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**OCEANA GOLD (NEW ZEALAND) LIMITED**
**MACRAES OPERATION**
**GOLDEN BAR WASTE ROCK STACK – STAGE 2**
**DESIGN REPORT**

Prepared for: 23 May 2023

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## Terminology Abbreviations

| | |
|---|---|
| **ECSP** | Erosion and Sediment Control Plan |
| **EGL** | Engineering Geology Limited |
| **FoS** | Factor of Safety |
| **HMSZ** | Hyde-Macraes Shear Zone |
| **MDE** | Maximum Design Earthquake |
| **MGP** | Macraes Gold Project |
| **MP4** | Macraes Phase 4 |
| **NSHM** | National Seismic Hazard Model |
| **NZSOLD** | New Zealand Society on Large Dams |
| **OBE** | Operating Basis Earthquake |
| **OGNZL** | Oceana Gold (New Zealand) Limited |
| **PGA** | Peak Ground Acceleration |
| **PSM** | Pells Sullivan Meynink |
| **SEE** | Safety Evaluation Earthquake |
| **TSF** | Tailings Storage Facilities |
| **UCS** | Unconfined Compressive Strength |
| $\mathbf{V_{s30}}$ | The average seismic shear-wave velocity from the surface to a depth of 30 m |
| **WDC** | Waitaki District Council |
| **WRS** | Waste Rock Stack |

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## 1.0 INTRODUCTION

Engineering Geology Ltd (EGL) has been requested by Oceana Gold (New Zealand) Limited Macraes Operation to undertake this design report for the Golden Bar Waste Rock Stack (Golden Bar WRS) Stage 2 which raises the stack up to RL610. This report is to support an application for a resource consent to expand the existing WRS.

The Macraes Mine is located at Macraes Flat in East Otago as shown in Figure 1. Gold and scheelite were initially produced at Macraes by underground mining from the 1890’s to the 1920’s. Gold production recommenced for the current operation in 1990 with an open pit mine. It was subsequently extended to include underground mining. Associated with the mining are waste rock stacks (WRS) for disposal of pit overburden material external to the open pit and tailings storage facilities (TSFs).

The Golden Bar Project is a satellite project located approximately 8 km southeast of the Macraes Mine as shown in Figure 1. The Golden Bar Project consists of an existing open pit mine and an existing WRS.

The first stage of the mining at Golden Bar occurred from 2004 to 2006. The existing layout of the Golden Bar Stage 1 Open Pit and Golden Bar WRS are shown in Figure 2. An existing silt pond (Clydesdale Silt Pond) is located at the toe of the northern extent of the existing WRS. The existing WRS has been in place since 2006 and the performance has met design expectations. There is no evidence of instability, deformation, and little surface erosion.

Extension (Stage 2) of the Golden Bar Open Pit, is proposed as part of the Macraes Phase 4 (MP4) Project. An extension of the WRS is also proposed to provide sufficient storage for overburden material (waste rock) mined from the pit. The planned WRS consists of a southwestern extension of the existing WRS, a 70 m extension from the front (northern) face of the current WRS, and a crest raise of approximately 60 m above as-built levels. The storage capacity of the extended WRS is approximately 14 $Mm^3$ with the new crest level at RL610. The proposed Stage 2 of the Golden Bar Pit and WRS are shown in Figure 3.

This design report is prepared for Golden Bar WRS Stage 2. Pells Sullivan Meynink (PSM) is undertaking the slope design for the Golden Bar Stage 2 Pit and their design considers the impact of the open pit on the stability of the WRS (Ref. 1). The analyses covered by this report therefore only considers the stability of the WRS slopes and excludes analyses of potential foundation shear failure toward the expanded pit. The potential for foundation shear failures away from the influence of the pit are considered in the PSM report.

## 2.0 SITE GRID

All plan grids, references and geological orientations referred to in this report are to mine north, which is approximately 45 degrees anti-clockwise from true north.

## 3.0 PERFORMANCE OF THE GOLDEN BAR STAGE 1 WRS

The existing Golden Bar Pit and WRS Stage 1 have been in place since 2006. EGL undertook a walkover of the site on 8 November 2022. Photo 1 shows the pit and Photo 2 shows the downstream slope of the WRS. At the toe of the WRS is the Clydesdale Silt Pond as seen in Photo 3, 6 and 7. The existing slopes are at approximately 2.35H:1V or 23 deg. There was no evidence of major instability or deformation of the WRS. The rehabilitated surface of the WRS was in good condition with little surface erosion. Minor seepage was observed out the toe of the WRS into the silt pond and localised minor slumping or minor backward erosion of the toe of the slope (due to seepage) was visible as is shown in Photo 7.

The Clydesdale Silt Pond was in good condition. There was minor sediment accumulation in the silt pond, which is consistent with the little sediment generation from WRSs observed at the Macraes Operation.

Photo 1 shows a small slip on the cut face above the ramp into the pit in the more weathered schist material. No notable slips were observed on the northern and eastern slopes of the Stage 1 pit.

## 4.0 PROPOSED WRS PROFILE

The proposed footprint and contours for Stage 2 of the Golden Bar WRS is shown in Figure 3 . The geometry of the WRS has been designed assuming 27 Mt of waste rock excavated from the pit and placed in the WRS. An average density of 2.18 t/m$^3$ is assumed for waste rock. This equates to 12.4 Mm$^3$ of storage required. The design allows for 14.0 Mm$^3$ with a crest of RL610. The design allows some contingency volume, which enables the staging of the WRS to allow for haul roads and minor variation in profile and extent if required.

The proposed slopes are at an angle of 2.5 horizontal to 1.0 vertical (2.5H:1V, or 22 deg). To achieve the required fill volumes and maintain operation of the Clydedale Silt Pond during construction, a locally steep section of slope is proposed directly above Clydesdale Silt Pond. The slope angle over this section is 1.35H:1V (37 degrees). Waste rock at Macraes stands much steeper than 1H:1V when end tipped. This section of slope is approximately 8 m high and has a 5m bench at its crest. Once rehabilitation of the northern slopes are complete the bench will be pushed down to infill the Clydesdale Silt Pond for closure. This proposed approach enables the existing silt pond to be used during the Stage 2 expansion of the WRS. This avoids affecting the gully downstream of the existing silt pond.

Photo 1 shows the proposed southwestern extension area above Golden Bar Pit and Photos 2 and 3 show the extension area in front of existing northern face of the Stage 1 WRS down to Clydesdale Silt Pond.

Stage 1 of the WRS targeted a curvilinear slope profile with minor benches to blend into the natural surrounding environment. A similar approach can be achieved as demonstrated by the contours on Figure 3. Figure 7 and 9 shows the profile proposed in cross section (Sections A-A’, B-B’, C-C’, D-D’, and E-E’). The locations of the sections are shown in Figure 2 to 6. The main slope profile shown is 2.5H:1V.

The WRS is set back at least 35 m from the main pit wall. The closest location is Section D-D’.

The waste rock placed in the Golden Bar WRS will be end-tipped, with each layer approximately 10-20 m high. The final outside surface will be profiled using bulldozers to the target profile, rehabilitation material placed, and the surface vegetated.

## 5.0 OPERATION LIFE

The estimated duration of the operation and rehabilitation of the Golden Bar WRS is approximately 3 years and the WRS will remain in place in perpetuity.

## 6.0 RESOURCE CONSENTS

It is anticipated that similar resource consent conditions held for the existing Golden Bar Project and other WRSs at the Macraes Operation will be applied to the Golden Bar Stage 2 Project. The proposed design is similar to the recent Deepdell East WRS and other WRS at the Macraes Operation and therefore is expected to be meet similar conditions.

## 7.0 BUILDING CONSENT

Building consent has been applied for some of the existing waste rock stacks at Macraes. EGL is not aware of the specific requirement under the New Zealand Building Act 2004 for waste rock stacks to have a building consent, however, understand uncertainty in the past around whether the rock stacks represent structures has led to building consents being applied for. A building consent was applied for the most recent Deepdell East WRS.

## 8.0 GEOLOGY

### 8.1. Regional Geology

The basement rock in Central and East Otago comprises Otago schist. The Otago schist is primarily composed of psammitic and pelitic grey schist derived from metamorphism of Mesozoic age sandstone and mudstone. In the area of the Macraes Flat, the rocks have been metamorphosed to green schist metamorphic facies, giving a strongly foliated fabric of dark grey micaceous and light grey quartz-rich laminations.

From previous geotechnical investigations of the Macraes Gold Project, it is apparent that the prominent geological structure includes a well-developed schistosity, with two dominant fault sets.

The major set of faults has an eastern trend. They exhibit Miocene (recent tectonic) deformations and are related to the formation of the Alpine Fault. This deformation has faulted and folded the surface within Central and East Otago to produce the present-day basin and range topography.

The second set of faults has a northern trend, and the most significant of these is the Hyde-Macraes Shear Zone (HMSZ). The Hyde-Macraes Shear Zone (HMSZ) comprises a mineralised shear zone which has been mapped for at least 25 km by OGNZL geologist. The HMSZ represents the principal gold bearing ore body exploited by OGNZL and generally strikes north and dips at about 15º to the east. Tectonic displacement associated with the HMSZ is inferred to be in the order of hundreds of metres, with the movement initiating some 120 to 150 million years ago. The ore-schist zone of the HMSZ consists of predominantly pelite and semipelite, however includes blocks of psammite, typically well foliated and containing quartz veins. The Footwall Fault is a dominant structure which defines the footwall of the Hyde-Macraes Shear Zone (HMSZ).

West of the Footwall Fault the schistosity is folded and has a varying trend over the project area revealing a series of anticlines and synclines. Foliation dips either to the northwest, north, west or southwest. East of the Footwall Fault (Hanging wall) the schistosity has more of an easterly trend. The Golden Bar project is located east of the Fault Wall Fault and HMSZ  and the dip direction of the foliation is to mine southeast as shown on the Geological Site Plan on Figure 6.

PSM reports (Ref. 1) the Golden Bar Pit targets the Eastern Lode ore zone which is positioned approximately 400m stratigraphically above the Footwall Fault.

## 8.2. Waste Rock Stack

The existing waste rock stack comprises schist rockfill from the mining of Stage 1 of Golden Bar Pit. The WRS is capped with rehabilitation material (mix of soil and rockfill) with a topsoil layer that has been grassed (Photos 2 and 3). Rehabilitation material may also have been placed over past topsoil, brown rock and ore stockpile areas. Rehabilitation soils shall be stripped and stockpiled prior to placing Stage 2 rockfill. This is essential to maximise rehabilitation materials for Stage 2.

## 8.3. Foundation Soils

Inspection of the farm access track cuts and the prevalent rock outcrops indicate that there is generally only a thin layer of soil overlying the schist bedrock at the Golden Bar area. In general, the soil depths of undisturbed ground over the proposed Golden Bar WRS Stage 2 footprint are expected to be in the order of 0 to 1 m (Photos 4 and 5). The soil generally comprises loess over residual soil (weathered underlying schist) and comprises layers of silt with varying amounts of clay, sand and gravel. Organic soils and weak soils can be expected in the gullies.

Surficial soils over the proposed footprint of the Golden Bar WRS are to be removed during construction. This includes organic soils, loess and residual soil. This removal is required to be removed to found the waste rock on the bedrock foundation and the surficial soil need to be stockpiled for rehabilitation purposes.

### 8.4. Foundation Schist Bedrock

Interpretation of geological mapping of Stage 1 OGNZL trenches by PSM (Ref.1) and field mapping of schist outcrops and exposures (see Figure 6 and Table 7) indicates the following:

- Foliation dips shallowly towards the south-east averaging a dip angle of 20º and dip direction of 125º (relative to mine north)
- Joints are steeply dipping to the north-east and south-west and are
  - Planar to undulating with rough surfaces
  - No infill material of thickness recorded
- Faults are moderately to steeply dipping towards the north and west, and steeply dipping toward the south
  - Planar to undulating with smooth to rough surface
  - Infill thickness ranging from 2 to 200 mm of gouge and rockfill (breccia)

A hanging wall shear is logged in past exploration boreholes and in the face of the Stage 1 Pit. The approximate position of the hanging wall shear logged on the Stage 1 Pit face is shown in Figure 6.

Large scale faults and shears were mapped along the east and north walls during mining of Stage 1 by OGNZL (Ref.1), summarised as:

- Above hanging wall shear
  - Moderately to steeply dipping towards the northeast
- Below hanging wall shear
  - Moderately dipping towards the east and southeast
  - Shallowly dipping towards the northeast

The defects mapped generally do not indicate adverse orientation with respect to the foundations for the WRS, apart from potential features locally above the cut face for the ramp down the north west side of the Stage 1 Pit. This area is likely to be below the hanging wall shear, where the mapped faults and shears are indicated to be moderately dipping to the east and southeast which would be towards the pit. Review of this area is recommended during detailed design of the pit and prior to building consent for the WRS.

No specific strength testing has been undertaken on the schist in the Golden Bar area. However, elsewhere on the Macraes Operation, the typical unconfined compressive strength (UCS) unweathered schist is about 20 MPa to 40 MPa, normal to the foliation. Schist typically has a lower UCS along the direction of foliation. This is reflective of the layered nature of the rock and the presence of weak, mica-rich laminations (foliation). It is anticipated that the strength of the schist underlying the proposed WRS will be consistent with that found elsewhere in the Macraes Operation.

PSM (Ref. 1) has assessed the rock mass conditions at the Macraes project. A summary is provided in Table 1. The rock mass is classified into five classes, A to E, Class A with the highest rock mass strength and Class E with the lowest.

PSM (Ref. 1) summarise the rock mass observed after the mining of the Golden Bar Stage 1 Pit:

1. Rock mass is typically more massive and stronger than other pits resulting in an upper-bound Geological Strength Index (GSI) classification relative to other Class B rock mass at Macraes
2. Large quartz veins are prominent along the walls
3. Jointing is well defined
4. Weathering extends to at least 70 m below the surface as evidenced by oxide staining along the joints on the east wall of the Stage 1 Pit
5. The massive, moderately strong rock mass is expected to continue east based on outcrops of psammite in the area.

Overall typical strength parameters used elsewhere for WRS designs at Macraes founded on schist are appropriate for Golden Bar WRS. EGL note there is a small risk of unknown geological defects (faults) away from the pit within the rock mass. Inspection of the foundation rock during stripping should be undertaken by a OGNZL geotechnical engineer or engineering geologist. Detailed design of the pit is required by PSM (Ref. 1).

## 9.0 DESIGN AND ANALYSES

### 9.1. General

Stability analyses of the WRS have been undertaken using the two-dimensional SLOPE/W programme (Ref. 2). This includes both static and seismic analyses. The analyses do not include the stability of potential shear failures in the Golden Bar Stage 2 Pit. This has been covered by the PSM report (Ref. 1) as noted above.

The stability of the WRS has been analysed using the same design approach and parameters as that used for the existing consented WRS projects (Ref. 4, 7 and 8).

Analyses of long-term static stability of the shoulders of the WRS and stability, when subjected to design earthquake loads, have been undertaken, using limit equilibrium methods. The Spencer solution (Ref. 3) has been used for analyses of circular potential failure surfaces.

Limit equilibrium analyses have been undertaken to calculate the Factor of Safety (FoS) for static and seismic loading conditions. Where seismic loading results in a FoS of less than one the yield coefficient ($k_y$) has been assessed and used to estimate permanent displacements resulting from the earthquake.

The seismic stability of the WRS is assessed for an Operating Basis Earthquake (OBE) with an Annual Exceedance Probability (AEP) of 1 in 150 and an Safety Evaluation Earthquake (SEE) with an AEP of 1 in 2,500. This is consistent with Condition 11.1 of Dunedin City Council (DCC) and Waitaki District Council (WDC) Consents (No. 201.2016.779, 201.2013.360.1, LUC-2016-234 and LUC-2013-225A, Ref. 4). Note that the SEE was previously referred to as the Maximum Design Earthquake (MDE) but has changed to SEE to follow the terminology used in the latest New Zealand Society on Large Dams (NZSOLD) New Zealand Dam Safety Guidelines 2015. The WRS is not a dam, however, the NZSOLD design criteria for dams were adopted. Under the OBE shaking intensity only minor deformations are acceptable, and the resulting damage must be easily repairable. For the SEE shaking intensity some deformation and damage is permitted, so long as stability is ensured.

A summary of the design criteria for the Golden Bar WRS is provided in Table 2.

Stability analyses have been undertaken for three cross sections (A-A', B-B' and C-C') through the WRS (locations shown on Figures 2-6). These are representative of the critical cross-sections in terms of loading, topography, and ground conditions. The cross sections are shown in Figure 7.

## 9.2. Seismic Hazard and Design Earthquake Loadings

The site is in an area of relatively low historic seismicity for New Zealand. However, some nearby faults are considered active with low slip rates, but they have the capability of generating rare but large earthquakes. They include the nearby Taieri Ridge and Billys Ridge (Macraes) Faults and the more distant Hyde and Waihemo Faults. These faults all have annual mean slip rates of less than 0.5 mm/year but are considered capable of generating earthquakes with magnitudes in the range of about Mw (moment magnitude) 6.4 to 7.3. The Alpine Fault, the largest and most active fault in New Zealand, is located approximately 200 km northwest of the site. The Alpine Fault has an annual mean slip rate of 25 mm/year and is considered capable of earthquakes of approximately Mw 8.3. Estimates on the return period of rupture of the Alpine Fault are around 150 to 300 years depending on interpretation and application of the science. The distance from the Alpine Fault to the site will attenuate the shaking. Higher intensity shaking can be expected from the local active faults.

