and spread surcharge loads (~15kPa). We have undertaken a simplified settlement analysis of the tailings materials, commensurate with the limited information available about the condition of the tailings, and anticipate that differential settlement of the tailings beneath the GRP foundation is unlikely to exceed 50 mm. Larger amounts of differential settlement could be experienced should the ground profile beneath the GRP vary from that interpolated from existing boreholes.

The possibility of larger differential settlements beneath the GRP could be managed by the ability to 'jack and pack' re-level the pontoons, and/or re-level individual elements of the plant as required to maintain operation tolerances.

The foundations for temporary buildings and infrastructure will require stripping of organic topsoil and replacement with a compacted gravel hardstand and/or gravel pads as required by the size and ground pressure generated by the structure. Specific investigation and design can be conducted prior to construction as required.

5.7 Backfilling L&M pond

As outlined in Section 1.3, WGL intend to use an approximately 400 m length of the western portion of the L&M pond to place overburden backfill that has been sourced from the starter pit. The current methodology includes the following:

1. Construction of a low temporary bund 100 m beyond the proposed reclamation area.
2. Construction of the main permanent bund at the eastern edge of the proposed reclamation area.
3. Dewatering of the reclamation area by pumping the water to the remnant L&M pond to the east.
4. End-tipping of overburden from the starter pit into the reclamation area, advancing toward the east.
5. Reclamation will be completed once approximately 400,000 m^3 of overburden backfill has been placed to a nominal elevation of 115 mRL.

We understand the dimensions of the temporary and permanent bunds have not yet been decided. However, based on bathymetric data, it appears that the temporary and permanent bunds may be in the order of 10 m and 15 m in height respectively.

The bathymetry survey suggests that the base of the pond has a layer of suspended solids ('muddy water') and this will be underlain by saturated, very soft to soft silt and clay tailings, with variable amounts of sand and gravel tailings from processing of the WQG. The pond tailings are inferred to be about 5 m thick in the centre of the pond increasing to about 10 m thick at the pond edge.

Bunds constructed on the pond floor will settle into the soft 'mud' and displace significant volumes of mud. During construction edge failures will occur which can cause instability on the top of the bund and pose a risk to construction traffic, especially dump trucks. The base width of the bunds should be built to approximately 2 to 3 times the height to provide capacity to accommodate some edge failure. Where active cracking and slumping is observed, dumping should be suspended, or trucks should dump short followed by push out of fill by a dozer. A specific job safety analysis and work procedure should be established for construction of the bunds due to the limited trafficking space compared to backfill dumping.

5.8 Waikaka Stream diversion

The footprint of the proposed stream diversion is shown on Figure 1.2 and Figure A1 running along the true left of the valley floor. We understand that the diversion will be constructed over its full length early in the mine life and comprise a bund, floodplain and low flow channel.

From a geotechnical perspective the key issue is excessive leakage from the base of the stream diversion into adjacent mine slopes and the attendant possibility of slope instability due to elevated groundwater levels. The issue of leakage from the stream diversion is raised by the hydrogeology study (Section 4.3.2).

Construction of the diversion on a compacted layer of low permeability Silt/Clay material would serve to perch the stream flow within the diversion and separate it from groundwater flows into the mine pit.

5.9 Terminal pond

As outlined in Section 1.3, a terminal void is proposed to remain on completion of mining and return of the material from SP1. Following backfilling, the terminal void is expected to be about 400,000 m^3, with a depth in the order of 25 – 30 m The terminal void will be left as a permanent pond and therefore will require recontouring to reduce slope angles for long term stability (FoS > 1.5). For the purpose of this design, we recommend adopting a design slope gradient of 3H:1V for long term slopes surrounding the terminal void, with local berms to establish a riparian environment around the pond edges. Further design work can be undertaken once the final configuration of the terminal pond is established later in the mine life.

6 Mine observation, monitoring and slope stability reassessments

6.1 Trial slopes

The geotechnical information that was gathered was limited, but sufficient to undertake a geotechnical assessment to support the resource consent application. However, due to uncertainty in the performance of the cut slopes in the UWS (Section 5.2) the slope designs are relatively conservative to accommodate the possibility of cut slopes transitioning from undrained to drained soil behaviour.

Based on the published geology and historic information the materials may behave as over consolidated soil or very weak rock, and therefore cut slopes could be manageable at steeper gradients. Accordingly, there is the potential for optimisation of the slope configurations, reducing the requirements for temporary buttressing of slopes and possibly allowing additional resource extraction along the mine boundaries.

Trial slopes are recommended in the starter pit and selected quarterly pit cells (tbd) to assess the performance of UWS over extended periods The trial slopes will be steeper than design and in locations where instability will not present a risk to boundaries, mine safety, or mining progress. This may include the following:

- Batter an approximately 100 m long portion of the Starter Pit at an overall slope angle of 80°, to depths of up to 20 mbgl. The purpose of this is to assess the stability of the materials in conditions that are not considered tolerable with currently adopted soil parameters. The duration of slope exposure also may extend out the length of time we can consider short-term conditions applicable. Currently we assume 4 months is appropriate, however potentially 12 months or longer may be appropriate and can be ascertained during the trial.

- Access for personnel and mine equipment should generally be prevented within 20 m of the crest and 20 m of the toe of the trial slope. Limited access for regular walkover observations and relocation of excavators and dump trucks is acceptable, operating within the safety procedures that will be developed for the mine.
- Regular, nominally weekly, walkover observations and recording of any development of slope crest cracking, toe bulging, cracking or thrusting, seepage changes, or any other changes would be required along these slopes to identify potential slope instability.
- Further information that will help in the reassessment of pit slope designs can be obtained by survey of temporary benchmarks such as wooden pegs by site personnel using a suitably accurate GPS system. Repeatable accuracy of 10 mm horizontally and 20 mm vertically would be required to make the monitoring worthwhile. A site GPS system able to be operated by staff would allow for efficient monitoring at intervals in step with the walkover observations. Peg spacing of 10 to 20 m along the crest of the trial slope would be appropriate.
- Installation of 2 piezometer nests approximately 10 m behind the crest of the trial slope. Each nest to contain 3 Casagrande standpipes, screened in each of the WQG, a UWS gravel lens and the UWS Slit/Clay unit. Monitoring of piezometer water levels from commencement of excavation and ongoing at the same time as the walkover observations.
- Develop a trigger action response plan TARP where actions are related to the amount and trend of slope movement that may be observed (see Section 6.3).
- Site visit(s) by an engineering geologist when full height cut slopes are visible in the Starter Pit to log pit wall exposures and assess the condition of the UWS gravel lenses and seepage, Slit/Clay units, bedding, organic horizons, and material characteristics.

6.2 L&M pond slopes

Pit slopes will be excavated parallel to the existing L&M pond along cells Q1 to Q3. ‘Panels’ of reverse circulation boreholes were drilled in the barrier between the pond and proposed pit cells. This drilling showed UWS gravel lenses persistent from the pond edge into the cells (see Figure A2, Appendix A). Groundwater pumping tests did not show any evidence for hydraulic connection between the pond and the UWS gravel lenses. The pond profile, thickness of tailings ‘mud’ infill, and grading of insitu gravel lenses suggest that it is relatively unlikely that hydraulic connection between the pond and the proposed pit cells could lead to rapid failure of pond water and ‘mud’ into the mine. While assessed as unlikely the consequence for disruption to mining is significant.

During excavation adjacent to the L&M pond we recommend:

- Daily walkover observations of the crest and toe of the works to check for subsidence and cracking at the crest and increasing and/or dirty seepage from gravel units in the cut batter. After excavation to the toe of the face walkover observations could be reduced to weekly intervals.
- Installation of piezometers, or use of existing piezometers (2 piezometers per mining cell) screened within UWS gravel lenses to monitor water levels as excavation progresses. The expected trend is for a decrease in water level as the gravel lenses drain, static water levels and sudden upward trends may suggest flow connected to the ponds. Monitoring of piezometer water levels from commencement of excavation and ongoing at the same time as the walkover observations.
- Further information that will help in the assessment of deformation at the crest of the slope can be obtained by survey of temporary benchmarks such as wooden pegs by site personnel using a suitably accurate GPS system. Repeatable accuracy of 10 mm horizontally and 20 mm vertically would be required to make the monitoring worthwhile. A site GPS system able to be

operated by staff would allow for efficient monitoring at intervals in step with the walkover observations. Peg spacing of 10 to 20 m along the crest of the slope would be appropriate. Develop a trigger action response plan TARP where actions are related to the amount and trend of slope movement that may be observed (see Section 6.3).

6.3 General observation and monitoring

Regular observation of slopes for signs of slope movement and instability is integral to the safe and efficient operation of the mine. Slope crests, haul ramps and boundary slopes require regular observation for signs of slope instability and recording of the results of those observations.
Areas of active mining and boundary pit walls exposed for longer periods should be walked over on a weekly basis. Observations should include subsidence and/or cracking along slope crests, groundwater seepage from gravel lenses, related erosion, undercutting and local slab failure, bulging, cracking or thrusting at the toe of slopes.

Monitoring of general mine slopes and groundwater conditions may be conducted. Installation of piezometers and survey pegs should be assessed specific to each mining cell and informed by the results of monitoring undertaken in the Starter Pit (Section 6.1) and Q1, 2, and 3 along the L&M pond boundary (Section 6.2).

A trigger action response plan (TARP) should be developed for the observation of slope movement on all slopes within the mine, with specific plans developed for trial slopes and mining adjacent to the L&M pond.

The purpose of the plan is to establish the level of response required if signs of slope movement or instability are observed, or monitoring measurements and trends exceed certain levels. Initial observations of instability might trigger increased frequency of monitoring and observations and an inhouse review of possible implications to mining progress and safety if the slope movements continue or escalate. Ongoing evidence of movement might trigger standoff of mining equipment and personnel from certain slopes and communication with the geotechnical consultant to undertake further assessment. Actions such as buttressing slopes, unloading slope crests and flattening batter slopes might be required to prevent effects encroaching along site boundaries.

The actual bulking factor being achieved in overburden backfill should be established by monitoring and surveying the placed volumes (and any settlement) in early mining cells. This is an important activity as it allows the arrangement of interim and final ex-pit dumps and pit voids to be adjusted accordingly. Reassessment of slope stability and pit slope angles

The results of observation and monitoring, especially for trial slopes should be communicated to the geotechnical consultants on a nominal quarterly basis, in addition to any communications required under slope performance TARPS.
The results from trial slopes and other key slopes will be used to update the understanding of material characteristics, groundwater drainage and slope failure mechanisms, and to reassess the slope design configurations that are recommended in this report. Reporting of the reassessments can be provided to the relevant regulatory authorities as appropriate if there is change proposed to slope configurations.

7 Recommendations

The recommendations provided in Sections 5 and 6 of this report are summarised as follows:

1 Slope configurations described in Table 5.2 and illustrated in Figure A5, Appendix A have been developed to meet slope stability criteria outlined in Section 5.2. These generally comprise 5 m wide berms spaced at 10 m intervals, with 10 m high slope gradients of 0.5H:1V for short

term cases and 1.5H:1V for long term cases. Placement of a temporary buttress against critical boundary slopes can negate the need to cut back to 2H:1V.

2 Localised slope instability may occur where groundwater seepage and erosion undercuts Silt/Clay materials. This instability should be manageable during day to day mining activities.

3 Instability may occur due to seepage connections between eth L&M pond and the mine. Buttressing of the slope will be required if seepage and erosion is progressing towards slope scale failure.

4 Trafficability is broadly manageable provided access ramps are properly drained and provision is made for subsoil drainage and sheeting with gravel where necessary. Planning of excavation to keep ‘dry’ Silt/Clay materials and wet gravel materials separated as much as possible will improve the transportation and handling of overburden and trafficability on the backfill.

5 Backfill stockpile slopes ranging from 1.5H:1V to 3H:1V are possible across the site depending on slope height and groundwater recharge or recovery in backfill materials.

6 Bearing capacity for structures and the potential for settlement of the GRP are manageable provided organic topsoil is stripped and replaced where necessary with compacted gravel hardstands and pads.

7 Construction of bunds to facilitate backfilling of part of the L&M pond will require specific attention to bund stability, settlement and safety of vehicles operating on the bund during construction.

8 The proposed Waikaka Stream diversion has the potential to leak into the underlying aquifers. Construction of the diversion on a compacted layer of low permeability Silt/Clay material would serve to perch the stream flow within the diversion and separate it from groundwater flows into the mine pit.

9 The terminal pond proposed at mine cell Q21 will require fattened batter slopes of approximately 3H:1V for long term stability around the pond edges.

10 An observational approach (Section 6) is proposed to monitor slope performance and investigate the possibility of being able to mine with steeper slopes than those proposed in this report. Steep trial slopes are proposed with regular walkover observations, piezometer installation and monitoring and survey peg monitoring.

11 Specific observation and monitoring is proposed for mine slope adjacent to the L&M pond to look for signs of hydraulic connection and progressive erosion that could lead to slope failure if no action is taken.

12 The trial slopes, L&M pond slopes and observations from general slopes within the mine, along with mapping and material characterisation by the geotechnical consultant can be used to regularly reassesses slope stability and slope design. There is the opportunity to develop steeper mine slopes with the collection and assessment of mine observations, as well as the ability to react to any observed instability and modify slopes designs and mining methods accordingly.

8 Applicability

This report has been prepared for the exclusive use of our client, Waikaia Gold Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Southland Regional Council the consenting authority will use this report for the purpose of assessing that application.

Recommendations and opinions in this report are based on data from discrete investigation locations. The nature and continuity of subsoil away from these locations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

An observational approach is recommended to assess the performance of the design slope configurations provided in this report. Observations and monitoring results collected on site should be provided to the geotechnical consultant so they can assess the stability of the cut slopes and provide updated slope configuration designs as appropriate. The assessment should include examination of the on-site conditions by the geotechnical consultant.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

....

Cole Brown
Engineering geologist

Authorised for Tonkin & Taylor Ltd by:

....

Clive Anderson
Project director

Technical review by:

....

Barry McDowell
Senior engineering geologist

16-Aug-22
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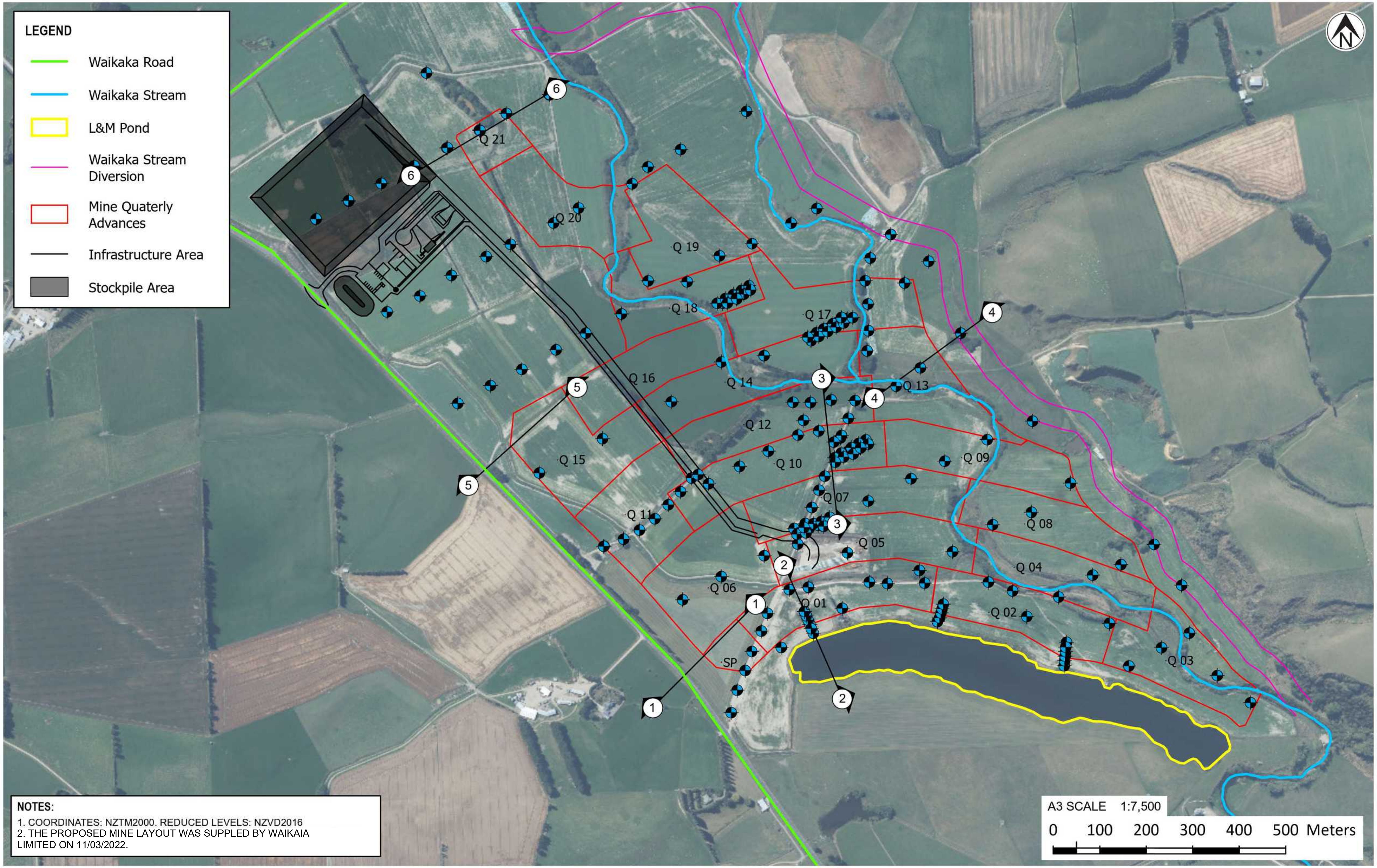
Appendix A: Figures

