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Ref: 6846

OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
TOP TIPPERARY TAILINGS STORAGE FACILITY
TECHNICAL REPORT

Prepared for:

13 April 2011

Oceana Gold (NZ) Ltd
P O Box 5442
Dunedin
OTAGO

OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
TOP TIPPERARY TAILINGS STORAGE FACILITY
TECHNICAL REPORT

EXECUTIVE SUMMARY

1. Construction of the new Top Tipperary TSF will create a tailings storage capacity of 36.7Mm^3.

2. The design of the embankment to form the TSF considers local site geology, seismic, climatic and operational conditions.

3. The design of the embankment incorporates the New Zealand Society on Large Dams (NZSOLD) and International Commission on Large Dams (ICOLD) recommendations for embankments. The Potential Impact Classification of the Mixed Tailings Impoundment is assessed to be **medium**.

4. The embankment for the Top Tipperary TSF will be constructed using downstream construction.

5. The existing Mixed Tailings and Southern Pit Option 11A TSF have been extensively monitored over a period of about 20 years with: piezometers installed in the embankment and tailings; seepage flows measured; deformations monitored; cone penetration tests carried out through the tailings with pore water pressure dissipation tests; boreholes drilled through the tailings with testing and sampling; test pits excavated on the tailings beach; and static and dynamic laboratory tests carried out. This provides significant information and precedent for the design of the Top Tipperary TSF, as well as confidence that the proposed embankment can be constructed and the TSF safely operated.

6. Stability analyses show that the embankment meets normally accepted standards for both static and seismic conditions.

7. Oceana Gold (New Zealand) Ltd (OceanaGold) is experienced at construction, operation and management of TSF’s.

8. Provided OceanaGold construct the embankments and operate the impoundment in accordance with the design recommendations, and monitoring and surveillance in accordance with recommendations, the Top Tipperary TSF will provide stable secure tailings storage.

CONTENTS

APPENDICES

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1.0 INTRODUCTION

Oceana Gold (New Zealand) Limited (OceanaGold) proposes an extension to the Macraes Gold Project. The *Macraes Phase III Project* will take the consented mine life through to 2020. A new tailings storage facility called the Top Tipperary Tailings Storage Facility (TTTSF) is proposed to be constructed in the upper Tipperary catchment basin. It will provide storage for approximately 50Mt (dry weight) of additional tailings. The TTTSF is formed by an embankment that is approximately 4.3km long and up to 70m high. The TTTSF will be required for tailings storage in May 2012 and embankment construction is planned to commence in August 2011.

Engineering Geology Ltd (EGL) has been contracted by OceanaGold to assess the feasibility of the TTTSF and undertake the design. This report documents the proposed design of the TTTSF and also covers construction, operation and closure. The report has been prepared to support a resource consent application for the TTTSF. Design details will be finalised following resource consent approval. The final design will be documented in a Design Report that will be used to support a Building Consent application

2.0 PROJECT HISTORY

The Macraes Mine is located at Macraes Flat in East Otago as shown in Figure 1. Gold and scheelite was initially produced at Macraes by underground mining from the 1890's to the 1920's. Production recommenced for the current operation in 1990 with an open pit mine. An overall layout of the current mine site in the vicinity of the TTTSF is shown in Figure 2.

The tailings at Macraes Mine are currently discharged into two tailings storage facilities (TSF), namely the Mixed Tailings Impoundment (MTI) and the Southern Pit Option 11A Impoundment (SP11A). One TSF rests while tailings are discharged to the other TSF. The existing TSF's are formed by large embankments constructed predominantly using mine overburden material. The tailings are currently being discharged to the MTI TSF. The embankments were initially of conventional downstream construction. In recent years they have been raised by upstream construction. The existing embankments have performed well. The embankment forming the proposed TTTSF will be of a similar design to the downstream construction sections of the existing TSF embankments, and will be constructed from similar materials.

3.0 SITE GRID

All plan grids and references to the site are based on mine north which is approximately 45 degrees anti-clockwise from true north.

4.0 SITE SETTING

4.1. Location and Topography

The location of the proposed TTTSF is shown in Figure 2. A larger scale plan of the TTTSF is shown in Figure 3. The TTTSF spans north and south of the Macraes-Dunback Road and is east of Frasers Pit and the Frasers East Rock Stack.

The main geomorphic feature is the gully associated with Tipperary Creek which is located on the north side of Macraes-Dunback Road. The gully trends in a south eastern direction. A large secondary gully, which is a tributary of Tipperary Creek, is located south of Macraes-Dunback Road. It is aligned east-west and is up to 10m deep. Both gullies merge beneath the proposed footprint of the embankment that forms the TTTSF.

From the northern most side of the TSF the ground generally falls gently (less than 10°) to the south until immediately adjacent to Tipperary Creek. Here there is a moderately to steeply inclined 10m high bank with slopes that locally exceed 30°. The ground to the north of Tipperary Creek is incised by north trending gullies that connect with Tipperary Creek. They are typically up to about 10m deep except for the gully immediately upstream of the main embankment which is about 15m deep.

Between the gully associated with Tipperary Creek and the large secondary gully the land falls gently to the east, except close to Tipperary Creek and the secondary gully where the land steepens locally up to 30°. South of the secondary gully the ground generally falls gently to the north east.

East of the main embankment at the north east end of the TTTSF the land slopes down to the south east towards Cranky Jims Creek between 6 and 17°. Near the south east end of the main embankment the ground drops gently to the north east at approximately 5° until adjacent to Tipperary Creak where the slopes steepen to the east to between 16 and 25°.

4.2. Site Climate

A detailed description of the local climate at Macraes is given in the Macraes Gold Project Expansion - Water Management Report (Ref.1), Macraes Gold Project Expansion – Groundwater Impact Assessment (Ref.2) and more recently in the Macraes Phase III Project Water Management Section 2 – Climate report (Ref.3). These reports include relevant historical records relating to rainfall, evaporation, runoff and temperatures.

The mean annual rainfall recorded since 1959 at the Glendale Station Site, located at the northwest upstream end of the TTTSF, is 628 mm with a maximum and minimum annual rainfall of 914mm (recorded in 1978) and 395mm (recorded in 1998) respectively. The probable maximum precipitation (PMP) estimated for the Macraes Mine site for a 2 day (48 hour) storm is 700 mm (Ref.1). Approximately 78% of mean rainfall (ie. around 470 mm/year) is estimated to be lost from the study area through evaporative process (Ref.2). These processes include evaporation from surface water features (e.g. streams and ponds) and the soil capillary fringe, as well as transpiration.

5.0 GEOTECHNICAL INVESTIGATIONS

Geotechnical investigations of the site were undertaken in 2010 by Golder Associates and EGL. The scope of the investigations is summarised in the following sections.

5.1. Golder Associates

The geotechnical investigation conducted by Golder was aimed at collecting information on the geotechnical characteristics of the soil and rock strata underlying the impoundment, including strength and mass permeability. The investigation comprised:

- Review of aerial photographs
- Review of geological data held by OceanaGold
- New geological mapping in the vicinity of the TSF
- Excavation and logging of 38 test pits
- Excavation and logging of six exploratory trenches to investigate the Macraes Fault as part of a separate fault hazard study by Golder (Ref.4)
- Drilling of 8 fully cored drillholes to depths of up to 50m, including packer testing and installation of piezometers.
- Excavation of an exploratory trench nearly 1000m long along the embankment footprint, crossing the Macraes Fault.

The results of the investigation are presented in a Preliminary Geotechnical Assessment Report (Ref.5) and are summarised in subsequent sections of this report. A geological summary plan prepared by Golder is shown in Figure 4. It includes locations of test pits and drillholes.

5.2. Engineering Geology Ltd

The geotechnical investigation by EGL was aimed at identifying suitable material for low permeability fill for use in Zone A1 of the embankment. The investigations comprised:

- Excavation and logging of 24 test pits within the footprint of the impoundment to assess the nature and suitability of materials for constructing the embankment forming the TSF
- Sampling of representative materials from the test pits for laboratory testing
- Laboratory testing to assist with confirming the suitability and characteristics of potential borrow materials

The locations of the test pits are shown in Figure 5. Logs of the test pits are presented in Appendix A. Results of laboratory tests are presented in Appendix B.

6.0 GEOLOGY

6.1. 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 Macraes Flat, the rocks have been metamorphosed to greenschist metamorphic facies, giving a strongly foliated fabric of dark grey micaceous and light grey quartz-rich laminations.

From previous geotechnical investigations and mining operations on site it is apparent that the prominent geological structures at Macraes Mine include a well developed schistosity with two dominant fault sets. The schistosity, that generally has a low eastern dip in the project area, has been folded by north trending folds to produce a series of anticlines and synclines.

The major set of faults has an eastern trend. They exhibit Miocene age (approx. 5 to 23 M years BP) tectonic deformations and are related to 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 major east trending fault in the area is the Macraes Fault (Billy's Ridge Fault) that is exposed in the wall of Frasers Pit and has been identified by Golder Associates to lie within the TTTSF site on the north side of Macraes-Dunback Road.

The second set of faults has a northern trend, and the most significant of these is the Hyde-Macraes Shear Zone.

The Hyde–Macraes Shear Zone (HMSZ) comprises a mineralised shear zone which has been mapped for at least 25km by OceanaGold geologists. The HMSZ represents the principal gold bearing ore body exploited by OceanaGold Limited and generally strikes north and dips at about 15° to the east. Tectonic displacement associated with the HMSZ is inferred to be in the order of hundreds of metres, with this movement initiating some 120 to 150 million years ago. The ore-schist zone of the HMSZ consists of predominantly pelite and semipelite, but includes blocks of psammite, typically well foliated and containing mineralised quartz veins.

The base of the HMSZ consists of up to several metres of grey breccia and clay gouge. The location of the outcrop of the base of the HMSZ is about 2km west of the proposed TTTSF. The HMSZ is inferred to be more than 500m below ground level at the location of the TTTSF.

6.2. Macraes Fault

The key feature of the impoundment geology is the Macraes Fault which has been investigated in detail by Golder (Ref's 4 and 5). The location of the Macraes Fault is shown in Figures 3 and 4. Six trenches, together with another trench nearly 1000m long beneath the embankment footprint, were excavated and logged in detail with the principal objective to determine whether the fault was active.

The Macraes Fault has offset the HMSZ by about 250 m in a reverse sense. This deformation has been accommodated by a number of faults, both parallel to foliation and cutting across foliation.

Trenches excavated near to the right abutment (i.e. west end of TTTSF) and along the footprint of the main embankment (east end of TTTSF) expose a number of faults inferred to have accommodated deformation associated with the Macraes Fault. The trenches suggest a widening zone of deformation, approximately 250 m wide at the right abutment (west end of TSF) and 600 m wide at the main embankment. Faults exposed in these trenches include the following:

- Several faults dipping at about 45° to the north, striking parallel to the overall trend of the Macraes Fault at the northern margin of the deformation zone.
- Several moderately to steeply dipping faults up to 600 mm across, striking parallel to the trend of the Macraes Fault, and cutting across foliation.
- Numerous foliation parallel faults striking obliquely to the overall trend of the Macraes Fault (but parallel to the local foliation orientation). Foliation-parallel faults are common in schist, particularly where tectonic deformation has resulted in flexural slip during folding.

From their study of the Macraes Fault, Golder concludes:

1. The surface expression of the Macraes Fault changes in the vicinity of the proposed TSF impoundment area. To the west, the topographic elevation difference across the Macraes Fault is about 50 m, and it is a subdued step in the landscape. This step decreases in elevation and width to the east to form a gentle, southeast-facing slope with no significant steps. The ridge that underlies the proposed main embankment represents the catchment divide between Tipperary Creek and Cranky Jims Creek. This ridge has no significant steps, warps or slope changes along the line of the Macraes Fault that indicate Quaternary or earlier tectonic deformation. This lack of offset suggests that much of the topographic offset across the Macraes Fault lineament could have formed due to differential erosion along the fault zone rather than ongoing fault displacement.

2. Trenches excavated across the Macraes Fault indicate a soil profile of less than 1m overlying weathered schist. No evidence for fault offset, warping or tilting was observed within the soils that cross the fault. The soils and Quaternary sediments include a 0.6 to 1.0m thick loess layer that occurred over almost the entire fault zone. This loess is interpreted to be at least 11,500 years old, though it has not been dated locally to confirm this age.

3. Because the loess layer is undeformed across the fault and is interpreted to be at least 11,500 years old, the likelihood of rupture of the Macraes Fault during the life of the TSF is considered very low. Accordingly, for this study the Macraes Fault is interpreted to have a recurrence interval in excess of 10,000 years that is equivalent to an annual exceedance probability of less than 1/10,000.

4. If the Macraes Fault and Billy's Ridge were to rupture co-seismically, the estimated total maximum offset would be 1.92 m, which could equate to 1.4 m vertically and 1.4 m horizontally. It is possible that the deformation would occur on more than one fault structure within the mapped zone of deformation. Regardless the design has been developed to accommodate this unlikely event.

6.3. Site Geology

6.3.1. Soils

The area of the TTTSF is covered by a veneer of topsoil, loess, colluvium and residual soil that varies between 0.3m and 2m (typically less than 1m), but there are localised zones where the soil can be deeper than 3.0m. The deepest soils generally occur on the eastern facing slopes where the loess is thickest.

Topsoil generally varies between 100 and 200mm in thickness on the gently sloping ground. It can be as deep as 400mm thick in shallow east to north east trending drainage channels that drain down to Tipperary Creek just north of the Macraes-Dunback Road.

The loess generally comprises silt with some clay and occasionally minor amounts of fine sand and fine schist gravel. Clayey silt and silty clay was only observed in a few locations. The colluvium generally comprises a mixture of silt and angular schist gravel and cobbles or gravelly silt with minor clay where the silt is derived from reworked loess. The gravel consists of highly weathered angular fine pebble sized clasts of schist.

Laboratory tests conducted on samples of loess obtained from the test pits include water content, particle size analyses, Atterberg Limits, Pinhole Dispersion, Crumb, compaction and permeability. Results of the tests are presented in Appendix B. Water content, Atterberg Limits, Pinhole Dispersion and Crumb test results are summarised in Table 1. Compaction test results are summarised in Table 2 and permeability tests in Table 3. The results indicate that the soils are typically sandy silt of low plasticity and are dispersive. This is typical of loess derived soils. When used in water retaining embankments filters are essential to prevent internal erosion.

Two permeability tests were conducted on samples of weathered schist (i.e.potential Zone A1 fil)l. The results indicated permeabilities of 5.8 x 10^{-9}m/s and 3.3 x 10^{-7}m/s. A maximum permeability of 10^{-7}m/s would normally be considered acceptable, so one result indicates an acceptable result while the other exceeds the 10^{-7}m/s criteria. There was not a large difference in particle size between the two samples. The sample with the lower permeability had 4 percent clay while the other was 2 percent. The intention is to blend the weathered schist with loess soils, where necessary, to achieve low permeability fill (Zone A1) for the TTTSF embankment. This blend has been used successfully to construct existing TSF and water storage embankments at the Macraes Gold Project. Figure 6 summarises the approximate thickness of excavatable weathered schist, at the test pit locations, likely to be suitable for constructing Zone A1 of the TTTSF embankment.

6.3.2. Schist

The soils are directly underlain by schist comprising well foliated, fine grained pelite to coarser grained psammite. North and south of the impoundment, foliation typically dips at 20° - 40° towards the east, which is consistent with the regional foliation pattern. Foliation locally dips towards the southeast as a result of drag folding adjacent to the Macraes Fault.

6.3.2.1. Weathering

The weathering profile encountered by the drill holes is summarised in the Golder report (Ref.5).

The weathering characteristics of the schist are complicated at this site by the presence of the Macraes Fault. Within the deformation zone of the Macraes Fault, the schist is mainly of lower strength than elsewhere due to zones of shearing. The depth of highly or moderately weathered schist (i.e. where weathering has significantly affected the strength of the schist) is relatively shallow at the impoundment. Five out of eight drill holes encountered 0.5m or less of highly or moderately weathered schist and the maximum depth of highly or moderately weathered schist encountered was 5m. Slightly weathered rock (having some discolouration, but not significant strength loss) was encountered to a depth of up to about 35m.

Most of the rock encountered at depths of up to about 2m in the trench beneath the main embankment was moderately weathered, with some zones comprising highly weathered or slightly weathered rock.

6.3.2.2. Strength

No new strength testing has been considered necessary as part of the investigations by either Golder or EGL. However, Golders have assessed strength based on observation of outcrop and core and their interpretation follows. Unweathered schist encountered by the drill holes outside the deformation zone of the Macraes Fault has mainly been described as moderately strong or strong. Observation of the core suggests that the rock strength is comparable to schist encountered elsewhere on the Macraes Gold Project. Typical unconfined compressive strength for unweathered schist is between about 20MPa and 40MPa, normal to bedding, which is consistent with the description of moderately strong. Schist typically has a lower unconfined compressive strength along the foliation, which reflects the layered nature of the rock and the presence of weak, mica-rich laminations.

Much of the rock encountered within the northern half of the embankment footprint has been affected by faulting associated with the Macraes Fault (refer to extent of Macraes Fault in Figure 3). The fault-affected schist is typically described as weak or very weak and is estimated to have an unconfined compressive strength in the range 1 to 5MPa.

Golder assess that within the Macraes Fault zone of deformation, approximately 50% of the rock mass comprises zones of weak or moderately strong schist and the remaining rock mass comprises very weak, highly weathered or sheared schist.

6.3.2.3. Rock Mass Discontinuities

Joints

Golder has measured joint orientations from outcrops and excavations and they are reported in detail (Ref.5). The most common joint orientations measured in the impoundment are steeply dipping (>70°) with a dip direction to the south or southwest. Other joints typically dip steeply to the west or northwest.

In the drill core joints are typically described as rough and planar to undulating. Most core breaks are along foliation, and many of these could have been induced during drilling or handling.

The widest spacing between joints or foliation partings is about 500mm. Much of the core is highly fractured, or sheared particularly within the deformation zone of the Macraes Fault.

Foliation

Golder has measured and reported in detail on foliation of the schist. Foliation typically dips at about 40° to the east in the vicinity of the proposed impoundment, which is consistent with the regional trend. The greatest concentration of foliation measurements dip towards about 100°, however, a significant number of measurements indicate foliation dipping to the southeast. This is consistent with the folding within the deformation zone of the Macraes Fault. Within the Macraes Fault zone the main embankment foliation dips between 35° and 55° to the east on the north side and generally 50° to 60° to the south-east, but as low as 20°, in the centre of the south side of the fault.

6.4. Groundwater Conditions

6.4.1. General

The groundwater table in the vicinity of the TTTSF has been measured in standpipe piezometers installed in eight drillholes shown in Figure 4. The measured water levels are summarised in the Golder geotechnical report (Ref.5).

The water level measurements show that the groundwater table is generally shallow (less than 4m) except at one location in the Macraes Fault zone (DDH5198 ~ approximately 7m) and beneath the main embankment, close to Tipperary Creek (DDH5201 ~ approximately 10m)

6.4.2. Permeability Tests Results

Evaluation of the packer tests conducted in the investigation drill holes has been undertaken by Golder (Ref.5). The rock mass permeability inferred from the packer tests is in the range of 5 x 10^{-6} to 3 x 10^{-9}m/s. Golder concludes that the rock mass permeability within the impoundment is similar to other sites around the Macraes Gold Project. The test results also suggest that the permeability of the rock mass within faulted schist (approximately half of the tests), is the same as unfaulted schist.

Golder also undertook three pit permeability tests to measure the permeability of the shallow rock mass (Ref.5). The locations were within the embankment footprint, near the southern margin of the Macraes Fault. Locations included faulted and unfaulted schist. The tests involved filling each test pit to a depth of about 0.5m and measuring the rate of fall of the water surface over a period of a few hours. Hydraulic conductivities of less than 10^{-9}m/s from these tests were calculated using SEEP/W.

6.4.3. Potential Seepage Paths

The TTTSF Embankment has a low permeability zone (Zone A1). An extensive network of subsurface drains to intercept and collect seepage is also proposed. This includes a chimney drain within the embankment at low elevation, and seepage collection drains located at the upstream toe of Zone A1 (upstream cutoff drain) and at the downstream side of Zone A1 (chimney drain base collector drain). No significant seepage loss is therefore anticipated through the embankment or at the foundation interface between the embankment and in situ ground.

The main source of seepage loss to the underlying rock and regional groundwater table will be from within the impoundment area where the tailings directly overlie the in situ ground. Golder has undertaken analyses to quantify seepage losses (Ref.6). Seepage losses are predicted to mainly occur along the fractures and crush zones within the more weathered rock to about 20m depth. The field mapping and boreholes do not indicate any areas of significant faulting or fracturing where localised seepage loss is likely to occur requiring remediation work (e.g. grouting), although this will be subject to inspection and confirmation during construction. Golder's seepage analyses (Ref.6) show that most of the seepage loss from the TSF is predicted to flow to the east and southeast and discharge into Tipperary Creek and Cranky Jims Creek.

7.0 SEISMIC HAZARD

In 2005 Geological and Nuclear Sciences (GNS) was engaged to undertake a seismic hazard study for the site (Ref.7). GNS has considerable experience in undertaking such studies both in New Zealand and overseas. Probabilistic estimates of seismic hazard in terms of acceleration response spectra were estimated for use in the design of the tailings embankments. Spectra were provided for return periods of 150, 475, 1,000, 2,500 and 10,000 years as well as for earthquakes associated with the closest active faults to the site (Billy's Ridge and Taieri Ridge).

A rigorous approach was adopted for determining estimates of seismic hazard. A catalogue of fault sources located within 100km of the site was compiled in conjunction with the Geology Department of University of Otago. This was used to update the earthquake and fault source model for the region. A logic tree format was adopted to enable explicit treatment of uncertainty. Estimates of ground motions were computed using the updated seismic source model for the region and three alternative attenuation functions (one NZ-based model and two overseas). The greatest weighting was given to the NZ-based model. The resulting spectra were de-aggregated to investigate the principal sources contributing to the peak ground acceleration (pga) and 1 sec period spectral acceleration for 475 and 10,000 year return periods. Several suitable earthquake acceleration time history records were selected, with appropriate scaling factors, for controlling ground motion events revealed by the de-aggregation of the hazard spectra.

Estimates of spectra were generally higher than previous estimates for the site except for short return periods (150 years) where estimates were lower. The increases were greatest for longer return periods. The increases are primarily a result of reassessment of the activities of the three closest faults to the Macraes Gold Project (Billy's Ridge, Taieri Ridge and Hyde faults). These three faults were all considered capable of generating up to M_w7 earthquakes, and due to their close proximity to the site can be expected to generate very strong shaking. The recurrence intervals for these faults are not known with great accuracy. Recurrence intervals in the range of between about 3,000 and 25,000 years were considered by GNS in the analyses for the Billy's Ridge and Taieri Ridge faults and between about 1,600 and 10,000 years for the Hyde Fault.