The design acceleration response spectra for OBE (1 in 150 AEP or 150-year recurrence interval) and SEE (1 in 2,500 AEP or 2,500-year recurrence interval) are provided in Table 3. These are derived from the National Seismic Hazard Model (NSHM) 2022 (Ref. 5) with an assumption of $V_{s30}$ condition of 1,500 m/s. $V_{s30}$ is defined as the average seismic shear-wave velocity from the surface to a depth of 30 m and is used to characterise the site response. Shear wave velocity testing for $V_{s30}$ has been undertaken at the existing TSF at Macraes which have similar foundation rock conditions. The Peak Ground Acceleration (PGA) for the OBE and SEE levels at the ground surface are 0.07 g and 0.32 g.

The design response spectra and PGA derived from the NSHM using a $V_{s30\,=}$ 1,500 m/s is for the response at foundation level. Ground motions will amplify through the rockfill mass of the WRS due to dynamic response of the fill mass and topographic effects. The ground motion amplification (ratio of peak crest acceleration to PGA) relationship given by Harder et al. (Ref. 6) has been used to determine the peak motion at the crest of the WRS. The method is based on actual measurements (from case histories) of ground motions recorded at the crests of embankments relative to those recorded near the base. Peak crest accelerations of 0.30 g and 0.63 g are estimated for OBE and SEE levels of ground motions.

## 9.3. Material Properties

The adopted material properties for stability analyses are summarised in Table 4. The details are provided in the sections below.

### 9.3.1. Waste Rock Characteristics

The waste rock is anticipated to consist of a mixture of psammitic and pelitic schist fragments. It is to be excavated from the Golden Bar Stage 2 Pit. The schist rock varies from completely to unweathered, depending on the relative depth of excavation.

Physical characteristics of the excavated rockfill were assessed during the design phase for the tailings embankments and were based on tests conducted on samples of rockfill, schist and other various rock types used for similar projects.

The waste rock to be placed in the Golden Bar WRS will be end-tipped, so it is assumed to be a non-structural fill without compaction. The waste rock segregates when end-tipped, such that each layer (approximately 10-20 m high) varies from coarse rock at the bottom to silty sandy rockfill at the top. Consequently, the Golden Bar WRS will consist of layers of rockfill of varying permeability. Generally, the rockfill could be expected to be free draining, except at the top of each lift where a thin, low permeability layer is created by the trafficking of the dump trucks.

The following shear strength function has been adopted for waste rock. It is consistent with that previously used for WRS at Macraes Gold Project (Ref. 4, 7 and 8):

Shear strength ($\tau$) $= 1.29\ \sigma'^{\,0.91}$ (kPa), where $\sigma'$ is the effective overburden pressure.

For stability analysis the design unit weight used is 21.5 kN/m$^3$.

### 9.3.2. Foundation Material Characteristics

A summary of the rock mass properties at the Golden Bar area is provided in Section 5.

Soils at the surface beneath the proposed footprint of the Golden Bar WRS are to be stripped before placement of waste rock. Any rehabilitation capping material on the existing WRS is to be removed and stockpiled for stability purposes and for rehabilitation of the final Stage 2 profile.

In general, it is expected that the majority of the foundation is comprised of Class B rock below the existing Stage 1 and proposed Stage 2 WRS. For the stability analyses, the properties of the Class C rock have been adopted. A Class C rock strength assumption applies lower strengths than Class B, and therefore for many sections the actual FOS is likely greater than presented in Table 6. The Hoek-Brown Failure Criterion (Ref. 9) has been adopted to determine the strength of the foundation rock mass.

## 9.4. Groundwater Conditions

The stability analyses for the WRS assume that the natural ground is saturated to the rock surface, and the waste rock is fully drained. It is likely that the foundation rock will be less saturated than assumed in the analysis i.e., higher strengths in the foundation. The WRS will be comprised of rockfill and gullies beneath the WRS are to be infilled with coarse rockfill to ensure good drainage. Some localised perched groundwater may occur on the thin low permeability trafficked layers within the WRS (refer Section 8.3.1), but due to the 10 to 20 m vertical spacing between these layers is unlikely to significantly affect the overall stability of the WRS.

## 9.5. Static Stability

Static stability analyses considered potential failure conditions using circular failure surfaces which passed through the rockfill material and/or original ground foundation. Only the critical failure slip surfaces are presented in this report.

The results of the static stability analyses are presented in Figures A1 to A6 in Appendix A and the results are summarised in Table 5. The results indicate that all the calculated Factors of Safety (FoS) are approximately at or above 1.5. Therefore, the performance of the WRS is satisfactory under static conditions.

## 9.6. Seismic Stability and Shear Deformation Analyses

Seismic stability and shear deformation analyses have been undertaken for both OBE (1 in 150 AEP) and SEE (1 in 2,500 AEP) levels of ground motion. The seismic stability analyses are conducted by limit equilibrium analyses with an applied average horizontal acceleration ($k_h$) for the potential failure mass. The ground motion is expected to be amplified through the rockfill mass due to dynamic and topographic effects. The design earthquake loadings, including the effects of ground motion amplification, are summarised in Section 8.2.

The seismic stability analyses have been undertaken for three potential failure surfaces with different depths (i.e. full depth, 2/3H and 1/3H below the crest of WRS, where H is the height from the crest of the WRS to the lowest point of the foundation). Pseudostatic stability has been initially performed. Pseudostatic stability analyses with a calculated FoS less than 1.0 imply that some permanent deformation will occur during the shaking. In these cases, permanent deformations of the embankments have been estimated using the Newmark type sliding block approaches (Ref. 10) of Makdisi and Seed 1978 (Ref. 11) and Bray and Macedo 2019 (Ref. 12). These approaches allow for dynamic responses of the potential sliding mass.

Lower and upper estimates are provided for the estimated seismically induced deformations. For the Bray and Macedo 2019 (Ref. 12) method, the lower estimate is the seismically induced permanent deformations with an 84% probability of exceedance, and the upper is the 16% probability of exceedance. Engineering judgement was used to develop lower and upper estimates using Makdisi and Seed 1978 method (Ref. 11) because they do not present results in a probabilistic framework.

There are variations in the estimates of seismically induced shear deformations calculated with the two methods. The different methods have differences in underlying assumptions and have used different earthquake records. To capture the epistemic uncertainty involved in utilising these methods, the averages of the results from the two methods are considered to provide the best estimates.

The results of the seismic stability analyses are presented in Figures A7 to A24 in Appendix A and are summarised in Table 6.

For all the OBE cases, pseudostatic FoSs are greater than 1.0. This indicates that yielding and deformation of the WRS are expected to be minimal. Therefore, meeting the performance objectives in Section 8.1.

The results of the analyses for all the SEE cases indicate FoSs less than 1.0 for the assessed potential failure surfaces. However, the estimated seismically induced deformations for the SEE level shaking are 1 to 7 cm which is very small for a large fill embankment. Such small deformations would not be noticeable within the rehabilitated terrain. However, EGL note shake down settlement of the rockfill under strong earthquake shaking and potential deformation on fault structures within the rock could result in some cracking of the waste rock surface. Any cracking is likely to be inconsequential or easily filled or reprofiled with an excavator. This is no different to many natural landforms following a strong earthquake.

## 9.7. Surface Drainage

Rainfall readily infiltrates into the waste rock stacks and no notable surface drainage controls have been required for the existing WRSs. The majority of surface water will seep through the waste rock stack and report to the existing Clydesdale Silt Pond or Golden Bar Pit. A catchment of 7.5 ha around the southwestern extension of the WRS currently reports down the natural slopes. During construction of the WRS a windrow will be maintained around the working tip head and running surface, which will control surface water within the WRS working area as shown in Figure 6. Surface water ponding within the working area can be directed to Clydesdale Silt Pond or Golden Bar Pit as required. Surface water infiltrating the rock stack in the southwestern area will seep out the toe of the WRS. Seepage flows in this area are expected to be low due to the attenuation effect of the rock stack. Experience on site is that flows out of the toe of the WRS have very low sediment content due to the filtering effect of the rock material in the WRS.

Where required perimeter bunds can be constructed around the toe of the WRS to manage stormwater runoff, either to create a silt capture bund or divert it into temporary silt ponds until permanent rehabilitation is in place. This is further discussed in Section 9.9.

## 9.8. Subsurface Drainage

Existing ephemeral gullies beneath the WRS footprint are to be filled with coarse free draining waste rock material either through high tip-head segregation or direct placement. This will enable subsurface drainage of gullies which are filled downstream by waste rock.

## 9.9. Erosion and Sediment Control

Runoff from the WRS during construction will be directed to the Clydesdale Silt Pond, Golden Bar Pit, or temporary local silt bunds or silt ponds. Any temporary local silt bunds or silt ponds will be minor and the need for these can be reviewed as part of environmental monitoring and erosion and sediment control as part of the operation of the WRS. These are or will be located in the gullies immediately downstream of the WRS.

The WRS will be constructed with the working surface sloping down away from the outside shoulder with windrows around the tip head and running surfaces. The runoff will infiltrate the rockfill and percolate through the coarse fill discharging as seepage downstream of the WRS. Experience to date indicates that very limited silt is generated from the rockfill during the construction of the WRS due to the nature of the schist and the progressive rehabilitation of the outside surfaces as the WRS is constructed. Most of the runoff infiltrates the rockfill and the silt is removed before the seepage emerges from the toe of the WRS. The existing Clydesdale Creek silt pond has very little sediment in it from the construction of the Stage 1 WRS.

The main risk from an erosion and sediment control perspective is stripping and stockpiling of the surface topsoil, loess and residual soils prior to placement on the waste rock. Surface water should be controlled within the cut or directed to the silt ponds or pit during these works and rockfill placement should follow promptly thereafter. Stockpiles of rehabilitation material will likely require perimeter bunding using rockfill, or surface drains to direct run off to the pit or to temporary silt ponds.

An erosion and sediment control plan for the Golden Bar Project Stage 2 must be prepared before commencing works, and it is recommended that this is submitted to the consenting authority for approval.

### 9.10. Rehabilitation

The final contoured surface of the WRS is to be rehabilitated by spreading weathered rock plus topsoil sufficient to strike and maintain a grass surface in the long-term.

## 10.0 CONSTRUCTION AND QUALITY CONTROL

Construction of the WRS will be staged starting from the downstream toe of the northern side of the WRS. Waste rock will be placed in layers up to the top elevation of the existing Stage 1 WRS, before expansion of the WRS to the southwest. Waste rock will be placed out to the perimeter and the WRS raised in layers covering the full footprint until it reaches the design height.

Construction of the WRS will be undertaken by OGNZL, or in part by contractors under the direct supervision of OGNZL employees. OGNZL is responsible for setting out the works, ensuring the rock stack is constructed to the design profile, that foundation stripping and preparation are carried out, subsurface drainage material in gullies is appropriate and suitably placed, surface drainage is properly constructed and maintained, and rehabilitation (i.e., topsoil and grassing) is completed to high standards. The proposed construction methods and rehabilitation strategies are similar to those employed on the existing TSFs and WRSs, and these have been successful during the 25 years of operation at the MGP.

Construction QA will be the responsibility of OGNZL with assistance from the Design Engineer. It will include:

- Setout of the work
- Approval of temporary erosion and sediment control works
- Inspection and approval of stripped surfaces prior to placement of waste rock
- Approval of the material and placement procedure of free-draining material in the gully floors
- Clean out of the Clydesdale Creek silt pond and backfill with selected waste rock and layer thickness
- Control of the placement of waste rock in layers between 10 m and 20 m thick

- Selection and control of placement of rehabilitation material and topsoil, and grassing
- Survey of finished surface
- Preparation of a construction report summarising the works completed

## 11.0 RISKS AND MITIGATIONS FOR RESOURCE CONSENT

The following risks and mitigations are outlined for the resource consent:

- All final slopes of the WRS have been checked to confirm they can achieve a long-term static FoS exceeding 1.5. EGL recommend the following risk mitigations:

    - Any rehabilitation material on the Stage 1 Golden Bar WRS shall be removed and stockpiled for stability and rehabilitation purposes of the Stage 2 WRS profile.
    - Any foundation soils over rock shall be removed and stockpiled prior to rock placement for stability and rehabilitation purposes.
    - Area between the WRS toe and Clydesdale Silt Pond is cleaned out of any accumulated sediment to rock before the placement of fill.
    - Foundation conditions are inspected and recorded by OGNZL geotechnical engineer during construction to confirm that all soils have been stripped and that there are no unfavourable fault structures within the rock which could affect the stability of the WRS
    - Ephemeral gullies beneath the WRS footprint be filled with coarse free draining waste rock material either through high tip-head segregation or direct placement to promote under drainage of the WRS

- An assessment of earthquake performance of the WRS has been undertaken and indicates satisfactory performance under both OBE and SEE levels of earthquake shaking. The pseudostatic FoSs are all greater than 1 for the OBE level of ground motion indicating minor deformations are likely. Under SEE shaking estimated seismically induced deformations are small. However, some cracking and settlement of the surface could be expected. Such deformations are unlikely to compromise the integrity of the WRS and can be readily repaired with an excavator, which is no different to many natural landforms.

- The WRS is located immediately adjacent to the pit. The effect of the pit on the stability of the WRS has been assessed by PSM. Detailed design of the pit is required, and further investigation can be undertaken as required. OGNZL will review the pit stability as the pit is developed. Any instability of the pit affecting the WRS during operation could be mitigated by reprofiling and rehabilitating prior to closure.

- An erosion and sediment control plan must be developed and submitted to the consenting authority for approval prior to commencing work. Surface water within the WRS working area will be controlled within the existing Clydesdale Silt Pond and Golden Bar Pit. Undercut of the foundation soils is the main risk for sediment generation and shall be controlled within the box cuts or directed to silt ponds or the pit. Local surface water control bunds and sediment retention bunds or ponds can be constructed as required. Generally, WRSs generate little sediment laden water once rockfill is placed as it is self-filtering.

## 12.0 CONCLUSIONS

The Golden Bar WRS is designed in accordance with accepted engineering practices. Existing WRS have been designed to similar standards and their performance to date has been satisfactory. Construction procedures, including supervision and quality control practices for the Golden Bar WRS, will meet accepted engineering standards. Risks and mitigations associated with the Golden Bar WRS Stage are highlighted in Section 11.0.

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# TABLES

**List of Tables**

**Table 1 PSM Summary of Rock Mass Classes at Macraes Mine (Ref. 1)**

| Class | Rock Mass | Estimated Rock Strength | Rock Quality Designation (RQD) | Estimated Geological Strength Index (GSI) | Typical Occurrence |
|---|---|---|---|---|---|
| A | Lithified rock with frequent defects and rare shearing | High rock strength | Good: 75 - 90% | 55 - 75<br>Mean = 65 | Below Footwall Fault |
| B | Fractured rock with frequent defects and some shearing | Low to high | Fair: 60 - 70% | 45 - 65<br>Mean = 55 | Above Hanging Wall Shear |
| C | Fractured to fragmented rock with frequent shearing | Low to medium | Poor to fair: 40 - 60% with zones of very poor: 0 - 10% | 40 - 50<br>Mean = 45 | Above Class D to top of Hanging Wall Shear |
| D | Fragmented / sheared rock | Extremely low to very low | Very poor: <15% | 20 - 30<br>Mean = 25 | Include Footwall Fault and zone of poor rock mass above |
| E | High to extremely weathered zone | Extremely low to soil | Very poor: 10 - 20% | N/A | Ranges between 30 - 70 m below surface |

**Table 2 Design Criteria**

| | |
|---|---|
| **Earthquake** | |
| Operating Basis Earthquake (OBE) | 1 in 150 AEP |
| Safety Evaluation Earthquake (SEE) | 1 in 2,500 AEP |
| **Stability** | |
| ***Static*** | Limit Equilibrium FoS ≥ 1.5 |
| ***Seismic*** | |
| OBE | Minor deformations are acceptable, and the resulting damage is easily repairable. |
| SEE | Some deformations and damages are permitted as long as the stability is ensured. |

**Table 3 Design Earthquake Response Spectra, NSHM 2022 (Vs30 = 1,500 m/s)**

| T (sec) | Spectral Accelerations | |
|---|---|---|
| | 150 yr (OBE) | 2500 yr (SEE) |
| 0 | 0.07 | 0.32 |
| 0.1 | 0.15 | 0.77 |
| 0.2 | 0.14 | 0.72 |
| 0.3 | 0.11 | 0.56 |
| 0.4 | 0.1 | 0.46 |
| 0.5 | 0.08 | 0.38 |
| 0.7 | 0.06 | 0.29 |
| 1 | 0.05 | 0.21 |
| 1.5 | 0.03 | 0.14 |
| 2 | 0.02 | 0.11 |
| 3 | 0.01 | 0.07 |
| 4 | 0.01 | 0.06 |
| 5 | 0.01 | 0.04 |
| 6 | 0.01 | 0.03 |
| 7.5 | 0 | 0.03 |
| 10 | 0 | 0.02 |