- **Figure A1 – Site Plan.**
- **Figure A2 - Geological cross section 1 and 2.**
- **Figure A3 – Geological cross section 3 and 4.**
- **Figure A4 – Geological cross section 5 and 6.**
- **Figure A5 – Example Application of Slope Configurations.**

C:\Users\crb\Desktop\Projects\Waikaka Mine\Waikaka Gold Mine\Waiakaka Gold Mine\Waiakaka Gold Mine.aprx   Layout: T+T A3 Landscape Map Template   2022-Jun-13 12:48 am   Drawn by CRB



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NOTES:
Basemap NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps contributors

REV	DESCRIPTION	GIS	CHK	DATE
A	First version	CRB		13/06/22

LOCATION PLAN

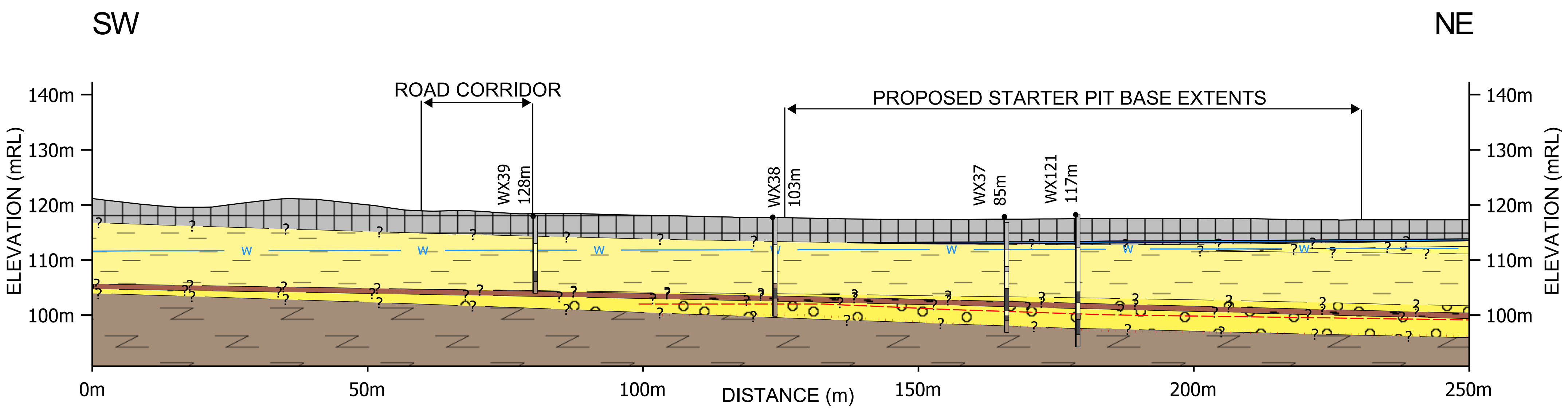
PROJECT No.	1018498.0000	
DESIGNED	CRB	JUN.22
DRAWN	CRB	JUN.22
CHECKED	BMCD	JUN.22
APPROVED		DATE

CLIENT WAIKAIA GOLD LIMITED

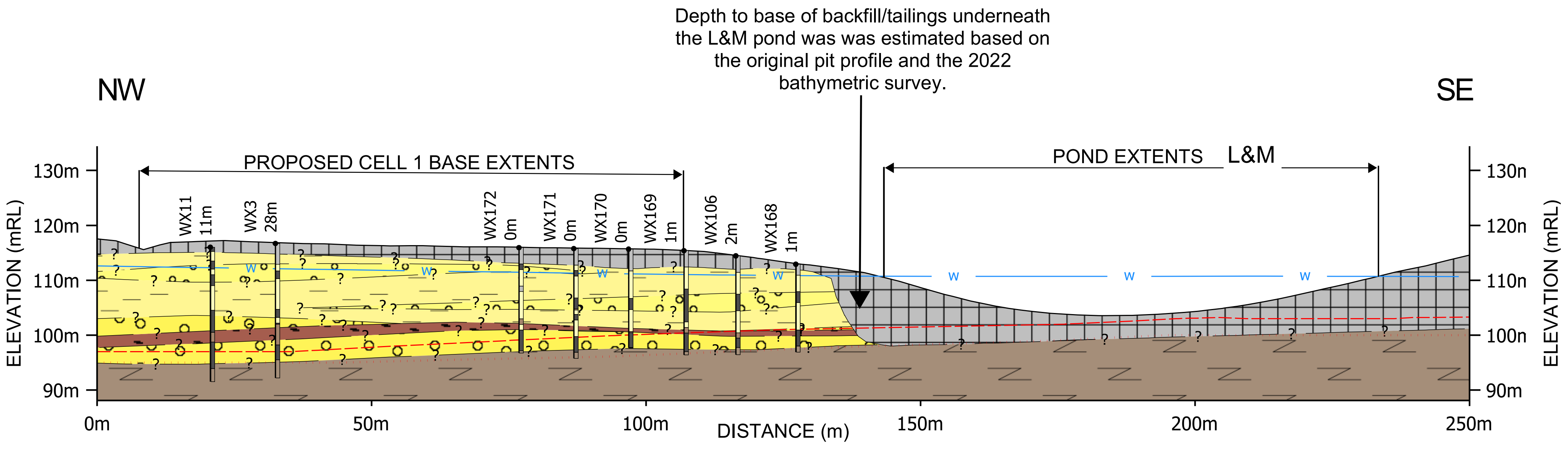
PROJECT WAIKAKA GOLD GEOTECHNICAL ASSESSMENT

TITLE SITE PLAN

SCALE (A3) 1:7,500   **FIG No.** FIGURE A1.   **REV** A



GEOLOGICAL CROSS SECTION 1
Starter Pit



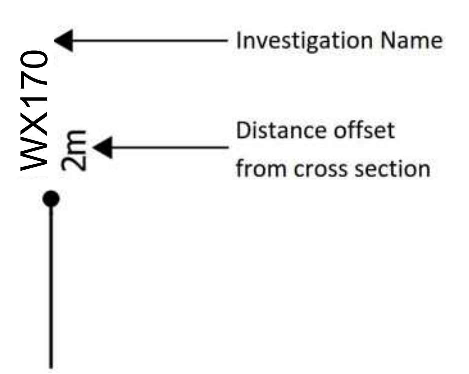
GEOLOGICAL CROSS SECTION 2
L&M Pond Boundary

A3 SCALE 1:1,000

0 10 20 30 40 50 Meters

Legend

- Tailings (sandy gravel/Gravelly sand)
- Tailings (Silt/Clay)
- Upper Waikaka Sequence Organic horizon
- Upper Waikaka Sequence (Silt/Clay)
- Upper Waikaka Sequence / Waikaka Quartz Gravel (sandy Gravel)
- Gore Lignite Measures
- Inferred Water Table
- Inferred geological contact
- Top of Waikaka Quartz Gravel
- Base of Waikaka Quartz Gravel



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Notes
1. All dimensions are in millimetres unless noted otherwise.
2. Coordinate datum: NZGD2000, New Zealand Transverse Mercator coordinates (NZTM2000.
3. Reduced levels: New Zealand Vertical Datum (NZVD2016).
4. The terrestrial ground profile is based on point cloud data from the Waikaia Gold Limited LiDAR survey.
5. The bathymetric profile of the L&M Pond is based on the 2022 Waikaia Gold Limited bathymetric survey.
6. The base and top of the Waikaka Quartz Gravel surfaces were supplied by Waikaia Gold Limited, dated 28 October 2021.
7. The depth of geological units presented is based on information obtained from recent investigations and historical investigations undertaken at point locations. The nature and continuity of the geology away from borehole locations may vary from those assumed in this drawing.

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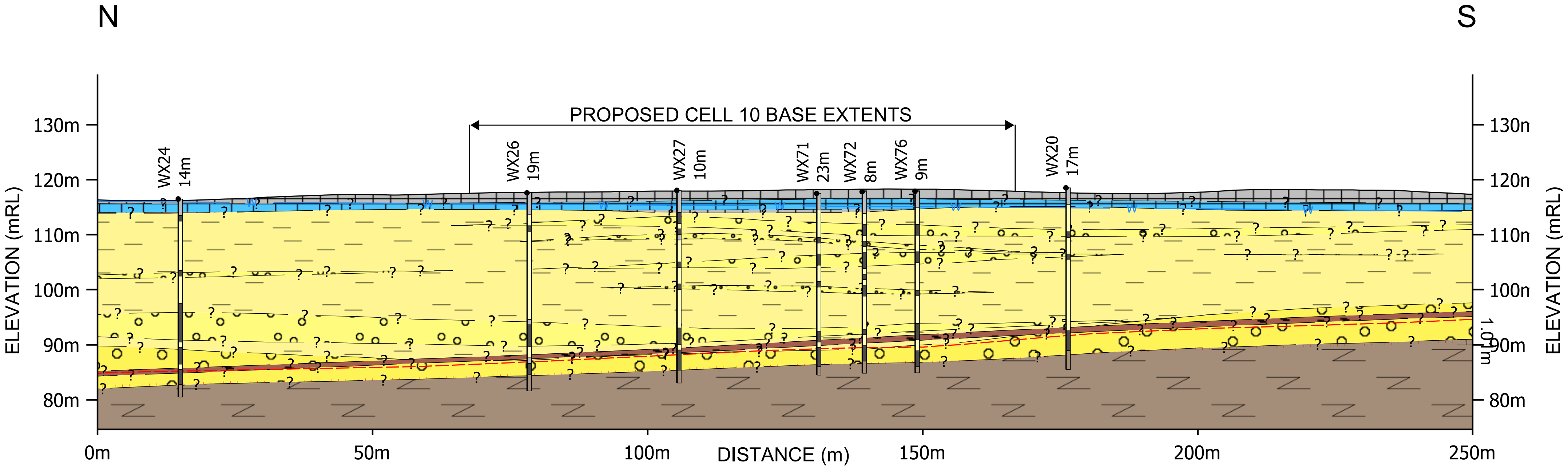
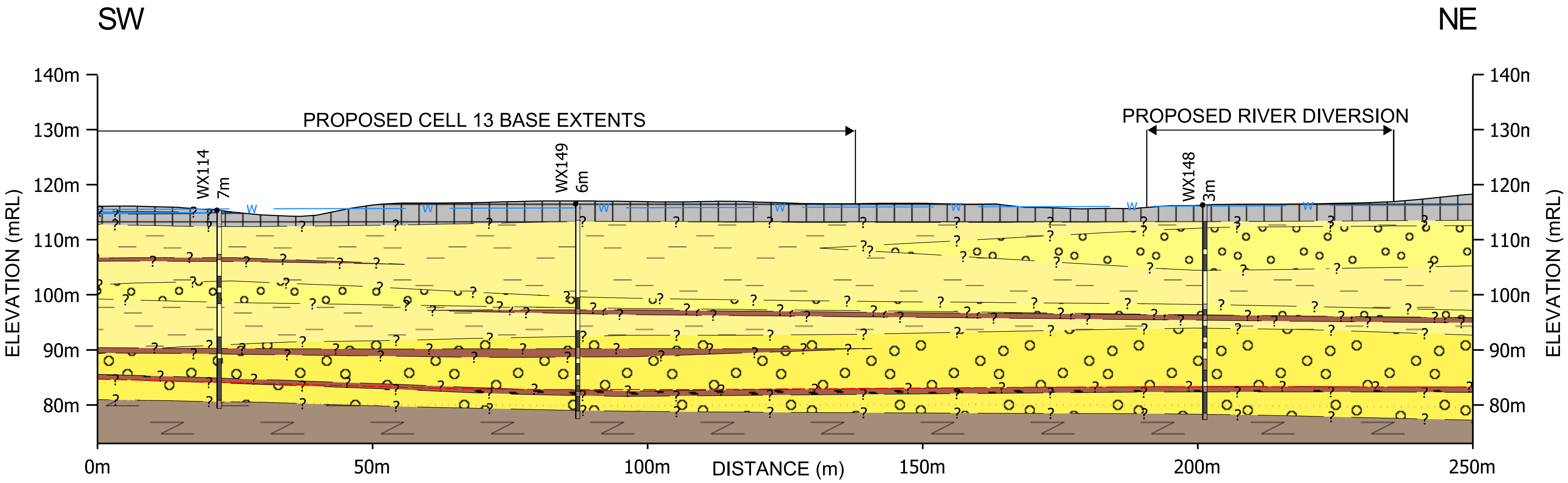
CLIENT	WAIKAIA GOLD LIMITED
PROJECT	WAIKAKA GOLD GEOTECHNICAL ASSESSMENT
TITLE	GEOLOGICAL CROSS SECTION 1 AND 2
SCALE (A3)	1:1000
FIG No.	FIGURE A2
REV	A



GEOLOGICAL CROSS SECTION 3
Internal Pit Cell



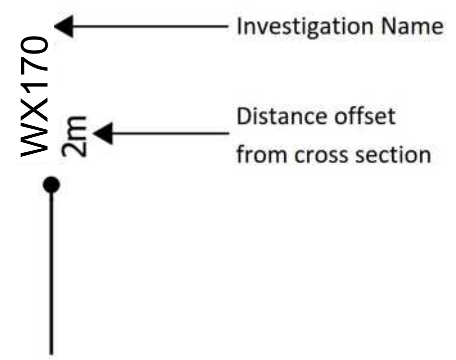
GEOLOGICAL CROSS SECTION 4
River Diversion Boundary

A3 SCALE 1:1,000

0 10 20 30 40 50 Meters

Legend

- Tailings (sandy gravel/Gravelly sand)
- Tailings (Silt/Clay)
- Upper Waikaka Sequence Organic horizon
- Upper Waikaka Sequence (Silt/Clay)
- Upper Waikaka Sequence / Waikaka Quartz Gravel (sandy Gravel)
- Gore Lignite Measures
- Inferred Water Table
- Inferred geological contact
- Top of Waikaka Quartz Gravel
- Base of Waikaka Quartz Gravel



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Notes
1. All dimensions are in millimetres unless noted otherwise.
2. Coordinate datum: NZGD2000, New Zealand Transverse Mercator coordinates (NZTM2000.
3. Reduced levels: New Zealand Vertical Datum (NZVD2016).
4. The terrestrial ground profile is based on point cloud data from the Waikaia Gold Limited LiDAR survey.
5. The bathymetric profile of the L&M Pond is based on the 2022 Waikaia Gold Limited bathymetric survey.
6. The base and top of the Waikaka Quartz Gravel surfaces were supplied by Waikaia Gold Limited, dated 28 October 2021.
7. The depth of geological units presented is based on information obtained from recent investigations and historical investigations undertaken at point locations. The nature and continuity of the geology away from borehole locations may vary from those assumed in this drawing.