In 2010 a detailed investigation was undertaken of the northern segment of the Billy's Ridge Fault, known as the Macraes Fault, by Golder Associates (Ref.4) and the results are summarised in Section 6.2. The Macraes Fault is adjacent to the Macraes Gold Project. The surface expression of the Macraes Fault is very subdued compared to the other structures that have reported tectonic movement during the Holocene period (last 10,000 years). Golders were able to conclude, based on trenching and soil dating techniques, that the Macraes Fault has not ruptured to the ground surface during the last 11,500 years and that there was no evidence of any late Quaternary deformation. On this basis the annual exceedance probability of rupture of the Macraes Fault is significantly lower than 1/10,000 (0.0001).

For design purposes the TTTSF has been assessed to have a medium potential impact classification (refer Section 10.2). According to the criteria recommended by Meija et al (Ref.8) for medium PIC dams, faults with annual exceedance probabilities of less than 1/2,500 (0.004) need not be considered and design earthquake ground motion need not be taken greater than associated with the 2,500 year return period. Consequently the northern segment of the Billy's Ridge Fault (i.e. Macraes Fault) need not be considered when assessing the seismic hazard for the site. The estimates of seismic hazard by GNS have been used in the stability analyses of the TTTSF (refer section 10.9). They assume that the Macraes Fault is active. This is conservative. Spectra for return periods of 150, 475 and 2,500 years have been considered in the stability analyses and they are shown in Figure 7.

8.0 IN-SITU ROCK, WASTE ROCK AND TAILINGS CHARACTERISTICS

8.1. In-situ Rock

Two sets of shear strength parameters have been adopted for the insitu rock with a lower shear strength for the shallow rock (less than 5m depth below original ground level) to take account of weathering. The shear strength parameters for the shallow rock are the same as those previously used for the design of the MTI and SP11A TSF embankments (Ref's 9 and 10). For the deeper, less weathered rock the design parameters have been taken as a lower bound of the rock strengths typically used for the pit design at Macraes Gold Project. The shear strength parameters do not take account of any major discontinuities or shear zones in the rock.

Rock shallower than 5m below original ground level.

Effective cohesion = 50kPa
Effective friction angle = 40 degrees

Rock greater than 5m below original ground level.

Effective cohesion = 150kPa
Effective friction angle = 45 degrees

Within the Macraes Fault Zone the rock strength for rock shallower than 5m below original ground level has been adopted.

8.2. Waste Rock

Existing tailings and water storage embankments at the site have been successfully constructed using rock from mine waste (primarily slightly to highly weathered schist). A large amount of laboratory and field testing has been undertaken on these materials both prior to construction commencing on site and during the operation of the mine and design parameters established. These same parameters have been adopted for stability analyses for the TTTSF embankment and are presented in detail in Appendix D and are summarised below. The shear strength functions for Zones A1, B and C are plotted below Table D1 in Appendix D and show that at low effective stress (less than about 100kPa) the equivalent effective friction angle is about 45 degrees with zero cohesion, which then reduces with increasing effective stress. The strength of Zone B and B1 is very similar and for analysis these materials are considered together and referred to as Zone B respectively.

Zones A1 and B

Density	22.5 kN/m^3
Shear strength (τ)	$\tau = 2.43\ \sigma_v'^{\,0.83}$ where σ_v' is the effective vertical overburden pressure

Zone C

Density	21.5 kN/m^3
Shear strength (τ)	$\tau = 1.29\ \sigma_v'^{\,0.91}$ where σ' is the effective vertical overburden pressure

8.3. Tailings

8.3.1. General

The tailings are discharged sub-aerially via spigots from the perimeter embankment which promotes segregation of the tailings and the formation of a more permeable beach adjacent to the embankment. Generally the coarse tails are deposited on the beach with the finer tails carried further from the embankment. However, tests at the existing TSF's indicate there are occasional thin lenses of finer tails, generally less than 100mm thick. Where these lenses have been traced on site it has been found that they extend over limited width and are not continuous.

In 2008 particle size distribution (PSD) tests were carried out on tailings obtained from the SP11A TSF beach and the results are plotted in Figure C1 (Appendix C). Tailings associated with the TTTSF will be similar to those from SP11A. The samples were specifically selected to sample the general tails, referred to as 'coarse', and the finer thin lenses, referred to as 'fine' tailings. Figure C1 shows that the 'coarse' tailings on the beach generally comprise:

Medium sand	(200-600 microns)	about 30%
Fine sand	(63-200 microns)	about 55%
Silt and clay	(fines less than 63 microns)	about 15%

Figure C1 shows that the 'fine' tailings are highly variable with a fines content generally varying between 50 and 100%. The PSD tests on the 'coarse' and 'fine' tailings are consistent with previous tests carried out on the tailings.

The average dry density of the tailings in the impoundment has been monitored by dividing the total tonnage (dry) of tailings produced by the Process Plant by the volume occupied in the impoundment. The dry density has increased with time and the latest calculation results in a dry density of 1.38t/m^3. In addition to this, tube samples have been taken of the tailings, generally in the beach area, to determine the dry density and water content which gives a wide scatter of results averaging between 1.33 to 1.43t/m^3 (individual range 1.1 to 1.7t/m^3) and 10 to 30% (individual range 5 to 50%) respectively. Generally out of necessity the tailings samples are taken during the TSF resting period and the samples are partially saturated with typical degrees of saturation varying between 30 and 100%. For design a bulk and saturated density of 1.86t/m^3 has been used for the tailings. For assessing tailings storage in the TTTSF an average dry density of 1.25t/m^3 has been adopted for year 1, 1.3t/m^3 for years 2 to 4 and 1.35t/m^3 for years 5 to 9. These are considered to be conservative assumptions.

The permeability of the tailings at The Macraes Gold Project has been determined from samples taken from the existing TSFs at various times. Laboratory tests indicate permeabilities varying from about 1 x 10^{-6} to 5 x 10^{-8} m/s.

8.3.2. Shear Strength

Static and liquefied shear strengths of the tailings are required for design. They are discussed separately in the following sections.

In 2005 and 2006 Engineering Geology Ltd (EGL) carried out an investigation for raising the MTI and SP11A TSF's to RL551 and the results are included in EGL's Engineering Feasibility Report (Ref.9). The report was reviewed by Richard Davidson (Senior Principal of URS Corporation, USA), acting as internal reviewer for OceanaGold, and Alan Krause (MWH Global, USA) acting as technical advisor to Otago Regional Council (ORC). The report was submitted to ORC in support of the Resource Consent application to raise both MTI and SP11A TSF's to RL551 so as to provide future tailings storage capacity. The consent was approved in 2006. Much of the design philosophy for the TSF's, including field and laboratory testing, is contained or referred to in the Engineering Feasibility Report (Ref.9). Subsequent to this further testing and analysis has been carried out on the tailings to determine appropriate design parameters and this is included in EGL's Design Report for raising the MTI to RL539 (Ref.10). The detailed information from these reports is not repeated in this report, but has been used for design and summarised where relevant.

8.3.2.1. Static Shear Strength

Numerous triaxial tests have been carried out on the tailings and effective cohesion values varying between 0 and 45kPa (average 17kPa) and friction angles of between 27 and 40 degrees (average 34 degrees) were measured. For design the following shear strength (static) parameters have been adopted for the tailings, and are consistent with previous design assumptions (Ref.9 & 10).

Effective cohesion	0 kPa
Effective friction	35 degrees

8.3.2.2. Shear Strength During and Post Earthquake

During strong earthquake shaking saturated tailings can be expected to liquefy. A considerable amount of work has been undertaken on tailings from the Macraes Gold Project to quantify the post earthquake residual (undrained) shear strength (Su_{liq}). This is particularly important for upstream construction where embankment stability is dependent on the strength of the tailings. For the initial design of the TTTSF it has been assumed that the tailings will be fully saturated and will liquefy when subject to earthquake ground motion with an average return period of 475 years or greater. The liquefied tailings are assumed to have a residual (undrained) shear strength (Su_{liq}) of 0.13. This value is based on the average of an empirically derived value of 0.06 and a conservatively determined laboratory value of 0.20. The empirically derived value was determined in accordance with the empirical equations developed by Seed et al (Ref.11), Olsen and Stark (Ref.12) and more recently by Idriss and Boulanger (Ref.13). These equations have been derived from back analyses of historical failures. The Su_{liq} value is based on either SPT or CPT tests. At the Macraes Gold Project CPT tests have been predominantly carried out in the tailings and therefore have been used for the determination of the design Su_{liq}. On this basis a Su_{liq}/σ'_v value of 0.06 was used for the post earthquake residual shear strength of the tailings based on CPT tests carried out through the tailings (refer Ref.9).

In 2005 cyclic simple shear laboratory tests were carried out at the University of Western Australia (UWA) on 4 representative tailings samples obtained from the MTI TSF. The samples were selected to represent a cross section of the tailings and resulted in Su_{liq}/σ_v values of 0.13, 0.52, 0.27 and 0.42 (refer Ref.9). These values are significantly higher than 0.06 determined using the empirical correlations. The UWA results are also consistent with cyclic shear tests on fine grained mine tailings reported in the literature (Ref.14). The UWA test results show significant post liquefaction dilatancy effects which will increase the residual undrained shear strength of the tailings. Post earthquake dilatancy effects are not necessarily taken into account in the empirical strength correlations which can result in lower inferred shear strengths.

In 2009 Prof Peter Byrne carried out state of the art dynamic analyses on a typical section of the MTI TSF (Ref.15). The analyses showed that using the UWA cyclic simple shear test results there is negligible void redistribution taking place which could potentially lead to expansion effects and the formation of pockets of water beneath barrier layers. Consequently for the MTI TSF it would be very conservative to adopt the empirical post earthquake residual shear strength parameters (Ref.11, 12 and 13) and the shear strength is likely to be closer to the laboratory test results. For design of the TTTSF we have adopted the average of the two values (i.e. average of the empirical Su_{liq}/σ'_v of 0.06 and a conservative laboratory test value of 0.20) resulting in a design Su_{liq}/σ'_v of 0.13.

9.0 LIQUEFACTION OF TAILINGS

The tailings that are to be stored in the TTTSF will come from the same ore body and be processed in a similar manner to the tailings stored in the existing MTI and SP11 TSFs. Consequently previous studies of tailings stored in the existing TSF's are relevant. Significant work has previously been carried out on the potential liquefaction of the tailings in the MTI TSF (Ref.9 and 10) and it is considered that this work provides a basis for use in the design of the TTTSF.

For the MTI TSF the analyses using empirical correlations indicate that liquefaction is unlikely for a 150 year return period earthquake ground motion. Further to this, the state of the art dynamic analyses carried out in 2009 by Prof Peter Byrne (Ref.15) indicate that no significant liquefaction is likely for a 475 year return period earthquake ground motion using the laboratory cyclic simple shear tests carried out on the tailings from the MTI TSF (Ref.9). Taking all these analyses into account it was conservatively assumed for design of the MTI and SP11A TSF that liquefaction of the tailings occurs for a 475 year return period earthquake ground motion (Ref.10).

Liquefaction of the tailings in the TTTSF is less critical than for the MTI TSF as the embankment is built entirely using downstream construction. The TTTSF tailings will be discharged continuously up to full height, with no resting period, and will initially not be consolidated to the same degree as the tailings in the MTI TSF. It is assumed for design that liquefaction of the tailings could occur under a 475 year return period earthquake ground motion.

10.0 TOP TIPPERARY TAILINGS STORAGE FACILITY EMBANKMENT

10.1. Embankment Layout and Geometry

The alignment and footprint of the TTTSF Embankment is shown in Figure 3. A typical embankment cross-section is shown in Figure 8 and cross-sections along the length of the embankment are shown in Figures 9 and 10. The embankment will be built in stages with the initial embankment constructed to RL530 as shown in Figure 8. The embankment will be raised as necessary to safely store the anticipated tailings production and normal operating pond water plus runoff from an extreme rainfall event. The anticipated crest height of the embankment with time is tabulated in Figure 8.

The catchment area for the TTTSF is 183ha, and this is shown in Figure 3. The area of the TTTSF when filled to maximum level and allowing for the inclined tailings surface is approximately 155ha.

10.2. Storage Capacity and Crest Level

The height-storage curve for the TTTSF is presented in Figure 11. The impoundment has a maximum tailing storage capacity of approximately 36.7Mm^3 (49.5Mt at 1.35t/m^3) with the embankment crest at RL560 and after allowing for the design storm and freeboard. This will provide for approximately 9 years of ore processing at a rate of 5.5Mt per annum. The initial embankment will be constructed to RL530 and this will provide storage for approximately 13 months of tailings production.

The embankment crest height must be advanced to provide sufficient storage for the tailings and normal operating pond water volume as well as the design storm. For assessing storage requirements the following tailings dry densities are assumed:

Year	Dry Density (t/m^3)
1	1.25
2-4	1.30
5-9	1.35

Freeboard on top of the storm is required to prevent overtopping by any wave action and run-up. A freeboard of 1 m is recommended based on the relatively small fetch and the shallow depth of ponded water. The design storm is taken equal to the 48 hour probable maximum precipitation (PMP) which is 700 mm.

Two curves are shown in Figure 11. One gives the volume of water that could be stored (i.e. level surface). The other is the volume of tailings and takes account of the sloping surface of the tailings. The difference between the two curves at a particular level is the volume of water that could be stored above the tailings assuming no water ponds against the upstream face of the embankment.

10.3. Surface Water Management on the Tailings Storage Facility

Water can accumulate on the surface of the TTTSF due to rainfall, from water released from the tailings slurry when it is discharged into the pond (i.e. supernatant) and from water pumped from pits. A large volume of water is lost due to evaporation, particularly over summer months. In wet periods water can accumulate.

Water collected in the TTTSF will be pumped back to the Process Plant for reuse. The return pump will be located on a pontoon floating on the water and positioned to achieve sufficient depth for the pump intake (normally a minimum of 2m). It will have a capacity of up to 1,500m^3/hour. Tailings discharge from the spigots is carefully controlled to maintain water in the vicinity of the return pump. Fresh water is added to the tailings water at the Process Plant for processing the ore. Consequently the amount of tailings water pumped back to the Process Plant can be varied, depending on how much fresh water is added at the Process Plant, to control the volume of water in the TSF.

Golder Associates has developed a site wide surface water model (Ref.16). The main purpose of the model is to predict water quality in receiving environment waterways. However, it also enables an assessment of the volume of water that can accumulate on the TTTSF. The model indicates that the volume of water that can accumulate is relatively small due to the high capacity of the return water pump. It is expected that the normal volume of water stored on top of the tailings in the TTTSF will be about 200,000m^3. The TSF can easily safely store a considerably greater volume of water, particularly as the tailings level rises. An indication of the volume of water that can be stored on the top of the tailings, without water ponding against the embankment, can be obtained from Figure 11. For example at RL540 there is 12.7Mm^3 of tailings storage capacity and at the same level 14.4Mm^3 of water could be stored. The difference between the two capacities (i.e. 1.7Mm3) is the volume of water that could be stored on top of the tailings with no water against the upstream face of the embankment. This is much greater than the combined volume of normal pond water (200,000m^3) and that associated with runoff from a 48 hour PMP rainfall event (approximately 1Mm^3).

10.4. Embankment Design

10.4.1. General

The New Zealand Society on Large Dams (NZSOLD) publication ‘New Zealand Dam Safety Guidelines’ (Ref.17) is the basis for design, construction and operation of dams in New Zealand. Design requirements are related to the Potential Impact Classification (PIC). Four different potential impact categories are defined (very low, low, medium and high). The categories are based on the incremental losses which a failure might give rise to. Incremental losses are those additional losses that might have occurred for the same natural event if the dam had not failed. In assessing which category is appropriate consideration needs to be given to the consequences of failure (life, socio-economic, financial and environmental). A dam breach study has been undertaken for the TTTSF (Ref.18). Such a study assumes a hypothetical breach of the embankment under both sunny day and flood induced conditions. The extent of the flooding is determined and the incremental consequences resulting from the breach are assessed.

10.4.2. Dam Breach Study and Potential Impact Classification

The consequences of a **hypothetical** breach of the TTTSF and determination of the PIC have been assessed in accordance with the Building (Dam Safety) Regulations 2008 (Ref.19). A breach of the dam could result in release of both pond water and tailings. Pond water would be expected to flow downstream and mix with normal stream and river waters before discharging into the sea north of Palmerston. Tailings would be expected to be deposited immediately downstream of the TTTSF embankment at an angle of response of about 3-4°. A small proportion would be carried in suspension by stream water further downstream and settle out at various locations, until large flood events occurred and carried the tailings out to sea.

The most likely initiating event for a sunny day failure of the TTTSF is a large earthquake. For the flood induced condition a 1 in 100 AEP flood event has been assumed. Breach of the TTTSF into either the Tipperary or Cranky Jims Creeks has been evaluated. Both these creeks are tributaries of the Shag River as indicated on Figure 1. Cranky Jims Creek joins with the Shag River approximately 7km downstream of the TTTSF. Tipperary Creek flows into McCormicks Creek and joins the Shag River 19km downstream of the TTTSF. The Shag River discharges into the sea north of Palmerston. The distance from the TTTSF to the sea is 43km via Tipperary Creek and 54km via Cranky Jims Creek. There are no permanently inhabited structures in the Tipperary, McCormicks or Cranky Jims Creeks that would potentially be at risk, but there are a number adjacent to the Shag River.

In the event of a breach under sunny day conditions the flows in the Shag River are predicted to be equivalent to about 1 in 2 AEP flood event. For the flood induced condition (i.e. 1 in 100 AEP flood event) the incremental depth of water in the Shag River, where houses are located, is small (up to 0.2m). Under both sunny day and flood induced breach conditions approximately 1,500,000m^3 of tailings are predicted to be deposited in Tipperary Creek and 500,000m^3 in Cranky Jims Creek.

The PIC is dependent on the damage level and the population at risk (PAR). Criteria for assessing damage levels are defined in Table 1 of the Building (Dam Safety) Regulations 2008. Four different categories of damage are specified (residential house, critical or major infrastructure, natural environment and community recovery time). The PIC is determined from Table 2 of the Regulations.

The level of damage due to a breach under sunny day conditions is assessed to be minimal for residential houses and infrastructure as the water level in the Shag River is assessed to be no greater than associated with a 1 in 2 AEP flood event and below existing house levels. Damage to the natural environment is considered major (heavy damage and costly restoration), a result of the effects associated with release of tailings and pond water. Community recovery time would generally be very short as damage to residential houses and infrastructure is assessed to be minimal. However, some people could be affected due to potential contamination of water in the Shag River (e.g. people taking water from Shag River for irrigation purposes) and there could be a loss of recreational amenity (e.g. fishing or swimming). Consequently the community recovery time damage level is assessed to be moderate to major. The PAR for a sunny day breach is likely to be low (in the range of 1 to 5) as water levels in the Shag River would be less than flood levels and would be below existing house levels. However, due to the short warning time associated with a breach some population could be at risk (e.g. people swimming, fishing or crossing the Grange Hill or Craig Road bridges). Taking into account the above, the PIC for a sunny day breach is **medium** according to Table 2 of the Dam Safety Regulations (PAR of between 1 and 5 and a major damage level).

A breach under flood induced conditions is predicted to only result in up to a 0.2m rise on top of the 1 in 100 AEP flood level in the Shag River. This is because the 1 in 100 AEP flood event results in significantly greater flows in the Shag River, than flows associated with a dam breach. Consequently the incremental level of damage is minimal for residential houses and moderate for roading infrastructure. Damage to the natural environment is considered major (heavy damage and costly restoration), a result of the effects associated with release of tailings and pond water. Community recovery time is assessed to be moderate to major, similar to that for a sunny day failure. A number of houses would be flooded by the 1 in 100 AEP flood event.

However, the incremental population at risk as a result of a dam breach is low (in the range of 1 to 5) because the incremental water levels in the Shag River associated with a dam breach are small (less than 0.2m). Taking into account the above, the PIC for a flood induced breach is **medium** according to Table 2 of the Dam Safety Regulations (PAR of between 1 and 5 and a major damage level).

Therefore, overall the PIC for the TTTSF calculated on the basis of a hypothetical breach is **medium**.

10.4.3. Static and Seismic Stability

For static loading conditions NZSOLD requires a minimum FOS of 1.5 and this has been adopted for design.

For earthquake design NZSOLD states that medium and high potential impact dams are generally designed to two levels of earthquake, namely the Maximum Design Earthquake (MDE) and Operating Basis Earthquake (OBE). This is in accordance with recommendations by the International Commission on Large dams (Ref's 20 and 21). The OBE is usually based on the "annual exceedance probability of about 1 in 150". Immediately following an OBE event there should be "either no damage or minor repairable damage". In New Zealand the recommendations of Meija et al (Ref.8) are normally adopted for determining the MDE. For a medium PIC dam Meija et al recommend that the design ground motion need not exceed the 2,500 year ground motion. Immediately following an MDE event "some damage is allowable, but it must not lead to catastrophic failure".

For this project the OBE has been taken equal to the 150 year return period earthquake ground motion determined by GNS (Ref.7). In addition, the response of the embankment to the 475 year return period earthquake ground motion has been considered. This is because there is potential risk of liquefaction of the tailings at this higher level of ground motion, although the affect on the stability is unlikely to be significant for a downstream construction embankment. The MDE has been taken equal to the 2,500 year return period earthquake ground motion determined by GNS. The 150, 475 and 2,500 year return period acceleration response spectra are shown in Figure 7.

In assessing the ability of an embankment dam or foundation to resist earthquake motions the potential for liquefaction has to be addressed. If liquefaction is possible then it is conservative to assume that the tailings will liquefy and have strength equal to the liquefied or residual strength of the tailings. This is the assumption that has been adopted in assessing seismic stability.

10.4.4. Flood Protection

The existing resource consents for the MTI and SP11A TSFs require that they be designed and operated to completely contain the runoff from a 48 hour PMP rainfall event with 1m freeboard. The PMP for 48 hours is 0.7m. The same design criteria are proposed to be adopted for the TTTSF.

It is not proposed to construct a spillway at every stage of raising the TTTSF. The TSF is designed to contain the extreme PMP event with a 1m freeboard. However, as for the existing TSF's, the TTTSF Emergency Action Plan will include for the excavation of an emergency spillway at the abutment of the TSF, should water levels ever reach potentially dangerous levels during operation. The TSF is monitored on a daily basis and generally high water levels will be controlled by pumping. However, should it be necessary to form the spillway then mine operation earthworks equipment is available on site at short notice to carry out the work.