**Table 4 Material Properties for Stability Analyses**

| Material | Strength Function | Uniaxial Compressive Strength, UCS (kPa) | Geological Strength Index, GSI | Material Constant, mi | Disturbance Factor, D | Unit Weight (kN/m3) |
|---|---|---|---|---|---|---|
| Rockfill | $\tau = 1.29\sigma'^{0.91}$ | - | - | - | - | 21.5 |
| Class A Foundation Rock | Generalised Hoek-Brown | 40000 | 65 | 12 | 0 | 27 |
| Class B Foundation Rock | Generalised Hoek-Brown | 40000 | 55 | 12 | 0 | 27 |
| Class C Foundation Rock (Adopted) | Generalised Hoek-Brown | 35000 | 45 | 12 | 0 | 27 |

**Table 5 Summary of Static Stability Analyses Results**

| Section | Potential Failure Surface | FoS | Figure |
|---|---|---|---|
| A-A' | Critical Failure Surface within WRS | 1.90 | A1 |
| | Failure Surface through the WRS and Foundation | 3.03 | A2 |
| B-B' | Critical Failure Surface within WRS | 2.26 | A3 |
| | Failure Surface through the WRS and Foundation | 2.62 | A4 |
| C-C' | Critical Failure Surface within WRS | 2.18 | A5 |
| | Failure Surface through the WRS and Foundation | 1.49 | A6 |

**Table 6 Summary of Seismic Stability Analyses Results**

| Section | Loading Condition | Toe of Failure Surface below Crest | $K_h$ (g)(1) | $K_y$ (g)(2) | Pseudostatic FoS | Seismic Displacement (cm)(3) | | | Figure |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Makdisi and Seed 1978 | Bray and Macedo 2019 | Best Estimates | |
| A-A' | OBE | H | 0.07 | - | 1.58 | - | - | - | A7 |
| | OBE | 2/3H | 0.19 | - | 1.26 | - | - | - | A8 |
| | OBE | 1/3H | 0.30 | - | 1.08 | - | - | - | A9 |
| | SEE | H | 0.32 | 0.28 | - | 0-1 | 0-1 | 0-1 | A10 |
| | SEE | 2/3H | 0.48 | 0.31 | - | 0-3 | 0-1 | 0-2 | A11 |
| | SEE | 1/3H | 0.63 | 0.35 | - | 2-8 | 0-5 | 1-7 | A12 |
| B-B' | OBE | H | 0.07 | - | 2.20 | - | - | - | A13 |
| | OBE | 2/3H | 0.19 | - | 2.09 | - | - | - | A14 |
| | OBE | 1/3H | 0.30 | - | 1.13 | - | - | - | A15 |
| | SEE | H | 0.32 | 0.33 | - | 0-1 | 0-1 | 0-1 | A16 |
| | SEE | 2/3H | 0.48 | 0.50 | - | 0-1 | 0-1 | 0-1 | A17 |
| | SEE | 1/3H | 0.63 | 0.37 | - | 1-6 | 0-4 | 1-5 | A18 |
| C-C' | OBE | H | 0.07 | - | 1.54 | - | - | - | A19 |
| | OBE | 2/3H | 0.19 | - | 1.65 | - | - | - | A20 |
| | OBE | 1/3H | 0.30 | - | 1.11 | - | - | - | A21 |
| | SEE | H | 0.32 | 0.27 | - | 0-1 | 0-1 | 0-1 | A22 |
| | SEE | 2/3H | 0.48 | 0.44 | - | 0-2 | 0-1 | 0-1 | A23 |
| | SEE | 1/3H | 0.63 | 0.36 | - | 1-7 | 0-5 | 1-6 | A24 |

(1) $K_h$ (g) - average acceleration within the potential failure mass for various return period earthquakes (for pseudostatic analysis only).

(2) $K_y$ (g) - yield acceleration within the potential failure mass for an FoS = 1.0, determined using pseudostatic approach.

(3) Estimated seismically induced permanent displacement during an earthquake. The range given here represents the lower and upper estimates. For the B&M method, it is the 84% and 16% probability of exceedance. The range given for the M&S method is developed by engineering judgement as they do not present results in a probabilistic manner.

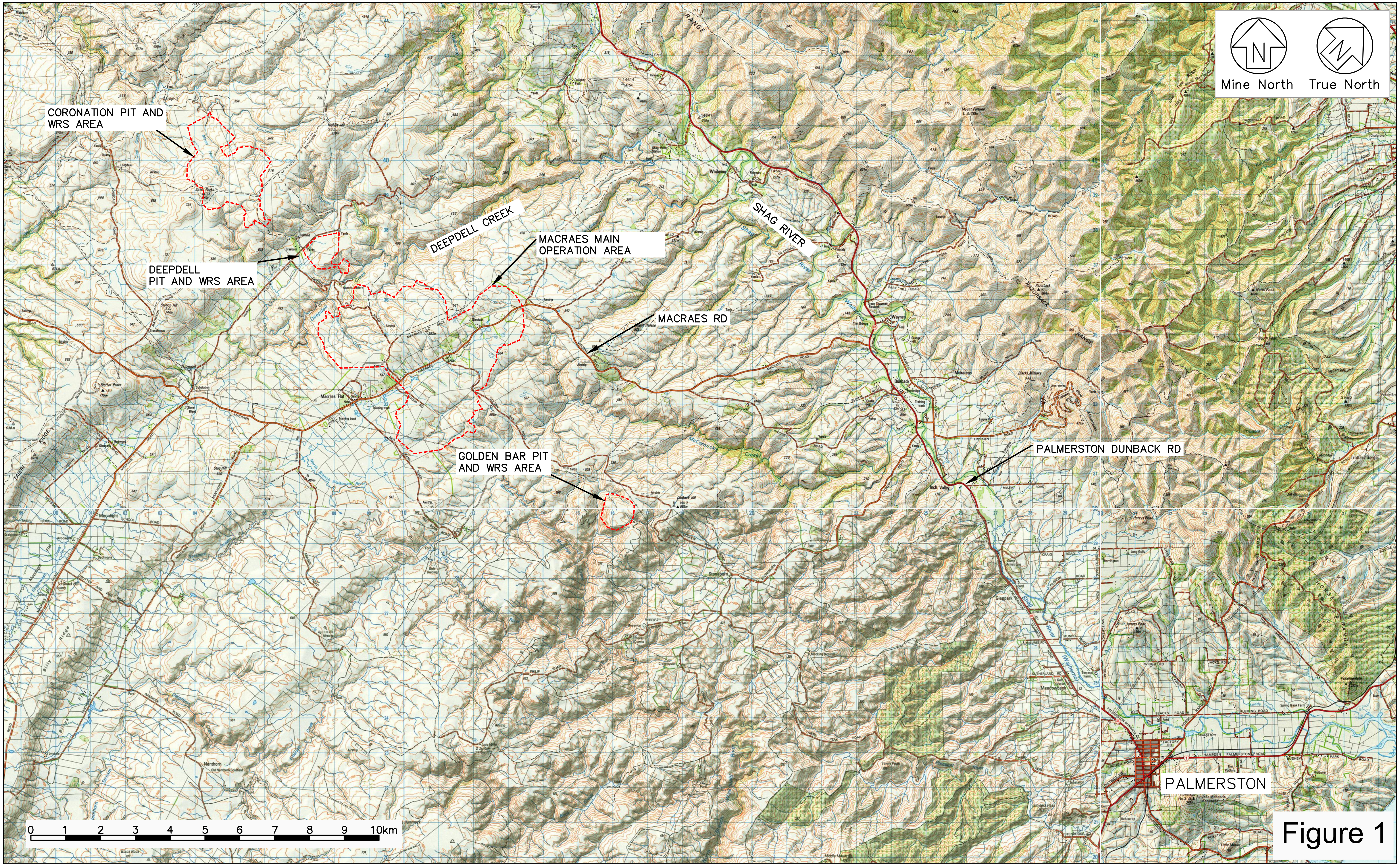
**Table 7 Geological Field Mapping Summary**

| Observation No. | MGPG-X | MGPG-Y | GPS Elev. | Observation Type | Colour | Lithology | Weathering | Strength | Anisotropy | Foliation Intensity | Structure | Jt Spacing | Surface Quality | GSI | Foliation Dip | Dip Dir (True N) | Dip Dir (MGPG) | Seepage | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GB01 | 71,004 | 6,190 | 563 | Rock outcrop (protruding) | Grey | Schist | Slightly weathered | Strong | A2 | 1 | Blocky | 0.5 - 1.0 m | Good | 65 | 25 | 100 | 145 | Dry | Outcrop on edge of old WRS |
| GB02 | 71,076 | 6,275 | 565 | Rock outcrop (protruding) | Grey | Schist | Slightly weathered | Strong | A2 | 1 | Blocky | 1.0 - 2.0 m | Good | 65 | 30 | 070 | 115 | Dry | Outcrop on edge of old WRS, 1-2 m colluvial silty gravel soil in bank near outcrop |
| GB03 | 70,897 | 6,658 | 532 | Rock outcrop (protruding) | Grey | Schist | Slightly weathered | Strong | A1 | 0 | Blocky | 1.0 - 2.0 m | Good | 65 | 20 | 080 | 125 | Dry | On slope above WRS |
| GB04 | 70,852 | 6,706 | 540 | Rock outcrop (protruding) | Grey | Schist | Slightly weathered | Strong | A2 | 1 | Blocky | 0.5 - 1.0 m | Good | 65 | 14 | 030 | 075 | Dry | Outcrop on Ridge |
| GB05 | 70,653 | 6,690 | 471 | Rock outcrop (protruding) | Grey | Schist | Slightly weathered | Strong | A3 | 1 | Blocky | 0.5 - 2.0 m | Good | 60 | 20 | 090 | 135 | Dry | Top of bluff above sediment dam |
| GB06 | 70,542 | 6,042 | 548 | Rock outcrop (protruding) | Grey | Schist | Slightly weathered | Weak to moderately strong | A3 | 3 | Seamy | 0.5 - 2.0 m | Fair | 35 | 30 | 010 | 055 | Dry | Outcrop in gully |
| GB07 | 70,556 | 6,153 | 544 | Soil outcrop (track cutting) | Light Brown | Loess Colluvium | | Very stiff to hard | | | Gravelly silt | 1.5 m thick | | | | | | Dry | Track cutting |
| GB08 | 70,588 | 6,191 | 530 | Rock outcrop (track cutting) | Grey | Schist | Slightly weathered | Strong | A2 | 3 | Blocky | 0.5 - 1.0 m | Good | 65 | 15 | 080 | 125 | Dry | Outcrop in gully. Foliation lineation perpendicular to dip |
| GB09 | 70,559 | 6,226 | 533 | Rock outcrop (track cutting) | Rusty brownish grey | Schist | Slightly weathered | Strong | A2 | 2 | Blocky-Massive | 1.0 - 2.0 m | Good | 70 | 33 | 055 | 100 | Dry | Track cutting, 0.1-0.2 m soil thickness |
| GB10 | 70,563 | 6,237 | 529 | Fault outcrop (track cutting) | Rusty lt brown | Schist | Highly weathered | Very weak | | | Fault breccia | Crushed | Fair | 20 | | 010 | 055 | Dry | Faults x2 oriented 85/155 and 85-055 (Macraes North) |
| GB11 | 70,595 | 6,433 | 490 | Fault outcrop (track cutting) | Rusty lt brown | Schist | Highly weathered | Very weak | | | Fault breccia | Crushed | Fair | 20 | | 045 | 090 | Dry | Fault oriented 75/045 |
| GB12 | 70,680 | 6,519 | 469 | Old erosion gully in WRS | Grey | Waste Rockfill | | Compact | | | | | | | | | | Dry | Old erosion gully in WRS slope, 0.5 to 1.0 m deep, inactive, grassed back over |
| GB13 | 70,647 | 6,634 | 440 | Rock outcrop (level) | Grey | Schist | Slightly weathered | Strong | A1 | 1 | Blocky-Massive | 1.0 - 2.0 m | Good | 70 | 24 | 020 | 065 | Dry | Rock exposed in floor of gully U/S of dam, TL side |
| GB14 | 70,624 | 6,692 | 442 | Rock outcrop (bluff) | Grey | Schist | Slightly weathered | Strong | A1 | 1 | Seamy-Blocky | 0.5 - 1.0 m | Good | 60 | 35 | 050 | 095 | Dry | RH abutment of silt dam |
| GB15 | 70,590 | 6,653 | 444 | Rock outcrop (cutting) | Grey | Schist | MW | Weak | A3 | 2 | Seamy disturbed | 0.5 - 1.0 m | Fair | 35 | 42 | 060 | 105 | Dry | LH abutment of silt dam, faulted/sheared zone |
| GB16 | 70,527 | 6,593 | 478 | Rock outcrop (level) | Grey | Schist | Slightly weathered | Moderately strong | A2 | 1 | Blocky | ? | Fair | 60 | 40 | 050 | 095 | Dry | < 0.1 m cover over rock in cow track |
| GB17 | 70,444 | 6,519 | 506 | Rock outcrop (protruding) | Grey | Schist | Slightly weathered | Strong | A1 | 2 | Blocky | 1.0 - 2.0 | Good | 65 | 28 | 060 | 105 | Dry | Outcrop of ridge |
| GB18 | 70,418 | 6,274 | 546 | Rock outcrop (level) | Grey | Schist | Slightly weathered | Strong | A1 | 1 | Blocky | ? | Good | 60 | 22 | 080 | 125 | Dry | Outcrop minimal soil cover |
| GB19 | 70,295 | 6,093 | 553 | Rock outcrop (protruding) | Grey | Schist | Slightly weathered | Strong | A1 | 1 | Blocky | 0.5 - 2.0 | Good | 65 | 21 | 055 | 100 | Dry | Outcrop on crest of slope |

1. MGPG = Macraes Gold Project Grid
2. Positions based on Handheld GPS (± 3m)
3. Mapping: OGNZL B. Adams, Heath

**FIGURES**

## List of Figures

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MACRAES OPERATION

*Locality Plan*

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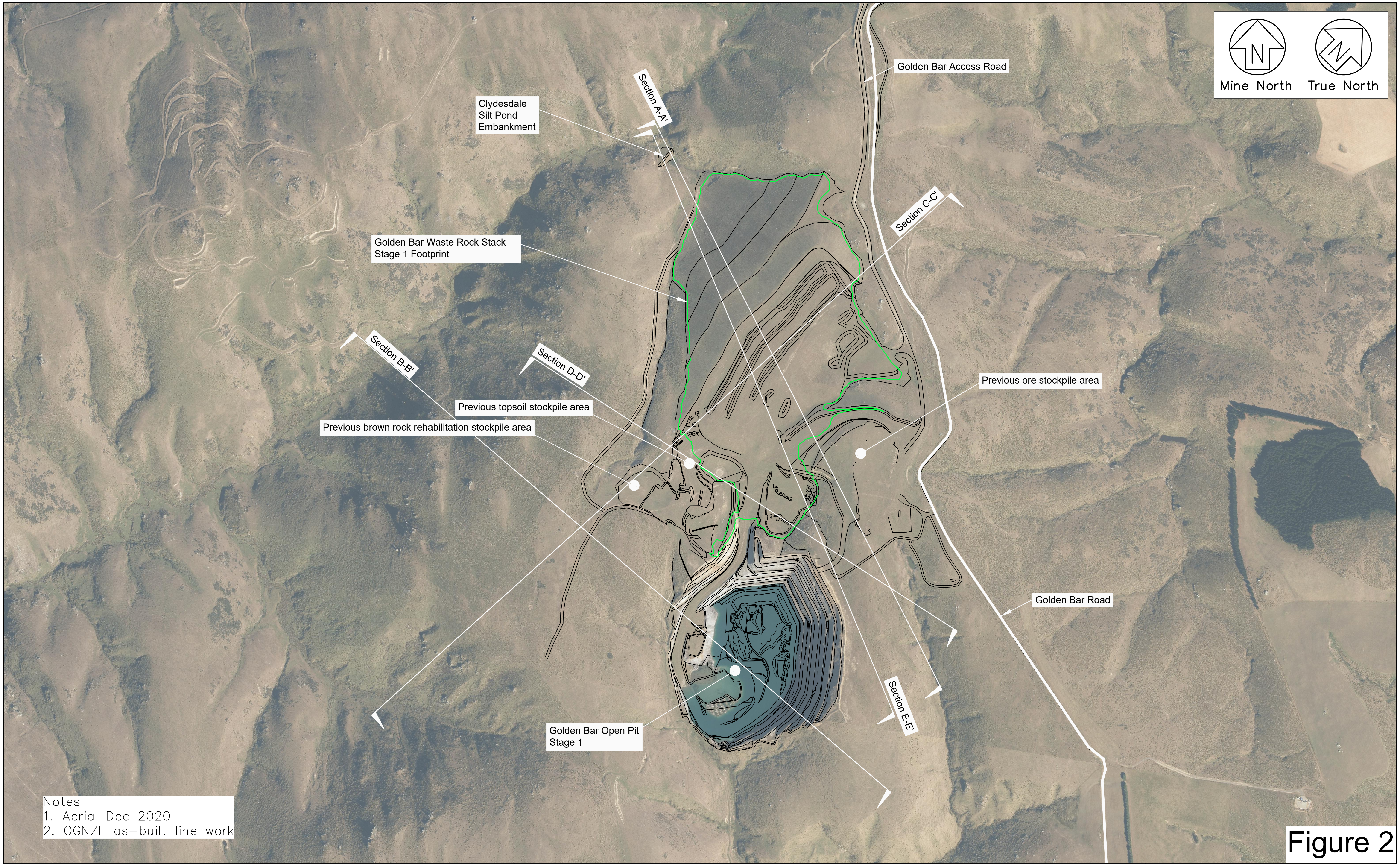