PROJECT No.	1018498.0000	
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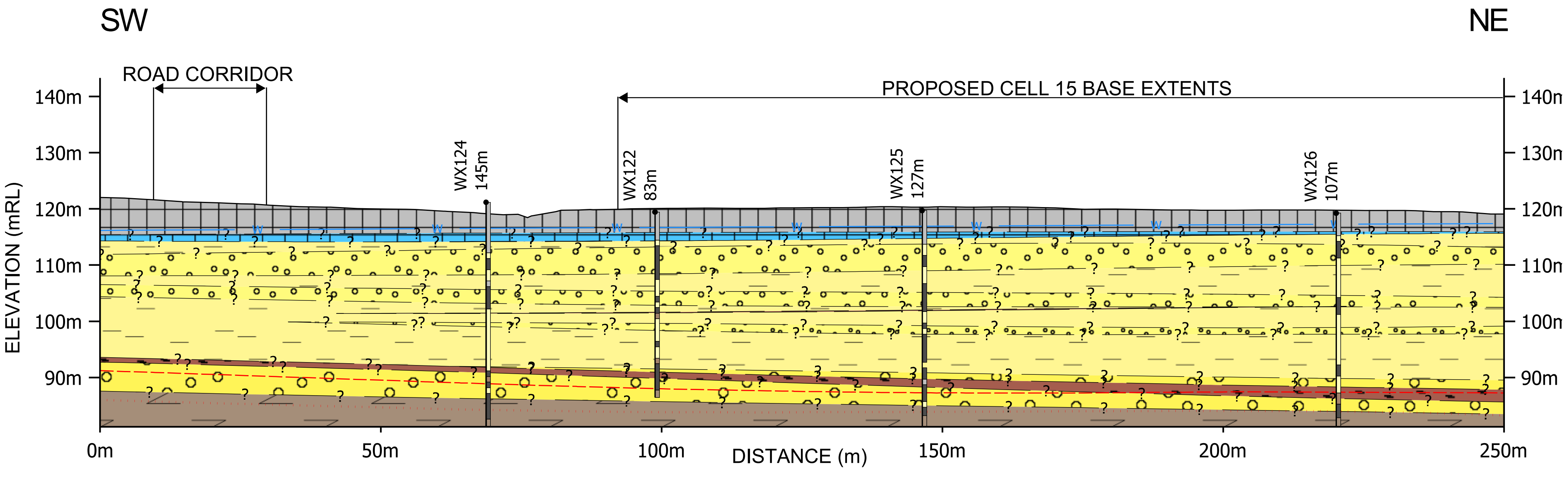
CHECKED	BMCD	JUN.22
APPROVED	DATE	

CLIENT	WAIKAIA GOLD LIMITED
PROJECT	WAIKAKA GOLD GEOTECHNICAL ASSESSMENT
TITLE	GEOLOGICAL CROSS SECTION 3 AND 4
SCALE (A3)	1:1000
FIG No.	FIGURE A3
REV	A

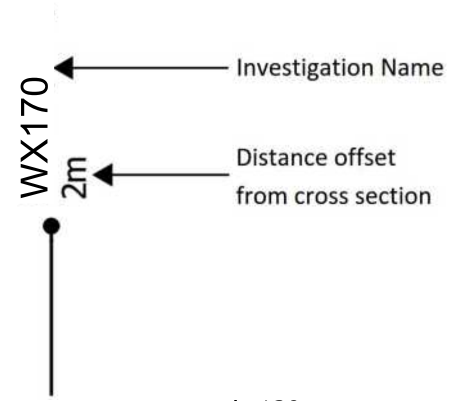


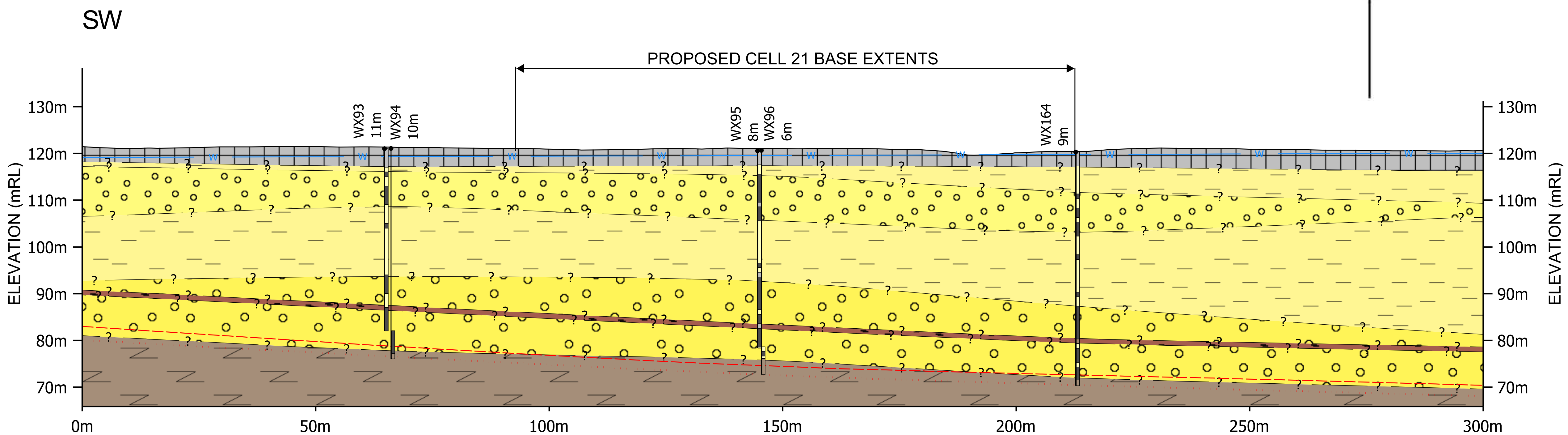
GEOLOGICAL CROSS SECTION 5

Road Boundary

Legend

- Tailings (sandy gravel/Gravelly sand)
- Tailings (Silt/Clay)
- Upper Waikaka Sequence Organic horizon
- Upper Waikaka Sequence (Silt/Clay)
- Upper Waikaka Sequence / Waikaka Quartz Gravel (sandy Gravel)
- Gore Lignite Measures
- Inferred Water Table
- Inferred geological contact
- Top of Waikaka Quartz Gravel
- Base of Waikaka Quartz Gravel





GEOLOGICAL CROSS SECTION 6

Final Void

A3 SCALE 1:1,000

0 10 20 30 40 50 Meters

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Notes
1. All dimensions are in millimetres unless noted otherwise.
2. Coordinate datum: NZGD2000, New Zealand Transverse Mercator coordinates (NZTM2000.
3. Reduced levels: New Zealand Vertical Datum (NZVD2016).
4. The terrestrial ground profile is based on point cloud data from the Waikaia Gold Limited LiDAR survey.
5. The bathymetric profile of the L&M Pond is based on the 2022 Waikaia Gold Limited bathymetric survey.
6. The base and top of the Waikaka Quartz Gravel surfaces were supplied by Waikaia Gold Limited, dated 28 October 2021.
7. The depth of geological units presented is based on information obtained from recent investigations and historical investigations undertaken at point locations. The nature and continuity of the geology away from borehole locations may vary from those assumed in this drawing.

PROJECT No.	1018498.0000	
DESIGNED	CRB	MAY.22
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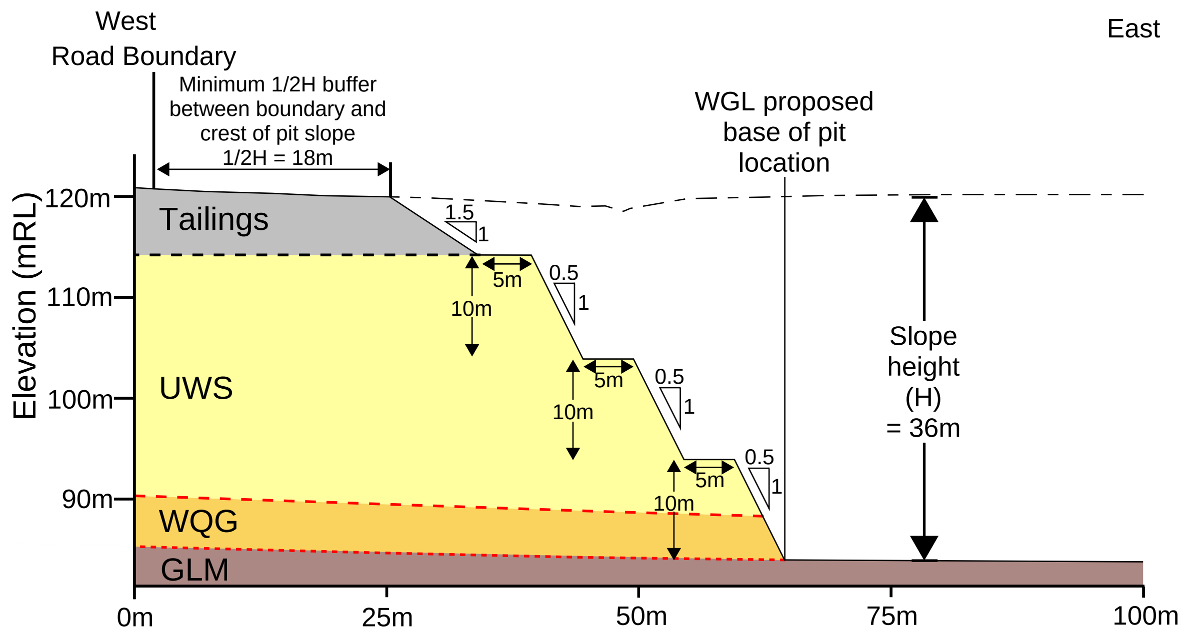
CLIENT WAIKAIA GOLD LIMITED

PROJECT WAIKAKA GOLD GEOTECHNICAL ASSESSMENT

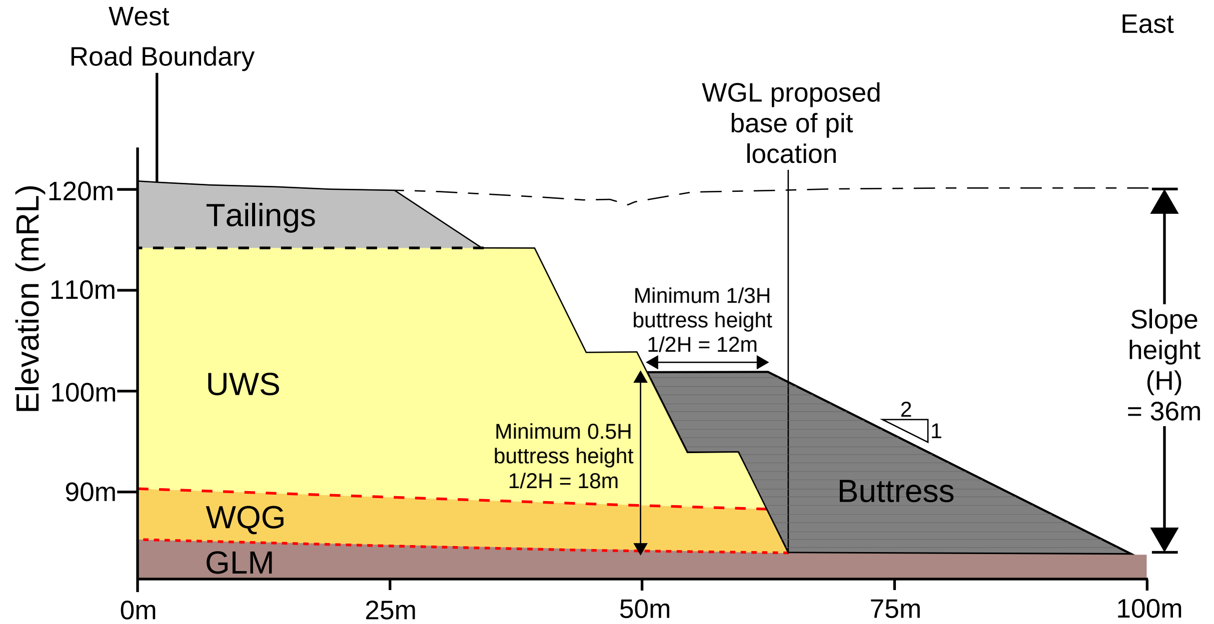
TITLE GEOLOGICAL CROSS SECTION 5 AND 6

SCALE (A3) 1:1000 FIG No. FIGURE A4 REV A

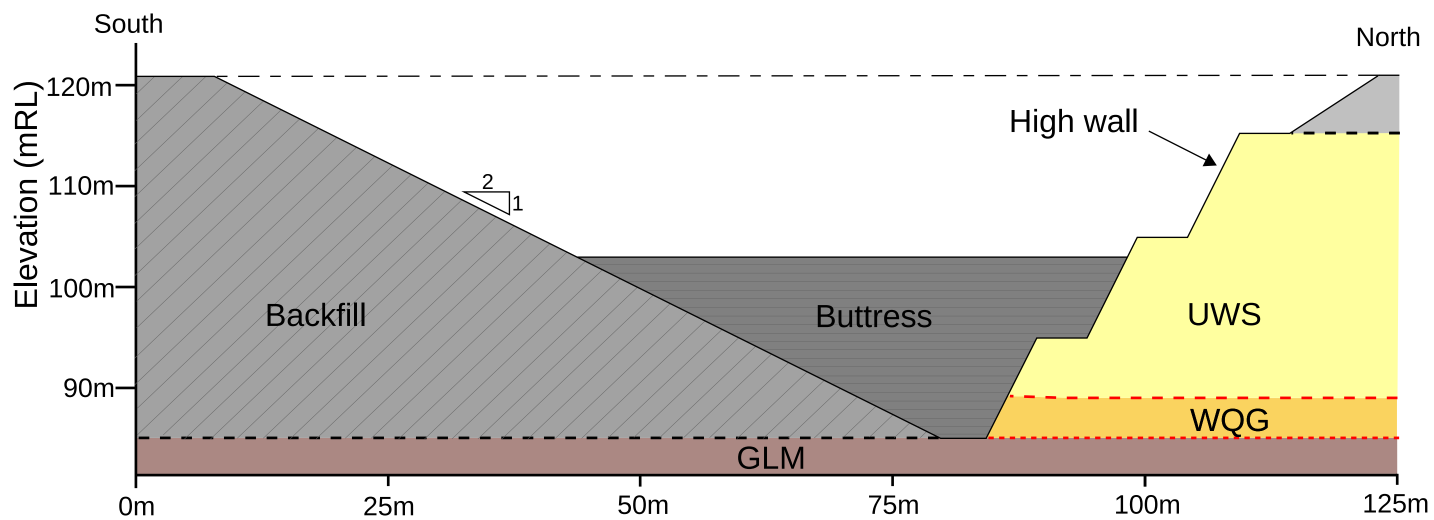
Schematic cross sections illustrating application of slope configuration along road boundary at Cross Section 5 (Refer to Table 5.2)



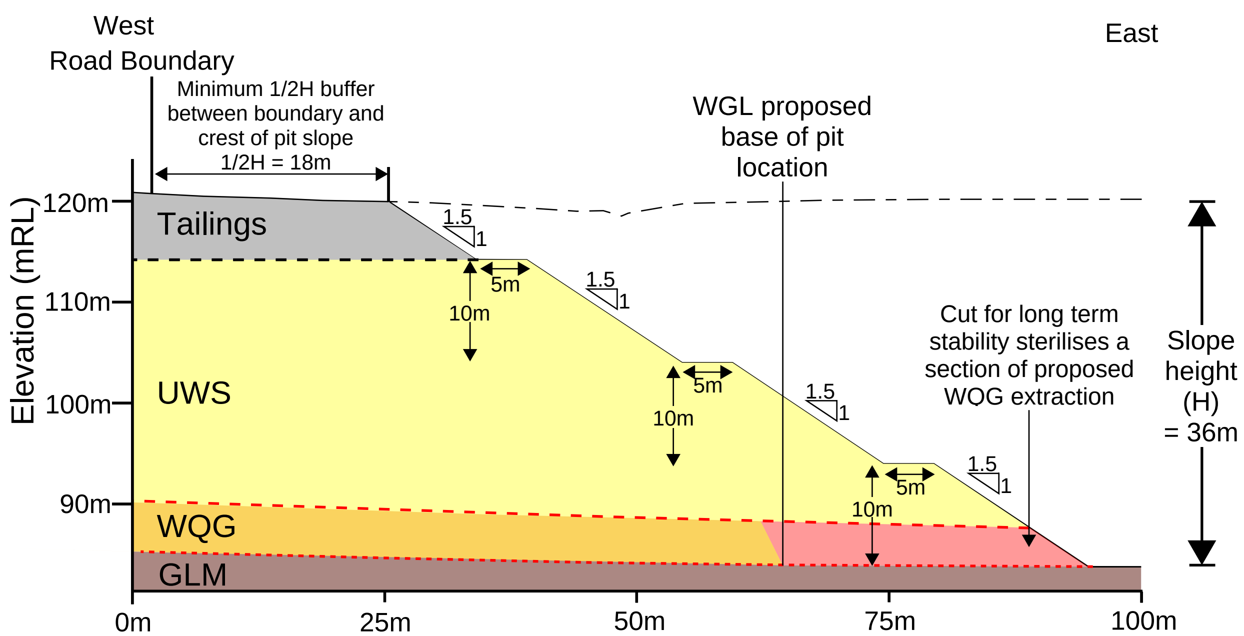
Temporary (undrained) case - West to East
(Refer to Config. No. 4 in Table 5.2)



Buttressing of temporary case after WQG extraction - West to East
(Refer to Config. No. 5 in Table 5.2)



Buttressing of temporary case after WQG extraction (drained) - North to South
(Refer to Config. No. 5 in Table 5.2)



Long term excavation with no buttress - West to East
(Refer to Config. No. 6 in Table 5.2)

A3 SCALE 1:750
0 8 16 24 32 40 Meters

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DESIGN CHECKED	BMCD	JUN. 22	PROJECT No.
DRAWING CHECKED	BMCD	JUN. 22	1018498.0000

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REV	DESCRIPTION	CAD	CHK	DATE

APPROVED DATE

CLIENT WAIKAIA GOLD LIMITED
PROJECT WAIKAKA GOLD GEOTECHNICAL ASSESSMENT
TITLE EXAMPLE APPLICATION OF SLOPE CONFIGURATIONS CROSS SECTION 5 SCHEMATICS
SCALE (A3) 1:1000 FIGURE A5 REV A

Appendix B: Slope stability results

Analysis Notes:
1. Name: CS1 - Case 01: Temporary Stability
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Factor of Safety

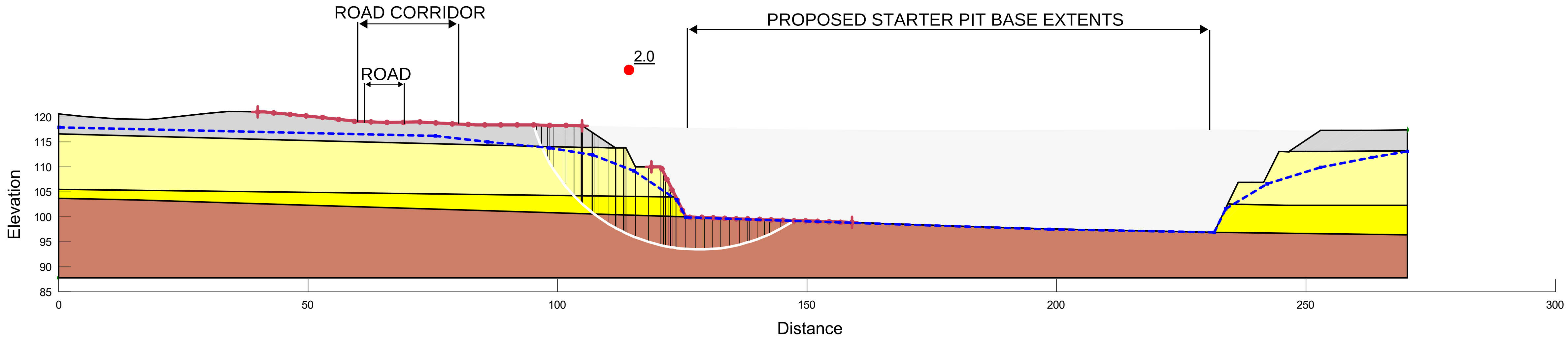
- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18		0	32
	Unit 2a - Clay (Undrained)	18	200		
	Unit 2b - Gravel (Drained)	19		3	45
	Unit 3 - Gore Lignite Measures (Drained)	18		10	40

<u>Case - Temporary stability of pit along boundary</u>
- Minimum width of buffer zone between boundary and crest of slope should be 1/3 of the slope height.