10.5. Embankment Zoning

The embankment is a zoned earth/rockfill structure with material for construction coming from soils derived from within the impoundment (loess, colluvium and weathered schist) and waste rock (schist) from Frasers Pit. The various embankment zones are shown on the typical cross-sections presented in Figure 8. A series of cross-sections through the embankment over the full footprint are presented in Figures 9 and 10.

The embankment design takes into account the depth of water that can be expected to pond against the upstream shoulder. In the early stages of impoundment there is much greater potential for water to pond against the upstream shoulder of the embankment. Consequently the initial embankment is designed as a water storage embankment with a low permeability central core and filter/chimney drain. The upstream and downstream shoulders are rockfill. Once tailings are stored up to RL522 the depth of water against the embankment from a 48 hour PMP rainfall event is 2m or less. Tailings will be discharged from the crest of the embankment. Once the tailings are up to RL535 the runoff from a PMP can be completely stored within the impoundment with no water up against the embankment.

Comments on the principal features of the embankment zoning follow:

Zone A1
The primary function of this zone is to limit seepage. It also provides sufficient strength to prevent the likelihood of instability, particularly when subject to the design seismic loads. The low permeability Zone A1 is intended to be sourced from locally borrowed weathered schist supplemented with loess and colluvium as necessary. If necessary additional weathered schist can be obtained from mining operations if necessary. Zone A1 requires heavy compaction to achieve the specified permeability (10^{-7} m/s).

Zone B
Zone B is a structural fill zone placed in 0.6m lift heights and subjected to compaction.

Zone B1 is structural fill placed between Zone A1 and Zone B to provide an intermediate particle size distribution, more suitable for filter compatibility, between the two fill types. Zone B1 is specifically selected, or reworked, to include more fines and a smaller maximum rock size (maximum 400mm diameter) than Zone B.

Zone C1
Zone C1 forms the downstream section of the embankment and is placed in lifts no higher than 2.5 m.

Zone D
Zone D is a vertical chimney drain. It functions to intercept seepage so as to limit the development of pore pressures in the downstream shoulder of the embankment. It also functions as a filter. It is associated with the initial embankment and is only constructed to RL520. Once tailings reach this level within the impoundment it is unlikely that under normal operating conditions any water will pond against the upstream face of the embankment and a tailings beach will have developed. If the

PMP event were to occur water is predicted to pond to only a depth of 2.5m at the upstream face of the embankment. The chimney drain will be constructed from Type A1 drainage material. This material will be designed to be filter compatible with Zone A1 of the embankment.

10.6. Drainage

10.6.1. Subsurface Drainage

The embankment design, shown in Figure 8 includes an upstream cutoff drain located along the upstream toe of the low permeability zone (Zone A1), and a limited height chimney drain with chimney base collector drain near the downstream toe of the low permeability zone. Underdrains are located in the three existing gullies (west, central and east) upstream of the embankment.

The plan location of the underdrains and upstream cutoff drains is shown in Figure 12. Details of the underdrains and upstream cutoff drains are shown in Figures 13 and 15. Details of the outlets beneath the embankment are shown in Figure 16. The purpose of the underdrains and upstream cutoff drains is to intercept tailings seepage and shallow groundwater flow. These drains are constructed using high quality drainage aggregate partly wrapped in geotextile. The bottom and sides of the drain are protected by geotextile and the top is overlaid with a finer filter compatible material (Type A drainage material consisting of sand or sandy gravel), rather than geotextile. This is to minimise the risk of clogging of the geotextile from precipitate in the tailings seepage water. In the event that the geotextile clogs then seepage water can still enter the drain via the top through the Type A drainage material. There has been no evidence of clogging of geotextile associated with subsurface drains at the Macraes Gold Project but iron hydroxide precipitate has been observed in the drain flow; however, there have been significant problems on other projects. A perforated ABS pipe is incorporated in the drains to provide greater flow capacity. Gravity outlets for the underdrains and upstream cutoff drains as well as chimney drain base collectors are located in the invert of Tipperary Creek. The outlets pass beneath the embankment to the downstream toe where seepage flows can be collected and monitored in a Seepage Collection Sump. The location of the Seepage Collection Sump is shown in Figure 12. A larger scale plan of the Sump is shown in Figure 17 and typical cross-sections are shown in Figure 18. From the Seepage Collection Sump seepage will be pumped back to the impoundment or directly to the Process Plant. The Seepage Collection Sump design shown in Figures 17 and 18 has a live storage capacity of approximately 6,000m^3. This is sufficient to store approximately 3 days maximum estimated seepage (refer Section 10.8). This will ensure that any seepage during the period from a pump breakdown/power failure/pipe blockage until either the seepage valves are closed at the Seepage Collection Sump or pumping is recommenced will be safely contained. The Seepage Collection Sump will have appropriate alarms with immediate notification to those responsible for the operation of the facility and a backup diesel pump and power supply (generator). The Seepage Collection Sump is proposed to have a low permeability earthfill (Zone A1 earthfill) liner and will also be HDPE lined to prevent seepage entering into the ground. The Seepage Collection Sump will be formed by an embankment constructed downstream of the TTTSF. This same embankment will initially function as the Initial Silt Pond during the first stage of construction of the TTTSF.

The TTTSF embankment design incorporates a chimney drain to an elevation of RL520 with a base collector drain, as shown in Figure 8. Details of the chimney and base collector drain are presented in Figure 14. The chimney drain is 1.5m wide up to RL515 and 0.75m wide above. A wider drain is provided at lower elevations where water can pond to greatest depth as a contingency in the event that there is some movement on the Macraes fault. The outlets from the chimney drain will pass beneath the embankment to the Seepage Collection Sump together with the underdrains and upstream cutoff drains as shown in Figure 16.

The embankment also includes a tailings seepage drain on the upstream shoulder of the embankment at RL540. The details of the drain are shown in Figure 15. The tailings seepage drain is to improve drainage of the tailings close to the embankment.

10.6.2. Surface Drainage

10.6.2.1 During Construction

The catchment area of the TTTSF is 183ha and is shown in Figure 3. During construction of the initial TTTSF Embankment it is proposed to form diversion drains to divert clean runoff. The diversion drains run from about RL523 and discharge downstream of the embankment at about RL515, as shown in Figure 19. These drains will be designed to discharge the 20 year return period flood flow. These drains will limit the catchment area at the initial embankment to about 12ha. Stormwater from the 12ha area will then be conveyed by a diversion culvert beneath the embankment construction area to allow the foundation preparation, earthworks and drainage works to be completed with less risk of stormwater damage, as well as minimise erosion and hence silt control requirements. Once the initial embankment reaches RL515 (i.e. the height of the diversion drains) higher level diversion drains may be constructed. A decant structure consisting of a manhole will be fitted to the upstream end of the diversion culvert and the initial embankment will then function as a silt pond. When the TTTSF is ready to receive tailings the diversion culvert will be plugged by partly grouting the intake manhole and the culvert pipe over the length of Zone A1. Further grouting of the downstream portion of the pipe can be carried out if some seepage still occurs. Any seepage from the culvert pipe, which cannot be stopped by grouting, will be collected and treated with the seepage from the subsurface drains.

10.6.2.2 Long Term

In the long term, drains will be established on the downstream benches of the embankment at RL498, RL520 and RL540 as shown in Figure 8. These drains will discharge down the shoulder of the embankment via rock armoured channels to an open drain constructed around the perimeter of the embankment. The perimeter drain will discharge to existing water courses as shown in Figure 20. This includes Tipperary and Cranky Jims Creeks located to the east of the TTTSF. Surface drainage from the southwest end of the TTTSF will drain to Frasers Pit. A small section of the northern side of the TTTSF embankment will discharge to the north into a gully that drains to Deepdell Creek.

10.7. Foundation Preparation

The foundations for the TTTSF Embankment will be situated on natural ground. Foundation preparation of the natural ground beneath the embankment will consist of stripping vegetation and excavating loess, colluvium, alluvium and any fill overlying the schist bedrock.

Foundation surfaces below Zone A1 shall be cleaned off with compressed air to enable observation of defects and assessment of the need for any special treatment such as slush or pressure grouting or the installation of additional subsoil drainage. Experience to date with the schist bedrock and in situ permeability testing at the proposed embankment site indicates that it has a relatively low permeability. With the previous MTI and SP11A embankments only slush grouting has been necessary to infill any small fractures apparent following foundation excavation. Low pressure grouting was used to infill defects in the schist rock associated with the SP11A TSF. If pressure grouting is required this will be achieved most probably using angled drillholes from the original ground surface. Grouting of previous exploration or investigation boreholes may need to be undertaken where such holes underlie the Zone A1 foundations. Any piezometers in the boreholes will be decommissioned prior to grouting.

Any irregularities in the excavated foundation surface that cannot be removed by excavation will be treated with dental concrete.

10.8. Seepage Estimates

Estimates of groundwater and seepage flows for assessing the potential environmental effects of the proposed TTTSF have been determined by Golder Associates (Ref.6). They estimate maximum flows to the various subsurface drains of 1800m^3/day (21litres/sec). Following closure, flows will reduce significantly with time. There is a lot of operating experience with subsurface drains at the Macraes Gold Project. The estimates are comparable to those observed at existing TSFs. Seepage modelling will be undertaken at final design to confirm design flows for sizing pipes within the subsurface drains. Existing subsurface drains have been sized to cope with the theoretical design flows with appropriate factors of safety. A minimum factor of safety (FOS) of about 6.5 has been determined for the drains based on measured flows and generally the FOS exceeds 10. The proposed subsurface drain sizes are similar to those installed within the SP11 TSF, which is comparable in terms of height and dimension of the deeper western portion of the TTTSF. Monitoring shows that the SP11 drains are working effectively to reduce pore water pressure build up in the tailings and embankment.

10.9. Stability

10.9.1. Potential Modes of Failure

Instability of the TTTSF embankment could potentially occur as a result of failure of the embankment or the foundations, or a combination of the two. Possible modes of failure for the TTTSF embankment include:

1. Instability of the embankment slopes
2. Bearing capacity type failure of the foundations
3. A combination of instability within the embankment and foundations
4. Instability associated with earthquake shaking at the site
5. Piping (internal erosion)
6. Loss of freeboard

The first, third and fourth modes of failure are presented in the following sections. The bedrock beneath the site is relatively strong so the risk of instability involving a bearing capacity type failure of the foundation (failure mode 2 listed above) is negligible. Also the risk of failure through the foundation rock along low angle defects (faults, joints or foliations) dipping to the east is considered highly unlikely.

Faults and joints are steeply dipping. Foliation dips to the east and southeast at typically 40°, and locally at 20°. However, this is too steep to form a plausible potential failure mechanism below the downstream shoulder of the main embankment.

Piping arising from internal erosion is a potential mode of failure (fifth mode of failure listed above), particularly where the low permeability zone of the embankment is constructed from dispersive or erodible material. The low permeability zone of the embankment (Zone A1) will be comprised of weathered schist supplemented with loess and colluvium. A similar blend of material has been used successively for other tailings and water storage embankments associated with the Macraes Gold Project. The greatest risk is at low elevations where water can pond directly against the upstream shoulder of the embankment. To prevent internal erosion and piping developing a filter zone/chimney drain is proposed where there is risk of water permanently ponding against the embankment.

The sixth mode of failure (loss of freeboard) can arise due to seismically induced deformation and settlement or settlement of foundations and embankment under static loading conditions. Seismically induced deformations are considered in the analyses presented in the following sections for the fourth mode of failure listed above. The likelihood of large settlements leading to loss of freeboard under either static or seismic load conditions is considered unlikely. The foundations for the proposed dam are rock and the embankment is to be constructed from materials that have a relatively high stiffness and are not vulnerable to significant strength loss when subjected to earthquake ground motion. The experience with other embankments constructed from similar materials, associated with the Macraes Gold Project, is that settlements can be expected to be small.

10.9.2. Analysis Procedures and Input Parameters

Stability of the embankment has been analysed using the two-dimensional SLOPE/W computer programme. The programme permits the user to select one of several procedures for computing the factor of safety. The stability analyses presented herein utilised the principle of limiting equilibrium and Spencer's solution method (Ref.23). Stability analyses have been conducted for both long-term steady state seepage conditions and seismic loading conditions. For the seismic case the stability has been assessed during earthquake shaking for average return periods of 475 and 2,500 years. The tailings have been assumed to be totally saturated and will liquefy when subject to the 475 year and 2,500 year return period ground motion. The 475 year return period ground motion has therefore been conservatively considered for the operating period of the TSF, rather than the OBE where no significant liquefaction is likely. The shear strength of the liquefied tailings has been assumed equal to the residual (undrained) shear strength.

The inputs for the stability analyses include a model describing the geometry, material strength and pore pressure conditions of both the embankment and underlying foundations. The highest section of the embankment, where it is located above the Tipperary Creek, has been analysed. This will be the most critical. The location of the section analysed is shown in Figure D1 of Appendix D.

10.9.2.1. Phreatic Surface

In all cases the phreatic surface has been taken at the surface of the tailings and extending along the downstream side of Zone A1 to the Chimney drain. For analysis of the embankment stability the phreatic surface is assumed to follow the foundation level downstream of Zone A1. No phreatic surface is assumed within the downstream Zone B and B1 and Zone C1 due to the high permeability of the rock fill. This has been confirmed by piezometers in the existing TSF embankments at Macraes Gold Project, which are of similar construction to that proposed for the TTTSF.

10.9.2.2. Static Shear Strength Parameters

The design static shear strength parameters for the in situ rock, waste rock and tailings are discussed in Sections 8.1, 8.2 and 8.3.2.1 respectively. The parameters are also summarised in Table D1 (Appendix D).

10.9.2.3. Shear Strength of Tailings During Earthquake Loading

The design shear strength parameters for the tailings during earthquake loading are discussed in Section 8.3.2.2 and summarised in Table D1 (Appendix D). It is conservatively assumed that the phreatic surface is at the surface of the tailings and that the tailings liquefy when subjected to the 475 year or greater earthquake ground motion. The liquefied tailings are assumed to have residual (undrained) shear strength of $Su_{liq}/\sigma_v' = 0.13$ (Refs. 9 and 10).

10.9.3. Stability Analyses

10.9.3.1. Static Analyses

The results of the static stability analyses are presented in Appendix D.

The factors of safety (FOS) for the upstream and downstream slopes of the initial embankment constructed to RL530 prior to receiving tailings are shown in Figures D3 and D4 respectively. The FOS's are 1.96 and 2.08 respectively, which are greater than the normally accepted minimum FOS of 1.5.

The long term static factor of safety of the downstream shoulder of the final embankment (RL560) is 1.92 (refer Figures D6). The equivalent FOS for the upstream shoulder has been analysed with the tailings at RL530 and the FOS is 1.87 (refer Figure D5). As the tailings level rises so the FOS will increase and therefore the long term FOS with the tailings at the maximum storage level will be greater than 1.87. These FOS are greater than the normally accepted minimum FOS of 1.5.

Where the embankment overlies the Macraes Fault the insitu rock will be weaker as noted in Section 8.1. However, the embankment height is lower and this will compensate in part for the effect the reduced strength will have on the FOS for shear failure through the in situ ground. As a check, stability analyses were carried out for a typical embankment section over the Macraes Fault with reduced shear strength parameters for the in situ rock. The stability analyses showed that with the reduced in situ rock strength the FOS is still greater than 1.5.

10.9.3.2. Seismic Simplified Deformation Analysis During Earthquake Shaking Using Pseudostatic Stability Analyses

Pseudostatic stability analyses during earthquake shaking have been undertaken for the TTTSF Embankment to estimate permanent deformations and the results are summarised in Table D2 in Appendix D. In all cases it is assumed that the phreatic surface is at the top of the tailings and the tailings liquefy. Analyses have only been undertaken for the downstream shoulder.

The upstream shoulder is buttressed by tailings and no plausible failure mechanism has been identified.

Earthquake loadings were applied using a horizontal coefficient determined from dynamic modelling using QUAKE/W for the 475 year return period earthquake ground motion and the MDE (2,500 year return period). The QUAKE/W modelling was undertaken using accelerograms and scaling factors recommended by GNS (Ref.7) to represent the 475 year return period and MDE earthquake ground motion shaking. Accelerations throughout the mass of tailings and within the downstream embankment were obtained from the QUAKE/W modelling. Representative horizontal accelerations to be applied to potential failure masses in the SLOPE/W analyses were determined following review of the spatial variation in acceleration predicted by QUAKE/W (spatial variations in acceleration occur because of the differing response of different sections of the embankment).

Under the 475 year return period earthquake ground motion some minor permanent displacement is predicted for potential failure surfaces. Larger permanent displacements are predicted for the MDE, but they are still relatively small (less than 100mm). Estimated permanent displacements for various potential failure surfaces are summarised in Table D2 in Appendix D. Estimates of the permanent displacements were made using both the Jibson (Ref 23) and Ambraseys and Menu method (Ref.24). Both methods gave similar results, but only the Jibson results are presented. These simplified analyses require the determination of the yield acceleration for a FOS of 1.0. The stability analyses to determine the yield accelerations are presented in Appendix D.

The permanent deformations predicted for the 475 year return period are insignificant. Permanent deformations for the MDE are small (less than 200mm) and would not result in release of tailings or liquor and so the performance of the embankment is considered satisfactory.

10.10. Embankment Instrumentation

The TTTSF embankment will be instrumented to monitor its performance during and after construction as is done for the existing TSFs and water storage embankments at the Macraes Gold Project. Instrumentation will include:

Piezometers

Vibrating wire piezometers will be installed to measure seepage pressures within the embankment. The piezometers will be installed at not less than 4 representative sections along the embankment and at each section piezometers will be located within the foundation rock and in the embankment within Zone A1 and Zone B. In the foundation rock one piezometer will be installed beneath the Zone A1 foundation and one piezometer just downstream of Zone A1. A piezometer will be installed at about 15m vertical intervals within Zone A1 and about 2 to 3 piezometers located at representative levels within Zone B, just downstream of Zone A1.

Deformation Prisms

Deformation prisms will be installed on the downstream face and crest of the embankment to monitor embankment deformations.

Seepage Flows

All seepage flows from the subsurface drains will be monitored where they enter the Seepage Collection Sump at the downstream toe of the main embankment. Samples can also be obtained from this location for testing the chemistry of the discharges.

11.0 CONSTRUCTION ASPECTS

11.1. Construction Volumes

The estimated construction volumes for the TTTSF embankment to RL560 are summarised below.

Zone A1	560,000 m^3
Zone B & B1	3,660,000 m^3
Zone C1	2,040,000 m^3
Total	6,260,000 m^3

The volumes of fill associated with the initial embankment to RL530 are summarised below:

Zone A1	160,000 m^3
Zone B & B1	680,000 m^3
Zone C1	0 m^3
Total	840,000 m^3

These estimates allow for an average of 1.5m of foundation sub excavation below Zones A1 and B1 and that section of Zone B upstream of Zone A1 below RL530, and an average of 0.75m of foundation sub excavation elsewhere below Zone B and Zone C1. A large volume of fill is required and construction will need to be carefully programmed to ensure that the design crest levels are achieved on time.

11.2. Embankment Construction

Embankment construction will be undertaken by a Contractor employed by OceanaGold or with OceanaGold's own equipment. Material similar to that used for the construction of the other existing tailings embankments at the Macraes Gold Project will be sourced from within the impoundment area for Zone A1, supplemented with mine waste as necessary. Waste rock for Zones B and C1 will come mostly from Frasers Pit, possibly with some fill from Southern Pit and Round Hill Pits when they are mined in the future.

Materials for structural fill zones (Zones A1, B and B1) are placed in thin layers (350mm for Zone A1 and 600 mm for Zone B and B1) and compacted to achieve the specified gradation, density and permeability requirements.

Compaction of Zone A1 can be achieved using sheepsfoot or vibrating steel drum rollers. The bulk of the Zone B and B1 material is generally track rolled and compacted using OceanaGold's plant placing the material. Material in Zone C1 is end-dumped and bladed out to lift heights of no greater than 2.5m with compaction by OceanaGold's plant running over and spreading the material.

11.3. Control of Clean Surface Water

The temporary control of stormwater runoff during construction is shown in Figure 17 and described in section 10.6.2.1.

11.4. Erosion and Sediment Control

Good earthworks practices will be required to reduce the quantity of silt laden runoff. This includes construction of temporary sediment retention ponds downstream of the works and minimising areas of loose, uncompacted material.

An Erosion and Sediment Control Plan (ESCP) for the Macraes Phase 3 Project has been prepared (Ref. 25). The ESCP identifies the practises and procedures to minimise erosion and sedimentation, and to treat runoff prior to discharge into tributaries of the Tipperary, Cranky Jims and Deepdell Creeks. Erosion and sediment control for construction of the TTTSF embankment will be undertaken in accordance with the ESCP recommendations.

Sediment control concepts are shown in Figure 19. For the initial construction of the TTTSF embankment a diversion drain will be constructed to intercept and divert clean runoff from above between RL515 and about RL520. An Initial Silt Pond will be constructed downstream of the proposed TTTSF embankment. The embankment forming this pond will later be used to form the Seepage Collection Sump (refer to Figure 18). Once the TTTSF embankment is up to RL515 a decant structure will be fitted to the upstream end of the diversion culvert and it will function as the primary sediment control structure for runoff from upstream until construction of the TTTSF embankment to RL530 is complete and the diversion culvert is grouted up. Runoff from the downstream shoulder of the initial TTTSF embankment will be treated by the combination of a silt pond formed by construction of a small embankment at the downstream toe of the TTTSF and by diverting runoff from the embankment into a gully to the north as indicated in Figure 19. The small embankment at the downstream toe of the TTTSF also forms the upstream wall of the Seepage Collection Sump (refer Figure 18). This pond will eventually be infilled when the TTSF embankment is subsequently raised.

As the embankment is raised additional sediment control structures will need to be constructed around the perimeter of the TTTSF embankment to treat runoff from the downstream shoulder before discharge to natural water courses. Runoff will be diverted to these structures via a perimeter surface drain as indicated in Figure 19. Experience to date at the Macraes Gold Project indicates that only small quantities of silt laden runoff are generated from construction of embankments and waste stacks. This is because most of the fill is permeable rockfill. Runoff percolates down through the rockfill which acts as a filter to intercept and retain sediment.

11.5. Construction Control and Management

Construction of the embankment will be under the direct supervision of staff from OceanaGold. A number of staff, assisted by surveyors and the Designer as necessary, are dedicated to this task with the ongoing raising of the SP11A and MTI TSF's and this will continue for the proposed TTTSF embankment. They assist the Contractor in planning construction activities and observe all construction activities. In addition, they undertake control testing of fill placed in the embankment as detailed in the

Contract Specification and undertake regular visual inspections as part of the surveillance requirements.