Figure 2

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Golden Bar WRS and Pit - Stage 1
*Site Plan*

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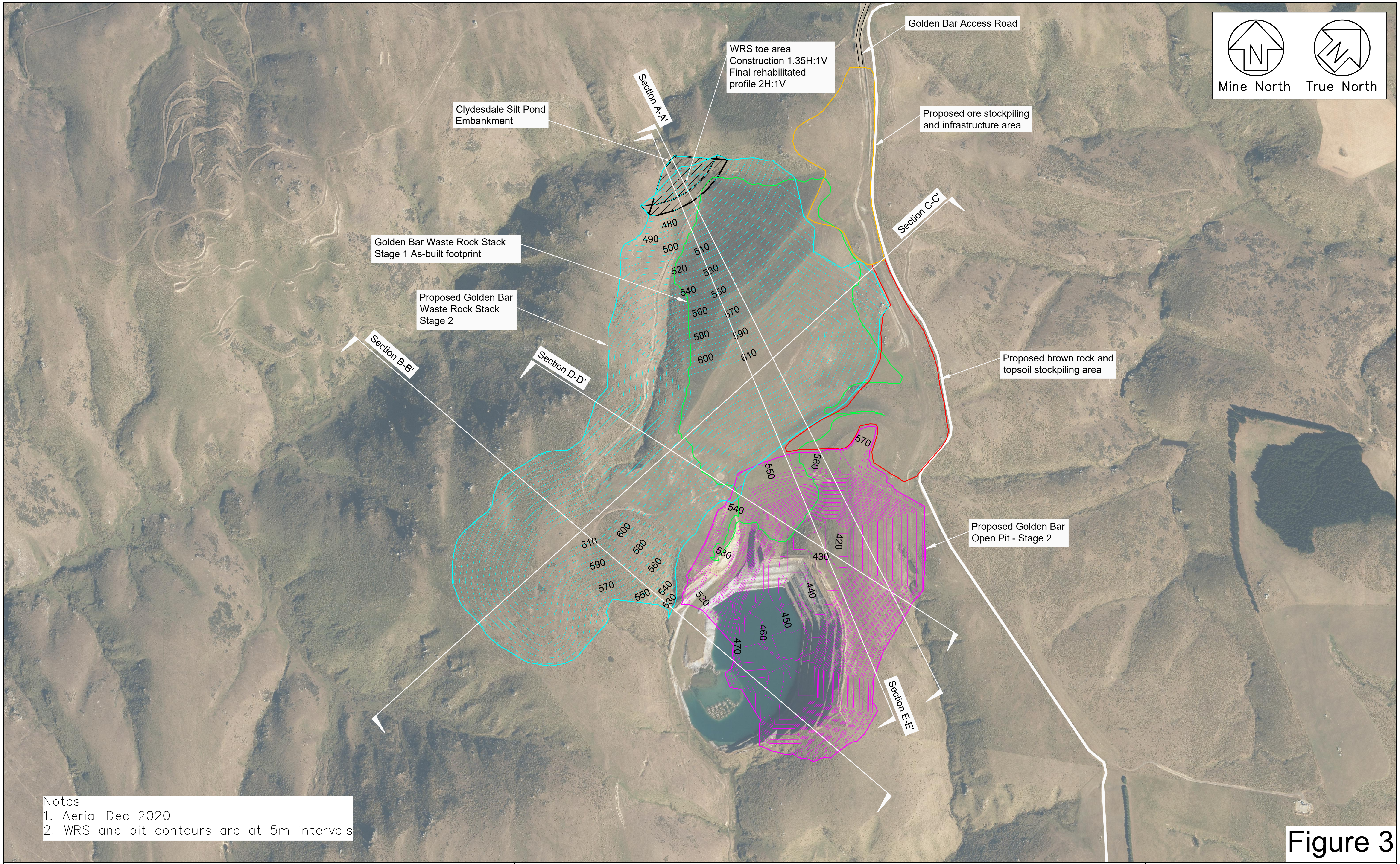


Figure 3


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*Layout and Section Plan*

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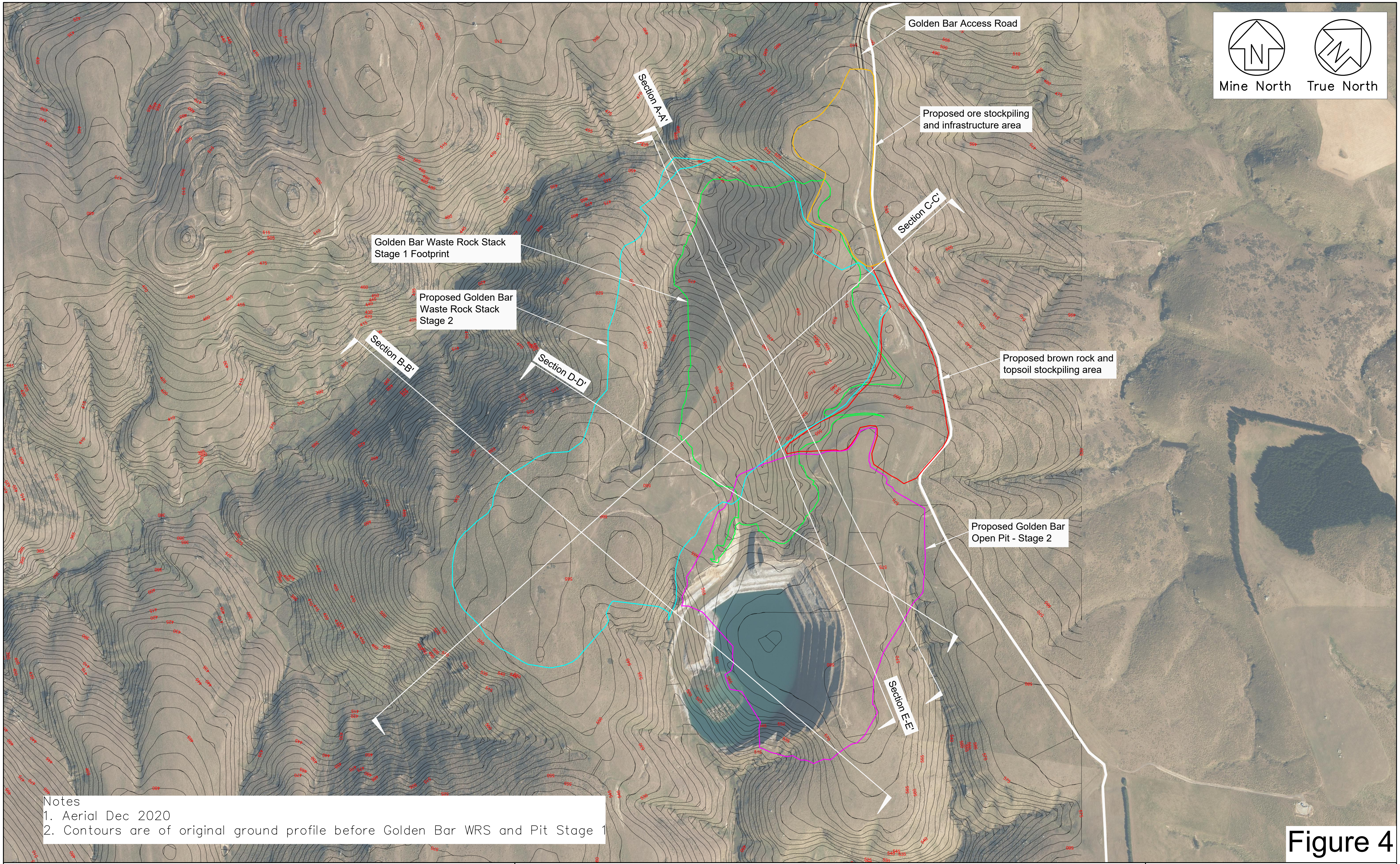


Figure 4


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*Original Ground Contour Plan*

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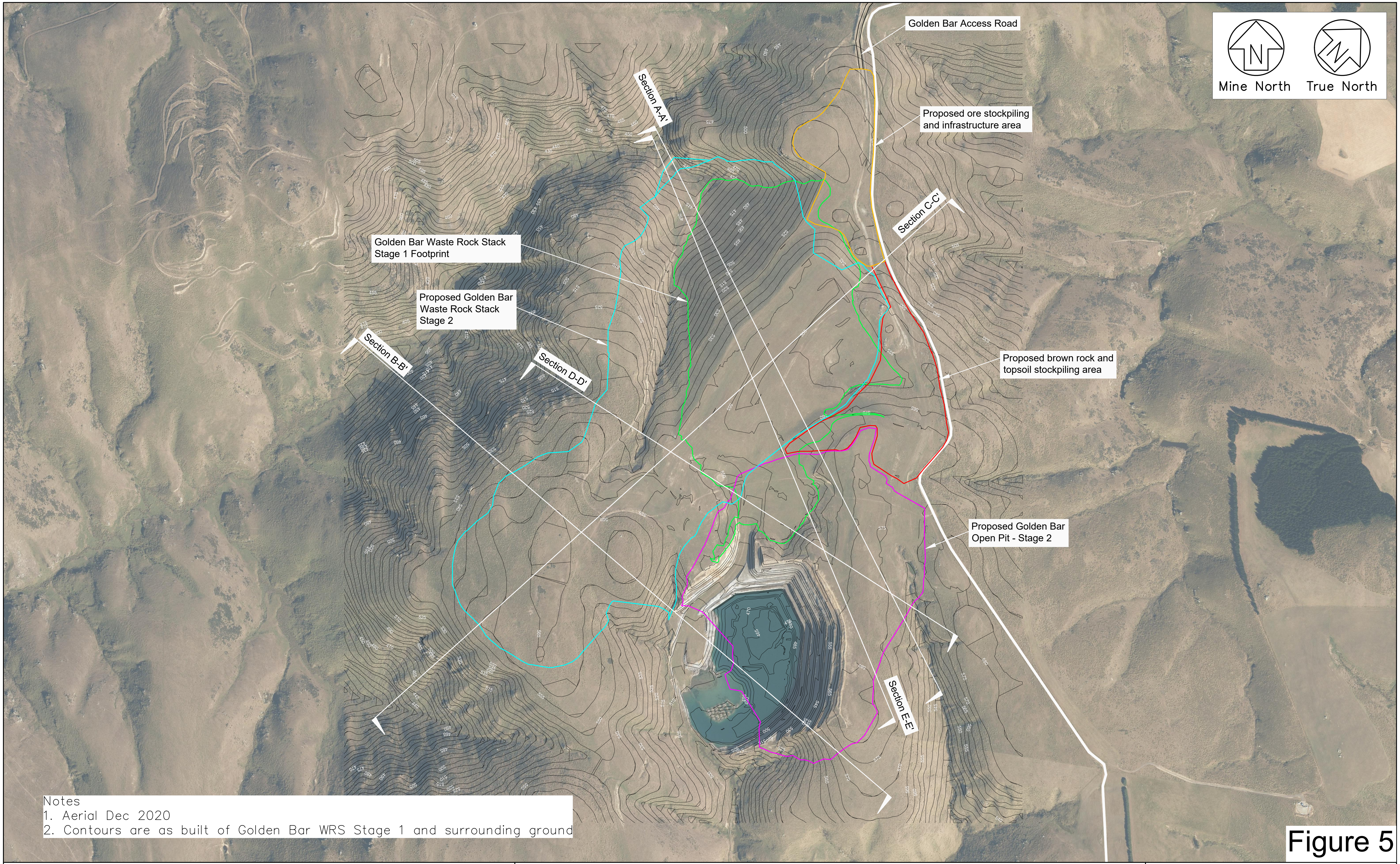


# Figure 5

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Golden Bar WRS and Pit - Stage 2
*Stage 1 As Built Contour Plan*

| | |
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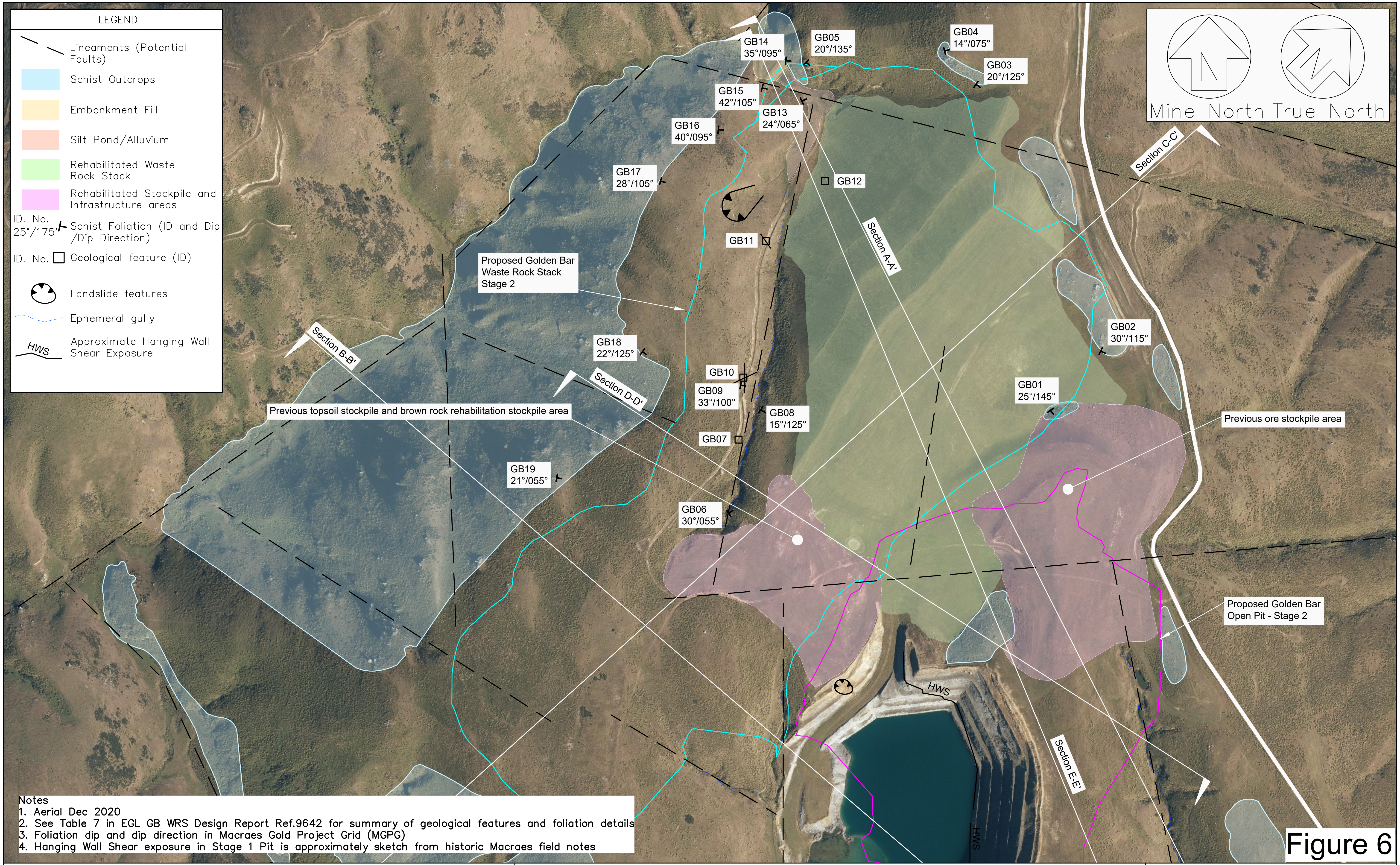


Notes
1. Aerial Dec 2020
2. See Table 7 in EGL GB WRS Design Report Ref.9642 for summary of geological features and foliation details
3. Foliation dip and dip direction in Macraes Gold Project Grid (MGPG)
4. Hanging Wall Shear exposure in Stage 1 Pit is approximately sketch from historic Macraes field notes