Batter dimensions for <40m slope height

1. <u>Tailings</u>
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. <u>Natural materials</u>
   - Cut at 0.5H:1V with 5m wide catch benches every 10m slope height



Title: 20220513_Waikaka Gold Mine_SlopeW.gsz

Analysis: CS1 - Case 01: Temporary Stability

Comments:

Scale: 1:1,000 @ A3

Job Number: 1014898

Analysed by: CRB

Checked by: BMCD

Tonkin+Taylor

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS1 - Case 02a: Long Term Stability (without buttress)
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

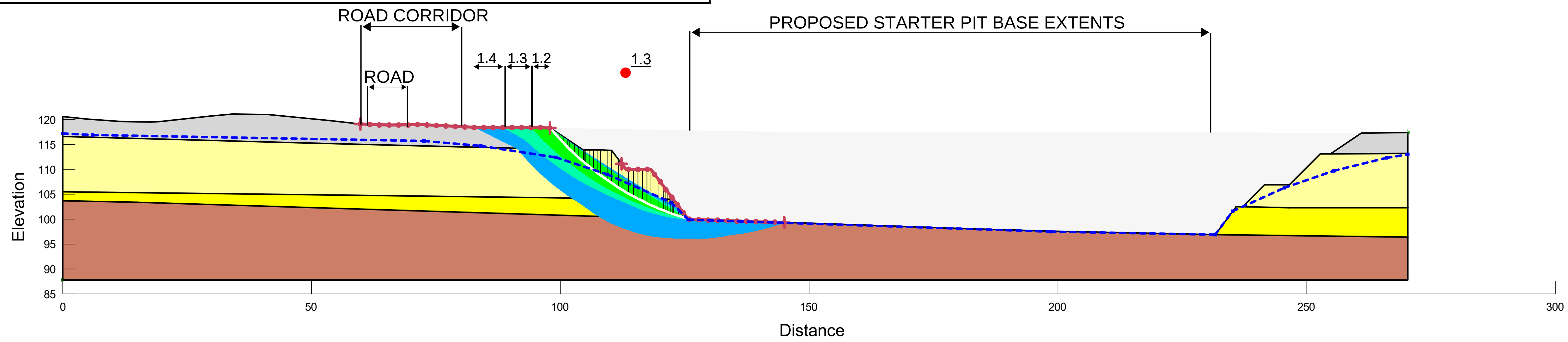
Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40

Case: Long term stability (no buttress) of pit adjacent to boundary
- For long term slopes with no buttressing, the base of the slope must be a horizontally offset by a minimum of 2.5x the slope height. E.g. For a 20m high slope, the base of slope must be 50m from the boundary.

Batter Dimensions (<30m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 1H:1V with 5m wide catch benches every 10m slope height



Tonkin+Taylor	Title: 20220513_Waikaka Gold Mine_SlopeW.gsz		Job Number: 1014898
	Analysis: CS1 - Case 02a: Long Term Stability (without buttress)		Analysed by: CRB
	Comments:	Scale: 1:1,000 @ A3	Checked by: BMCD

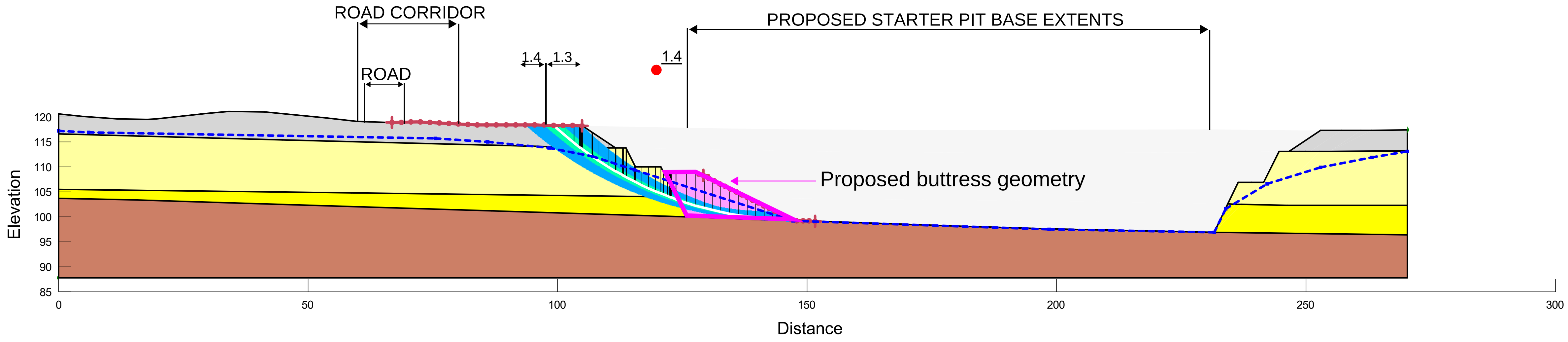
Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS1 - Case 02b: Long Term Stability (with buttress)
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Long term Stability (with buttress) - Batter Dimensions (<30m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of 1/2 of slope height.
2. Natural materials
   - Cut at 1H:0.5V with 5m wide catch benches every 10m slope height
3. Buttress
   - Construction of buttress adjacent to temporary slope, with following dimensions:
     - Minimum height of 1/2 of slope height
     - Minimum width of crest is 1/3 of the slope height
     - Battered at 2H:1V.

Factor of Safety
- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40
	Unit 4 - Backfill (Drained)	18	0	32



Tonkin+Taylor	Title: 20220513_Waikaka Gold Mine_SlopeW.gsz		Job Number: 1014898
	Analysis: CS1 - Case 02b: Long Term Stability (with buttress)		Analysed by: CRB
	Comments:	Scale: 1:1,000 @ A3	Checked by: BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

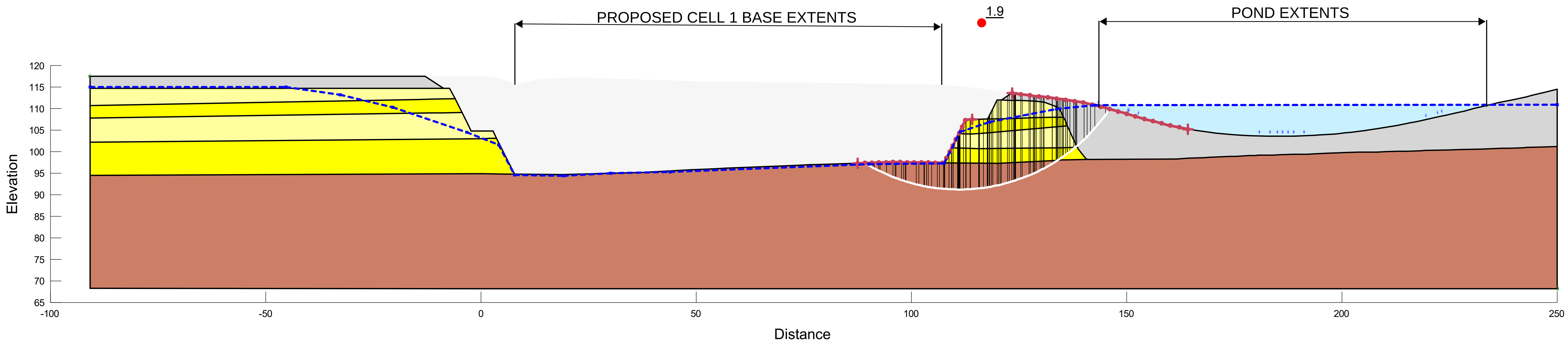
Analysis Notes:
1. Name: CS2 - Case 01: Temporary Stability
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Temporary Stability - Batter Dimensions (<40m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 0.5H:1V with 5m wide catch benches every 10m slope height

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18		0	32
	Unit 2a - Clay (Undrained)	18	200		
	Unit 2b - Gravel (Drained)	19		3	45
	Unit 3 - Gore Lignite Measures (Drained)	18		10	40



Title: 20220513_Waikaka Gold Mine_SlopeW.gsz

Job Number: 1014898

Analysis: CS2 - Case 01: Temporary Stability

Analysed by: CRB

Comments:

Scale: 1:1,000 @ A3

Checked by: BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

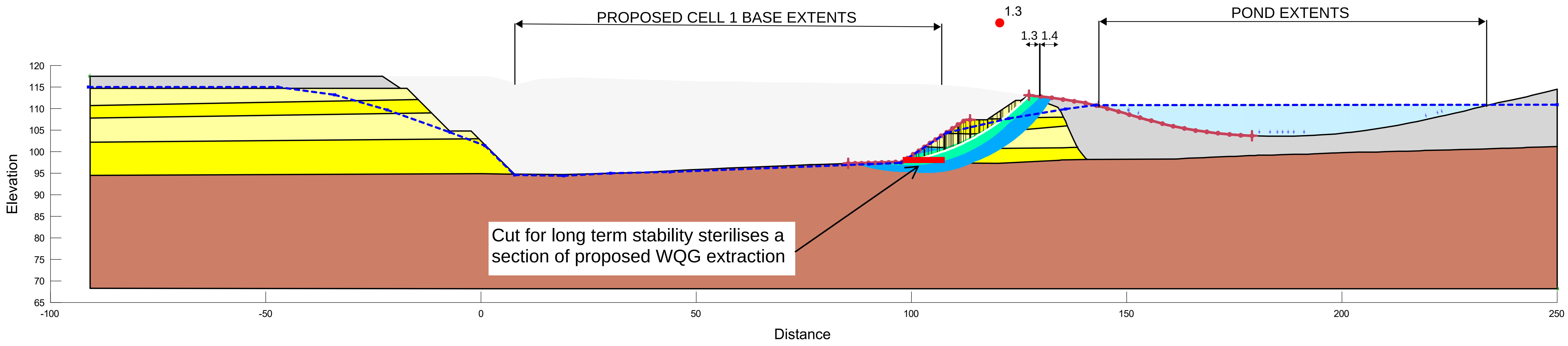
Analysis Notes:
1. Name: CS2 - Case 02a: Long Term Stability (without buttress)
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

<u>Long term Stability (No buttress) - Batter Dimensions (<30m slope height)</u>
1. <u>Tailings</u>
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. <u>Natural materials</u>
   - Cut at 1H:1V with 5m wide catch benches every 10m slope height

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40



Tonkin+Taylor	Title: 20220513_Waikaka Gold Mine_SlopeW.gsz	Job Number:	1014898
	Analysis: CS2 - Case 02a: Long Term Stability (without buttress)	Analysed by:	CRB
	Comments: Scale: 1:1,000 @ A3	Checked by:	BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS2 - Case 02b: Long Term Stability (with buttress)
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

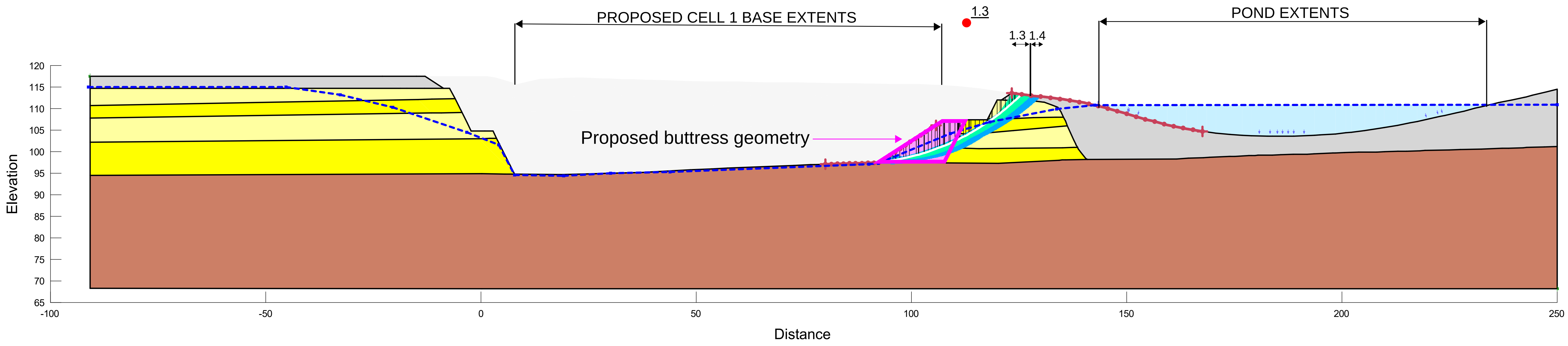
Long term Stability (with buttress) - Batter Dimensions (<30m slope height)

1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of 1/2 of slope height.
2. Natural materials
   - Cut at 1H:0.5V with 5m wide catch benches every 10m slope height
3. Buttress
   - Construction of buttress adjacent to temporary slope, with following dimensions:
     - Minimum height of 1/2 of slope height
     - Minimum width of crest is 1/3 of the slope height
     - Battered at 2H:1V.

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40
	Unit 4 - Backfill (Drained)	18	0	32



Tonkin+Taylor

Title: 20220513_Waikaka Gold Mine_SlopeW.gsz	Job Number: 1014898
Analysis: CS2 - Case 02b: Long Term Stability (with buttress)	Analysed by: CRB
Comments: Scale: 1:1,000 @ A3	Checked by: BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

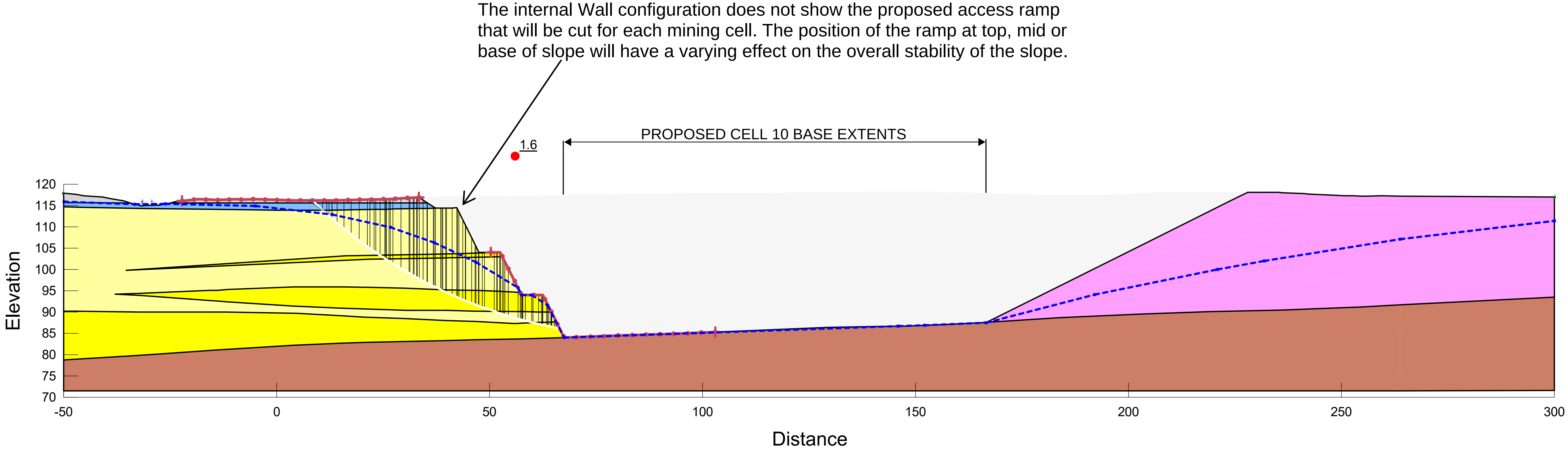
Analysis Notes:
1. Name: CS3 - Case 01: Temporary Stability
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Temporary Stability - Batter Dimensions (<40m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 0.5H:1V with 5m wide catch benches every 10m slope height

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18		0	32
	Unit 1b - Waikaka Blue (Undrained)	18	25		
	Unit 2a - Clay (Undrained)	18	200		
	Unit 2b - Gravel (Drained)	19		3	45
	Unit 3 - Gore Lignite Measures (Drained)	18		10	40
	Unit 4 - Backfill (Drained)	18		0	32