Regular surveys of the embankment will be undertaken to ensure works are correctly set out and for payment purposes.

The requirements for monitoring and surveillance will be summarised in an Operation, Maintenance and Surveillance Manual that will be prepared for the TSF.

12.0 TAILINGS MANAGEMENT

12.1. General

Tailings disposal involves the pumping of tailings from the Process Plant to the TSF and discharge into the impoundment. Careful management of tailings discharge into the impoundment can produce the following benefits:

- higher tailings densities
- the creation of a more permeable zone of tailings adjacent to the embankment
- the prevention of ponding water against the embankment and abutments
- and the creation of a surface that can be rehabilitated to a useful landform.

Mixed tailings will be pumped to the tailings impoundment from the Process Plant at a slurry density of 25 - 35% solids by mass. The specific gravity of the tailings solids is $2.7t/m^3$. Based on experience with the existing operation it is expected that the initial dry density of the settled tailings will increase with time. The tailings dry densities adopted for assessing tailings storage in the proposed TTTSF are summarised in Section 10.2.

12.2. Objectives of Tailings Management

To maximise the advantages that can be obtained with good tailings management it is necessary to discharge the tailings sub-aerially. This involves deposition of tailings above water (as opposed to deposition below water, i.e. subaqueous deposition) and is normally achieved by discharging the tailings slurry via multiple spigot discharge points. As the tailings slurry pours from the discharge points, the coarsest fraction tends to settle at, or close to the spigot, with the finer fractions moving with the flowing water towards the decant pond. With time, a tailings 'beach' is formed, the grading of which becomes finer the further the distance from the points of discharge. Evaporation from the beach surface dries and increases the density of the tailings. To maximise the exposed area of tailings it is necessary to pump off water ponded on the tailings surface as quickly as possible. Due to the relatively low rainfall at Macraes Flat, and the demand for water at the Process Plant, the area of tailings covered by water should generally be quite small. However, during early stages of operation, surface runoff into the impoundment could result in inundation of the tailings during periods of heavy rain.

The advantages of sub-aerial deposition are summarised below:

- the density of the settled tailings is greater so that more tailings can be stored. In addition the tailings will consolidate less with time which is helpful when contouring the final surface and the tailings will have higher shear strengths and be less susceptible to liquefaction when subjected to strong earthquake shaking.

- a zone of coarser, higher permeability tailings adjacent to the embankment can be created, if tailings are discharged from the embankment. This zone can act to drain the tailings mass via the underdrainage system and can substantially reduce seepage forces on the embankment. Also the likelihood of liquefaction of tailings immediately upstream of the embankment is substantially reduced. In addition it results in a sandy zone that is filter compatible with the low permeability zone of the embankment (Zone A1). Tests by the USBR (Ref.26) have shown that the tailings are sufficiently coarse to infill any cracks that develop in the embankments rather than flow through.

- the shape of the tailings beach can be controlled by varying the positions from which tailings are discharged. This allows control over where water is impounded. By discharging tailings from the embankment crest it is possible to avoid water ponding directly against the embankment or adjacent abutments.

12.3. Tailings Deposition Strategy

The tailings will be pumped from the Process Plant using high density polyethylene pipes and discharged sub-aerially from the embankment in the lower south eastern portion of the TSF. The main tailings pipeline will be laid along the embankment with multiple spigots discharging on the upstream side of the embankment.

The floating pontoon and return pumps will be located in Tipperary Creek and will be repositioned as the tailings level rises. They will be located where the depth of water is at least 2m deep, so that the pump intake will be unobstructed. Tailings discharge via the spigots will be regulated to maintain the required beach profile to keep the ponding water in the required location for the return pump.

Towards the end of the life of the TSF some end pipe discharging may be required to achieve the required profile of the tailings.

13.0 REHABILITATION AND CLOSURE

13.1. Introduction

The proposed rehabilitation and closure strategy for the TTTSF will allow the area to be returned to the pre-mining land use with the minimum potential for adverse environmental effects. A plan of the proposed finished contours and surface drainage is shown in Figure 20.

13.2. Closure Manual

Following the granting of resource consents for the construction and operation of the TTTSF, a Closure Manual will be prepared by OceanaGold. The objective of the Closure Manual will be to set out practical measures which will allow the facility to be operated in accordance with the conditions of the consents and the rehabilitation and closure principles outlined in this section.

13.3. Objectives of Rehabilitation and Closure

The objectives of the rehabilitation and closure of the tailings impoundment are:

- developing an acceptable post-closure land use;
- providing acceptable, stable, post-closure landforms;
- ensuring the secure ultimate disposal of the tailings in a manner which minimises the risk of release of potential contaminants into the environment in the longer term; and
- allow the eventual termination of all monitoring and maintenance procedures when environmental risks are assessed to be negligible.

13.4. Rehabilitation of Tailings Embankment

The downstream batter of the embankment will be rehabilitated once the embankment is complete, or as construction progresses. This will involve the direct placement of a growing medium over the rockfill batter slopes followed by revegetation with pasture/tussock species (Figure 21).
Revegetation of the embankment will proceed as follows:

- smooth and compact surface to reduce voids and prevent the loss of rooting medium volume into the waste rock;
- spread stockpiled topsoil/subsoil over the surface as a rooting medium;
- cultivate to improve infiltration rates;
- topdress with molybdenised superphosphate;
- seed/plant with pasture/tussock species; and
- topdress with maintenance fertiliser as required.

13.5. Final Tailings Deposition Strategy

An assessment of the post-closure consolidation of the tailings will be undertaken at the final design stage. If it is significant this effect could be allowed for, in part, by filling to above the final design landform grades with tailings during the final stage of tailings deposition.

It is also proposed to allow the tailings beach to settle for a period of time prior to finally covering with waste rock. At the end of this settlement period, additional tailings will be deposited to re-establish the surface grades, as required. The duration of this settlement period will be established during the final design phase for the tailings impoundment.

13.6. Covering Strategy

Following completion of tailings deposition, the tailings impoundment will be covered and rehabilitated to the final planned landform. The objectives of this cover are:

- to allow for subsequent settling of the tailings;
- to provide a surface that can be revegetated for the purposes of establishing post-closure land use.

This cover will be constructed as follows:

- stabilisation of the final decant pond areas, which may consist of saturated slimes, with a veneer of waste rock as required;
- overfilling with waste rock any areas in which significant settlement due to tailings consolidation is anticipated;
- grading of the surface of the tailings impoundment with waste rock to promote stormwater runoff and the construction of stormwater drainage channels and outlet structures
- ensuring that waste rock covers the highest levels of the tailings to a minimum depth such that tailings moisture content will not be significantly affected by evapotranspiration (i.e. the evaporative zone depth);
- spreading a layer of topsoil, and weathered schist over the surface of the waste rock as a rooting medium; and
- proceeding with cultivation as outlined above for the downstream batter of the embankment.

13.7. Surface Drainage

The surface of the TTTSF will slope down to the west as shown in Figure 20. A perimeter drain will be constructed at the contact with natural ground. The perimeter drain will drain to the southwest and discharge into an existing gully that will eventually discharge into Frasers Pit. It will not be possible for water to pond on the surface of the TTTSF. Surface drains will be constructed on the outside shoulder of the TTTSF embankment. They are described in section 10.6.2.2. All final perimeter drains will be designed to safely discharge the 1 in 100 AEP flood flow.

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TABLES

TABLE 1. SOIL CLASSIFICATION AND DISPERSITIVITY TESTS

Test Pit	Depth (m)	Description	Water Content (%)	Atterberg Limits	Pinhole Dispersion Test [1]	Crumb Test [2]
TP3	0.2 – 0.8	sandy SILT, minor clay/gravel	19.3	LL=27 PI=5	D1	Grade 3
TP4	0.2 - 4	gravelly, silty SAND, minor clay	15.4	NP	ND4	Grade 4
TP7	0.3 – 1.4	sandy SILT, minor clay, trace gravel	12.7	LL=22 PI=1	D1	Grade 4
TP9	0.3 – 1.2	sandy SILT, some clay, trace gravel	17.2	LL=24 PI=3	D1	Grade 4
TP11	0.3 – 0.9	sandy SILT, some clay, trace gravel	18.6	LL=23 PI=1	ND4	Grade 4
TP15	0.4 – 1.7	sandy SILT, some clay	21.0	LL=21 PI=3	ND4	Grade 4
TP15	2.6 – 3.4	sandy SILT, minor clay, trace gravel	21.6	LL=25 PI=1	ND4	Grade 3
TP17	1.4 – 2.3	sandy SILT, minor clay, trace gravel	21.2	LL=28 PI=4	ND3	Grade 1
TP20	0.3 – 1.2	sandy SILT, minor clay, trace gravel	21.4	LL=27 PI=3	D2	Grade 2
TP21	0.3 – 1.0	sandy SILT, minor clay, trace gravel	22.3	LL=30 PI=6	D1	Grade 3/4

(1) Pinhole Dispersion Test Classification

D1 highly dispersive
D2 Dispersive
ND 3 slightly dispersive
ND 4 moderately dispersive
ND 1 non –dispersive
ND2 non –dispersive

(2) Crumb Test Classification

Grade 1 non-dispersive
Grade 2 Intermediate
Grade 3 Moderately dispersive
Grade 4 highly dispersive

TABLE 2. COMPACTION TEST RESULTS

Test Pit	Depth (m)	Description	Water Content (%)	Maximum Dry Density (t/m^3)	Optimum Water Content (%)
TP4	2.0 – 4.0	gravelly, silty SAND, minor clay	15.4	1.97	11.5
TP11	0.3 – 0.9	sandy SILT with minor clay, trace gravel	18.6	1.83	15.0
TP15	2.6 – 3.4	sandy SILT with minor clay, trace gravel	21.6	1.85	14.0
TP17	1.4 – 2.3	sandy SILT with minor clay, trace gravel	21.2	1.86	14.0

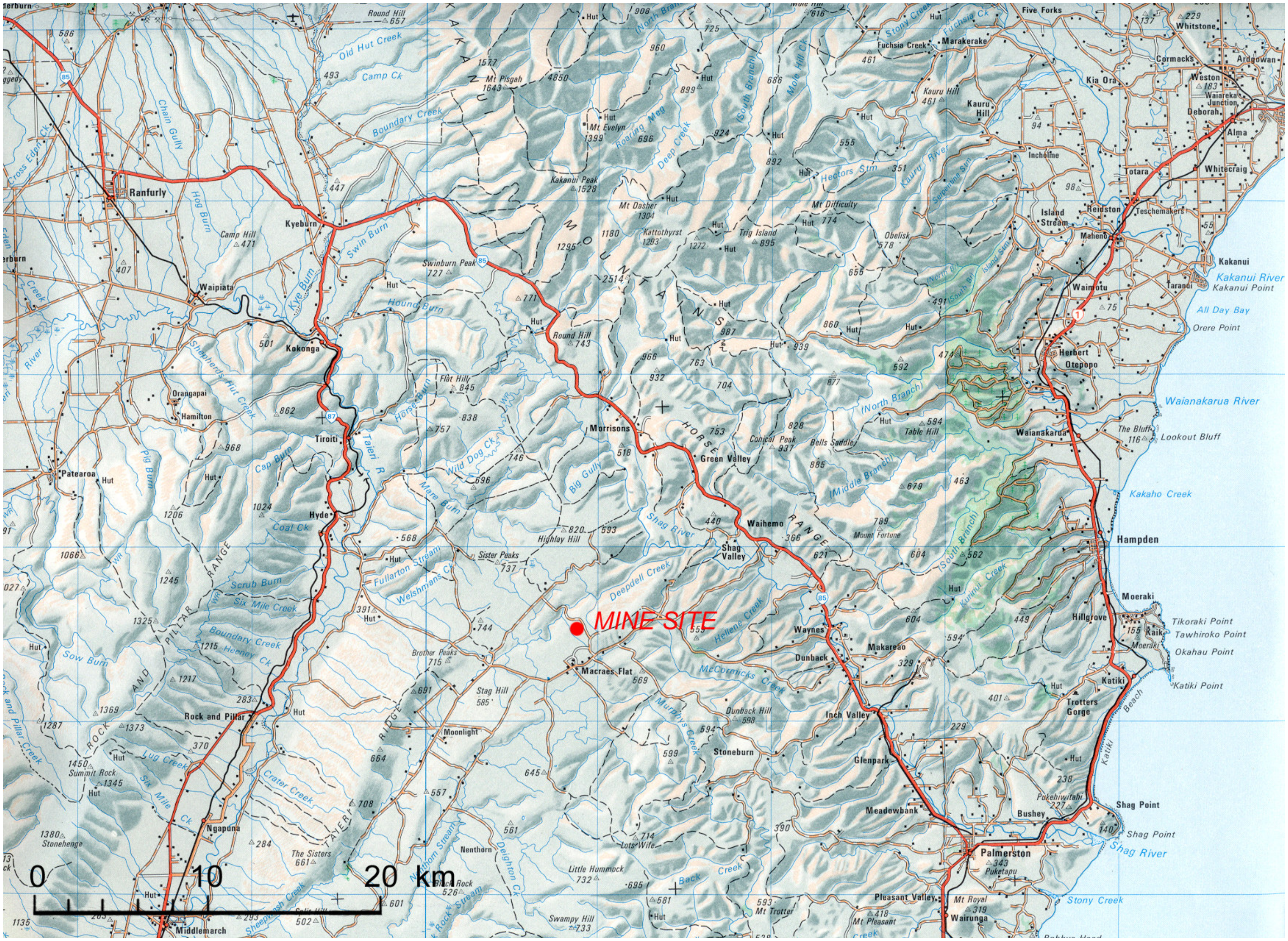
TABLE 3. LABORATORY TEST RESULTS ON WEATHERED SCHIST

Test Pit	Depth (m)	NWC (%)	Particle Size Distribution				Compaction Test[1]		Permeability[2] (m/s)	Pinhole Dispersion Test	Crumb Test
			Clay (%)	Silt (%)	Sand (%)	Grave (%)	OWC (%)	MDD (t/m^3)			
TP5	0.6-2.0	17.4	4	30	44	22	16.0	1.79	5.8×10^{-9}	ND4	Grade 3
TP6	1.5-4.0	12.7									
TP16	0.5-1.8	8.1	2	23	31	44	11.0	2.00	3.3×10^{-7}	ND3	Grade 2/3
TP21	1.0-2.0	11.9									

[1] Vibratory hammer compaction test (NZS 4402:1986, Test 4.1.3).
[2] Falling head permeability test. Tabulated permeability is the average of two tests, each with a different initial head.

Notes
1) Laboratory tests carried out using combined samples, except the natural water content which was on the individual samples.
2) Pinhole Dispersion Test and Crumb Test classification is given with Table 1

FIGURES



True North

Mine North

Figure 1

Source: NZMS Sheet 15 Waitaki.

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OCEANA GOLD LTD

Macraes Gold Project- Locality Plan

Ref. No.: 1410
Date: 26 June 2002
Drawn: SP
File: local.grf

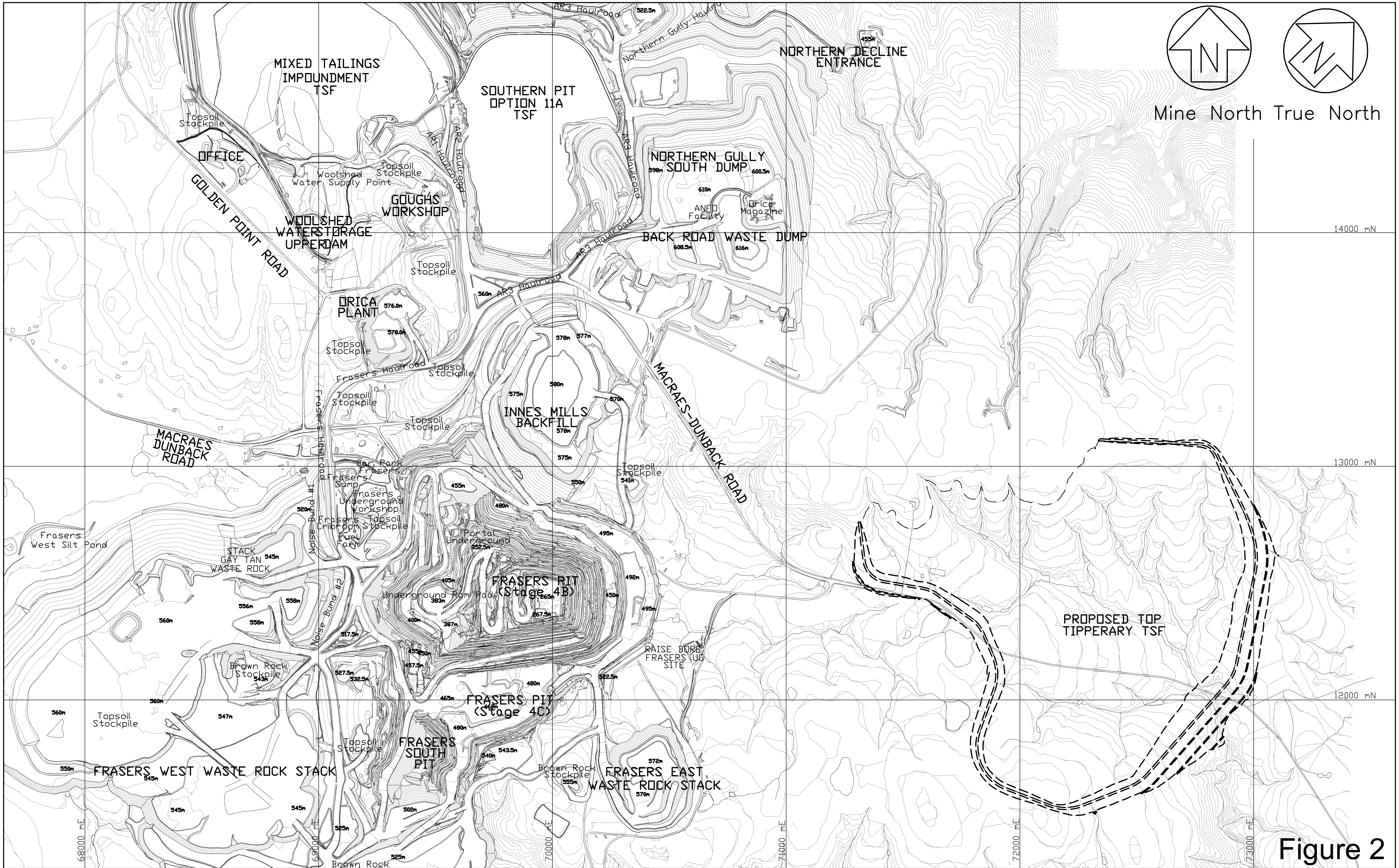

Figure 2

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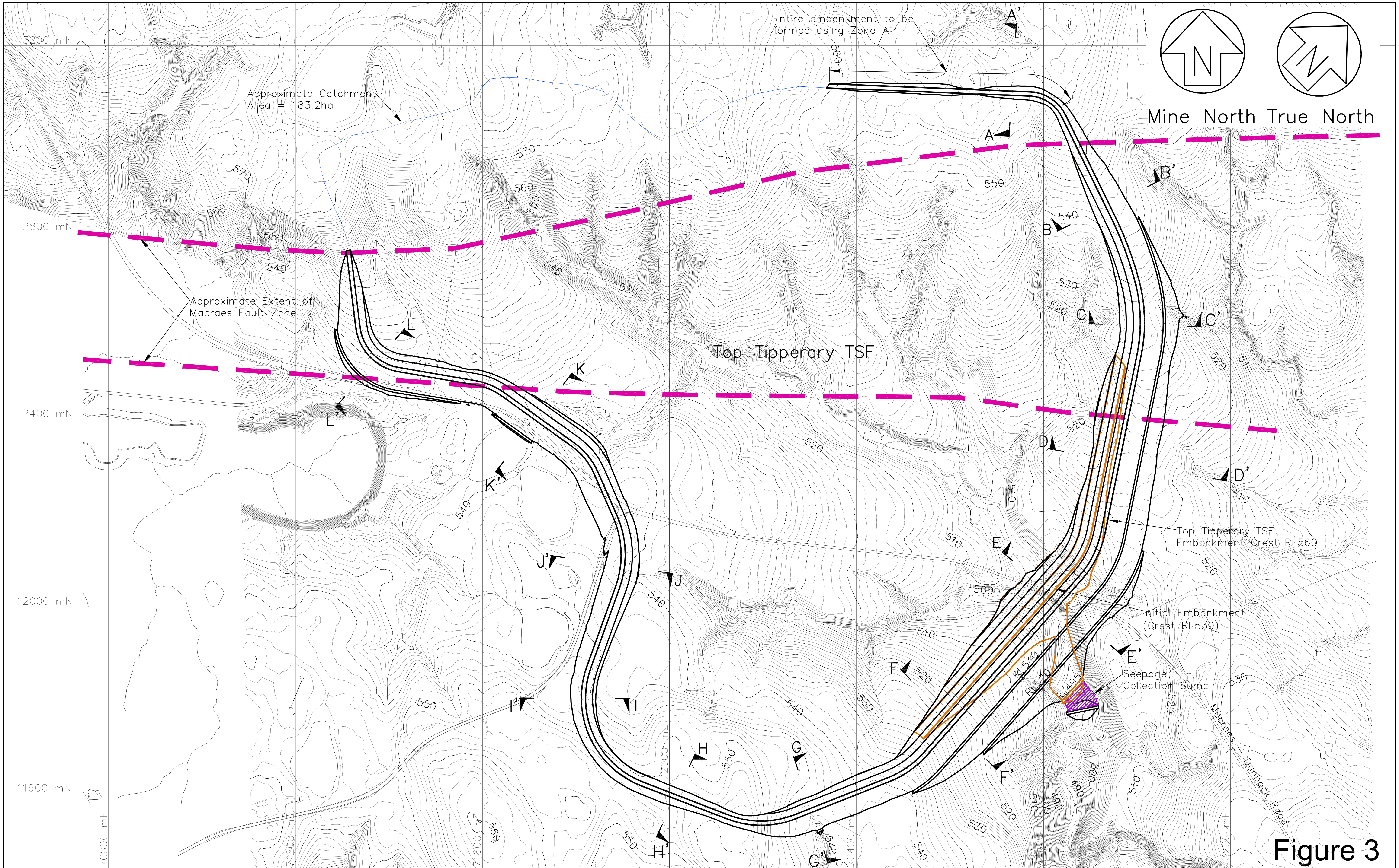
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Site Plan

Drawing No.	6846-Figure 2
Date:	13 Jan 2011
Drawn:	BL
Scale:	1:15000 (@A3)
Filename:	6846-Figure 2.dwg