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*Geological Map*

| | |
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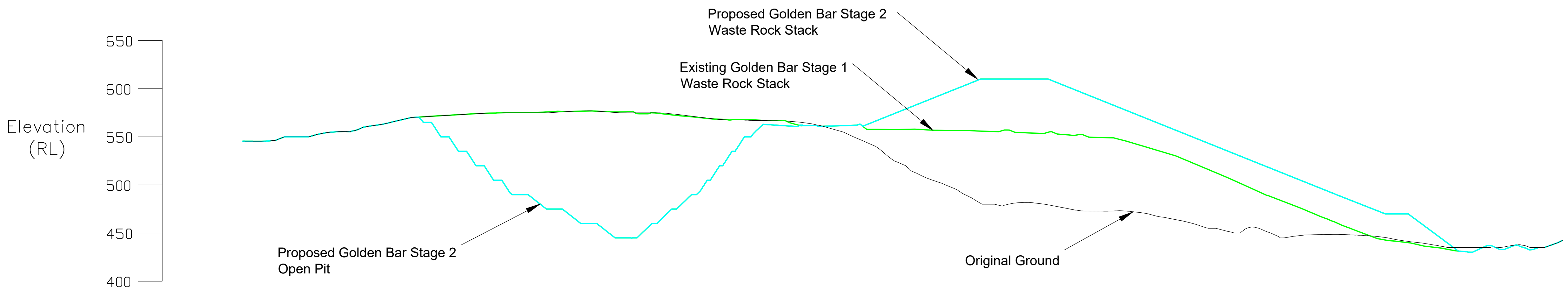
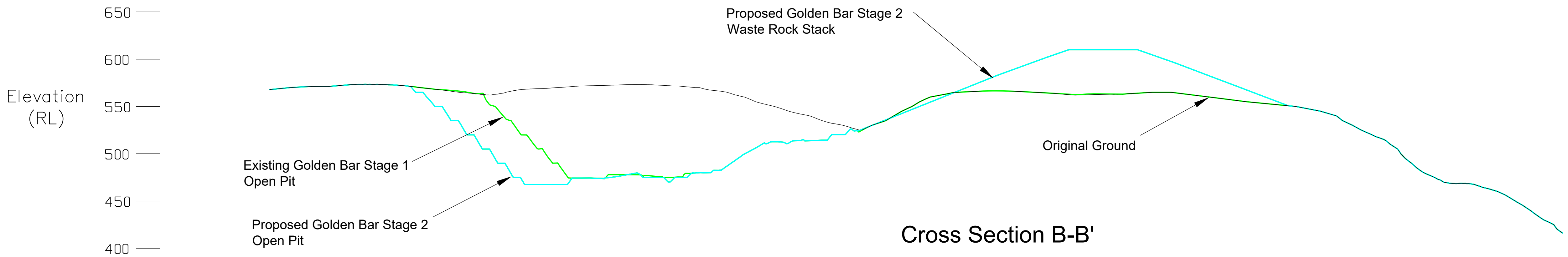



Cross Section A-A'

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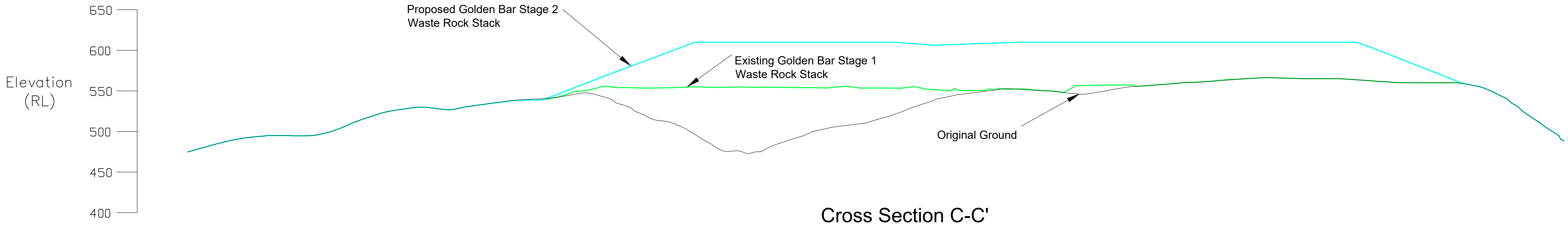


Cross Section C-C'

# Figure 7

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*Cross Sections*

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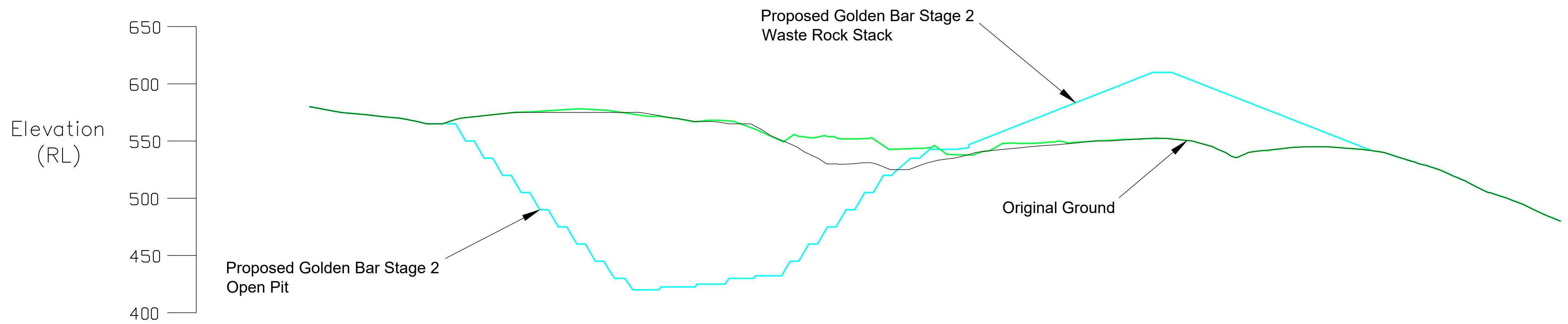


Cross Section D-D'

Figure 8

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*Cross Sections*

| | |
|---|---|
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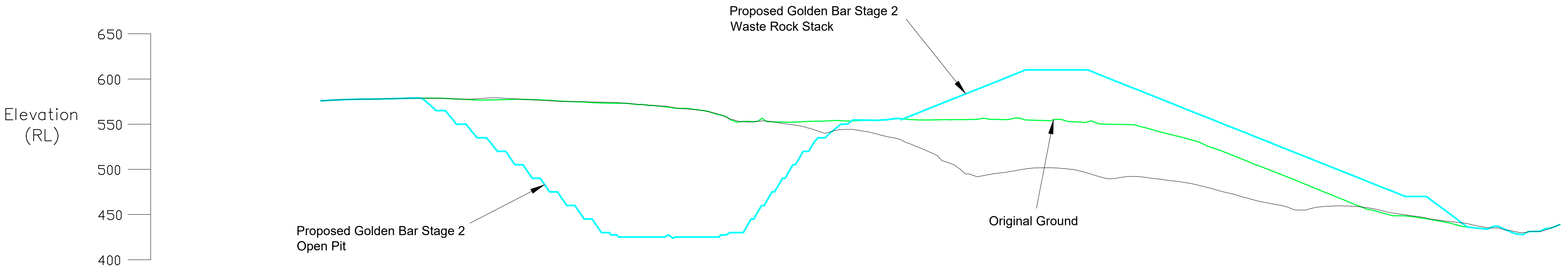


Cross Section E-E'

Figure 9

EGL Geotechnical, Earthquake and Dam Engineers

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OCEANA GOLD (NEW ZEALAND) LIMITED
MACRAES OPERATION
Golden Bar WRS - Stage 2
*Cross Sections*

| | |
|---|---|
| Drawing No. | 9642–Fig 9 |
| Date: | May 2023 |
| Drawn: | ET |
| Scale: | 1:5000 (@A3) |
| Filename: | 9642–Fig2–5,7–9.dwg |

# PHOTOGRAPHS

**List of Photographs**

**Photo 1: Golden Bar Pit and proposed southwestern extension area**

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**Photo 7: Clydesdale Silt Pond and Golden Bar WRS**

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| --- | --- |
|  |  |
| **Photo 10: Field Mapping Location GB03** | **Photo 11: Field Mapping Location GB04** |
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|  |  |
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**Photo 21: Field Mapping Location GB15**

**Photo 22: Field Mapping Location GB16**

**Photo 23: Field Mapping Location GB17**

**Photo 24: Field Mapping Location GB18**

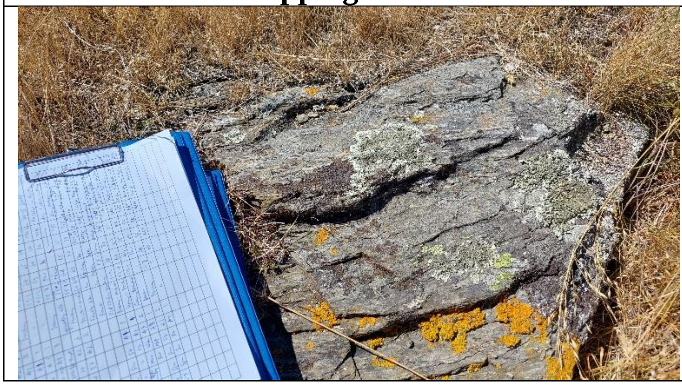
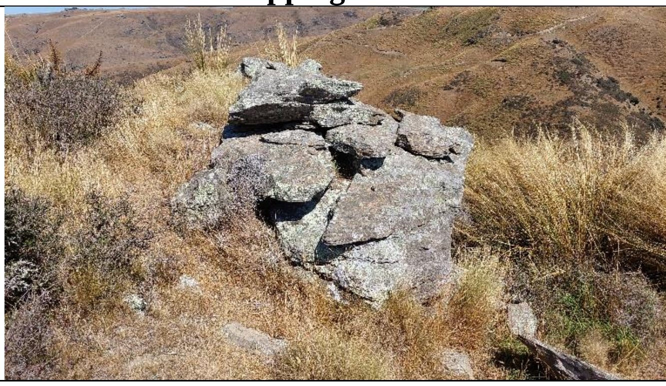


**Photo 25: Field Mapping Location GB19**

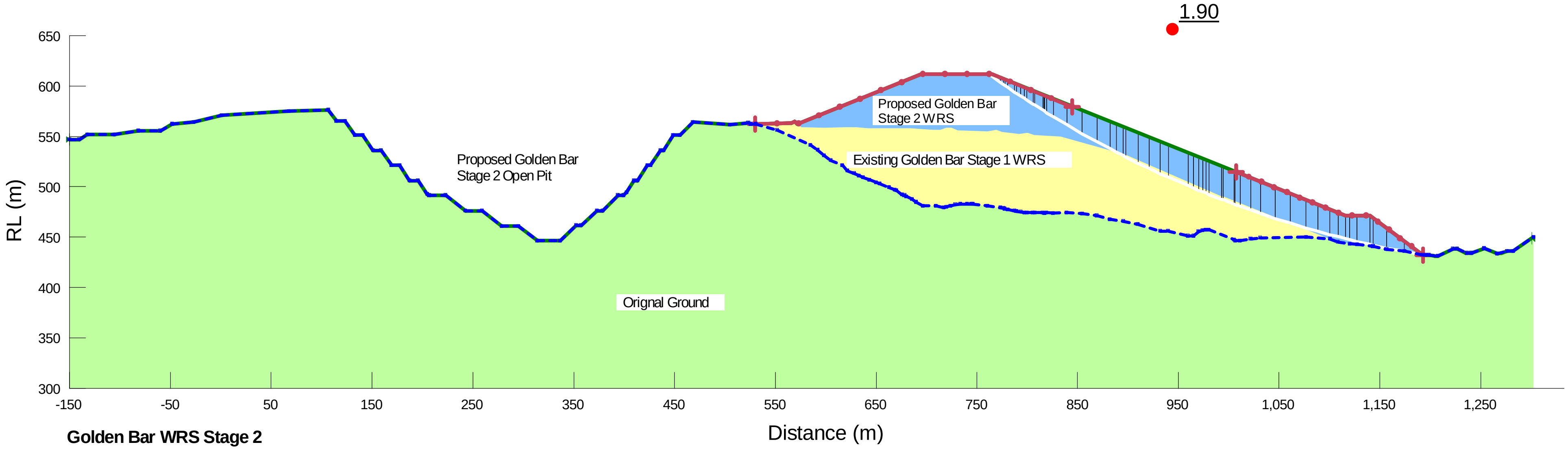


# APPENDIX A

# STABILITY ANALYSES

## Appendix A List

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



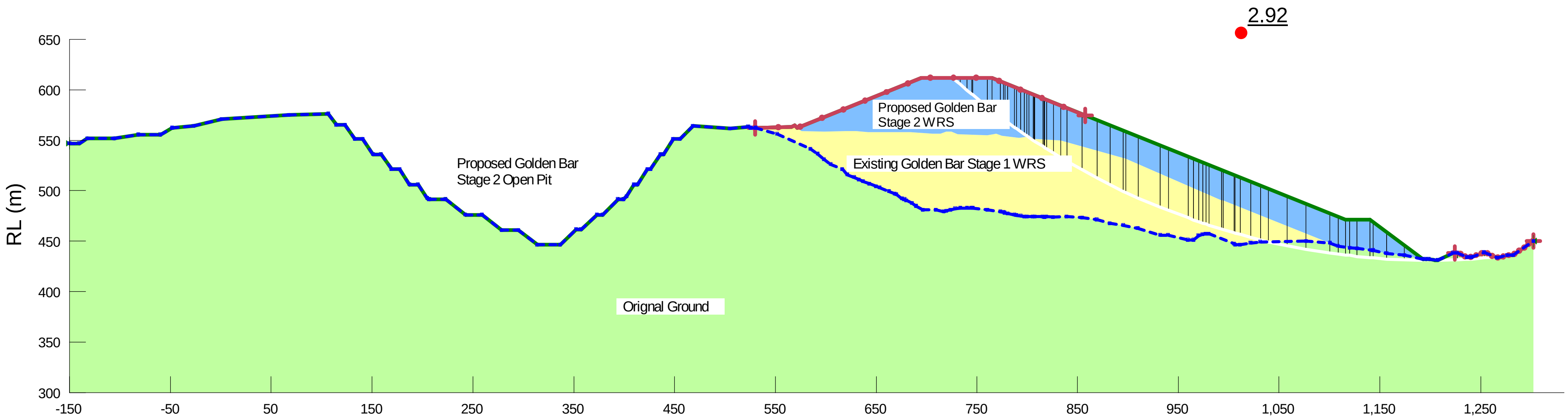

**Golden Bar WRS Stage 2**
**Stability Analysis - Section A-A' Static - 01 - Failure Surface within WRS**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0**
**Factor of Safety: 1.90**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A1**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



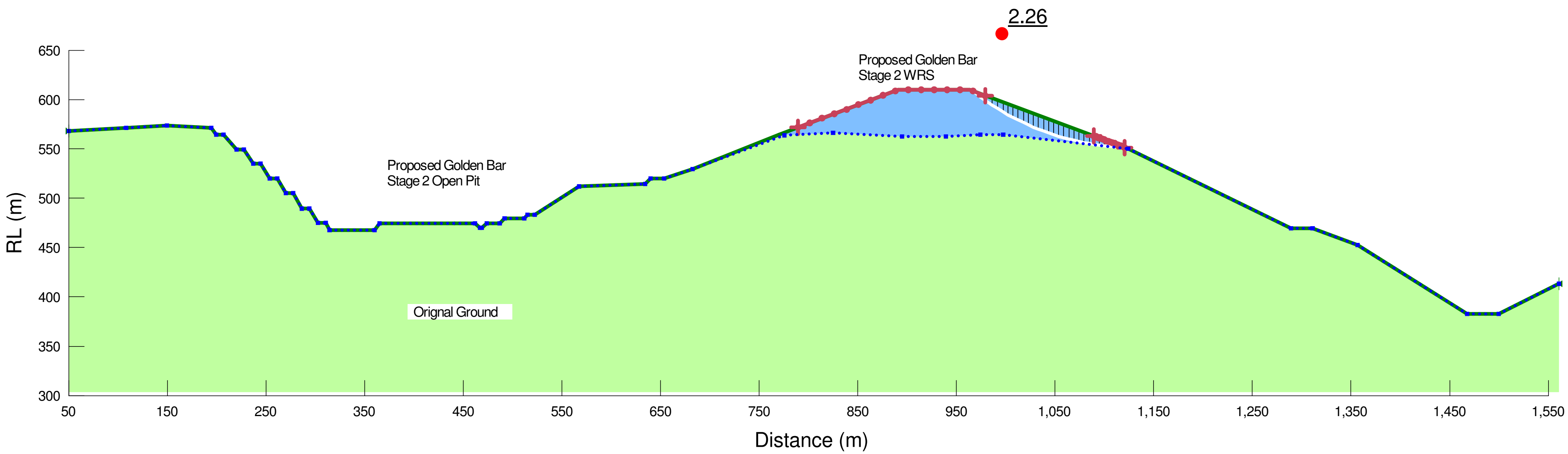

**Golden Bar WRS Stage 2**
**Stability Analysis - Section A-A' Static - 02 - Failure Surface through WRS and Foundation**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0**
**Factor of Safety: 2.92**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A2**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Surface | Include Ru in PWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 | No |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 | No |