Tonkin+Taylor	Title: 20220516_Waikaka Gold Mine_SlopeW.gsz		Job Number: 1014898
	Analysis: CS3 - Case 01: Temporary Stability		Analysed by: CRB
	Comments:	Scale: 1:1,000 @ A3	Checked by: BMCD

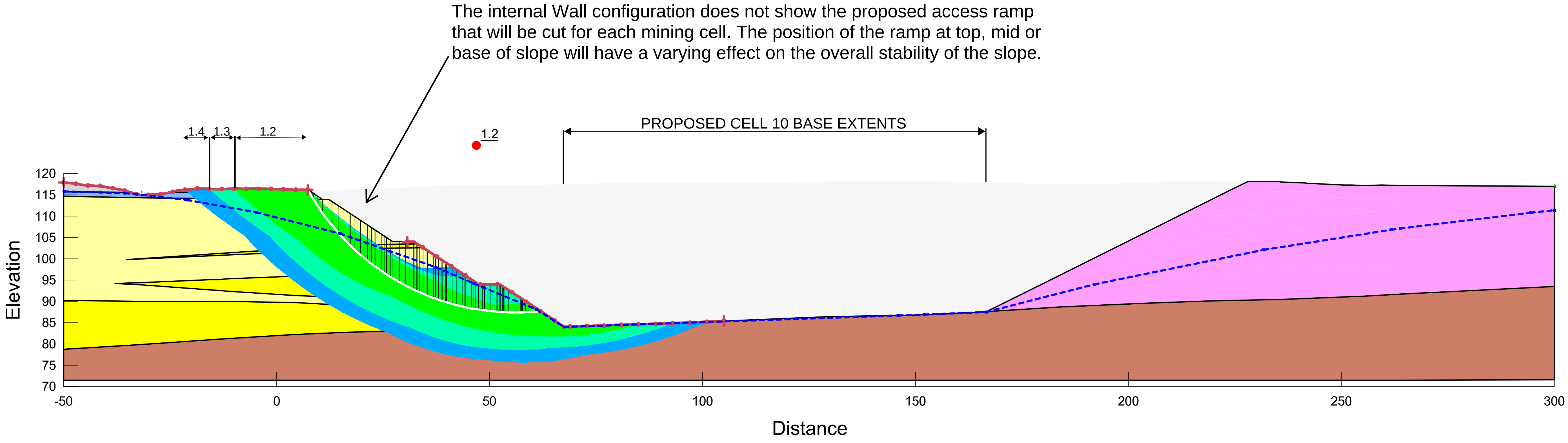
Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS3 - Case 02: Long Term Stability
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Long term Stability - Batter Dimensions (<50m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 1.5H:1V with 5m wide catch benches every 10m slope height

Factor of Safety
- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 1b - Waikaka Blue (Drained)	18	0	22
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40
	Unit 4 - Backfill (Drained)	18	0	32



Tonkin+Taylor

Title: 20220516_Waikaka Gold Mine_SlopeW.gsz		Job Number:	1014898
Analysis: CS3 - Case 02a: Long Term Stability		Analysed by:	CRB
Comments:	Scale: 1:1,000 @ A3	Checked by:	BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS3 - Case 03a: Backfill Stability
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

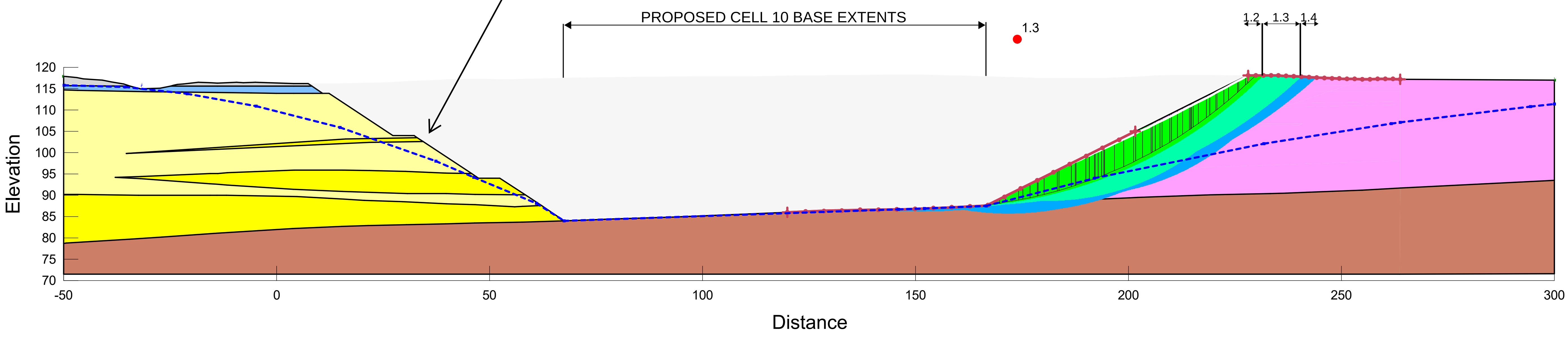
Backfill Stability - Batter Dimensions (Reduced groundwater level)
- Batter of 2H:1V

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 1b - Waikaka Blue (Drained)	18	0	22
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40
	Unit 4 - Backfill (Drained)	18	0	32

The internal Wall configuration does not show the proposed access ramp that will be cut for each mining cell. The position of the ramp at top, mid or base of slope will have a varying effect on the overall stability of the slope.



Tonkin+Taylor

Title: 20220516_Waikaka Gold Mine_SlopeW.gsz	Job Number: 1014898
Analysis: CS3 - Case 03a: Backfill Stability (Reduced groundwater level)	Analysed by: CRB
Comments: / Scale: 1:1,000 @ A3	Checked by: BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

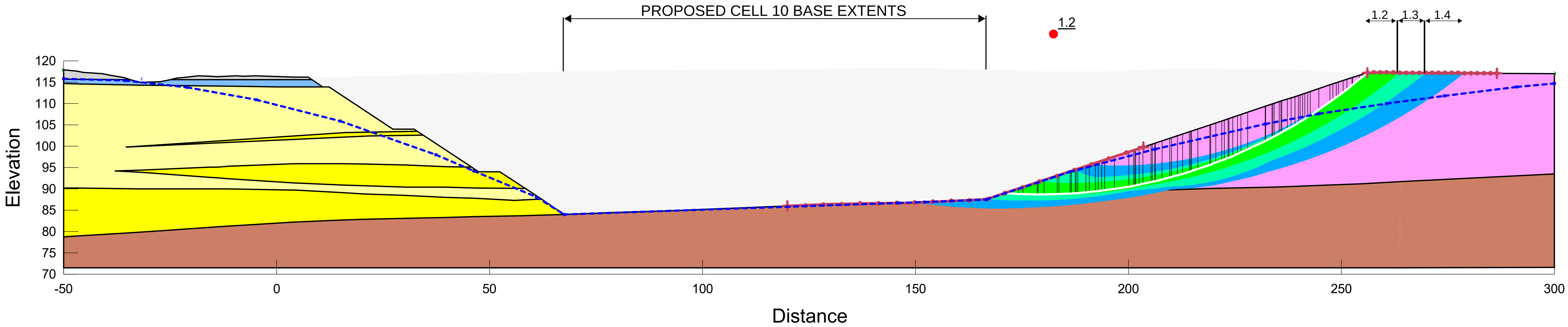
Analysis Notes:
1. Name: CS3 - Case 03b: Backfill Stability - High Groundwater
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Backfill Stability - Batter Dimensions (Recovered groundwater level)
- Batter of 3H:1V

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 1b - Waikaka Blue (Drained)	18	0	22
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40
	Unit 4 - Backfill (Drained)	18	0	32



Title: 20220516_Waikaka Gold Mine_SlopeW.gsz
Analysis: CS3 - Case 03b: Backfill Stability (Recovered groundwater level)
Comments:
Scale: 1:1,000 @ A3
Job Number: 1014898
Analysed by: CRB
Checked by: BMCD

Tonkin+Taylor

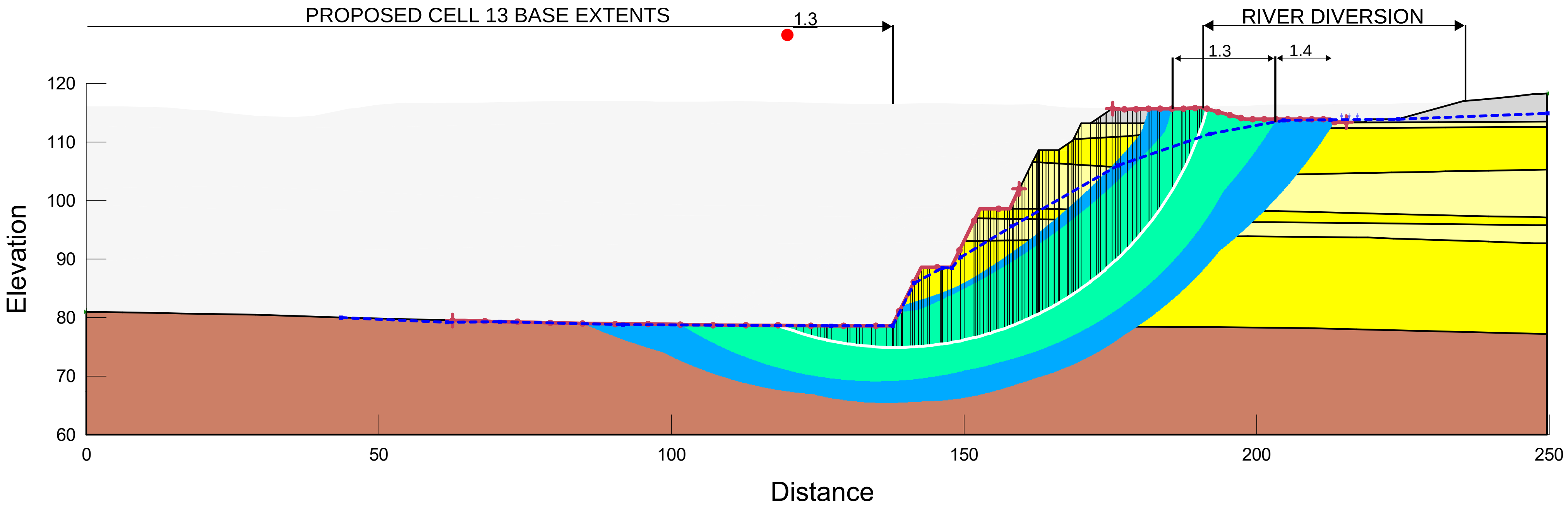
Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS4 - Case 01: Temporary Stability
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Temporary Stability - Batter Dimensions (<40m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 0.5H:1V with 5m wide catch benches every 10m slope height

Factor of Safety
- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18		0	32
	Unit 2a - Clay (Undrained)	18	200		
	Unit 2b - Gravel (Drained)	19		3	45
	Unit 3 - Gore Lignite Measures (Drained)	18		10	40



Title: 20220516_Waikaka Gold Mine_SlopeW.gsz

Analysis: CS4 - Case 01: Temporary Stability

Comments:

Scale: 1:1,000 @ A3

Job Number: 1014898

Analysed by: CRB

Checked by: BMCD

Tonkin+Taylor

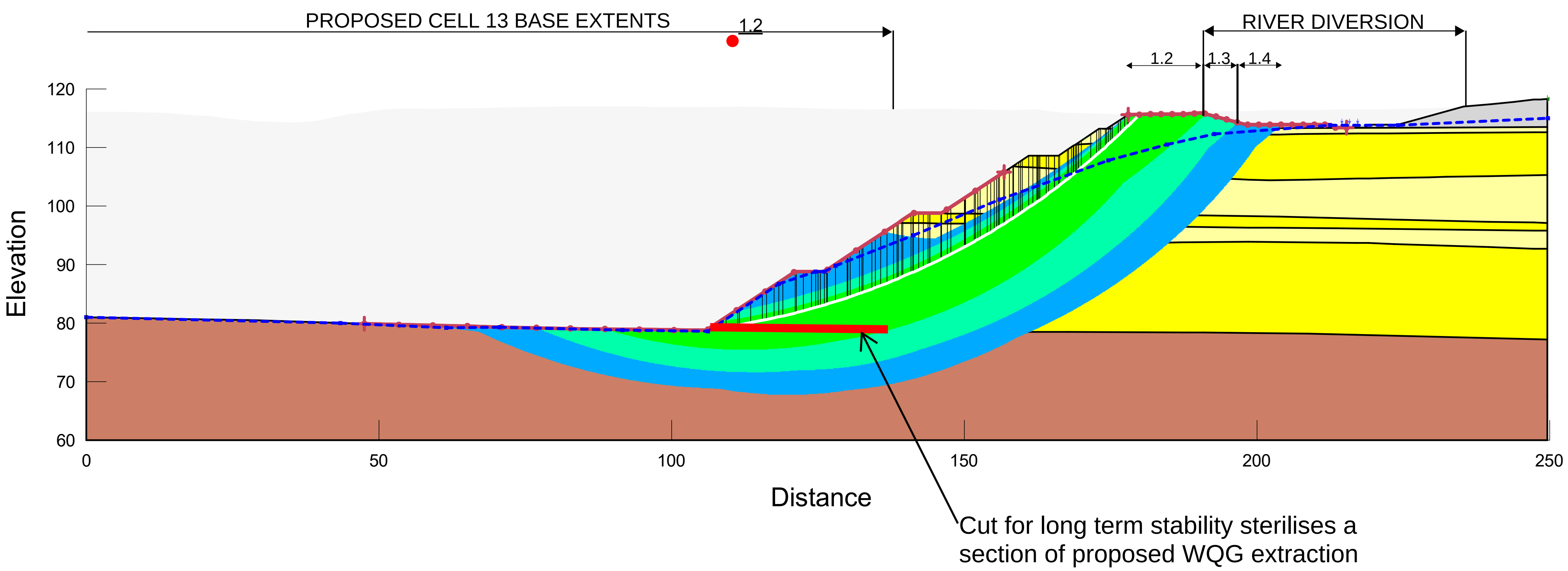
Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS4 - Case 02a: Long Term Stability (without buttress)
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Long term Stability (No Buttress) - Batter Dimensions (<50m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 1.5H:1V with 5m wide catch benches every 10m slope height

Factor of Safety
- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40



Tonkin+Taylor	Title: 20220516_Waikaka Gold Mine_SlopeW.gsz	Job Number: 1014898
	Analysis: CS4 - Case 02a: Long Term Stability (without buttress)	Analysed by: CRB
	Comments: / Scale: 1:1,000 @ A3	Checked by: BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS4 - Case 02b: Long Term Stability (with buttress)
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

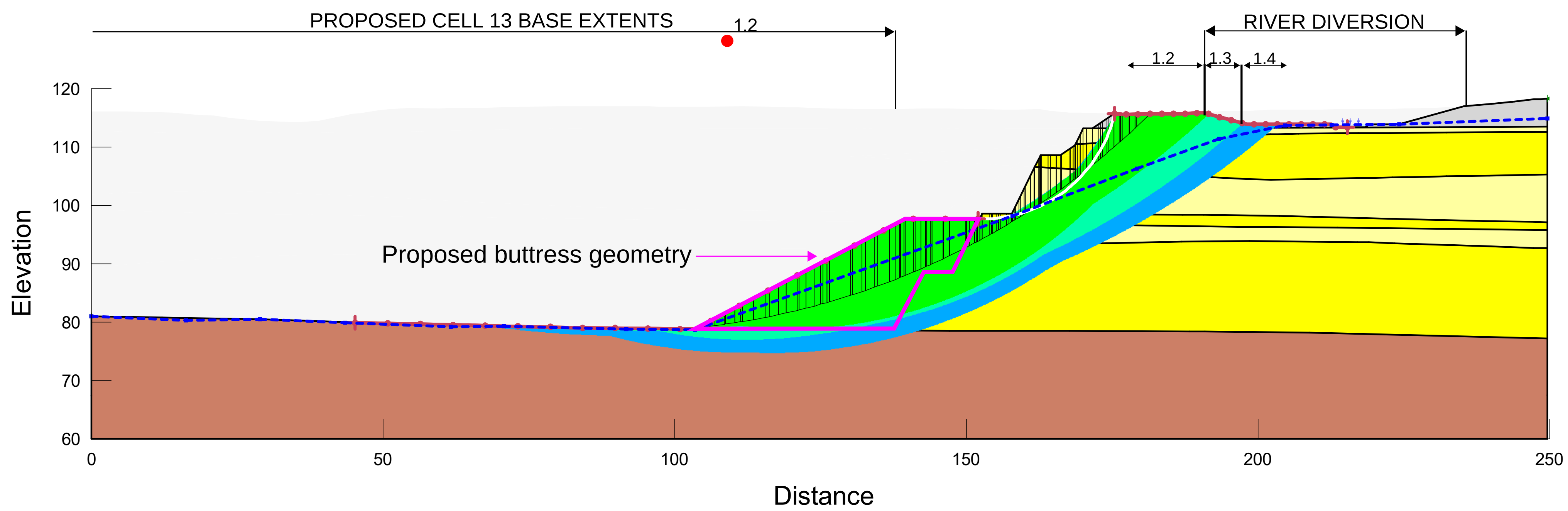
Long term Stability (with buttress) - Batter Dimensions (<40m slope height)

1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of 1/2 of slope height.
2. Natural materials
   - Cut at 1H:0.5V with 5m wide catch benches every 10m slope height
3. Buttress
   - Construction of buttress adjacent to temporary slope, with following dimensions:
     - Minimum height of 1/2 of slope height
     - Minimum width of crest is 1/3 of the slope height
     - Battered at 2H:1V.