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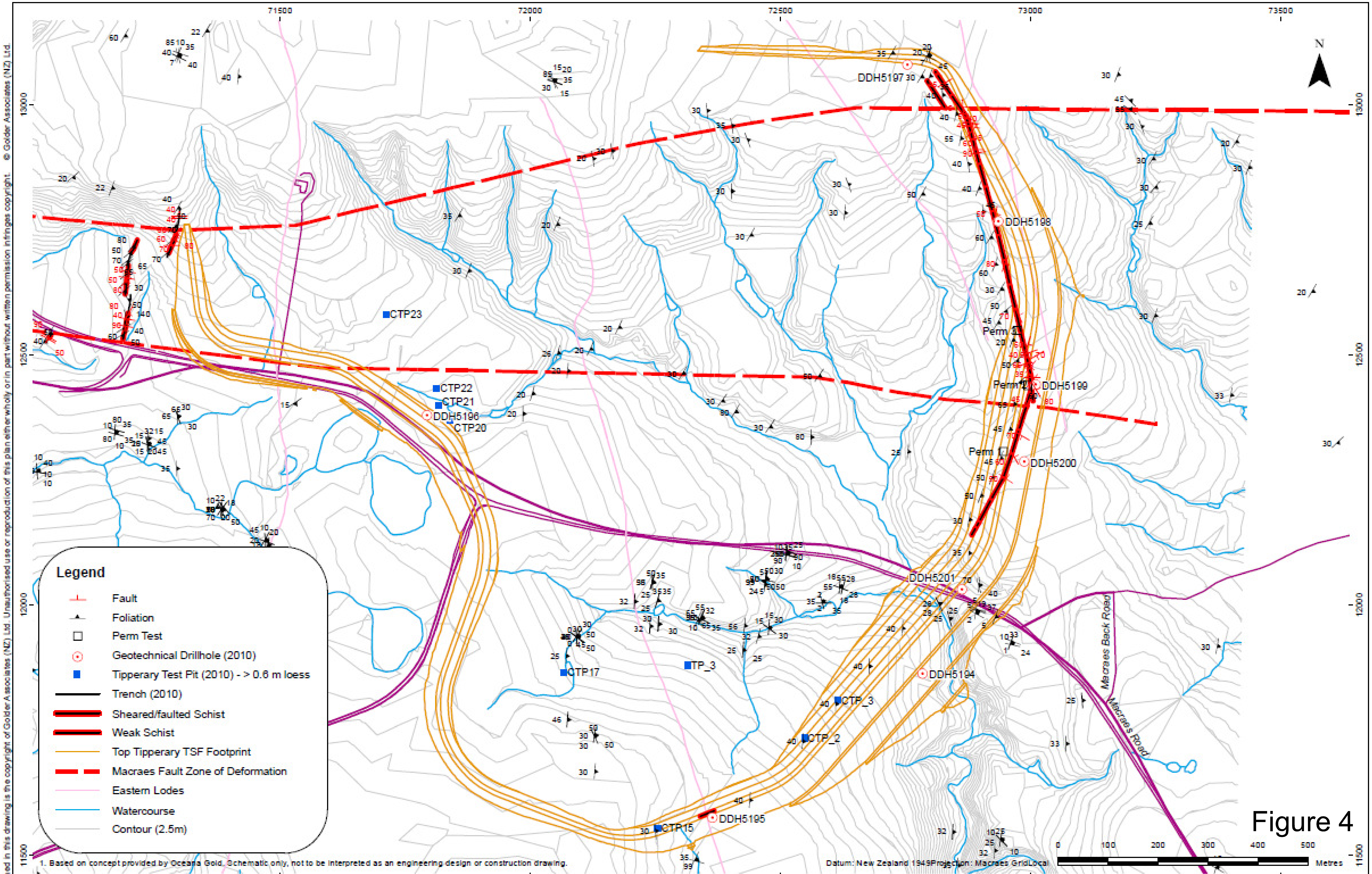
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Site Plan

Drawing No.	6846-Fig 3
Date:	13 Jan 2011
Drawn:	BL
Scale:	1:7500 (@A3)
Filename:	6846-Fig 3.dwg



DRAFT

TITLE **TOP TIPPERARY TSF GEOLOGICAL SUMMARY PLAN**

DECEMBER 2010

PROJECT 1078301051

3

Golder Associates

S:\GIS\Projects-Numbered\2010\10783x\01xxx\1078301_051_OceanaGold_MacraesTailings\MapDocuments\Task002GeotechnicalInvestigation\Fig03_TopTipperaryTSFGeologicalSummaryPlan_GIS.mxd

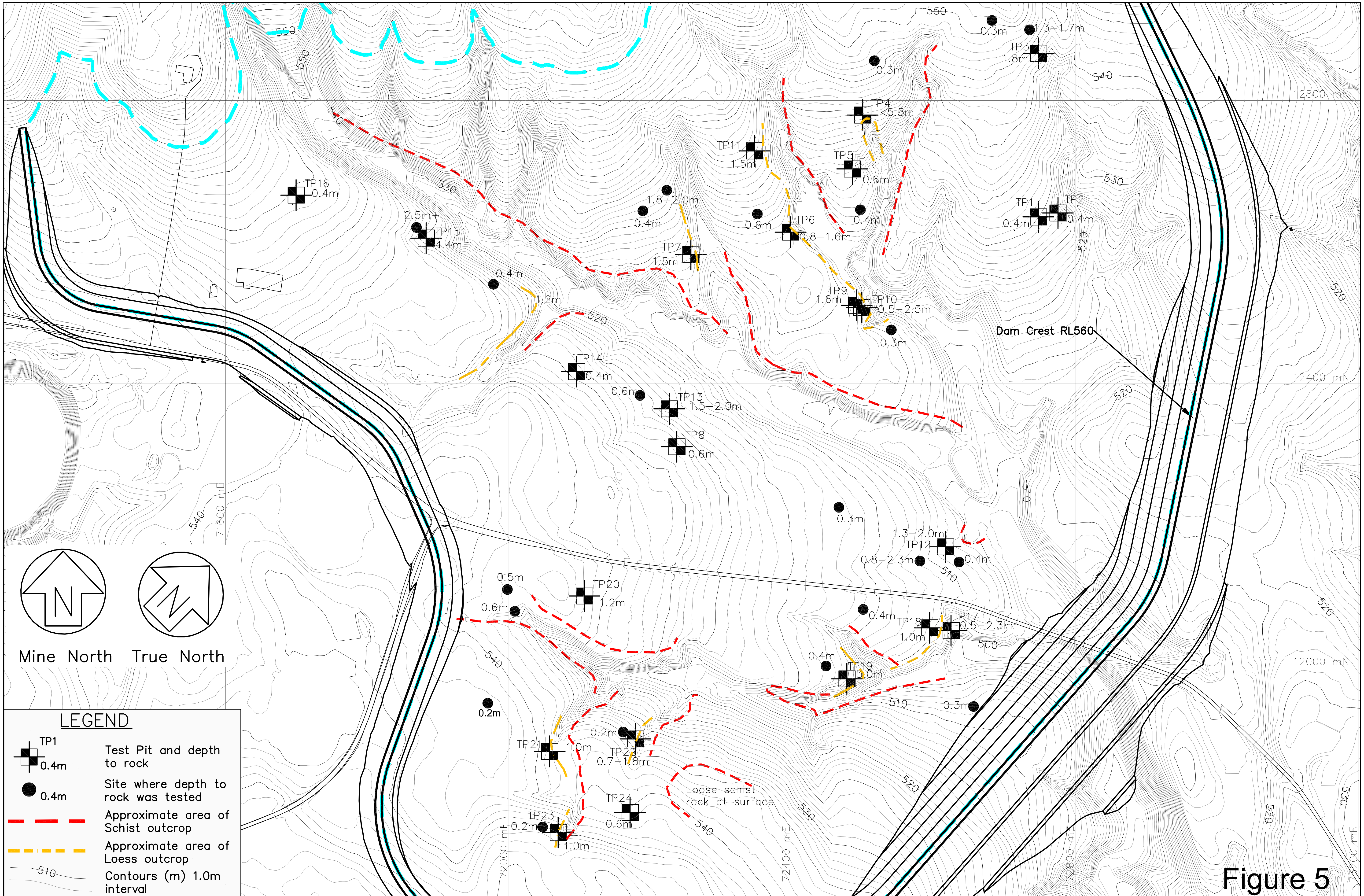


Figure 5

OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT

Top Tipperary TSF

Test Pit Location Plan

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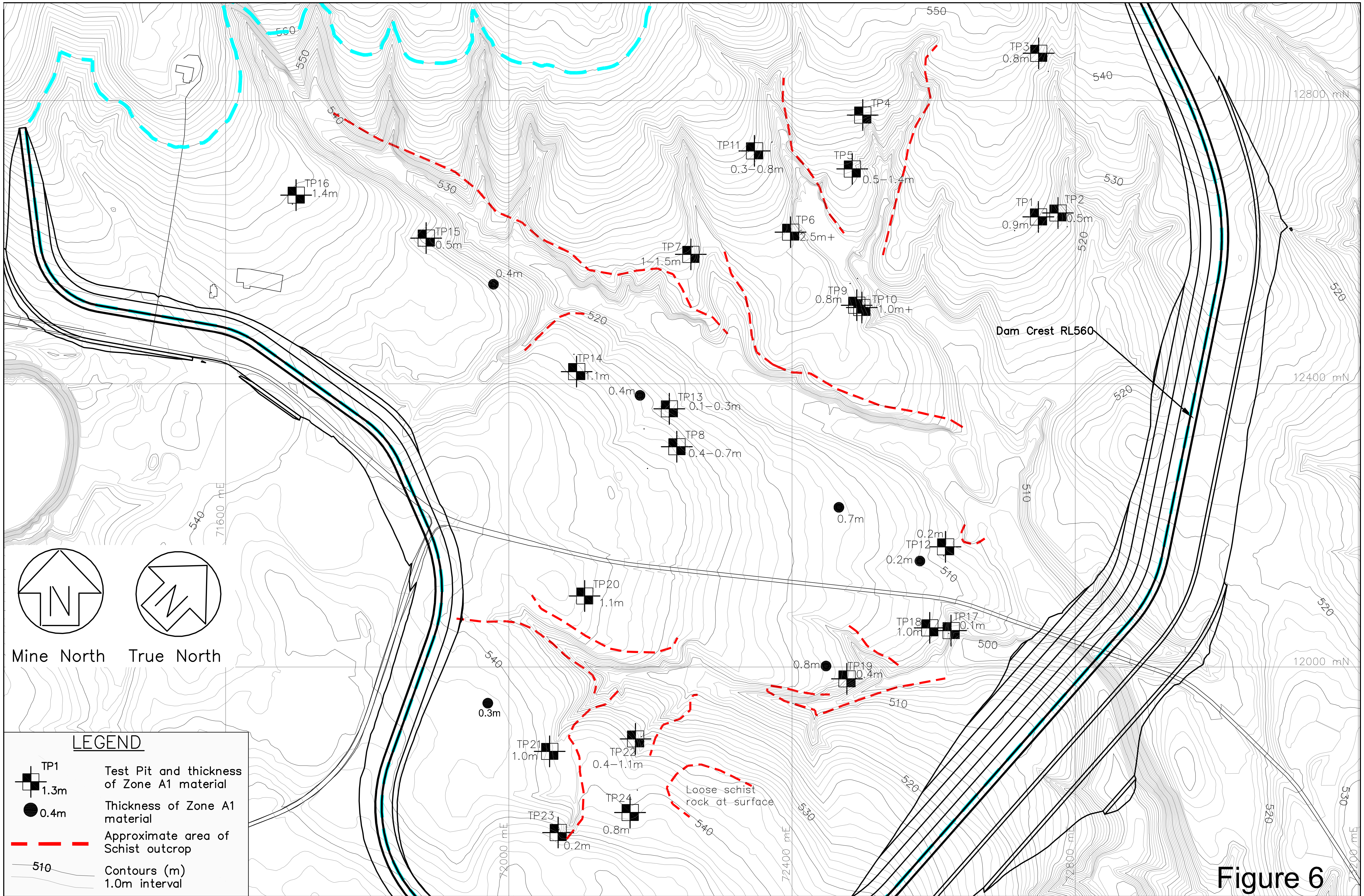
Drawing No.	6846–Fig 5
Date:	Nov 2010
Drawn:	DM
Scale:	1:5000 @ A3
Filename:	6846–Fig 5–6.dwg



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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Approximate thickness of Zone A1 Material

Drawing No.	6846–Fig 6
Date:	Nov 2010
Drawn:	DM
Scale:	1:5000 @ A3
Filename:	6846–Fig 5–6.dwg

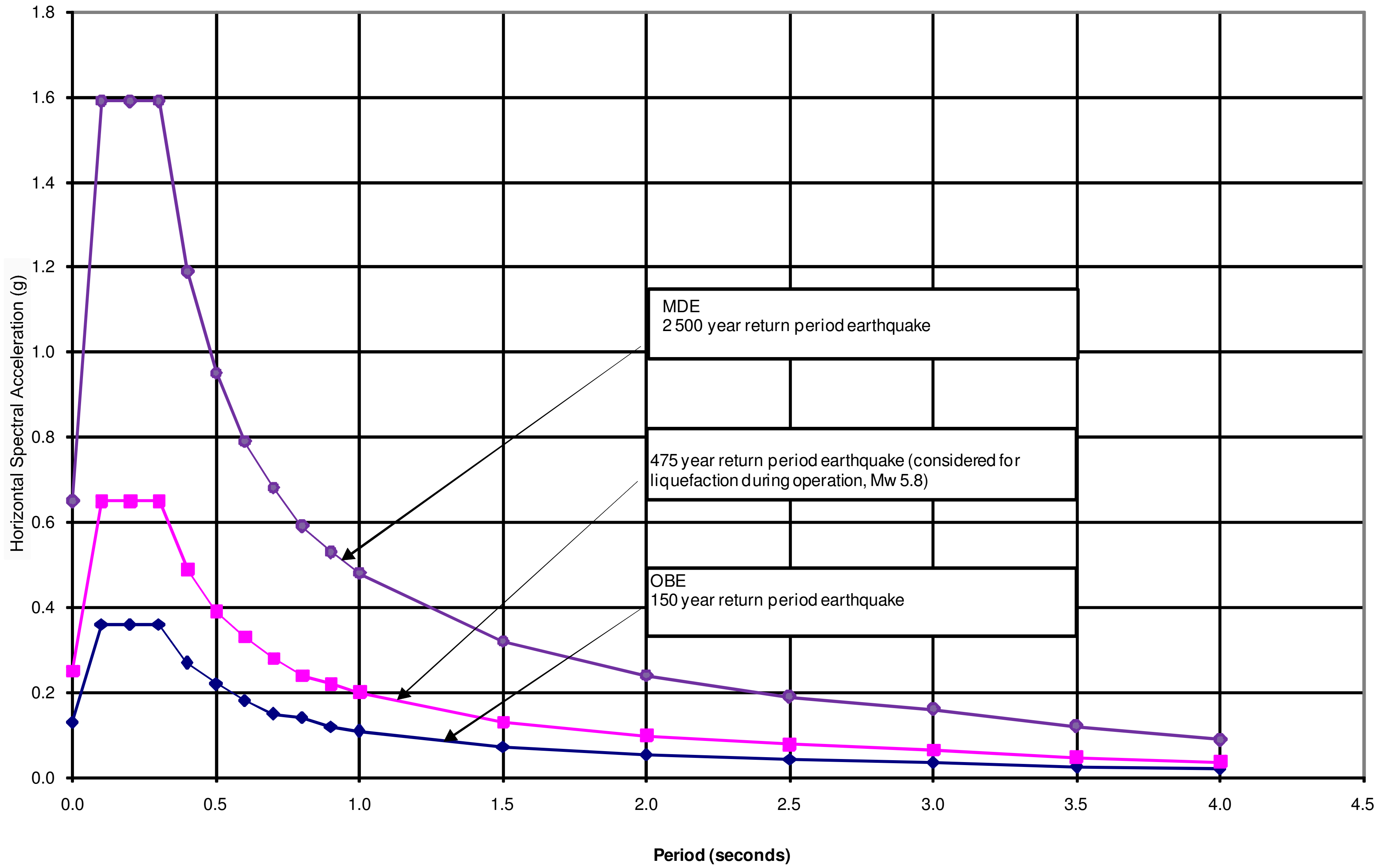

Figure 7

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Acceleration Response Spectra (5% Damping)

Drawing No.	6846–Fig 7
Date:	14 Jan 2011
Drawn:	BL
Filename:	6846–Fig 7.dwg

Date	Minimum Crest Level[1,2] (mRL)
1 May 2012	530
1 May 2013	536
1 May 2014	541
1 May 2015	545
1 May 2016	548
1 May 2017	551
1 May 2018	554
1 May 2019	557
1 May 2020	560

1. Minimum Crest Level required to safely store anticipated tailings production plus normal operating water and runoff associated with PMP with 1m freeboard.

2. Embankment not to be constructed more than 8m above tailings level at any time above RL530.

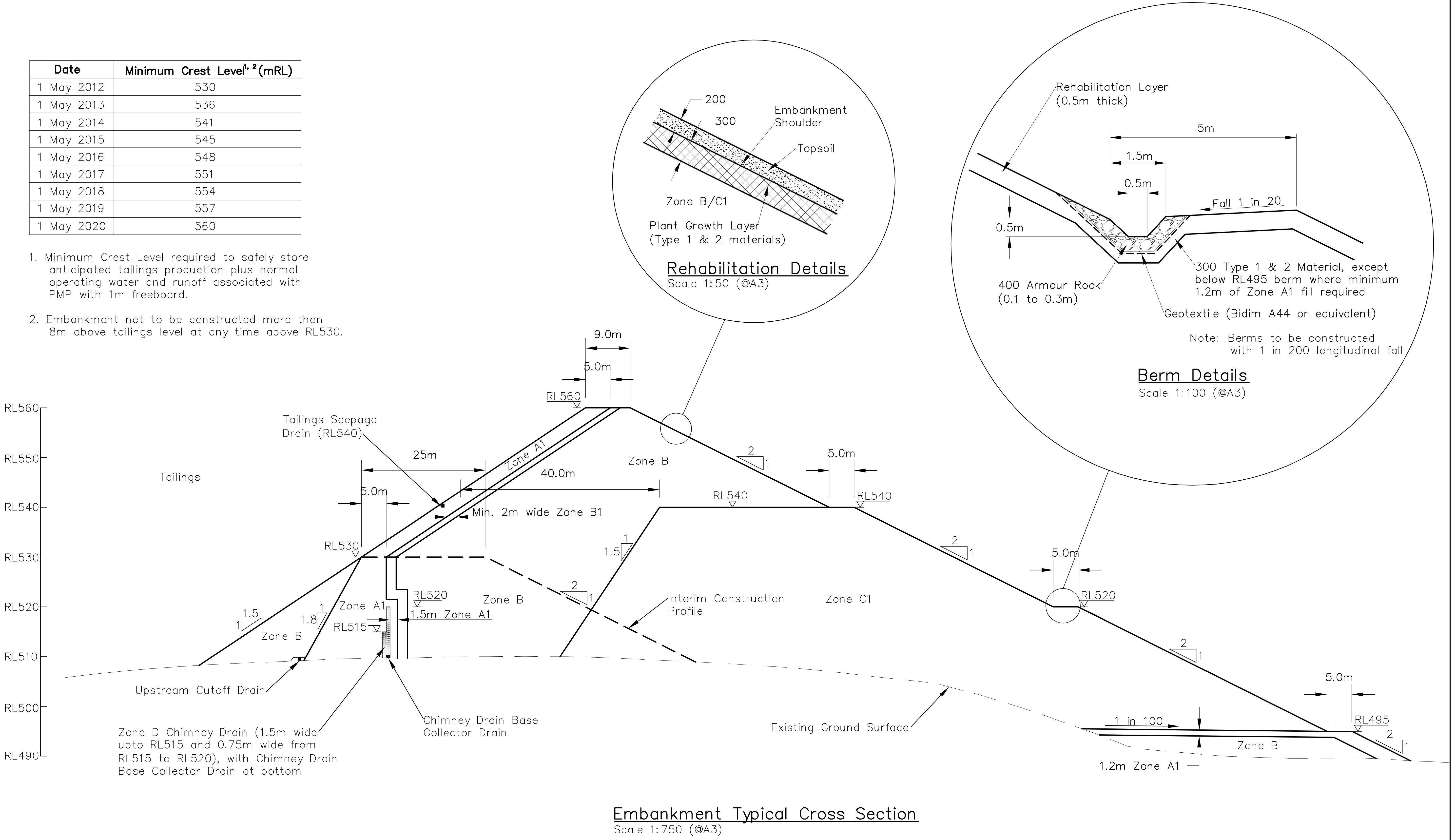

Figure 8

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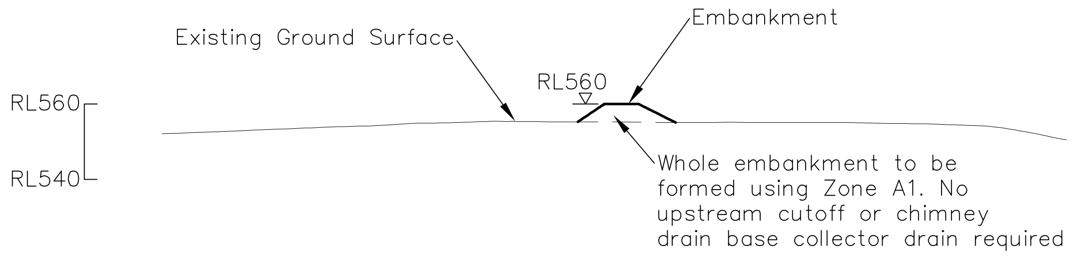
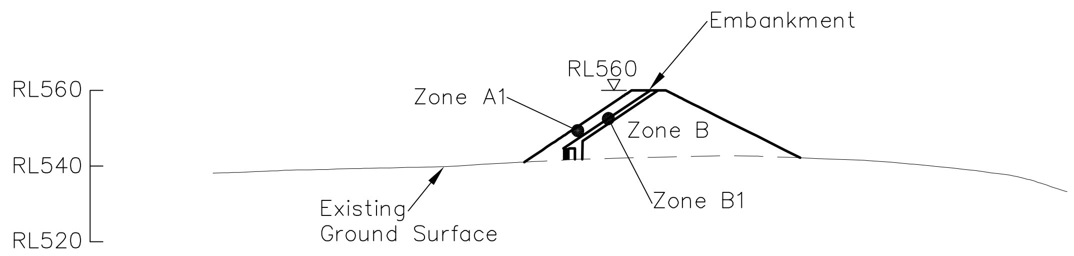
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Embankment Typical Cross Section