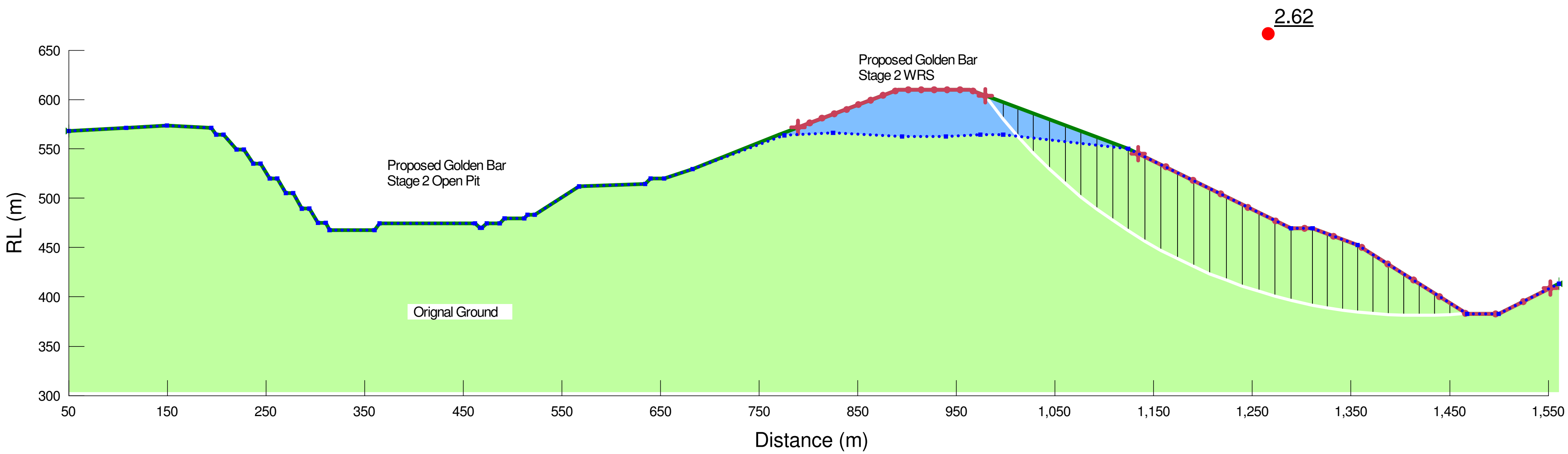

**Golden Bar WRS Stage 2**
**Stability Analysis - Section B-B' Static - 01 - Failure Surface within WRS**

**Analysis Type: Spencer**
**Factor of Safety: 2.26**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A3**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Surface | Include Ru in PWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 | No |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 | No |



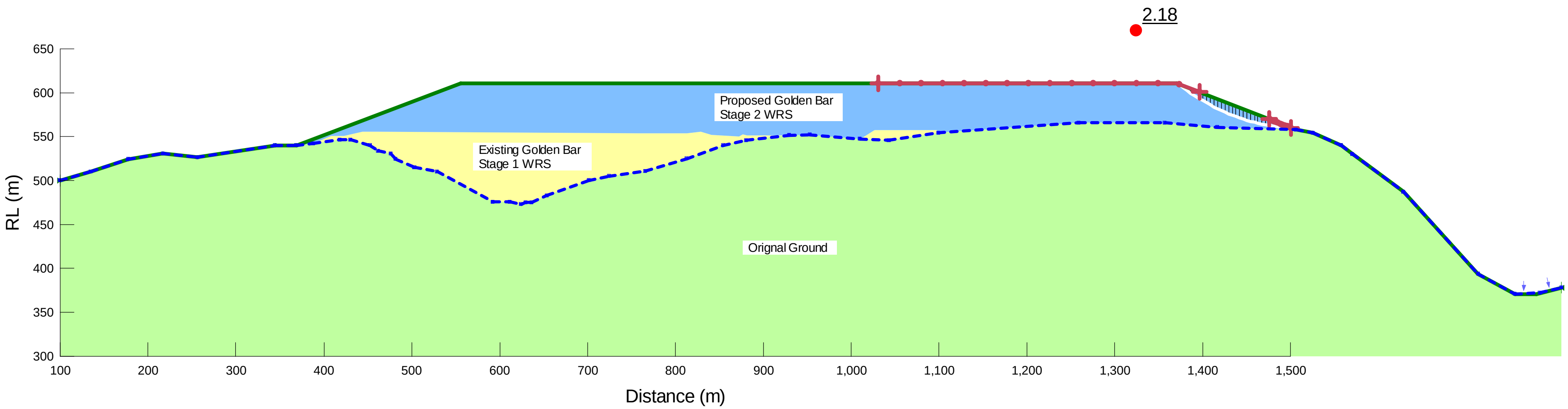

**Golden Bar WRS Stage 2**
**Stability Analysis - Section B-B' Static - 02 - Failure Surface through WRS and Foundation**

**Analysis Type: Spencer**
**Factor of Safety: 2.62**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A4**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



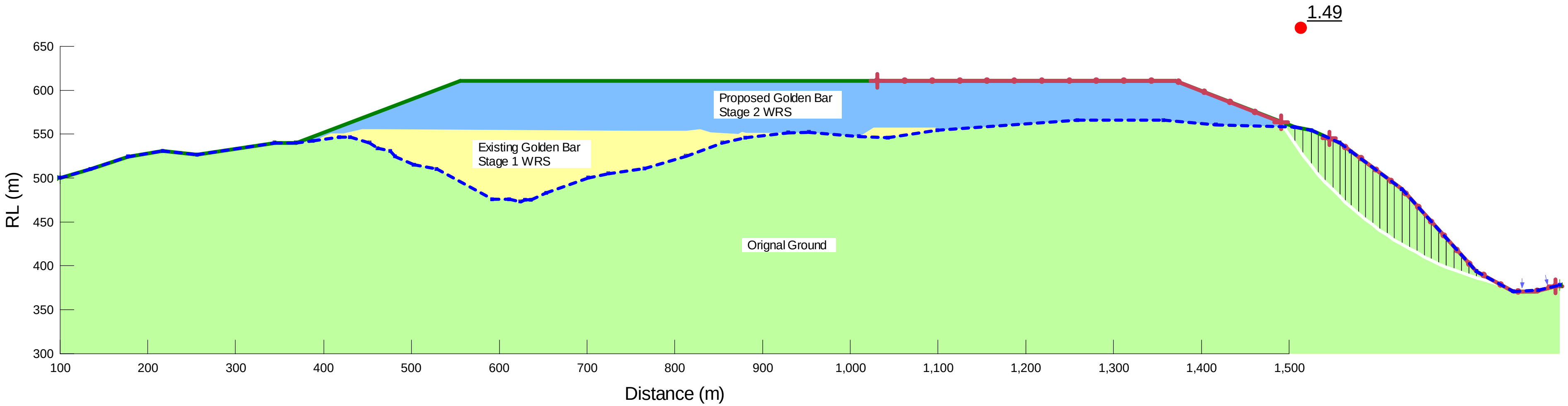

**Golden Bar WRS Stage 2**
**Stability Analysis - Section C-C' Static - 01 - Failure Surface within WRS**

**Analysis Type: Spencer**
**Factor of Safety: 2.18**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A5**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



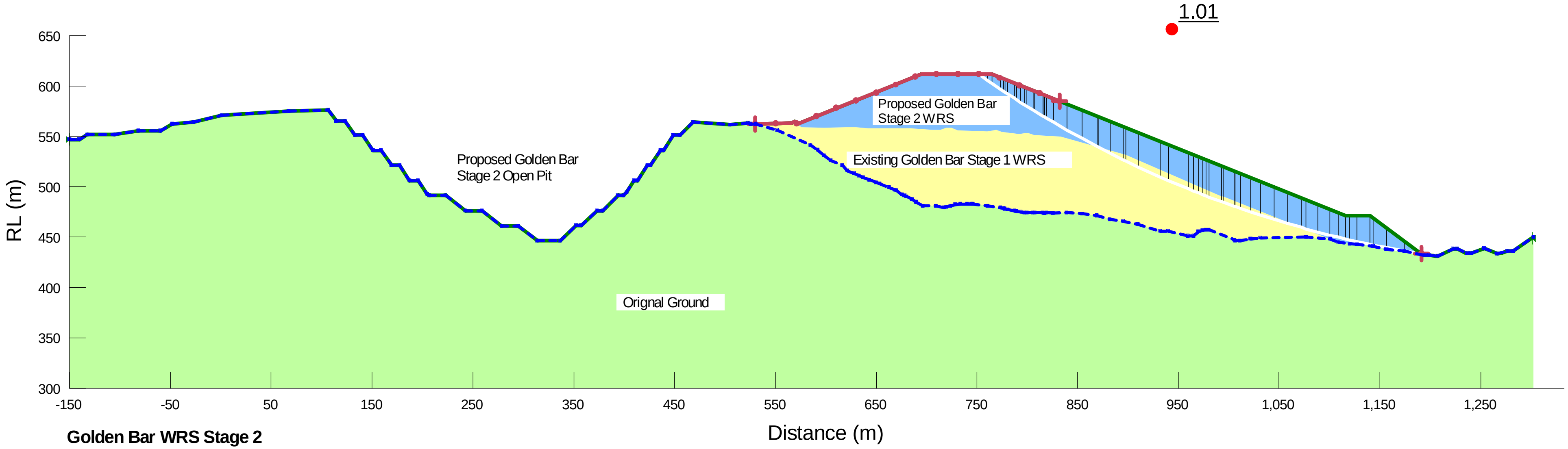

**Golden Bar WRS Stage 2**
**Stability Analysis - Section C-C' Static - 02 - Failure Surface through WRS and Foundation**

**Analysis Type: Spencer**
**Factor of Safety: 1.49**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A6**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



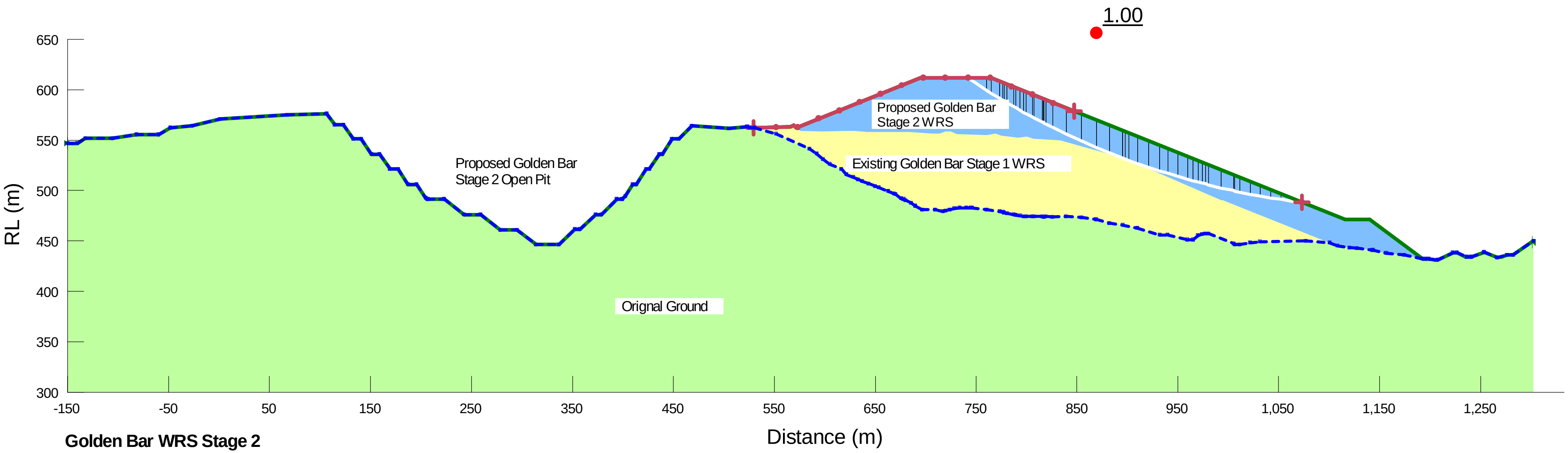

**Golden Bar WRS Stage 2**
**Stability Analysis - Section A-A' Seismic - 04 - Full Depth Failure Surface - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.28**
**Factor of Safety: 1.01**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A7**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



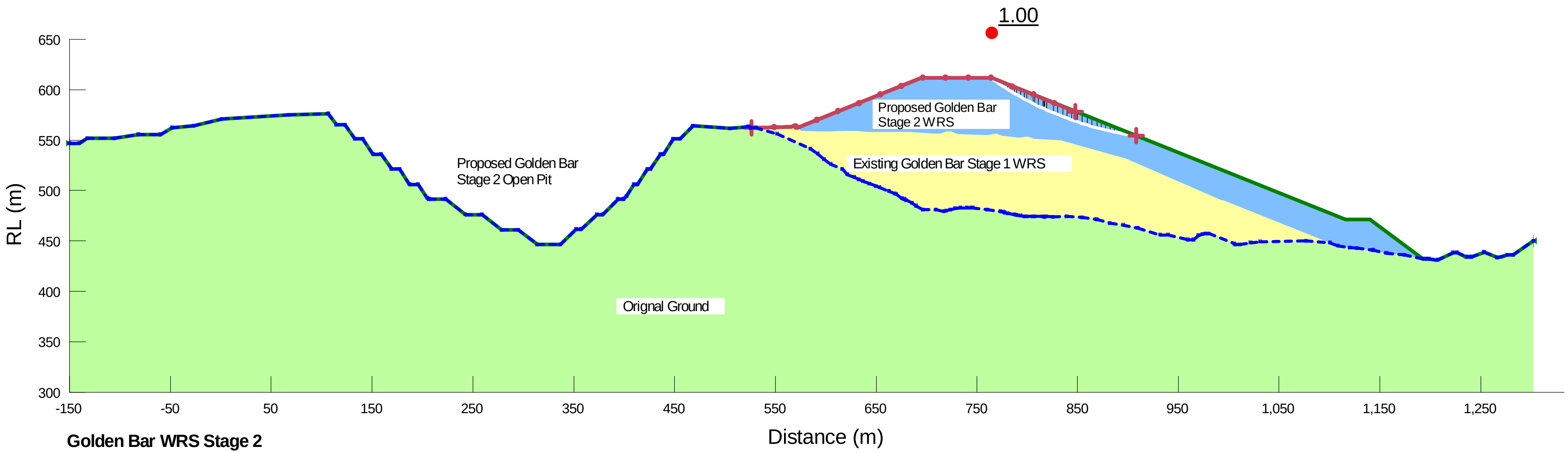

**Golden Bar WRS Stage 2**
**Stability Analysis - Section A-A' Seismic - 05 - Failure Surface located 2/3H below Crest - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.31**
**Factor of Safety: 1.00**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A8**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



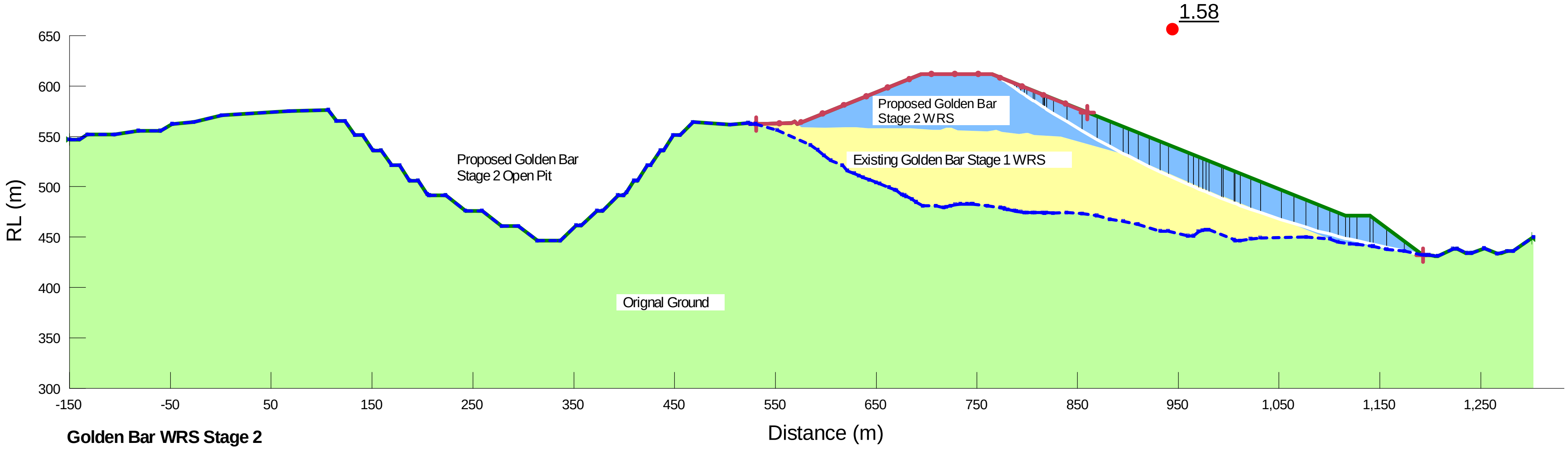

**Golden Bar WRS Stage 2**
**Stability Analysis - Section A-A' Seismic - 06 - Failure Surface located 1/3H below Crest - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.35**
**Factor of Safety: 1.00**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A9**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