Factor of Safety

Red	≤ 0.9 - 1.0
Orange	1.0 - 1.1
Yellow-green	1.1 - 1.2
Green	1.2 - 1.3
Aqua	1.3 - 1.4
Blue	1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40
	Unit 4 - Backfill (Drained)	18	0	32



Tonkin+Taylor

Title: 20220516_Waikaka Gold Mine_SlopeW.gsz		Job Number: 1014898
Analysis: CS4 - Case 02b: Long Term Stability (with buttress)		Analysed by: CRB
Comments:	Scale: 1:1,000 @ A3	Checked by: BMCD

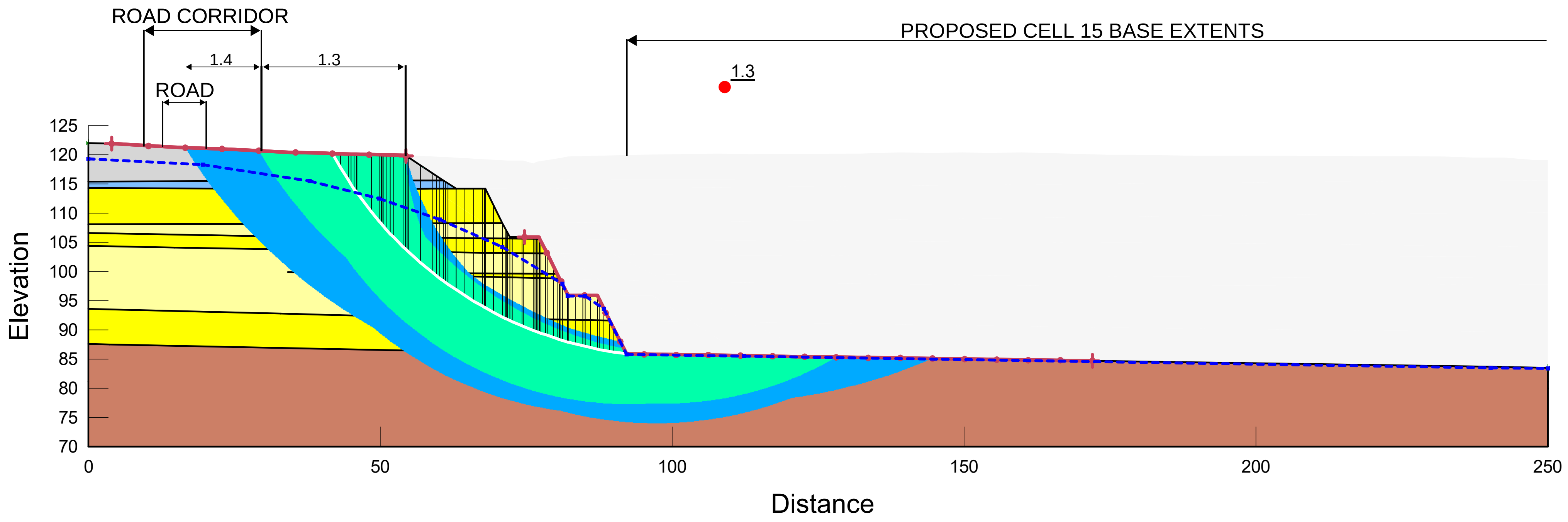
Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS5 - Case 01: Temporary Stability
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Temporary Stability - Batter Dimensions (<40m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 0.5H:1V with 5m wide catch benches every 10m slope height

Factor of Safety
- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18		0	32
	Unit 1b - Waikaka Blue (Undrained)	18	25		
	Unit 2a - Clay (Undrained)	18	200		
	Unit 2b - Gravel (Drained)	19		3	45
	Unit 3 - Gore Lignite Measures (Drained)	18		10	40



Tonkin+Taylor

Title: 20220516_Waikaka Gold Mine_SlopeW.gsz		Job Number: 1014898
Analysis: CS5 - Case 01: Temporary Stability		Analysed by: CRB
Comments:	Scale: 1:1,000 @ A3	Checked by: BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS5 - Case 02a: Long Term Stability (without buttress)
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

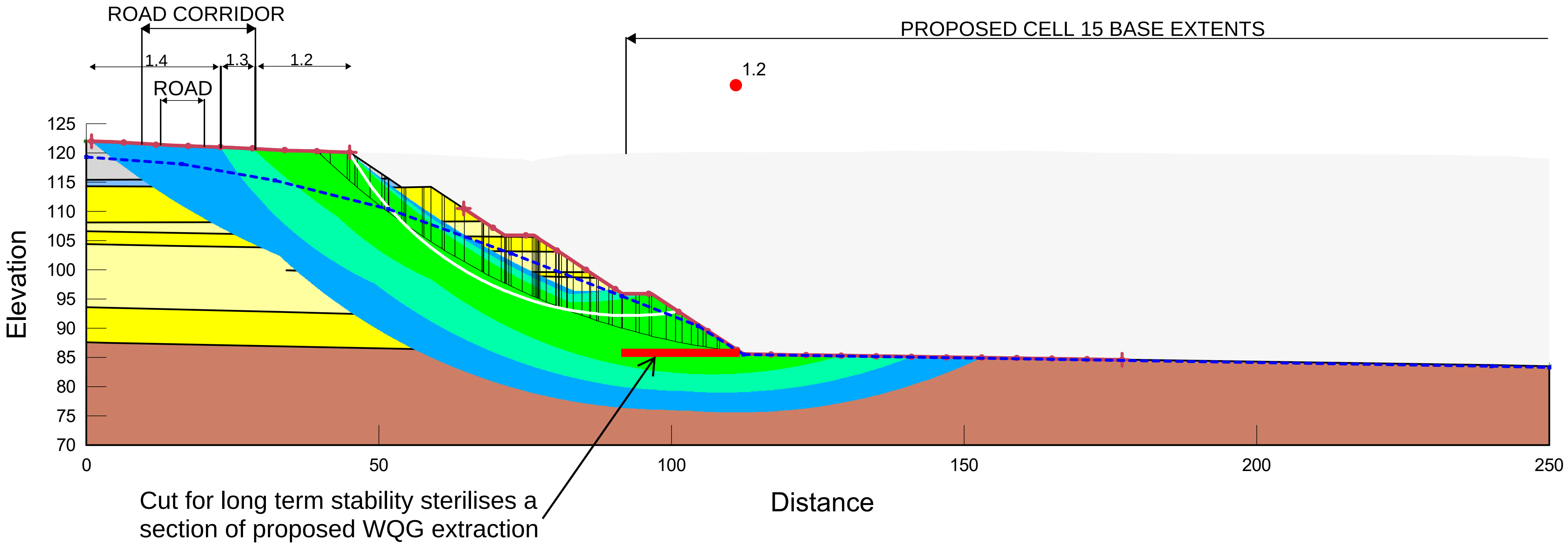
Long term Stability (No buttress) - Batter Dimensions (<50m slope height)

1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 1.5H:1V with 5m wide catch benches every 10m slope height

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 1b - Waikaka Blue (Drained)	18	0	22
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40



Tonkin+Taylor

Title: 20220516_Waikaka Gold Mine_SlopeW.gsz	Job Number: 1014898
Analysis: CS5 - Case 02a: Long Term Stability (without buttress)	Analysed by: CRB
Comments: Scale: 1:1,000 @ A3	Checked by: BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

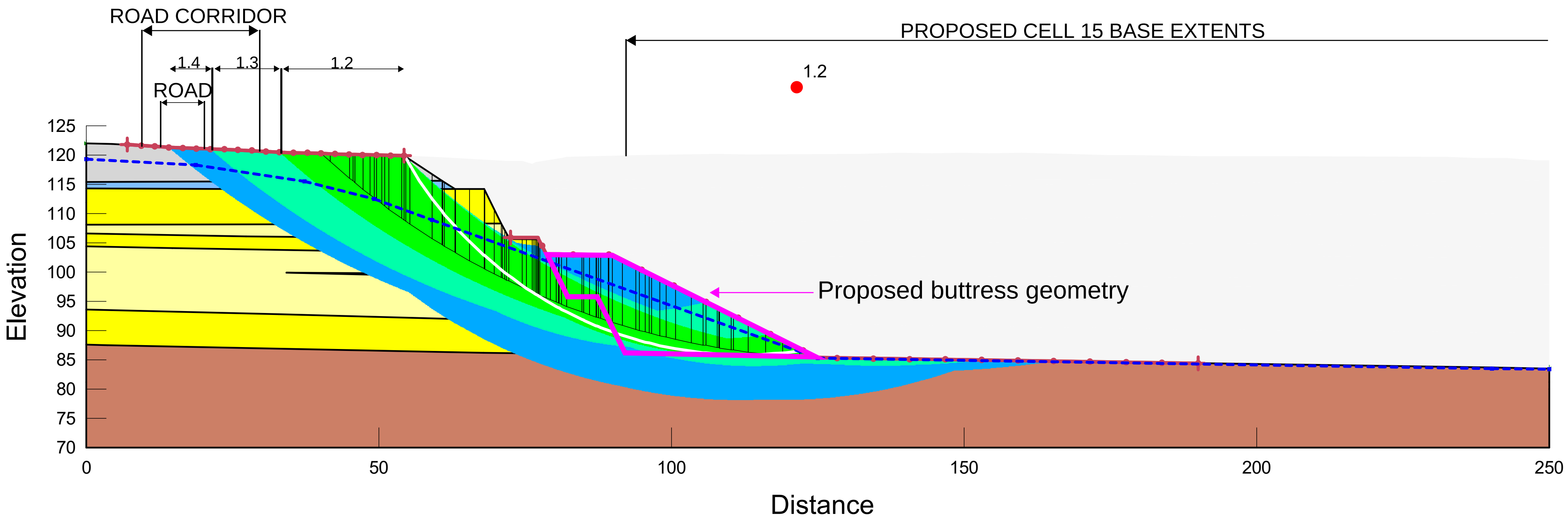
Analysis Notes:
1. Name: CS5 - Case 02b: Long Term Stability (with buttress)
2. Method: Morgenstern-Price
3. Direction of movement: Left to Right
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

Long term Stability (with buttress) - Batter Dimensions (<40m slope height)
1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of 1/2 of slope height.
2. Natural materials
   - Cut at 1H:0.5V with 5m wide catch benches every 10m slope height
3. Buttress
   - Construction of buttress adjacent to temporary slope, with following dimensions:
     - Minimum height of 1/2 of slope height
     - Minimum width of crest is 1/3 of the slope height
     - Battered at 2H:1V.

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 1b - Waikaka Blue (Drained)	18	0	22
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40
	Unit 4 - Backfill (Drained)	18	0	32



Title: 20220516_Waikaka Gold Mine_SlopeW.gsz		Job Number: 1014898
Analysis: CS5 - Case 02b: Long Term Stability (with buttress)		Analysed by: CRB
Comments:	Scale: 1:1,000 @ A3	Checked by: BMCD

Tonkin+Taylor

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS6 - Case 01: Temporary Stability
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

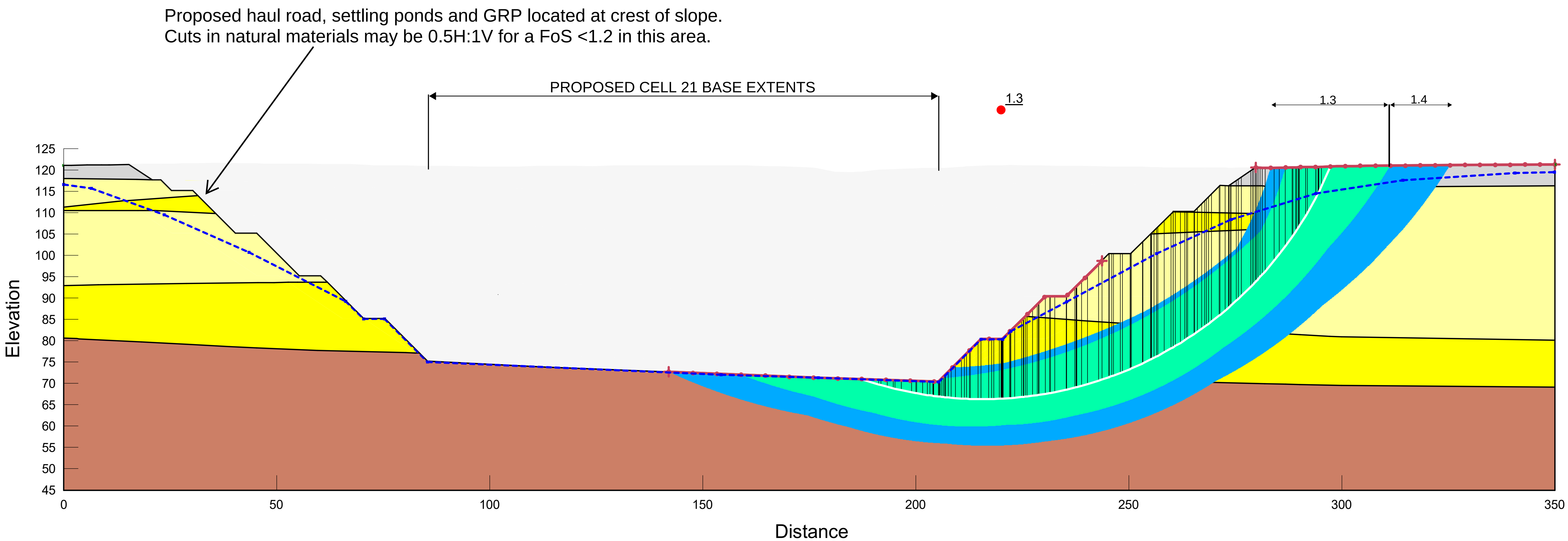
Temporary Stability - Batter Dimensions (<50m slope height)

1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 1H:1V with 5m wide catch benches every 10m slope height

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion (kPa)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18		0	32
	Unit 2a - Clay (Undrained)	18	200		
	Unit 2b - Gravel (Drained)	19		3	45
	Unit 3 - Gore Lignite Measures (Drained)	18		10	40



Tonkin+Taylor	Title: 20220516_Waikaka Gold Mine_SlopeW.gsz	Job Number:	1014898
	Analysis: CS6 - Case 01: Temporary Stability	Analysed by:	CRB
	Comments: Scale: 1:1,000 @ A3	Checked by:	BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Analysis Notes:
1. Name: CS6 - Case 02: Long Term Stability
2. Method: Morgenstern-Price
3. Direction of movement: Right to Left
4. Slip Surface Option: Entry and Exit
5. PWP Conditions Source: Piezometric Line
6. Optimization: No
7. Tension Crack Option: (none)
8. F of S Calculation Option: Constant
9. Horz Seismic Load:

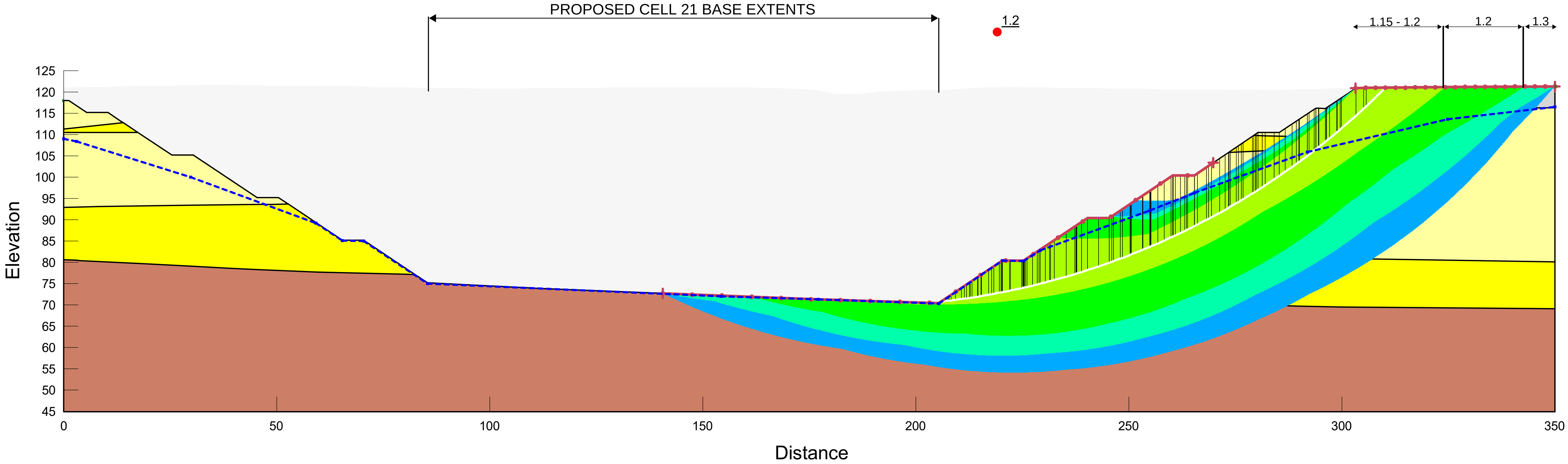
Long term Stability - Batter Dimensions (<50m slope height)

1. Tailings
   - Cut at 1.5H:1V with catch bench at base, minimum width of half of slope height.
2. Natural materials
   - Cut at 1.5H:1V with 5m wide catch benches every 10m slope height