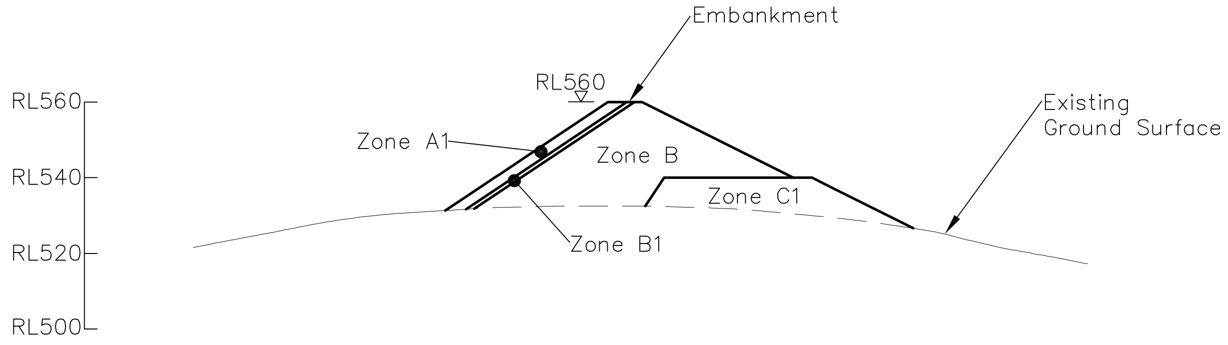
Drawing No.	6846-Fig 8
Date:	13 Jan 2011
Drawn:	BL
Scale:	As shown
Filename:	6846-Fig 8.dwg



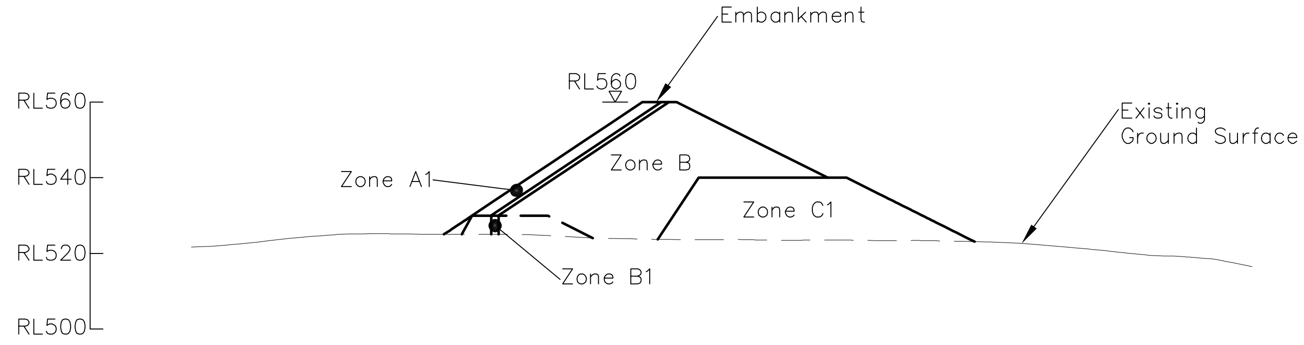
Section A – A'



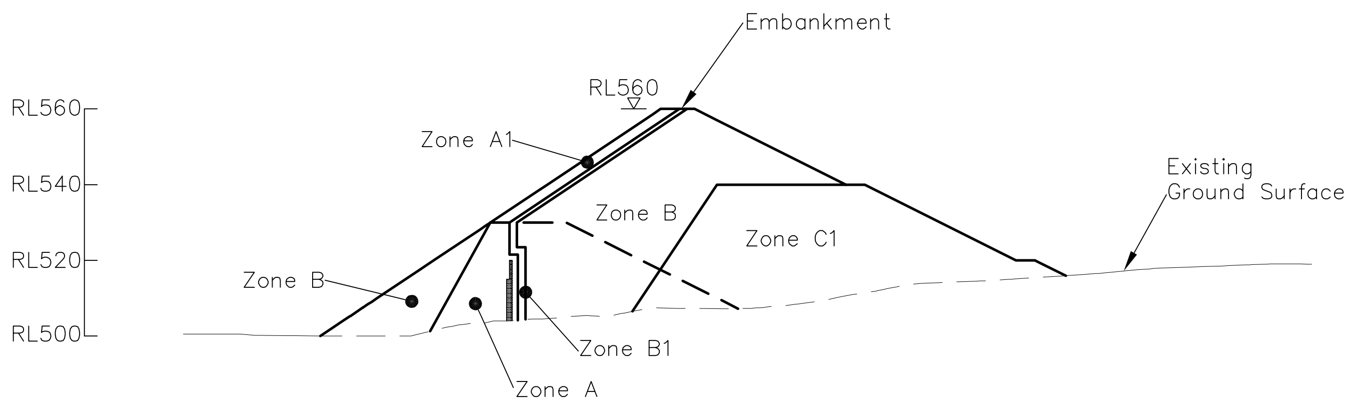
Section B – B'



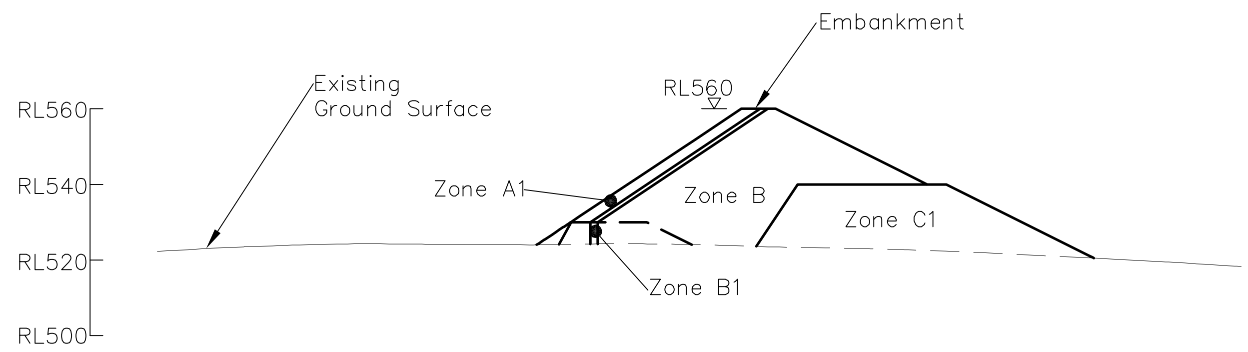
Section C – C'



Section D – D'



Section E – E'



Section F – F'

Figure 9

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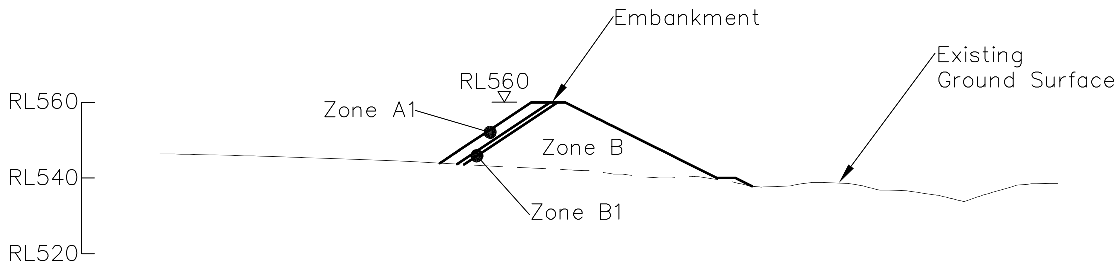
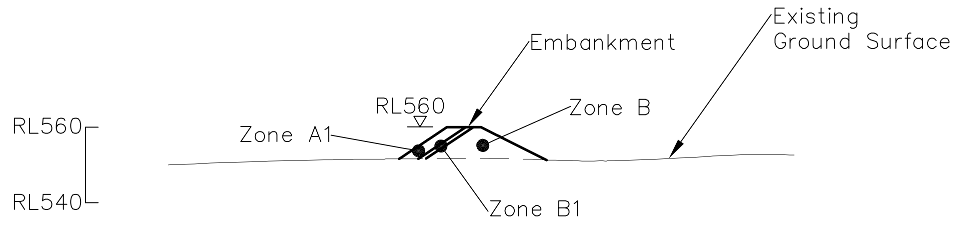
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Embankment Cross Sections 1 of 2

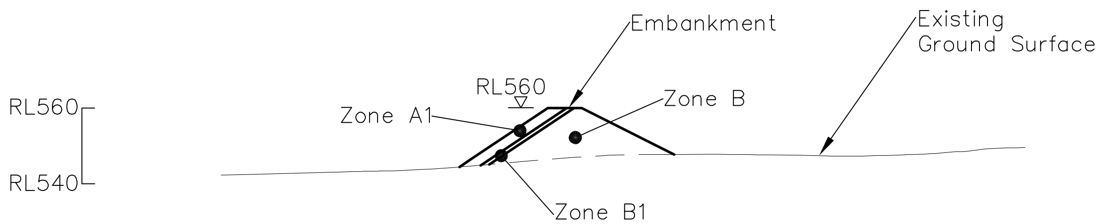
Drawing No.	6846–Fig 9
Date:	13 Jan 2011
Drawn:	BL
Scale:	1:2000 (@A3)
Filename:	6846–Fig 9.dwg



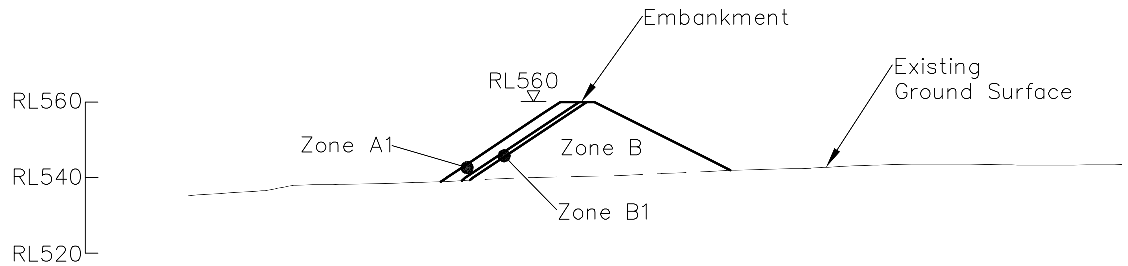
Section G – G'



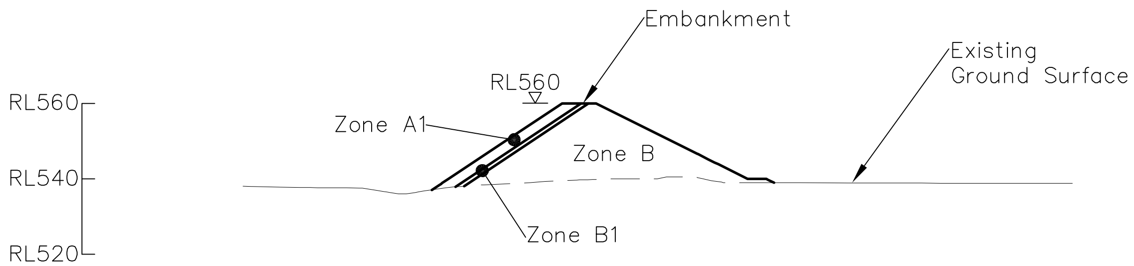
Section H – H'



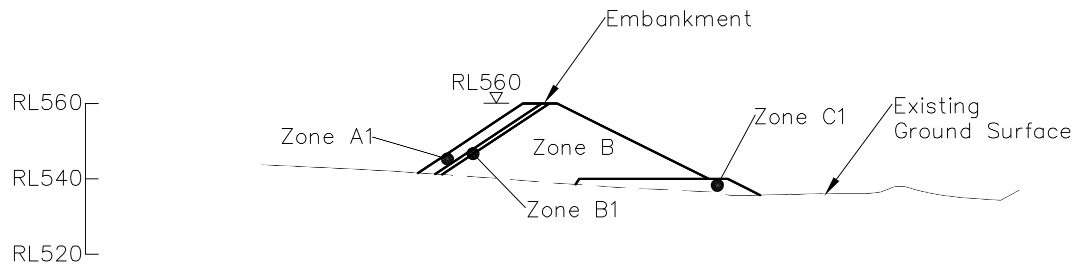
Section I – I'



Section J – J'



Section K – K'



Section L – L'

Figure 10

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Embankment Cross Sections 2 of 2

Drawing No.	6846-Fig 10
Date:	13 Jan 2011
Drawn:	BL
Scale:	1:2000 (@A3)
Filename:	6846-Fig 10.dwg

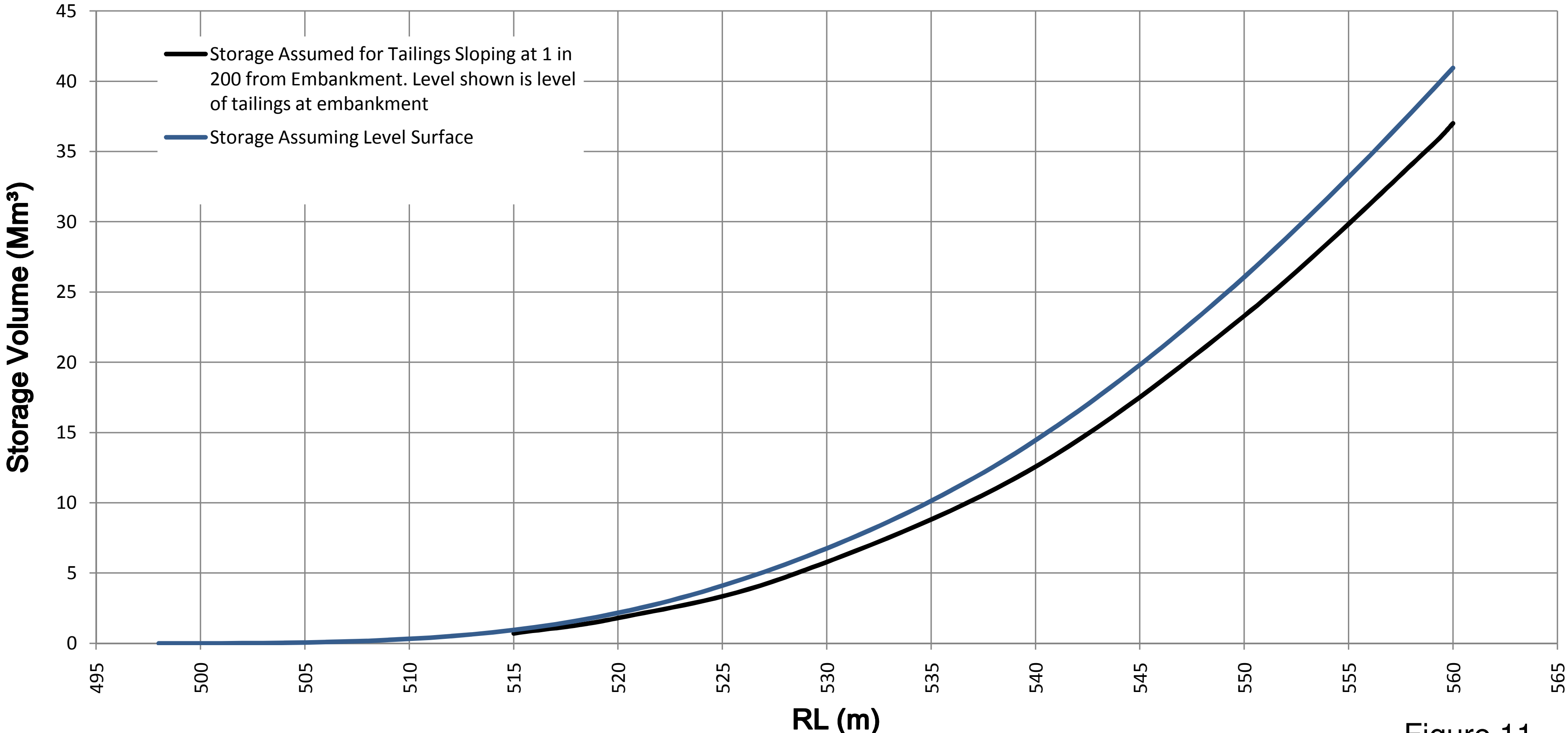

Figure 11

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Auckland , NZ Ph (09) 4862546 Fax (09) 4862556

OCEANA GOLD (NZ) LTD
Macraes Gold Operation
Tailings and Water Height Storage for Top Tipperary TSF

Ref. No: 6846 - Fig 11
Date: 14 Jan 2011
Drawn: BL
File: 6846 - Fig 11.xlsx

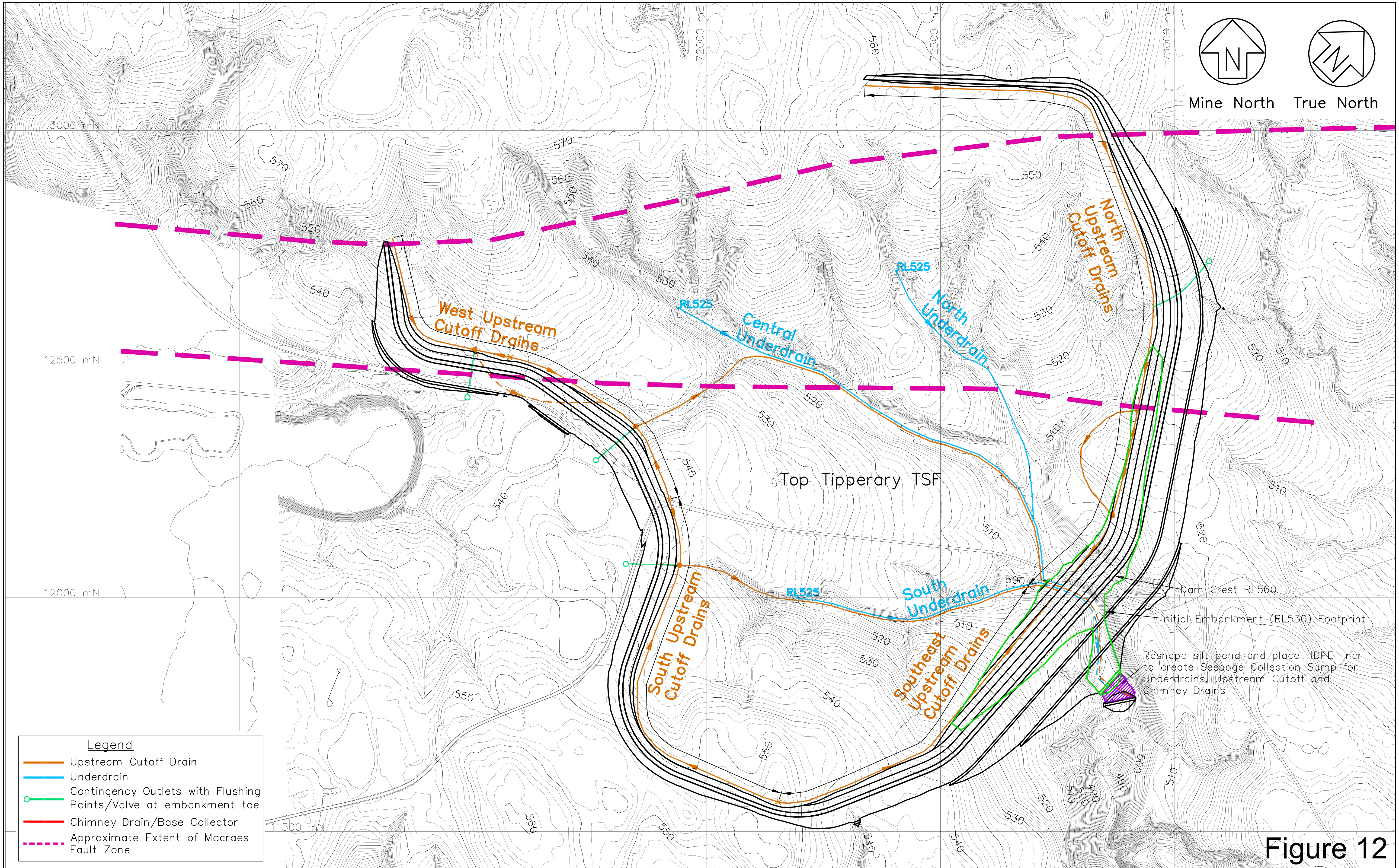

Figure 12

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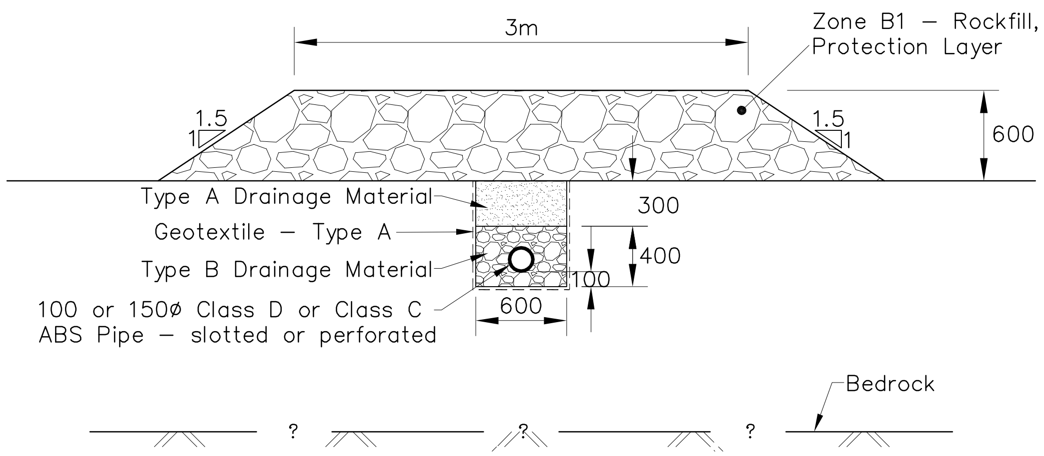
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Sub - Surface Drainage Plan

Drawing No.	6846-Fig 12
Date:	27 Jan 2011
Drawn:	BL
Scale:	1:7500 (@A3)
Filename:	6846-Fig 12.dwg