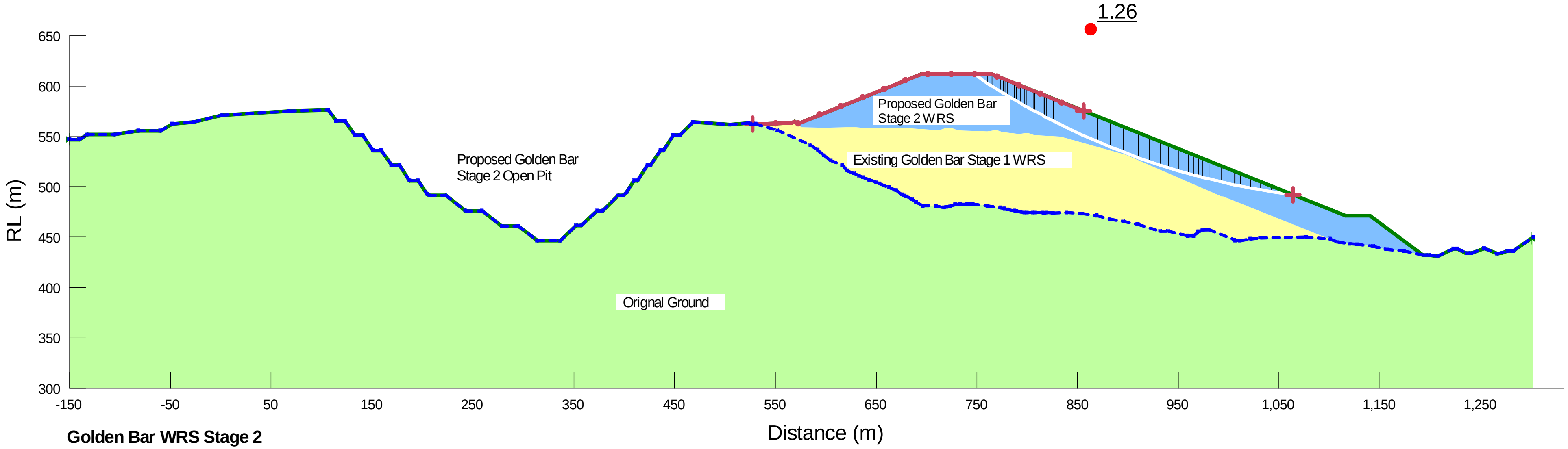

**Golden Bar WRS Stage 2**
**Stability Analysis - Section A-A' Seismic - 01 - Full Depth Failure Surface - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.07**
**Factor of Safety: 1.58**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A10**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



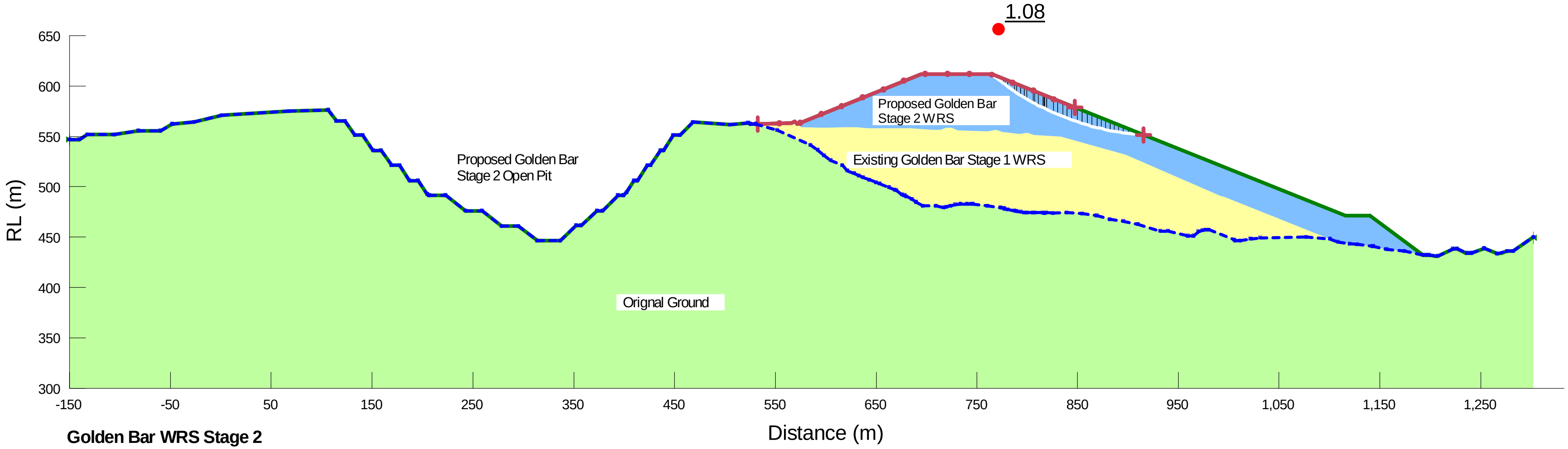

**Golden Bar WRS Stage 2**
**Stability Analysis - Section A-A' Seismic - 02 - Failure Surface located 2/3H below Crest - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.19**
**Factor of Safety: 1.26**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A11**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



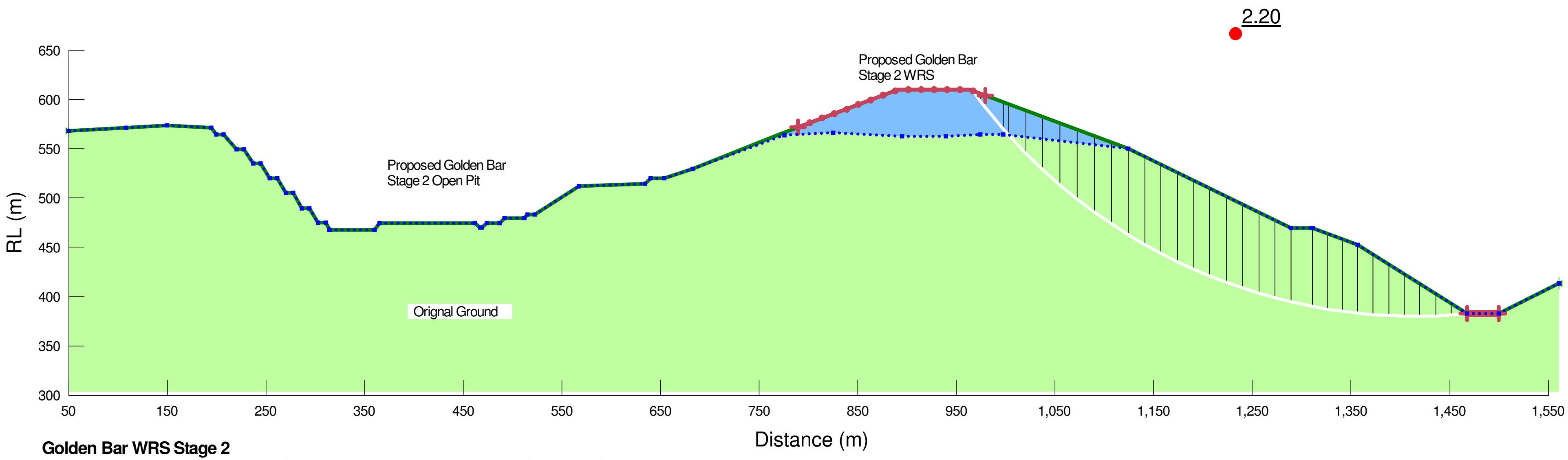

**Golden Bar WRS Stage 2**
**Stability Analysis - Section A-A' Seismic - 03 - Failure Surface located 1/3H below Crest - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.3**
**Factor of Safety: 1.08**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A12**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Surface | Include Ru in PWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 | No |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 | No |



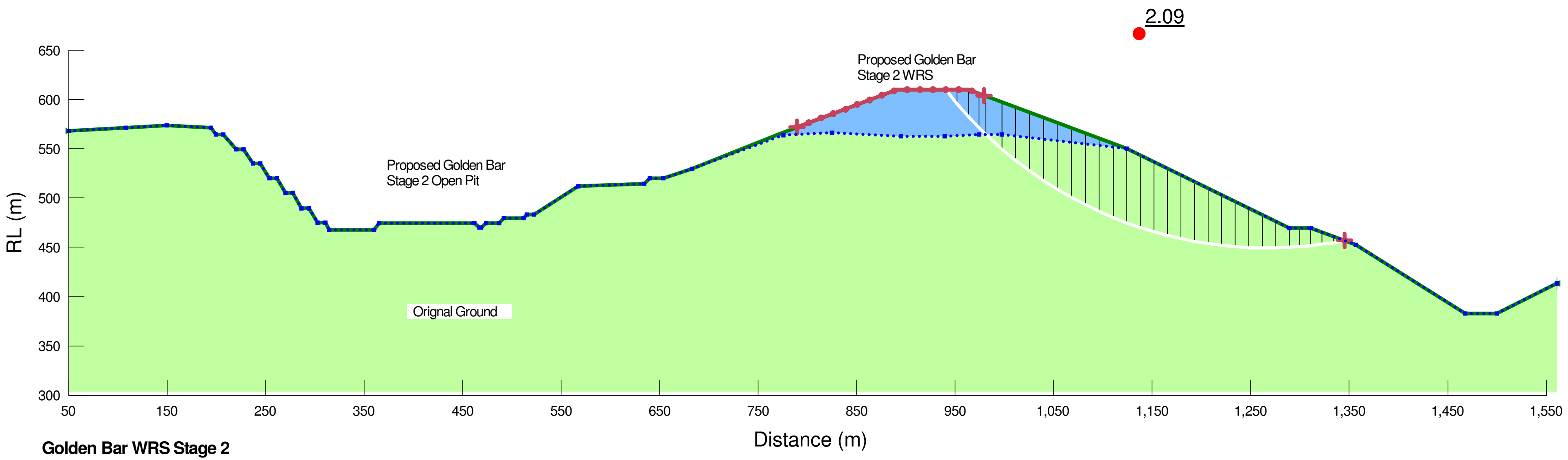

**Golden Bar WRS Stage 2**
**Stability Analysis - Section B-B' Seismic - 01 - Full Depth Failure Surface - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.07**
**Factor of Safety: 2.20**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A13**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Surface | Include Ru in PWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 | No |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 | No |



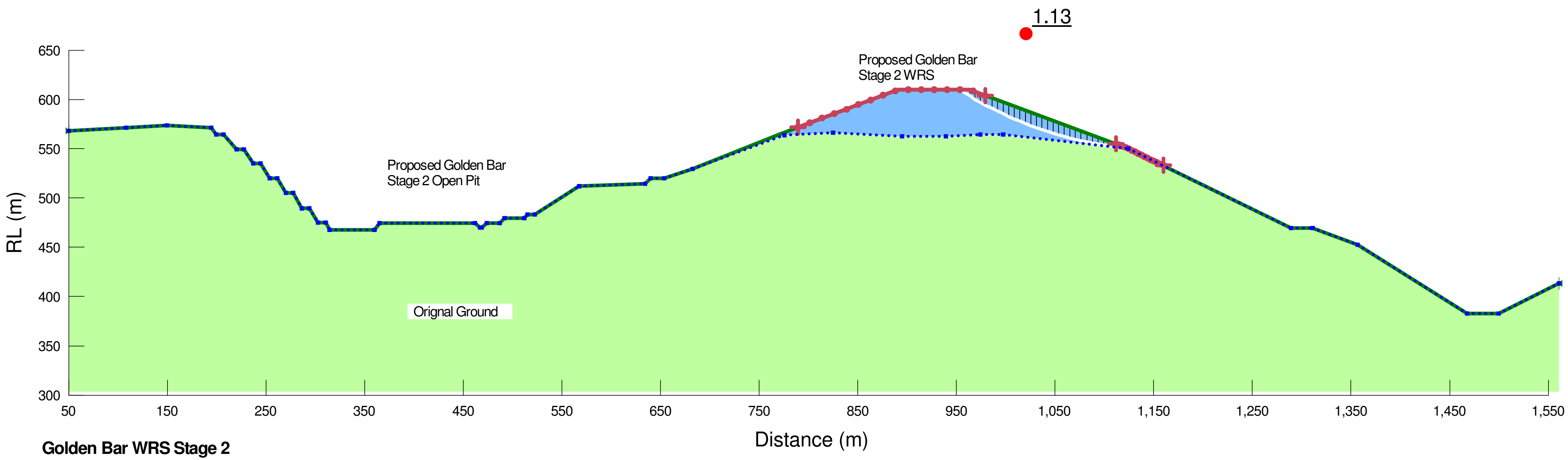

**Golden Bar WRS Stage 2**
**Stability Analysis - Section B-B' Seismic - 02 - Failure Surface located 2/3H below Crest - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.19**
**Factor of Safety: 2.09**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A14**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Surface | Include Ru in PWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 | No |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 | No |



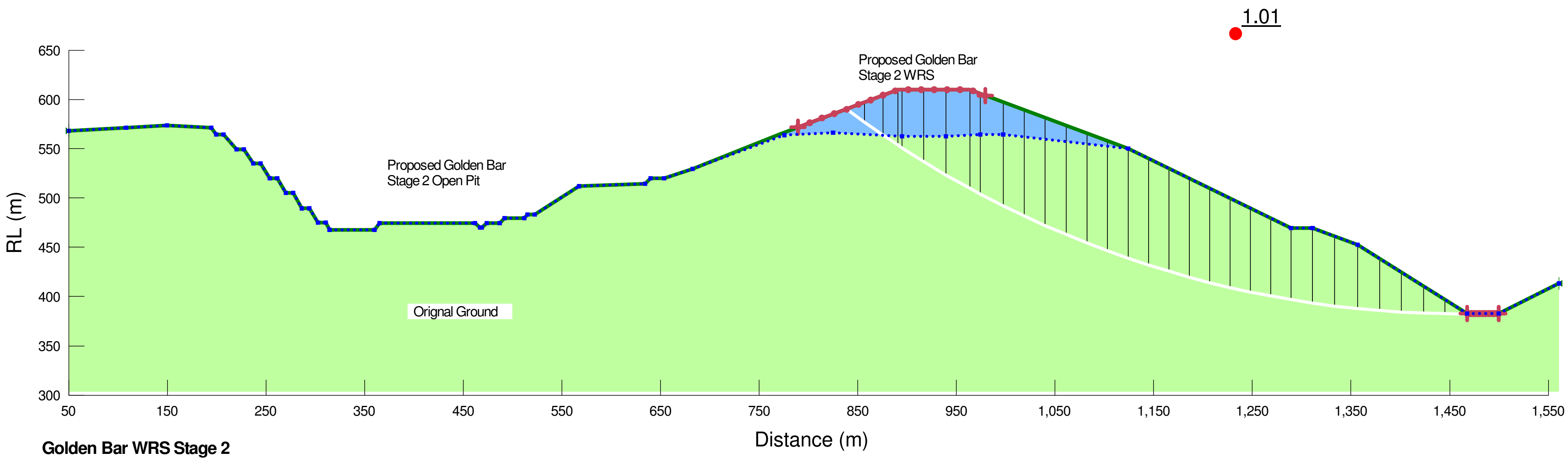

**Golden Bar WRS Stage 2**
**Stability Analysis - Section B-B' Seismic - 03 - Failure Surface located 1/3H below Crest - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.3**
**Factor of Safety: 1.13**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A15**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Surface | Include Ru in PWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 | No |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 | No |



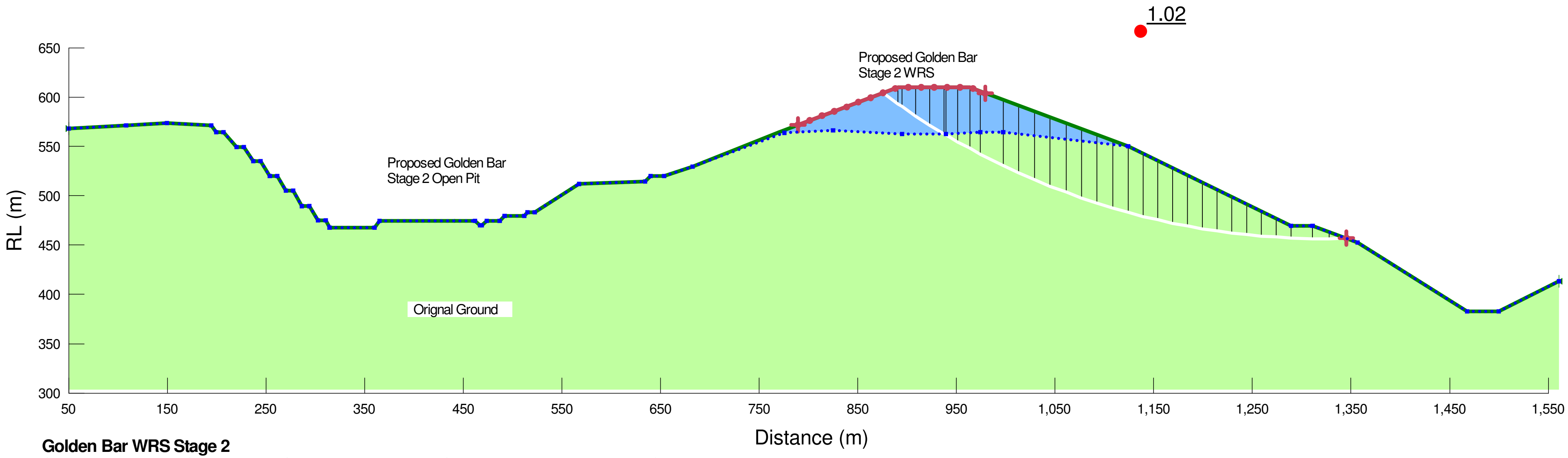

**Golden Bar WRS Stage 2**
**Stability Analysis - Section B-B' Seismic - 04 - Full Depth Failure Surface - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.33**
**Factor of Safety: 1.01**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A16**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Surface | Include Ru in PWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 | No |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 | No |