Factor of Safety

- ≤ 0.9 - 1.0
- 1.0 - 1.1
- 1.1 - 1.2
- 1.2 - 1.3
- 1.3 - 1.4
- 1.4 - 1.5

Color	Name	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
	Unit 1a - Tailings (Drained)	18	0	32
	Unit 2a - Clay (Drained)	18	10	30
	Unit 2b - Gravel (Drained)	19	3	45
	Unit 3 - Gore Lignite Measures (Drained)	18	10	40



Tonkin+Taylor

Title: 20220516_Waikaka Gold Mine_SlopeW.gsz		Job Number: 1014898
Analysis: CS6 - Case 02: Long Term Stability		Analysed by: CRB
Comments:	Scale: 1:1,000 @ A3	Checked by: BMCD

Directory: T:\Christchurch\TT Projects\1018498\WorkingMaterial\Slope stability\

Appendix C: Laboratory testing

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 21/3744

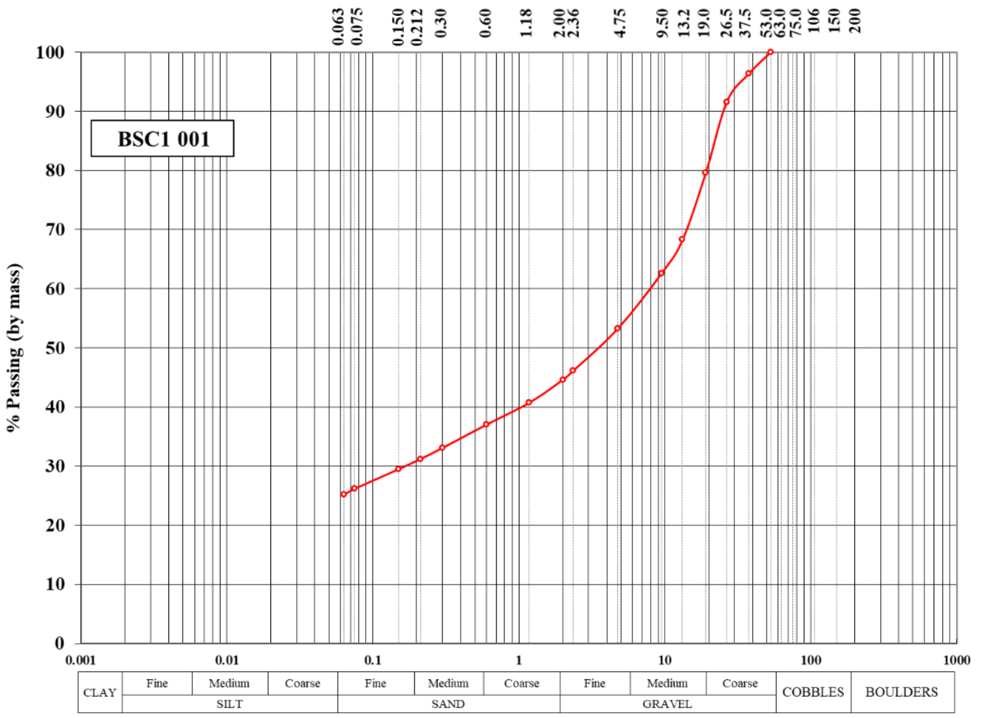
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	Waikaia Gold Ltd, No 7 RD, Gore	**Attention:**	N. Becker
Job Description:	Waikaka Gold Mine Investigations		
Sample Description:	Silty GRAVEL with some sand and some clay	**Client Order No:**	N/A
Sample Source: (cs)	BSC1 001 (RL 118 - 113)	**Sample Label No:**	N/A
Date & Time Sampled:	Unknown	**Sampled By:**	Unknown
Sample Method:	Unknown	**Date Received:**	11-Dec-21

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	100
37.5	96
26.5	92
19.0	80
13.2	68
9.50	63
4.75	53
2.36	46
2.00	45
1.18	41
0.60	37
0.30	33
0.212	31
0.150	29
0.075	26
0.063	25



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	15.2 %
Liquid Limit: (LL)	29
Plastic Limit: (PL)	21
Plasticity Index: (PI)	8

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.*
- *This report may not be reproduced except in full.*

Tested By: K. Hipkins, C. Pearson & L.T. Smith **Date:** 6-Jan-22 to 1-Mar-22

Checked By:

ACCREDITED IANZ TESTING LABORATORY № 434

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 21/3744

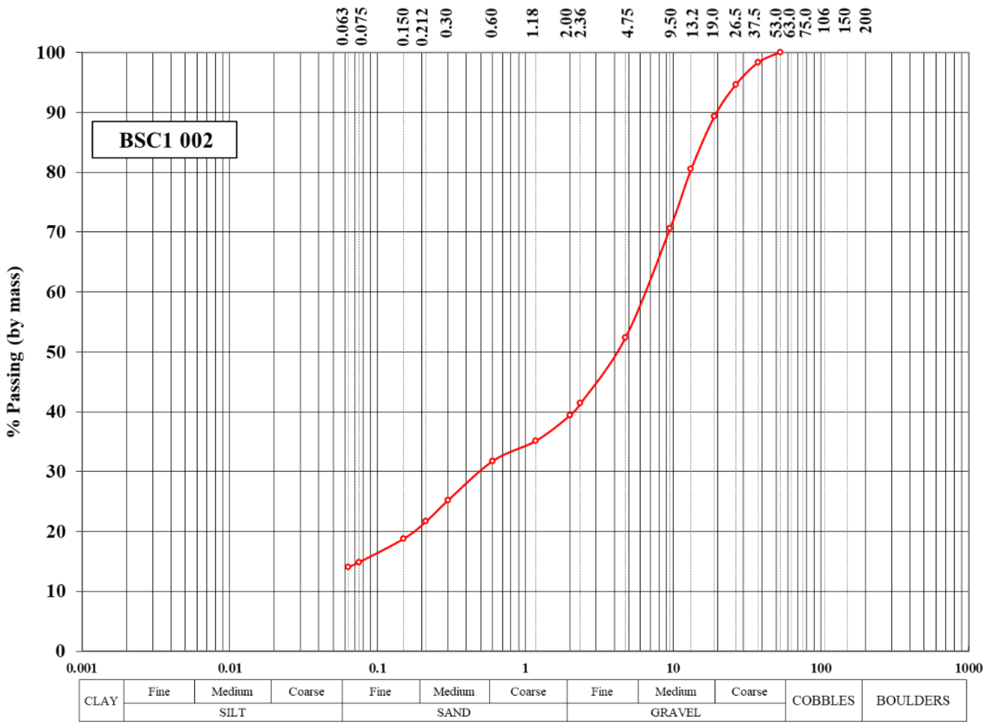
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	Waikaia Gold Ltd, No 7 RD, Gore	**Attention:**	N. Becker
Job Description:	Waikaka Gold Mine Investigations		
Sample Description:	Sandy GRAVEL with some silt & trace of clay	**Client Order No:**	N/A
Sample Source: (cs)	BSC1 002: (RL 113 - 108)	**Sample Label No:**	N/A
Date & Time Sampled:	Unknown	**Sampled By:**	Unknown
Sample Method:	Unknown	**Date Received:**	11-Dec-21

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	100
37.5	98
26.5	95
19.0	89
13.2	81
9.50	71
4.75	52
2.36	41
2.00	39
1.18	35
0.60	32
0.30	25
0.212	22
0.150	19
0.075	15
0.063	14



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4

Water Content: ("All In" As Received)	12.1 %
Liquid Limit: (LL)	24
Plastic Limit: (PL)	19
Plasticity Index: (PI)	5

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

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Tested By: K. Hipkins, C. Pearson & L.T. Smith **Date:** 6-Jan-22 to 1-Mar-22

Checked By:

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Reference No: 21/3744

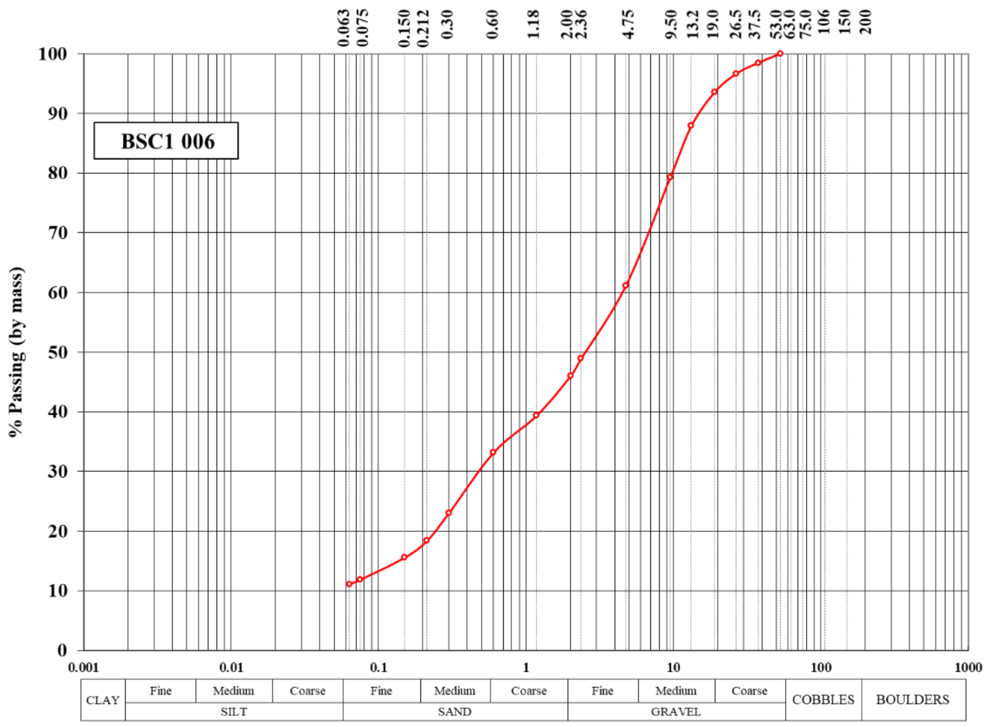
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	Waikaia Gold Ltd, No 7 RD, Gore	**Attention:**	N. Becker
Job Description:	Waikaka Gold Mine Investigations		
Sample Description:	Sandy GRAVEL with minor silt	**Client Order No:**	N/A
Sample Source: (cs)	BCS1 006: (RL 91 - 85)	**Sample Label No:**	N/A
Date & Time Sampled:	Unknown	**Sampled By:**	Unknown
Sample Method:	Unknown	**Date Received:**	11-Dec-21

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	100
37.5	98
26.5	97
19.0	94
13.2	88
9.50	79
4.75	61
2.36	49
2.00	46
1.18	39
0.60	33
0.30	23
0.212	18
0.150	16
0.075	12
0.063	11



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	10.7 %
Liquid Limit: (LL)	Not Applicable
Plastic Limit: (PL)	Non - Plastic
Plasticity Index: (PI)	Non - Plastic
Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.	

Notes:

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Tested By: K. Hipkins, C. Pearson & L.T. Smith **Date:** 6-Jan-22 to 1-Mar-22

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Reference No: 21/3744

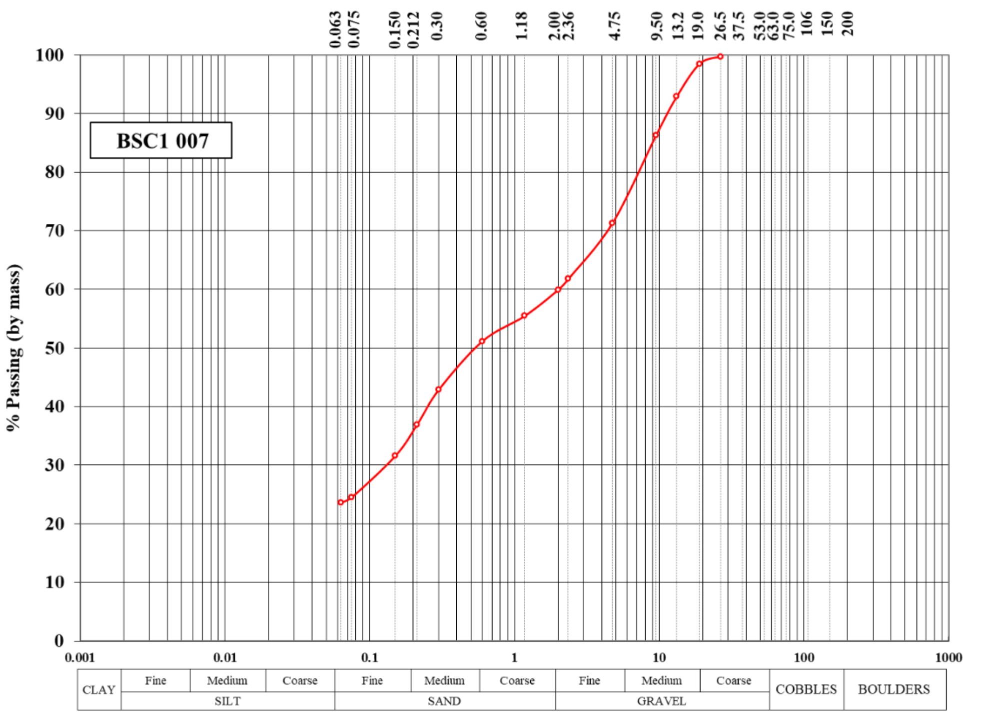
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	Waikaia Gold Ltd, No 7 RD, Gore	**Attention:**	N. Becker
Job Description:	Waikaka Gold Mine Investigations		
Sample Description:	Silty SAND & GRAVEL with trace of clay	**Client Order No:**	N/A
Sample Source: (cs)	BSC1 007: (RL 85 - 78)	**Sample Label No:**	N/A
Date & Time Sampled:	Unknown	**Sampled By:**	Unknown
Sample Method:	Unknown	**Date Received:**	11-Dec-21

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	
37.5	
26.5	100
19.0	98
13.2	93
9.50	86
4.75	71
2.36	62
2.00	60
1.18	55
0.60	51
0.30	43
0.212	37
0.150	32
0.075	25
0.063	24



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	10.6 %
Liquid Limit: (LL)	22
Plastic Limit: (PL)	18
Plasticity Index: (PI)	4

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.*
- *This report may not be reproduced except in full.*

Tested By: K. Hipkins, C. Pearson & L.T. Smith **Date:** 6-Jan-22 to 1-Mar-22

Checked By:

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Reference No: 21/3744

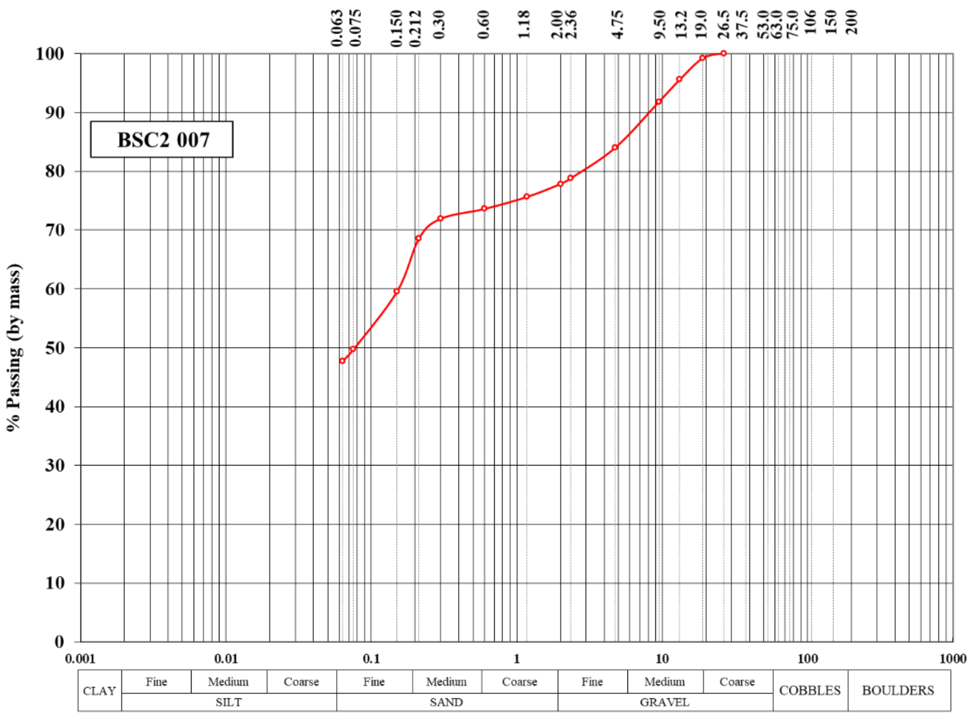
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	Waikaia Gold Ltd, No 7 RD, Gore	**Attention:**	N. Becker
Job Description:	Waikaka Gold Mine Investigations		
Sample Description:	Gravelly Sandy Silty CLAY	**Client Order No:**	N/A
Sample Source: (cs)	BSC2 007: (RL 85 - 79)	**Sample Label No:**	N/A
Date & Time Sampled:	Unknown	**Sampled By:**	Unknown
Sample Method:	Unknown	**Date Received:**	11-Dec-21

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	
37.5	
26.5	100
19.0	99
13.2	96
9.50	92
4.75	84
2.36	79
2.00	78
1.18	76
0.60	74
0.30	72
0.212	69
0.150	60
0.075	50
0.063	48