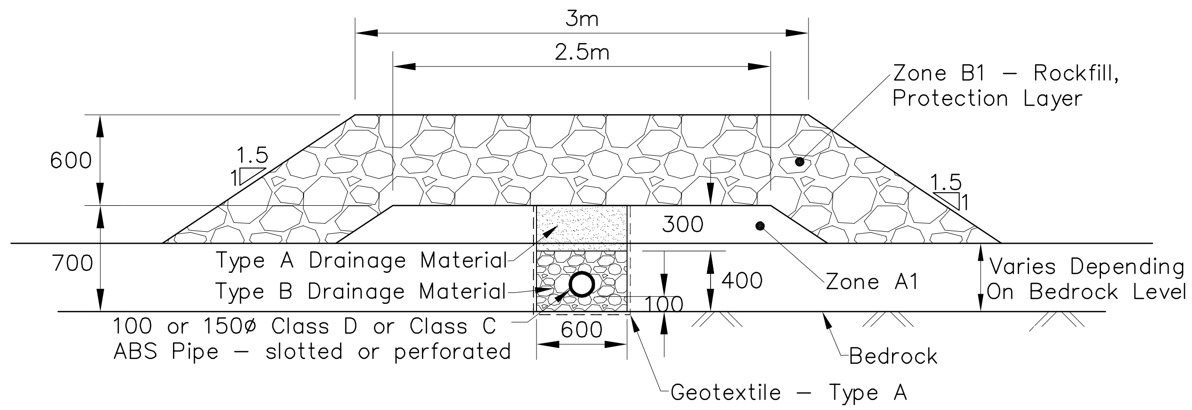
Notes:
1. Slots 5mm wide x 150 long at 300 centres.
   Two rows of slots, with slots offset each side of pipe.
2. Perforations in accordance with Transit F/2 specification.
3. ABS pipe specifications;

   ABS 160, PN 12 – Class D

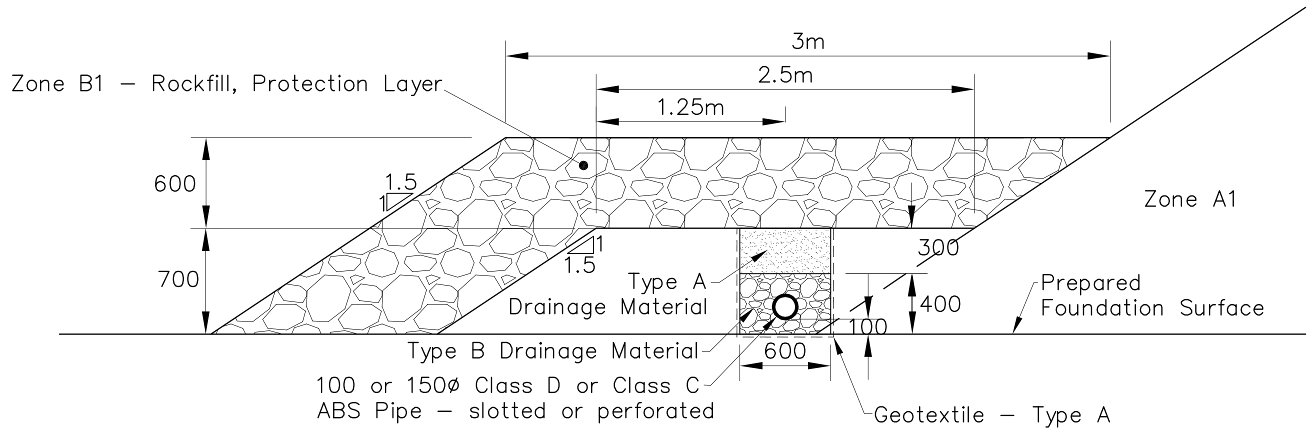
   ABS 160, PN 9 – Class C



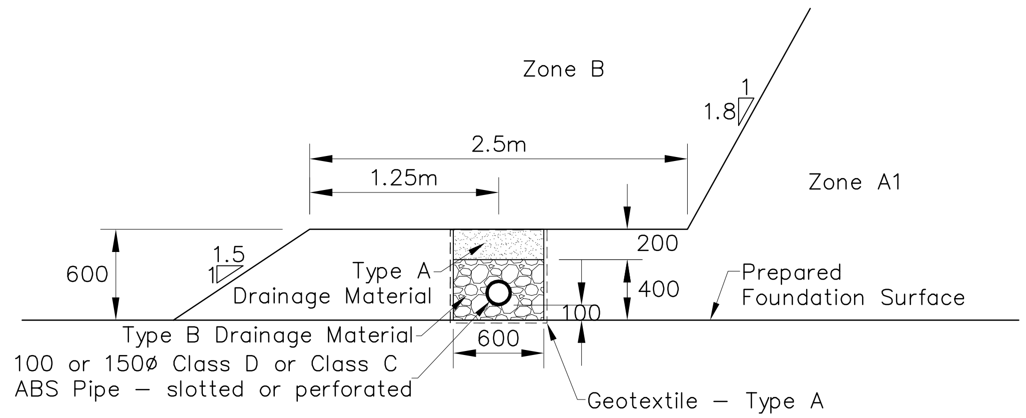
Underdrain (Typical) Where Depth To Bedrock Greater Than 0.7m



Underdrain (Typical) Where Depth To Bedrock Less Than 0.7m



Upstream Cut-Off Drain Above RL530



Upstream Cut-Off Drain Below RL530

Figure 13

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT

Top Tipperary TSF

Upstream Cutoff and Underdrain Details

Drawing No.	6846-Fig 13
Date:	13 Jan 2011
Drawn:	BL
Scale:	1:50 (@A3)
Filename:	6846-Fig 13.dwg

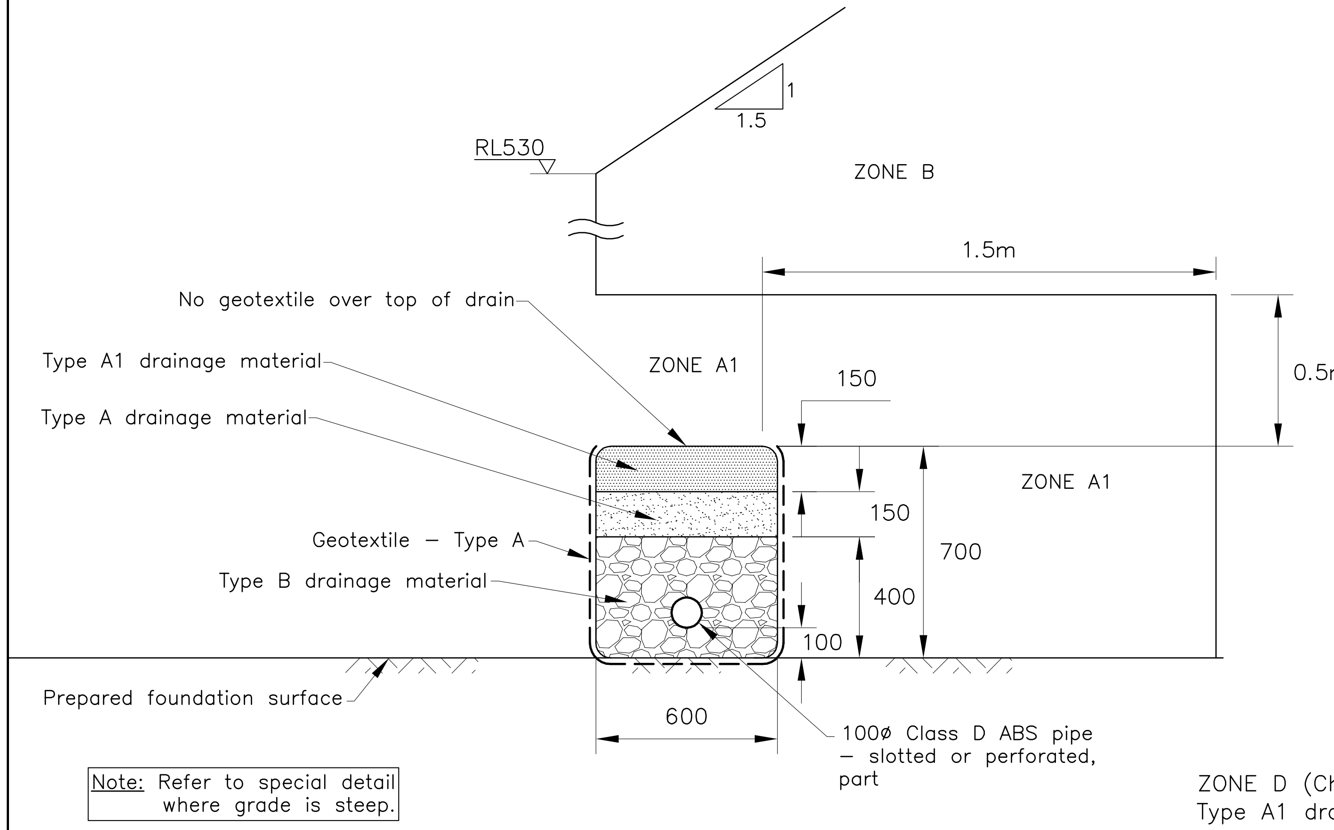
Notes: 1. Slots 5mm wide x 150 long at 300 centres. Two rows of slots, with slots offset each side of pipe.

2. Perforations in accordance with Transit F/2 specification.

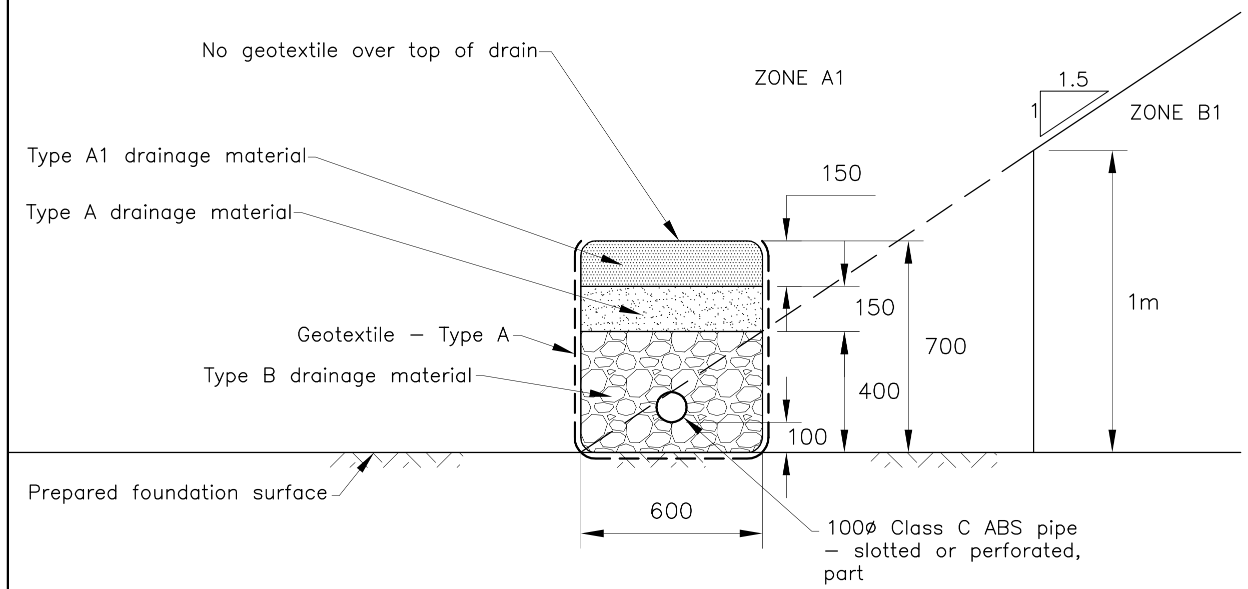
3. ABS pipe specifications;

ABS 160, PN 12 – Class D

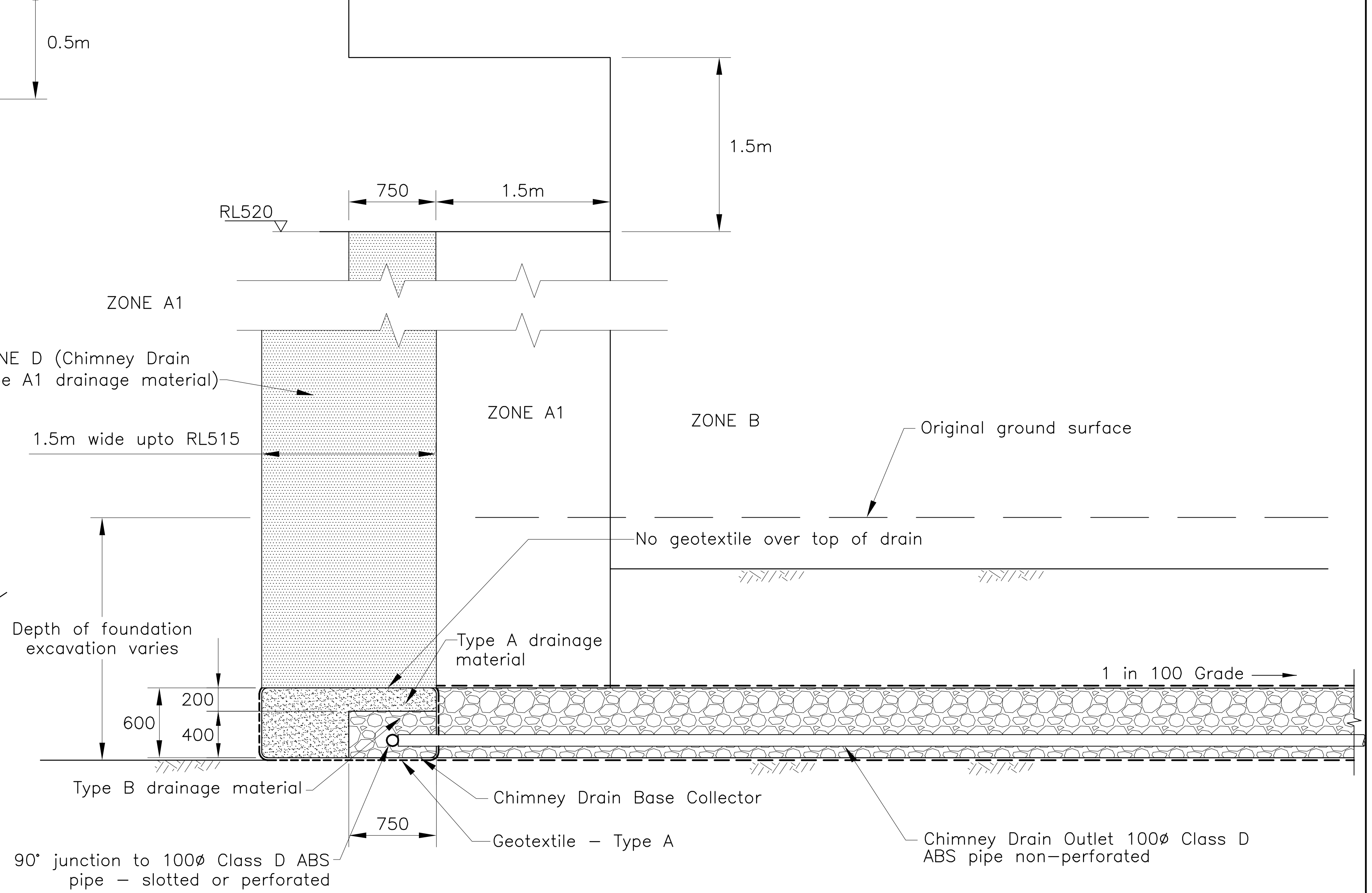
ABS 160, PN 9 – Class C



CHIMNEY DRAIN BASE COLLECTOR ABOVE RL520 AND BELOW RL530
Scale 1:25 (@A3)



CHIMNEY DRAIN BASE COLLECTOR ABOVE RL530
Scale 1:25 (@A3)



CHIMNEY DRAIN DETAIL BELOW RL520
Scale 1:50 (@A3)

Figure 14

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Chimney Drain and Base Collector Details

Drawing No.	6846–Fig 14
Date:	13 Jan 2011
Drawn:	BL
Scale:	As shown
Filename:	6846–Fig 14–15.dwg

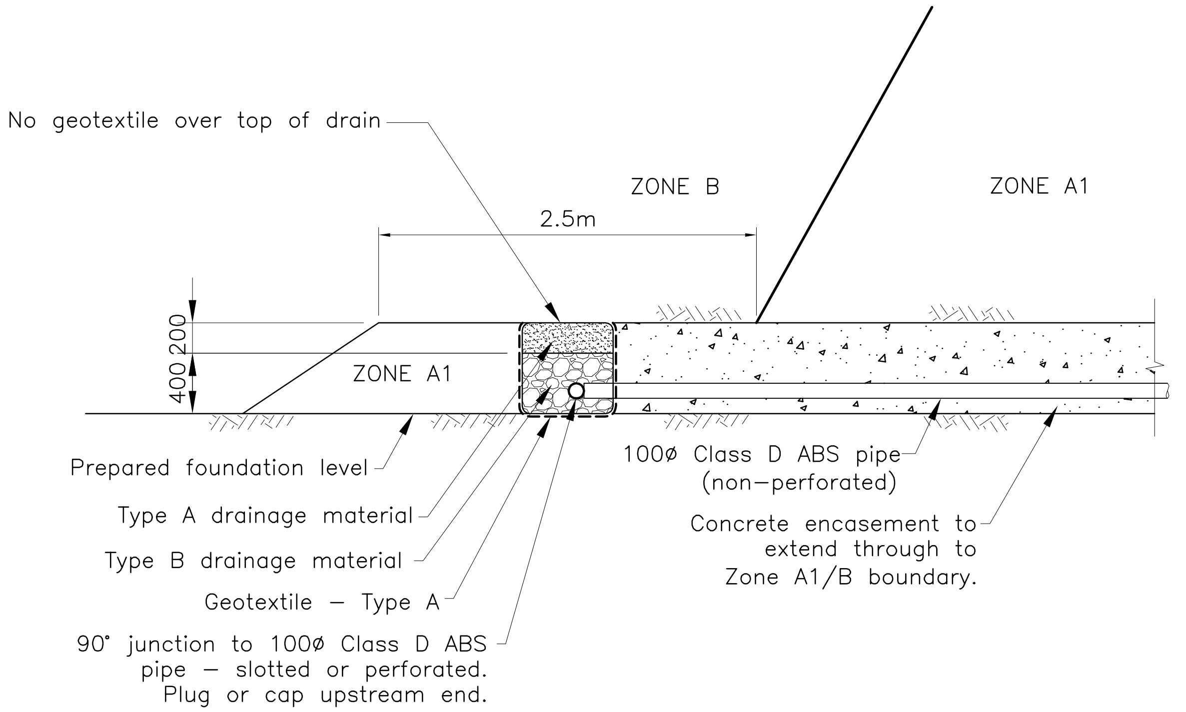
Notes: 1. Slots 5mm wide x 150 long at 300 centres. Two rows of slots, with slots offset each side of pipe.

2. Perforations in accordance with Transit F/2 specification.

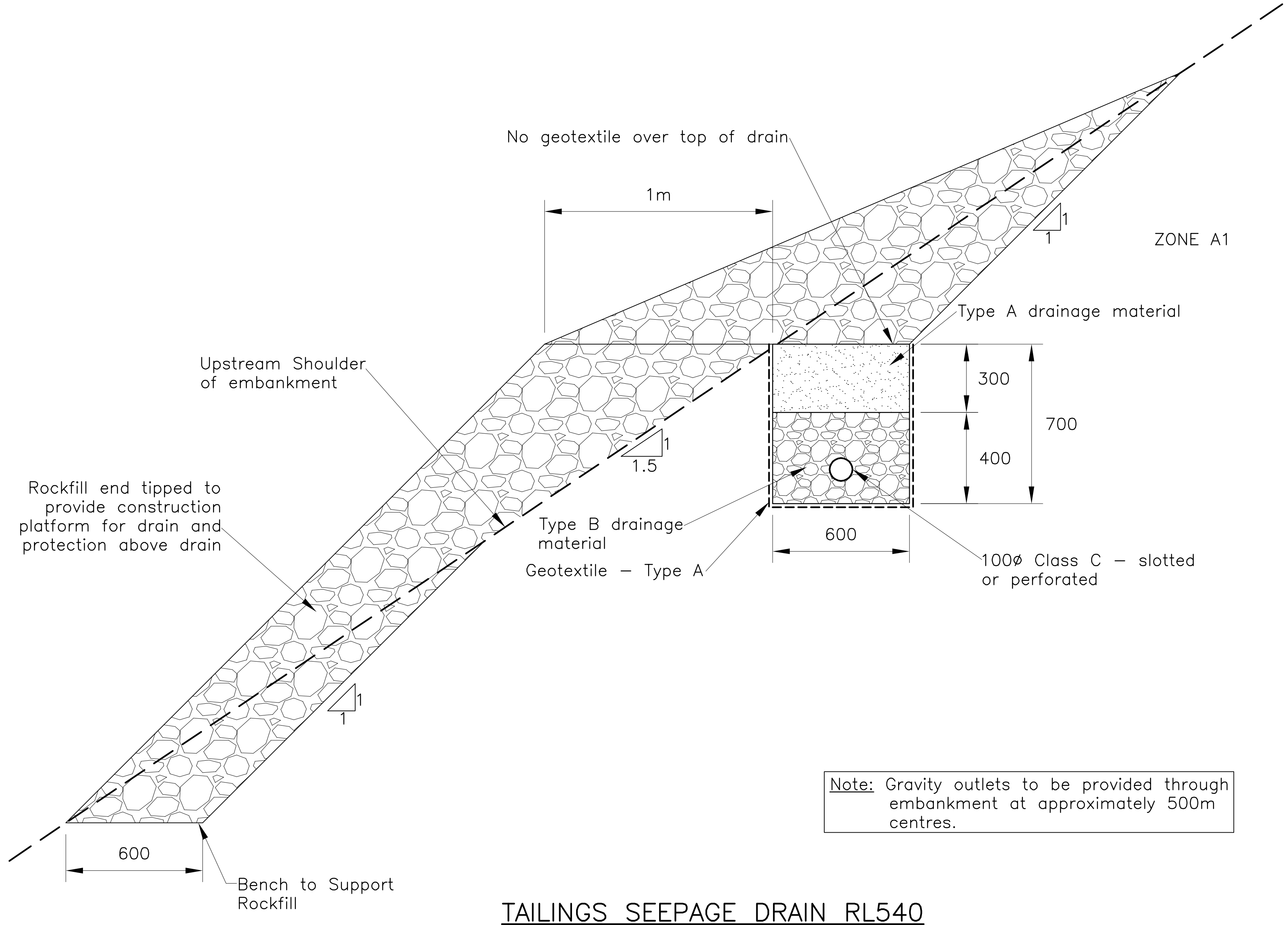
3. ABS pipe specifications;

ABS 160, PN 12 – Class D

ABS 160, PN 9 – Class C



UPSTREAM CUTOFF DRAIN – OUTLET DETAIL THRU ZONE A1
Scale 1:50 (@A3)



Note: Gravity outlets to be provided through embankment at approximately 500m centres.