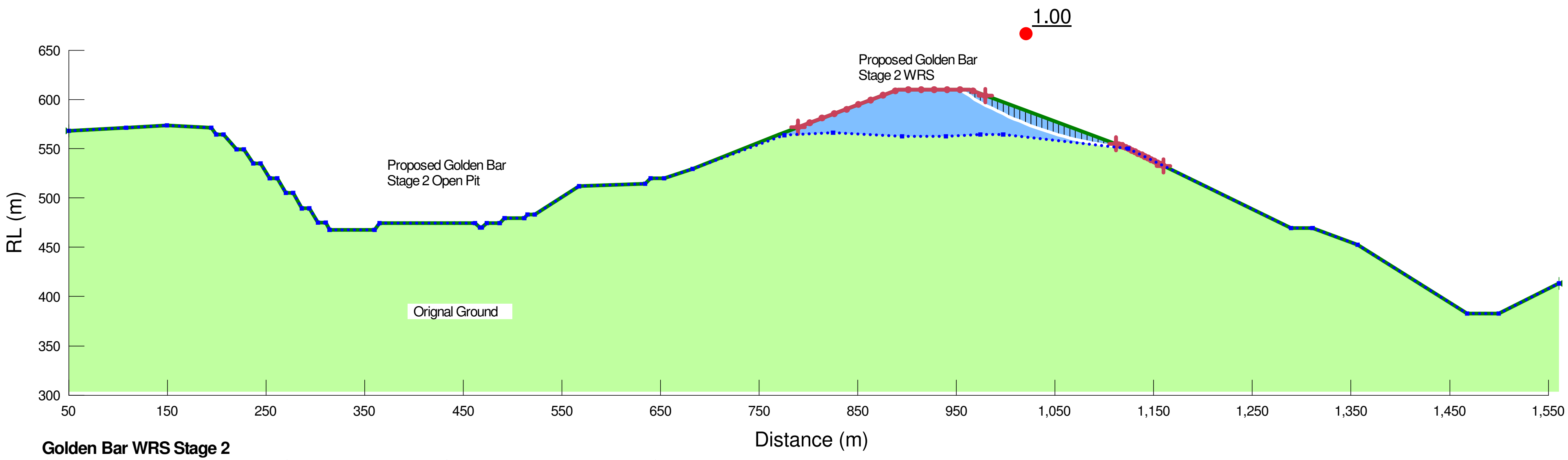

**Golden Bar WRS Stage 2**
**Stability Analysis - Section B-B' Seismic - 05 - Failure Surface located 2/3H below Crest - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.5**
**Factor of Safety: 1.02**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A17**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Surface | Include Ru in PWP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 | No |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 | No |



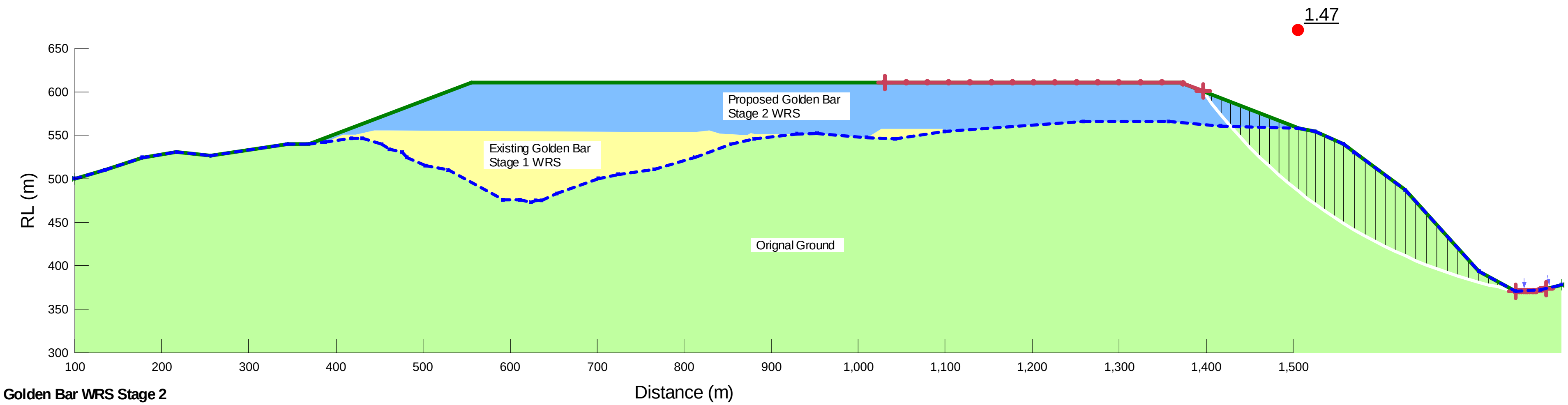

**Golden Bar WRS Stage 2**
**Stability Analysis - Section B-B' Seismic - 06 - Failure Surface located 1/3H below Crest - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.37**
**Factor of Safety: 1.00**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A18**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



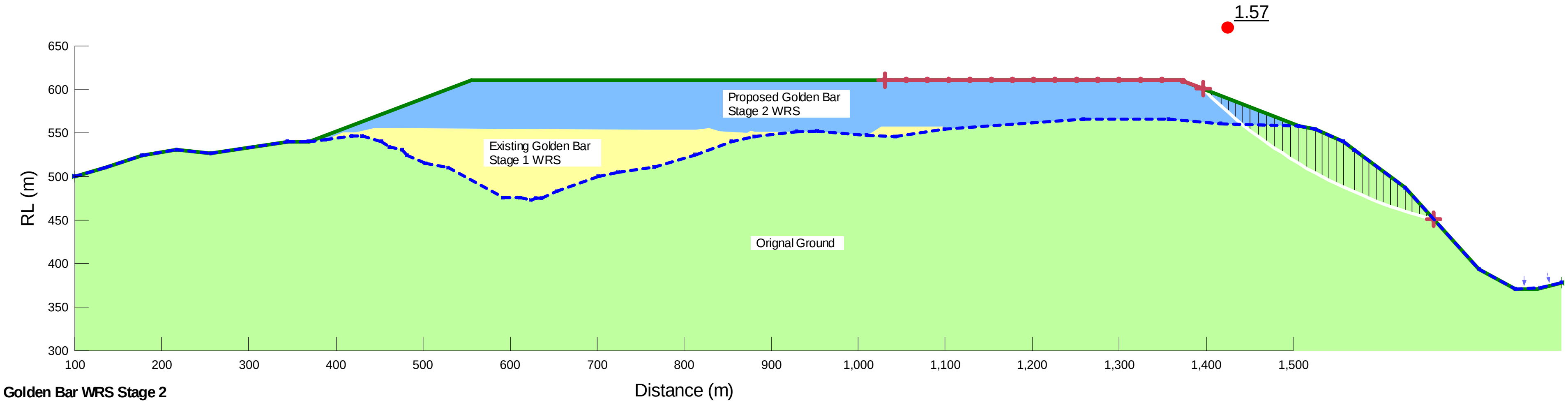

**Golden Bar WRS Stage 2**
**Stability Analysis - Section C-C' Seismic - 01 - Full Depth Failure Surface - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.07**
**Factor of Safety: 1.47**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A19**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



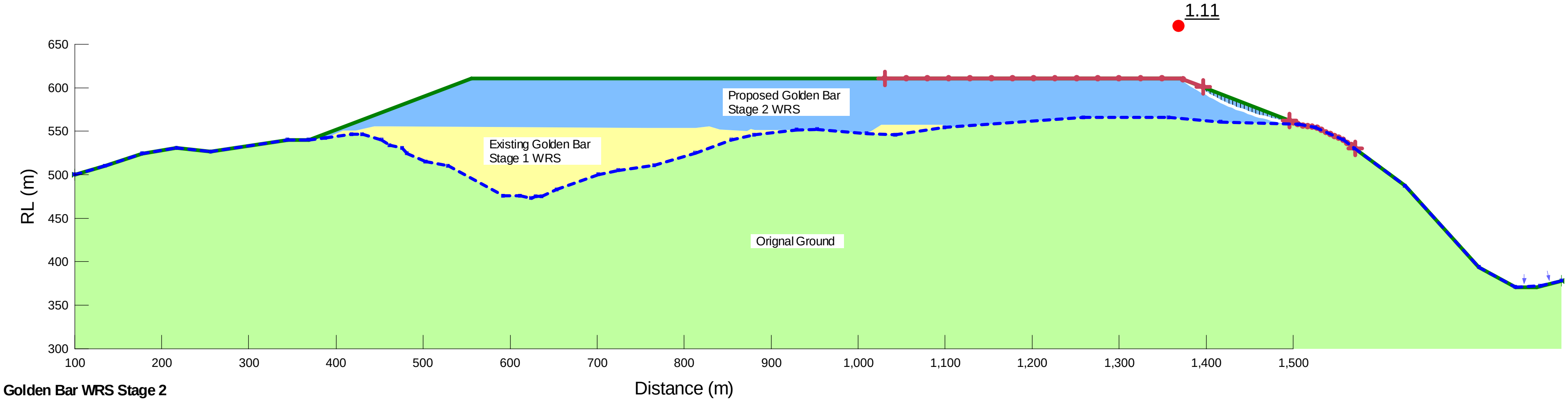

**Golden Bar WRS Stage 2**
**Stability Analysis - Section C-C' Seismic - 02 - Failure Surface located 2/3H below Crest - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.19**
**Factor of Safety: 1.57**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A20**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



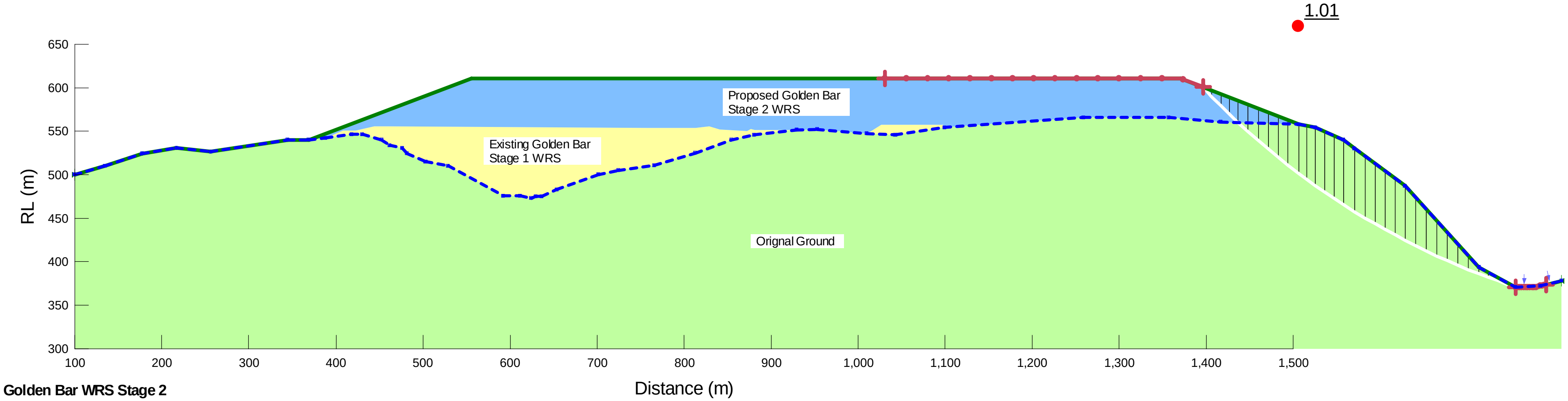

**Golden Bar WRS Stage 2**
**Stability Analysis - Section C-C' Seismic - 03 - Failure Surface located 1/3H below Crest - OBE**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.3**
**Factor of Safety: 1.11**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A21**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



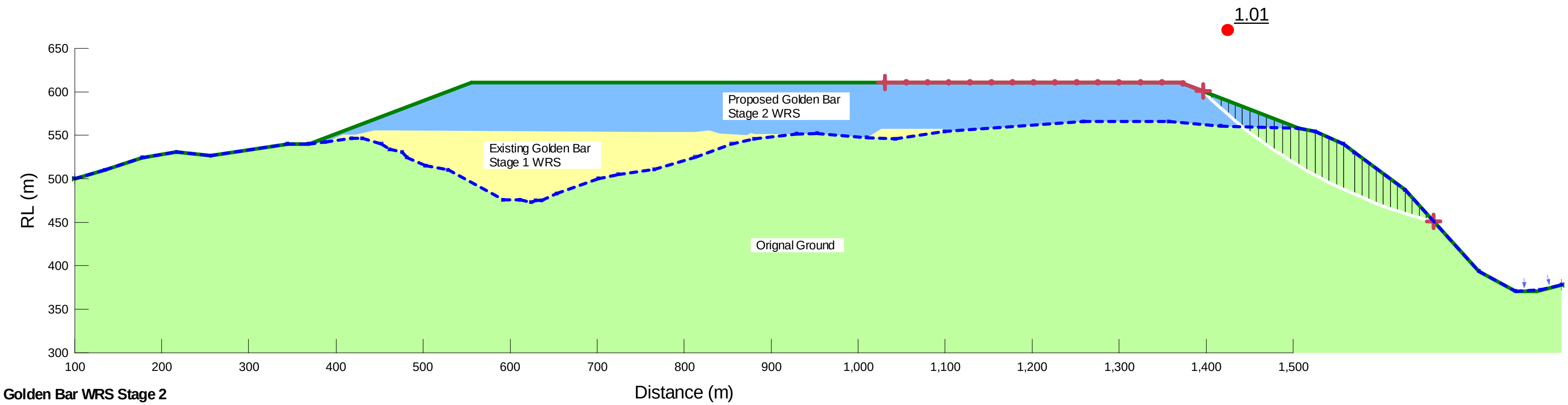

**Golden Bar WRS Stage 2**
**Stability Analysis - Section C-C' Seismic - 04 - Full Depth Failure Surface - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.27**
**Factor of Safety: 1.01**

**Unit Weight of Water: 9.81 kN/m³**

## Figure A22

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |



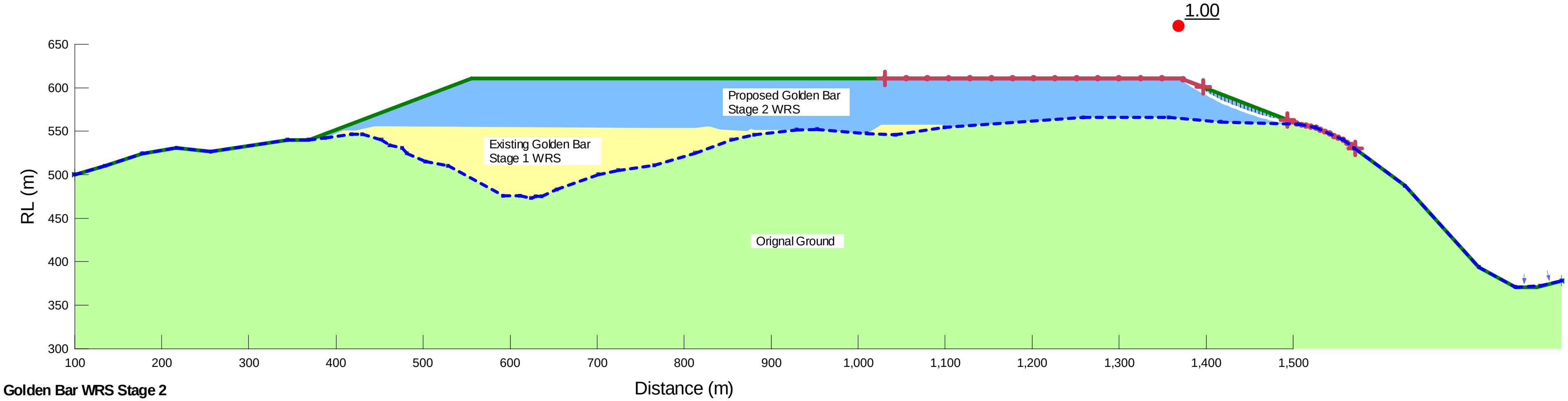

**Golden Bar WRS Stage 2**
**Stability Analysis - Section C-C' Seismic - 05 - Failure Surface located 2/3H below Crest - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.44**
**Factor of Safety: 1.01**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A23**

| Color | Name | Slope Stability Material Model | Unit Weight (kN/m³) | Strength Function | UCS Intact (kPa) | Parameter mb | Parameter s | Parameter a | Calculated from | Intact Rock Parameter mi | Geological Strength Index GSI | Disturbance Factor D | Max Confining Stress Sigma 3 (kPa) | Phi-B (°) | Piezometric Line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Class C Foundation | Hoek-Brown | 27 | | 35,000 | 1.6830724 | 0.0022180849 | 0.50808574 | Yes | 12 | 45 | 0 | 5,000 | 0 | 1 |
| | Existing Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |
| | New Rockfill | Shear/Normal Fn. | 21.5 | Function 2 - 1.29 x sigma^0.91 | | | | | | | | | | 0 | 1 |




**Golden Bar WRS Stage 2**
**Stability Analysis - Section C-C' Seismic - 06 - Failure Surface located 1/3H below Crest - Yield Acceleration**

**Analysis Type: Spencer**
**Horz Seismic Coef.: 0.36**
**Factor of Safety: 1.00**

**Unit Weight of Water: 9.81 kN/m³**

**Figure A24**