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	13.6 %
Liquid Limit: (LL)	31
Plastic Limit: (PL)	17
Plasticity Index: (PI)	14

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

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Tested By: K. Hipkins, C. Pearson & L.T. Smith **Date:** 6-Jan-22 to 1-Mar-22

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Reference No: 21/3744

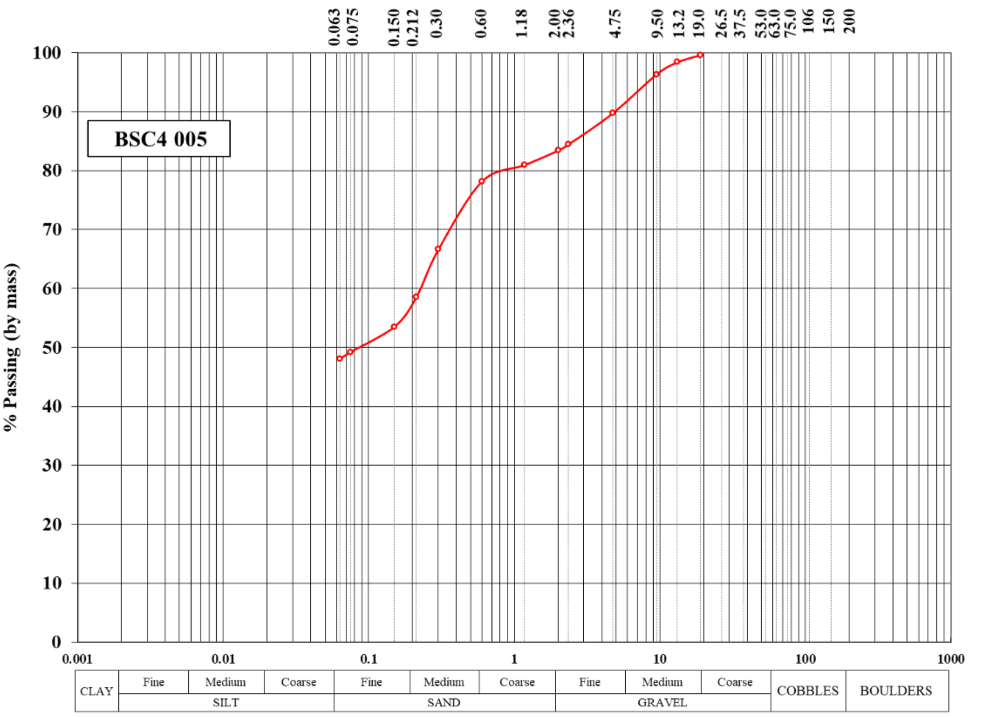
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	Waikaia Gold Ltd, No 7 RD, Gore	**Attention:**	N. Becker
Job Description:	Waikaka Gold Mine Investigations		
Sample Description:	Sandy Silty CLAY with some gravel	**Client Order No:**	N/A
Sample Source: (cs)	BSC4 005: (RL 94 - 88)	**Sample Label No:**	N/A
Date & Time Sampled:	Unknown	**Sampled By:**	Unknown
Sample Method:	Unknown	**Date Received:**	11-Dec-21

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	
37.5	
26.5	
19.0	100
13.2	98
9.50	96
4.75	90
2.36	84
2.00	83
1.18	81
0.60	78
0.30	67
0.212	59
0.150	54
0.075	49
0.063	48



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	20.1 %
Liquid Limit: (LL)	34
Plastic Limit: (PL)	17
Plasticity Index: (PI)	17

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

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Tested By: K. Hipkins, C. Pearson & L.T. Smith **Date:** 6-Jan-22 to 1-Mar-22

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P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 21/3744

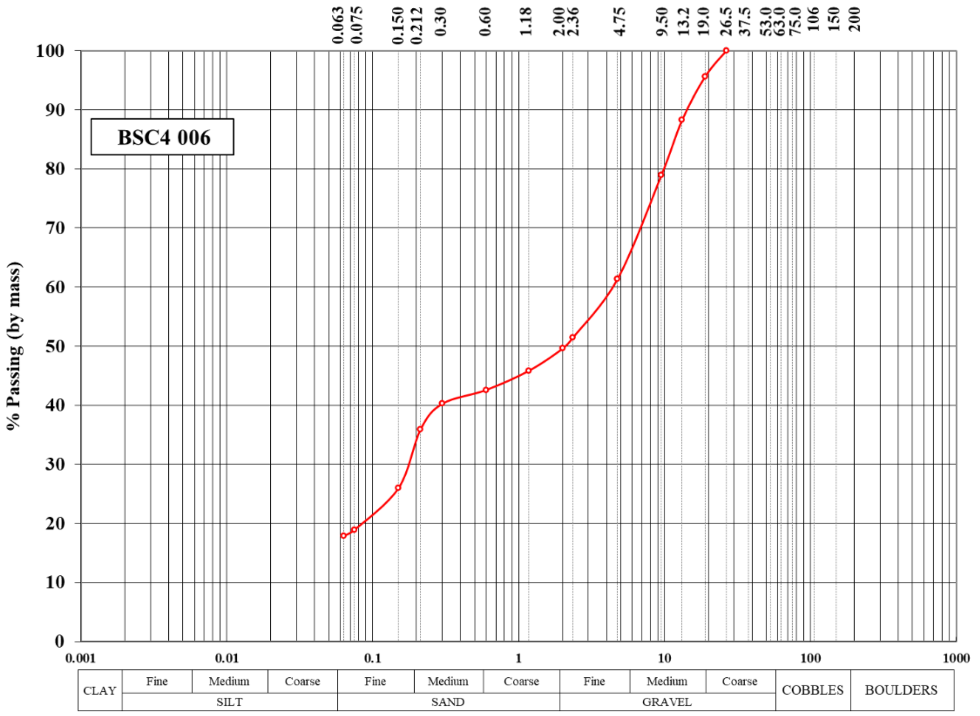
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	**Waikaia Gold Ltd, No 7 RD, Gore**	**Attention:**	**N. Becker**
Job Description:	**Waikaka Gold Mine Investigations**		
Sample Description:	**Sandy GRAVEL with some silt**	**Client Order No:**	**N/A**
Sample Source: [(cs)]	**BSC4 006: (RL 88 - 83)**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method:	**Unknown**	**Date Received:**	**11-Dec-21**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	
37.5	
26.5	100
19.0	96
13.2	88
9.50	79
4.75	61
2.36	51
2.00	50
1.18	46
0.60	43
0.30	40
0.212	36
0.150	26
0.075	19
0.063	18



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	**20.4 %**
Liquid Limit: (LL)	**22**
Plastic Limit: (PL)	**Non - Plastic**
Plasticity Index: (PI)	**Non - Plastic**

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

- ***Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information [(cs)] and sampling.***
- ***This report may not be reproduced except in full.***

Tested By: **K. Hipkins, C. Pearson & L.T. Smith** **Date:** **6-Jan-22 to 1-Mar-22**

Checked By:

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Reference No: 21/3744

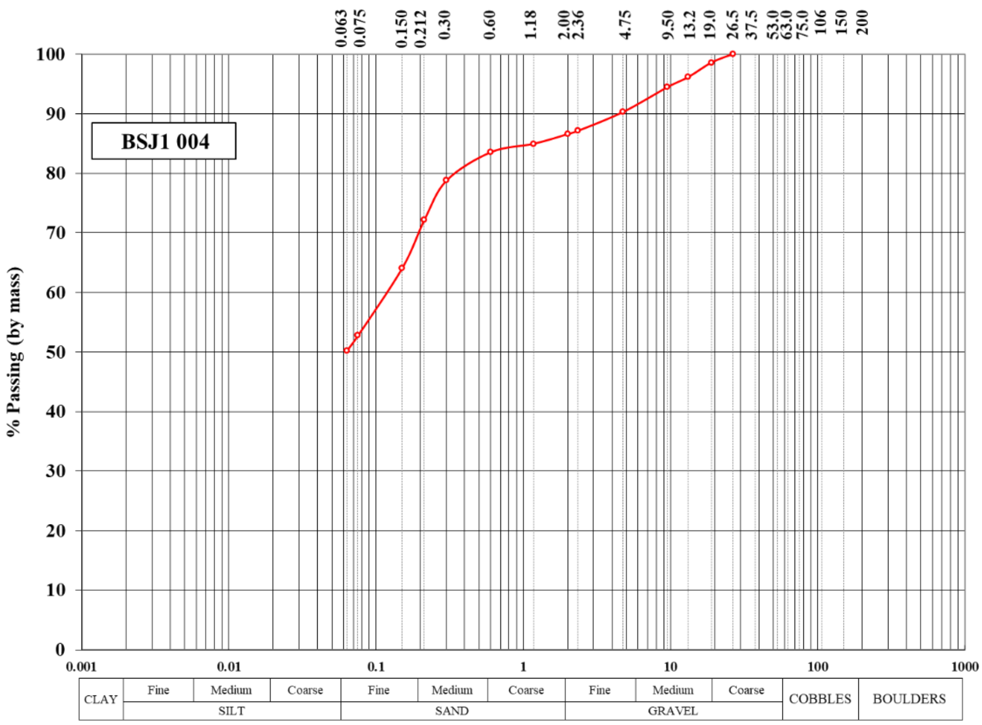
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	**Waikaia Gold Ltd, No 7 RD, Gore**	**Attention:**	**N. Becker**
Job Description:	**Waikaka Gold Mine Investigations**		
Sample Description:	**Sandy Silty CLAY with some gravel**	**Client Order No:**	**N/A**
Sample Source: (cs)	**BSJ1 004: (RL 100 - 96)**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method:	**Unknown**	**Date Received:**	**11-Dec-21**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	
37.5	
26.5	100
19.0	99
13.2	96
9.50	94
4.75	90
2.36	87
2.00	87
1.18	85
0.60	84
0.30	79
0.212	72
0.150	64
0.075	53
0.063	50



The sample was received in a natural state. The percentage passing the 63μm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	**6.1 %**
Liquid Limit: (LL)	**30**
Plastic Limit: (PL)	**16**
Plasticity Index: (PI)	**14**

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 μm test sieve.

Notes:

- ***Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information (cs) and sampling.***
- ***This report may not be reproduced except in full.***

Tested By: **K. Hipkins, C. Pearson & L.T. Smith** **Date:** **6-Jan-22 to 1-Mar-22**

Checked By:

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Reference No: 21/3744

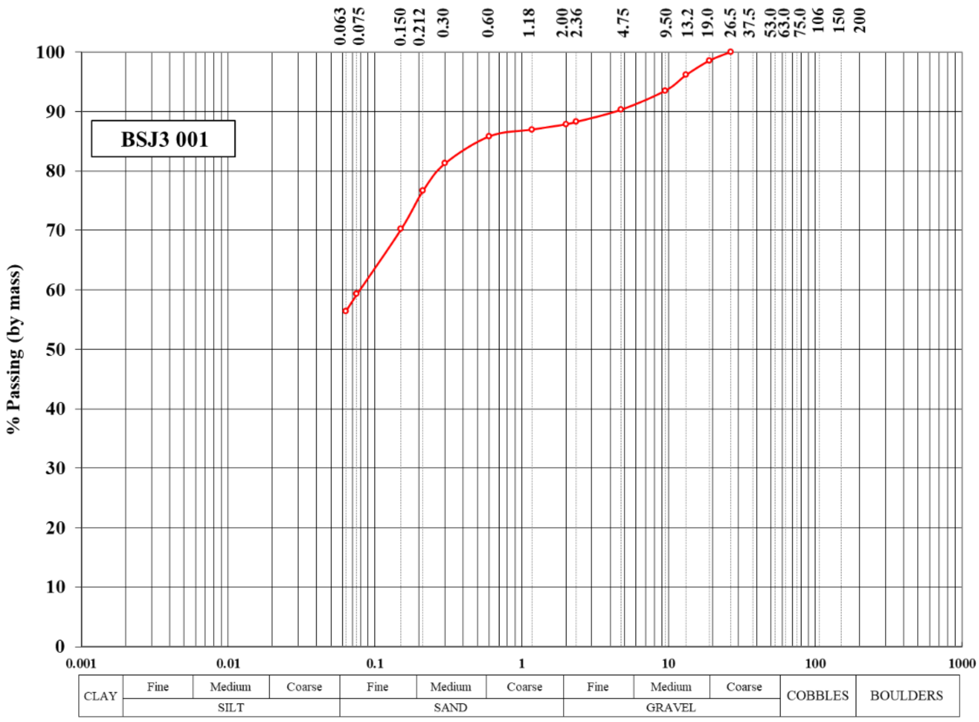
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	Waikaia Gold Ltd, No 7 RD, Gore	**Attention:**	N. Becker
Job Description:	Waikaka Gold Mine Investigations		
Sample Description:	Sandy Silty CLAY with some gravel	**Client Order No:**	N/A
Sample Source: (cs)	BSJ3 001: (RL 118 - 112)	**Sample Label No:**	N/A
Date & Time Sampled:	Unknown	**Sampled By:**	Unknown
Sample Method:	Unknown	**Date Received:**	11-Dec-21

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	
37.5	
26.5	100
19.0	99
13.2	96
9.50	94
4.75	90
2.36	88
2.00	88
1.18	87
0.60	86
0.30	81
0.212	77
0.150	70
0.075	59
0.063	56



The sample was received in a natural state. The percentage passing the 63μm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	25.4 %
Liquid Limit: (LL)	30
Plastic Limit: (PL)	20
Plasticity Index: (PI)	10

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 μm test sieve.

Notes:

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Tested By: K. Hipkins, C. Pearson & L.T. Smith **Date:** 6-Jan-22 to 1-Mar-22

Checked By:

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Reference No: 21/3744

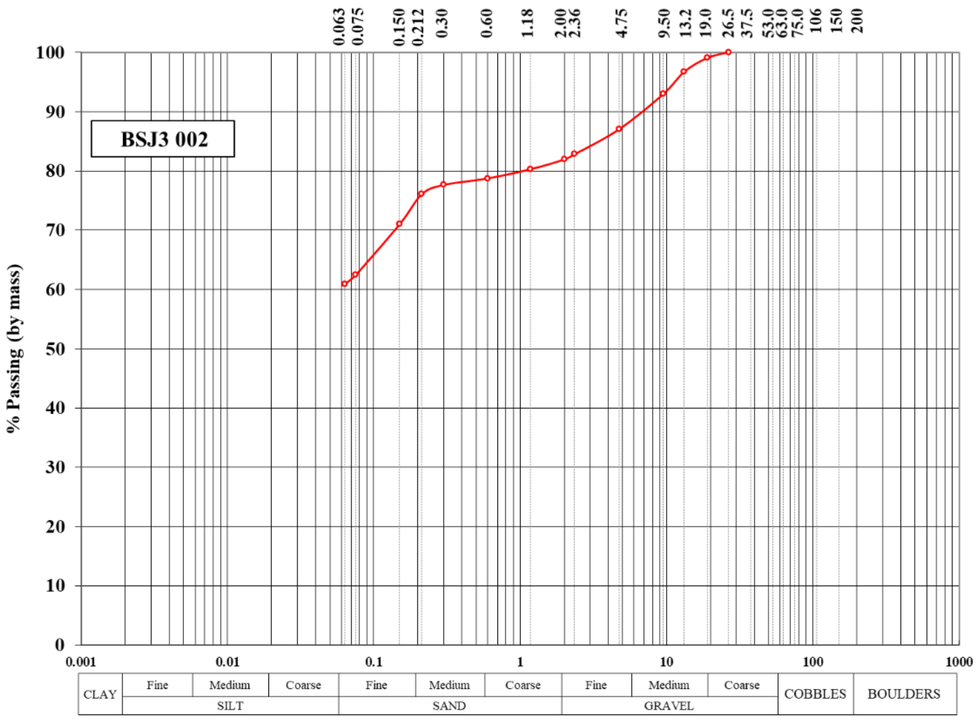
Date: 1 March 2022

TEST REPORT – WAIKAKA GOLD MINE INVESTIGATIONS

Client Details:	**Waikaia Gold Ltd, No 7 RD, Gore**	**Attention:**	**N. Becker**
Job Description:	**Waikaka Gold Mine Investigations**		
Sample Description:	**Sandy Silty CLAY with some gravel**	**Client Order No:**	**N/A**
Sample Source: [cs]	**BSJ3 002: (RL 112 - 100)**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**Unknown**
Sample Method:	**Unknown**	**Date Received:**	**11-Dec-21**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1)

Test Sieve (mm)	% Passing (by mass)
53.0	
37.5	
26.5	100
19.0	99
13.2	97
9.50	93
4.75	87
2.36	83
2.00	82
1.18	80
0.60	79
0.30	78
0.212	76
0.150	71
0.075	63
0.063	61



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference.

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	**15.5 %**
Liquid Limit: (LL)	**43**
Plastic Limit: (PL)	**21**
Plasticity Index: (PI)	**22**

Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.

Notes:

- ***Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the client supplied information [cs] and sampling.***
- ***This report may not be reproduced except in full.***

Tested By: **K. Hipkins, C. Pearson & L.T. Smith** **Date:** **6-Jan-22 to 1-Mar-22**

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

ACCREDITED IANZ TESTING LABORATORY
№ 434

Test results indicated as not accredited are outside the scope of the laboratory's accreditation