TAILINGS SEEPAGE DRAIN RL540
Scale 1:25 (@A3)

Figure 15

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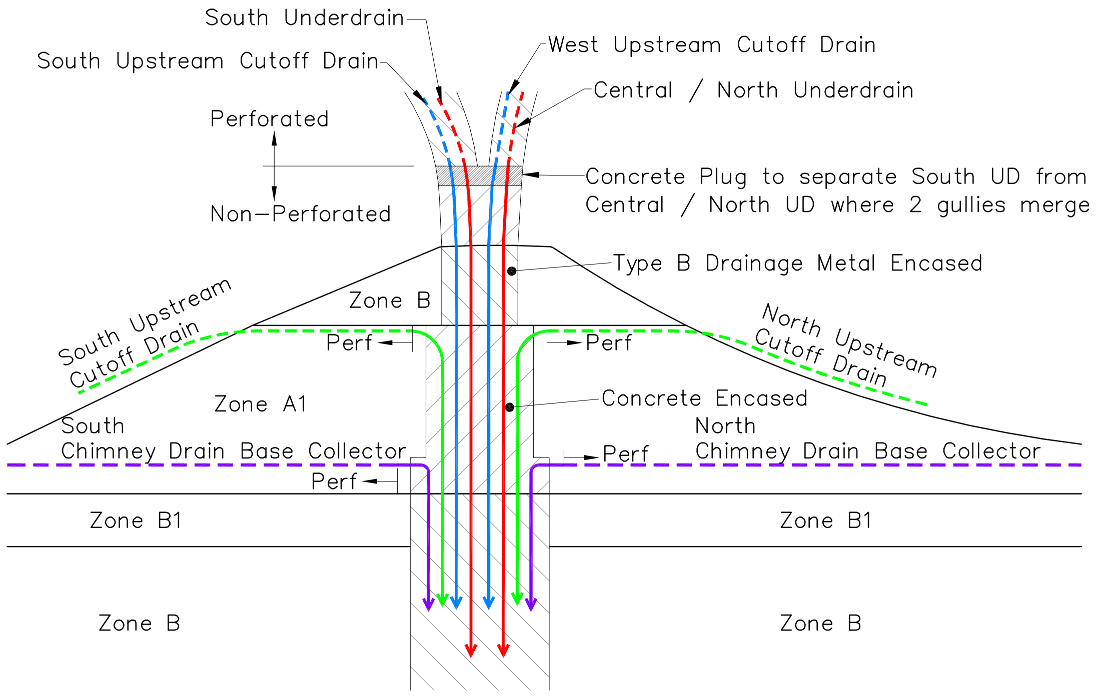
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Tailings Seepage Drain RL540 and Upstream Cutoff Drain Outlet Details

Drawing No.	6846–Fig 15
Date:	13 Jan 2011
Drawn:	BL
Scale:	As shown
Filename:	6846–Fig 14–15.dwg



Schematic Plan of Drains Beneath Embankment (N.T.S.)

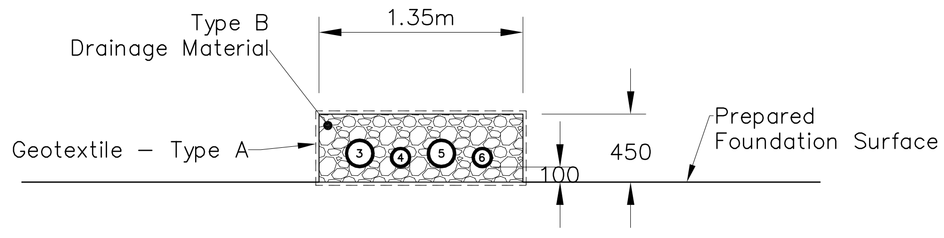
Notes

1. South UC, South UD, West UC and Central / North UD are non–perforated from where they join (i.e. where two gullies merge). A concrete plug is to be constructed to ensure separation of flows.

2. Southeast UC, North UC, South CD and North CD become non–perforated where they become concrete encased beneath Zone A1.

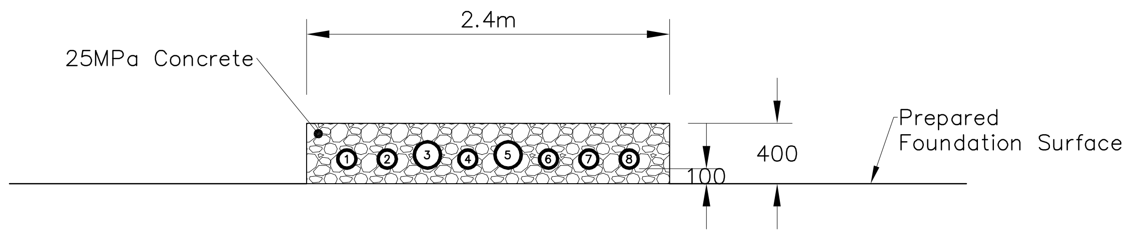
Drain Legend

Drain Number	Pipe Dia / Class	Drain
1	100ø ABS Class C – non–perforated	North Chimney Drain
2	100ø ABS Class C – non–perforated	North Upstream Cutoff
3	150ø ABS Class C – non–perforated	Central / North Underdrain
4	100ø ABS Class C – non–perforated	West Upstream Cutoff
5	150ø ABS Class C – non–perforated	South Underdrain
6	100ø ABS Class C – non–perforated	South Upstream Cutoff
7	100ø ABS Class C – non–perforated	Southeast Upstream Cutoff
8	100ø ABS Class C – non–perforated	South Chimney Drain



Collector Drain Details Beneath Zone B (Upstream of Zone A1)

Scale 1:50

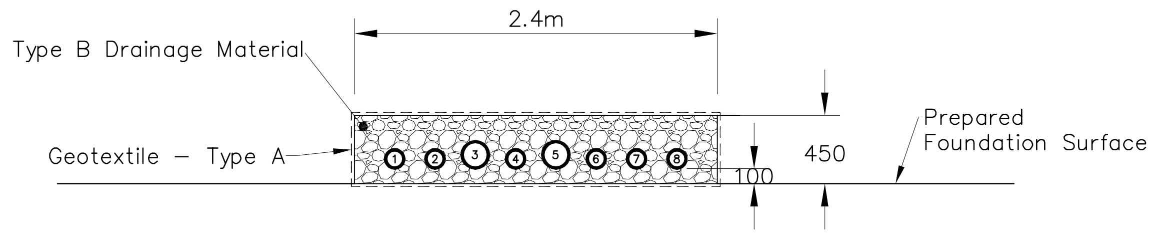


Collector Drain Details Beneath Zone A1

Scale 1:50

Notes

1. Chimney drain collectors (Drains 1 and 8) only present downstream of chimney drain



Collector Drain Details Beneath Zone B (Downstream of Zone A1)

Scale 1:50

Notes

1. Central / North and South Underdrains (3 and 5) and North and Southeast Upstream Cutoffs (2 and 6) to be fitted with valves and pressure gauges

2. Section details viewed looking downstream

Figure 16

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Subsurface Drain Details Beneath Embankment

Drawing No.	6846–Fig 16
Date:	13 Jan 2011
Drawn:	BL
Scale:	As shown
Filename:	6846–Fig 16.dwg

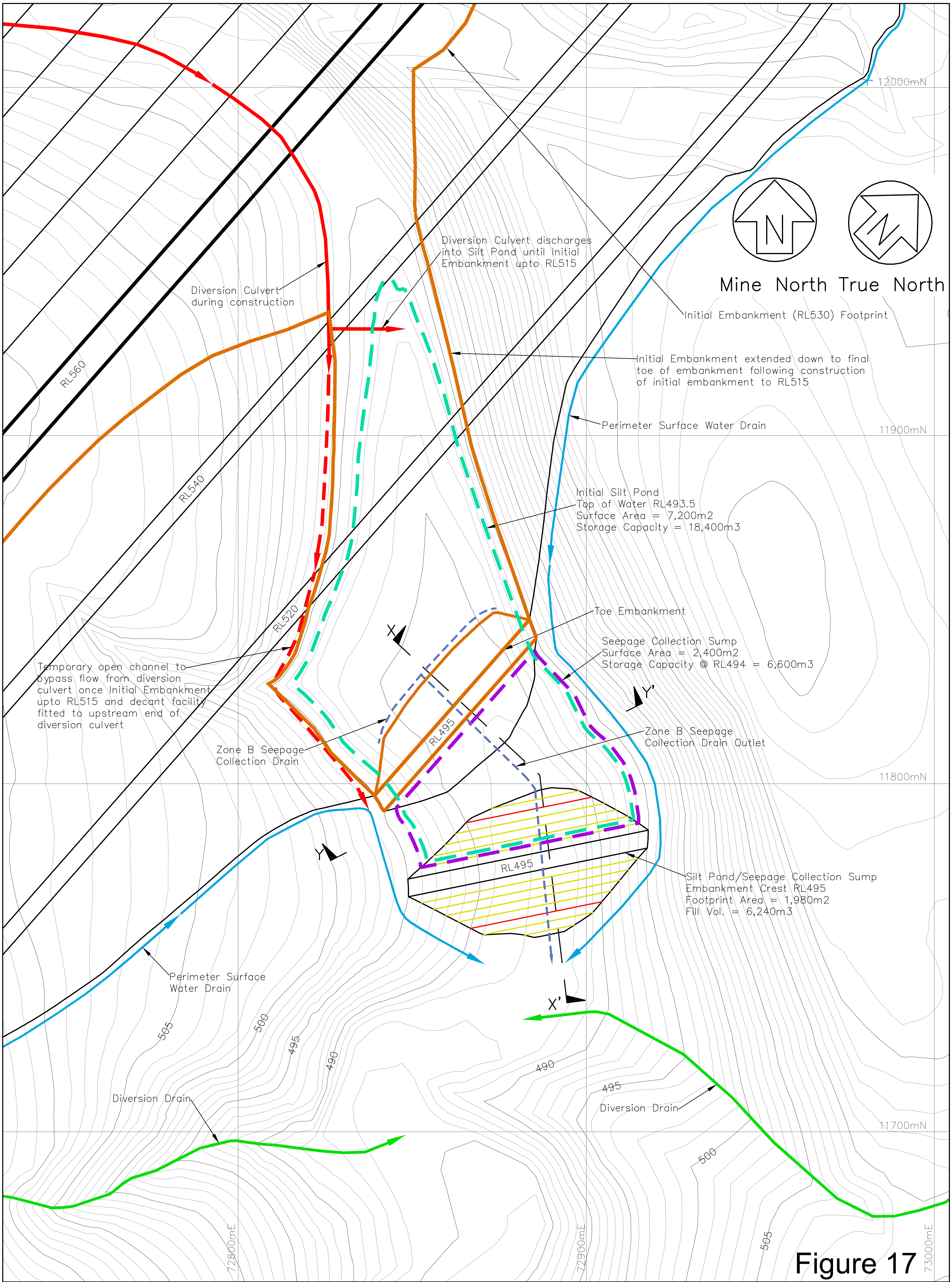
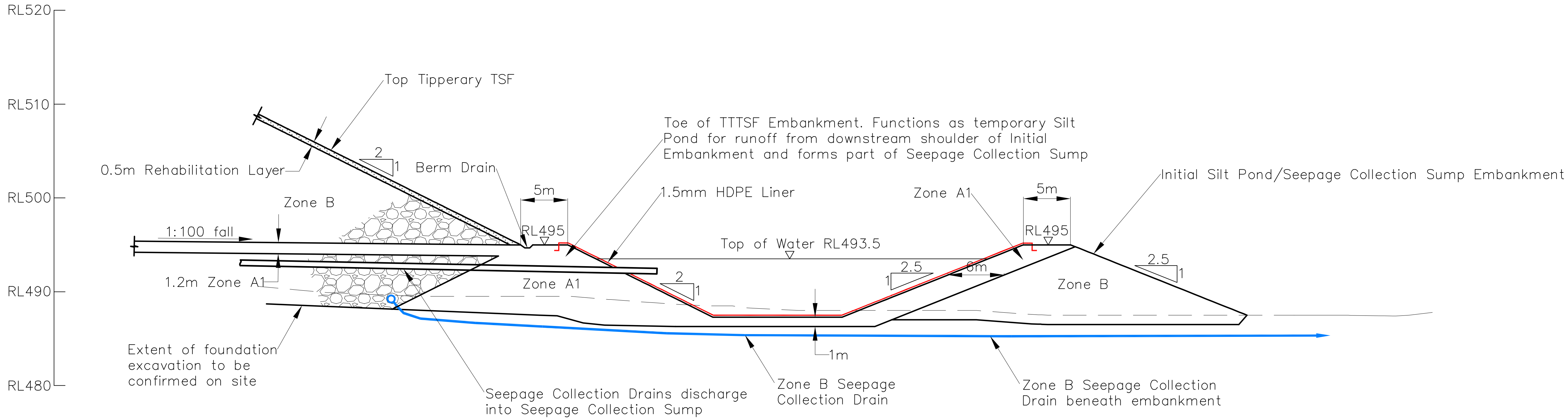
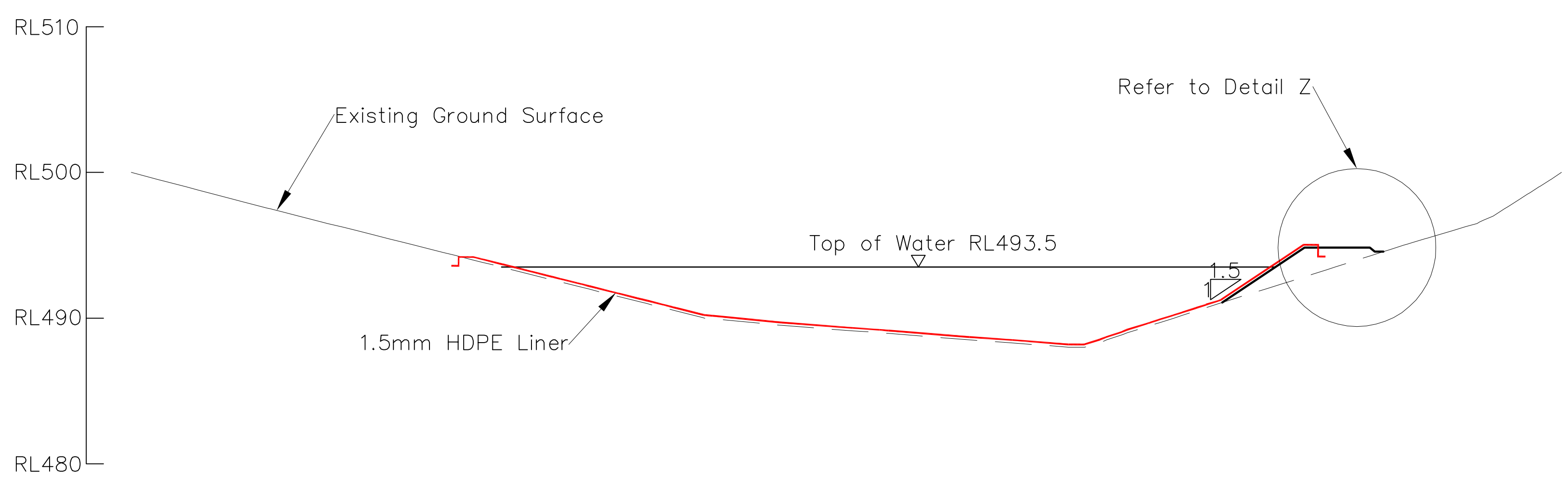


Figure 17

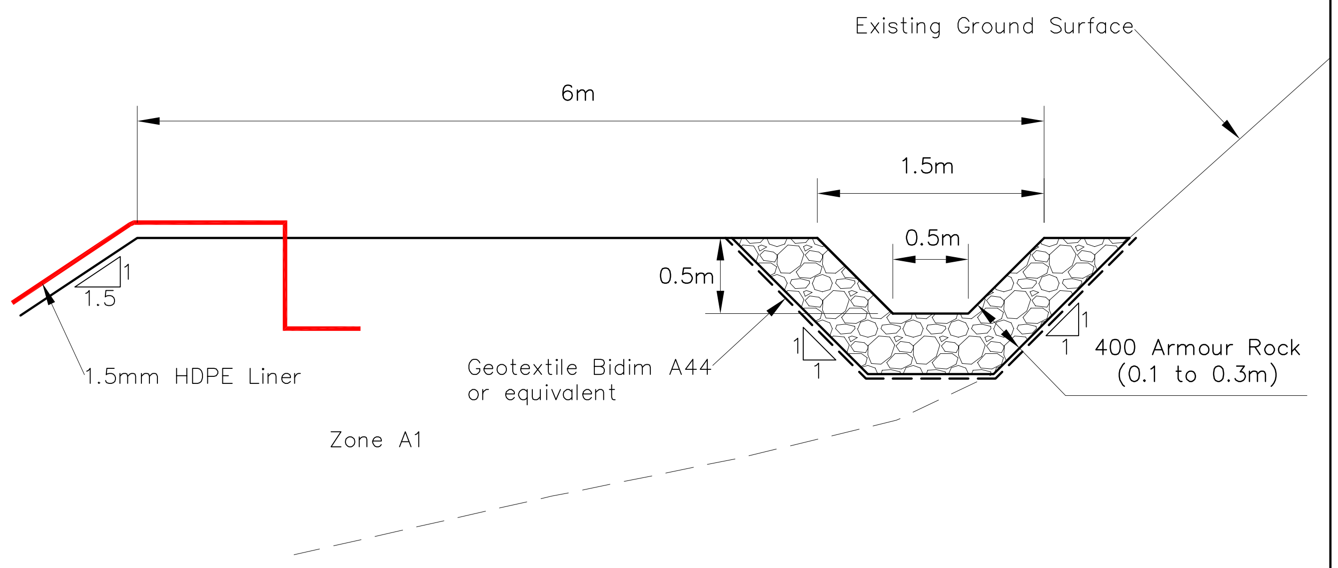
ENGINEERING GEOLOGY LTD Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany Ph (09)486-2546, Fax (09)486-2556	OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT Top Tipperary TSF *Silt Pond/Seepage Collection Sump Embankment*	Drawing No. 6846–Fig 17 Date: 28 Feb 2011 Drawn: BL Scale: 1:1000 (@A3) Filename: 6846–Fig 17–18.dwg



SECTION X – X'
Scale 1:500 (@A3)



SECTION Y – Y'
Scale 1:500 (@A3)



DETAIL Z
Scale 1:50 (@A3)

Figure 18

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Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany
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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Seepage Collection Sump Cross Sections and Detail

Drawing No.	6846–Fig 18
Date:	28 Feb 2011
Drawn:	BL
Scale:	As shown
Filename:	6846–Fig 17–18.dwg

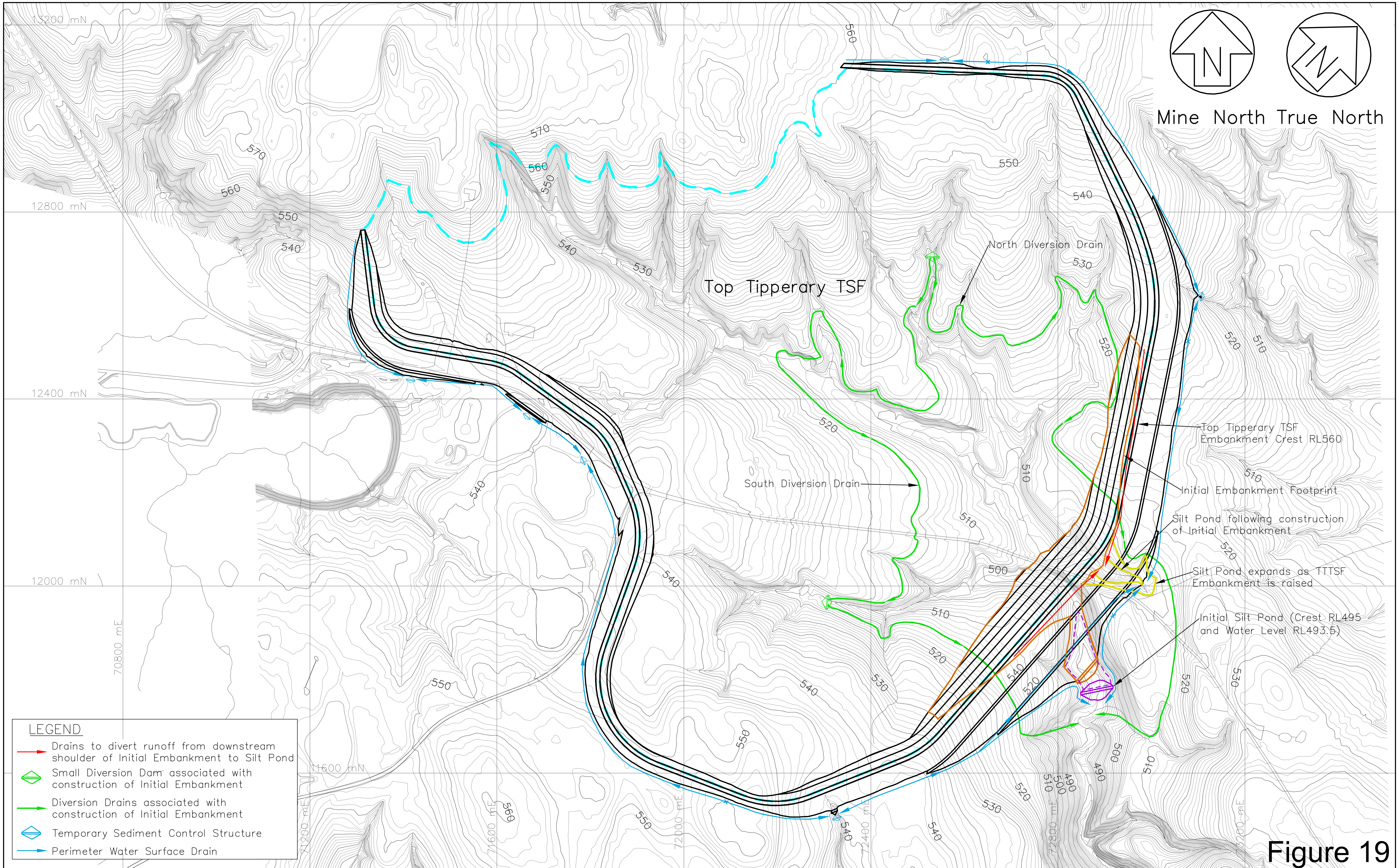

Figure 19

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Construction Diversion Drains and Silt Ponds

Drawing No.	6846-Fig 19
Date:	27 Jan 2011
Drawn:	BL
Scale:	1:7500 (@A3)
Filename:	6846-Fig 19.dwg

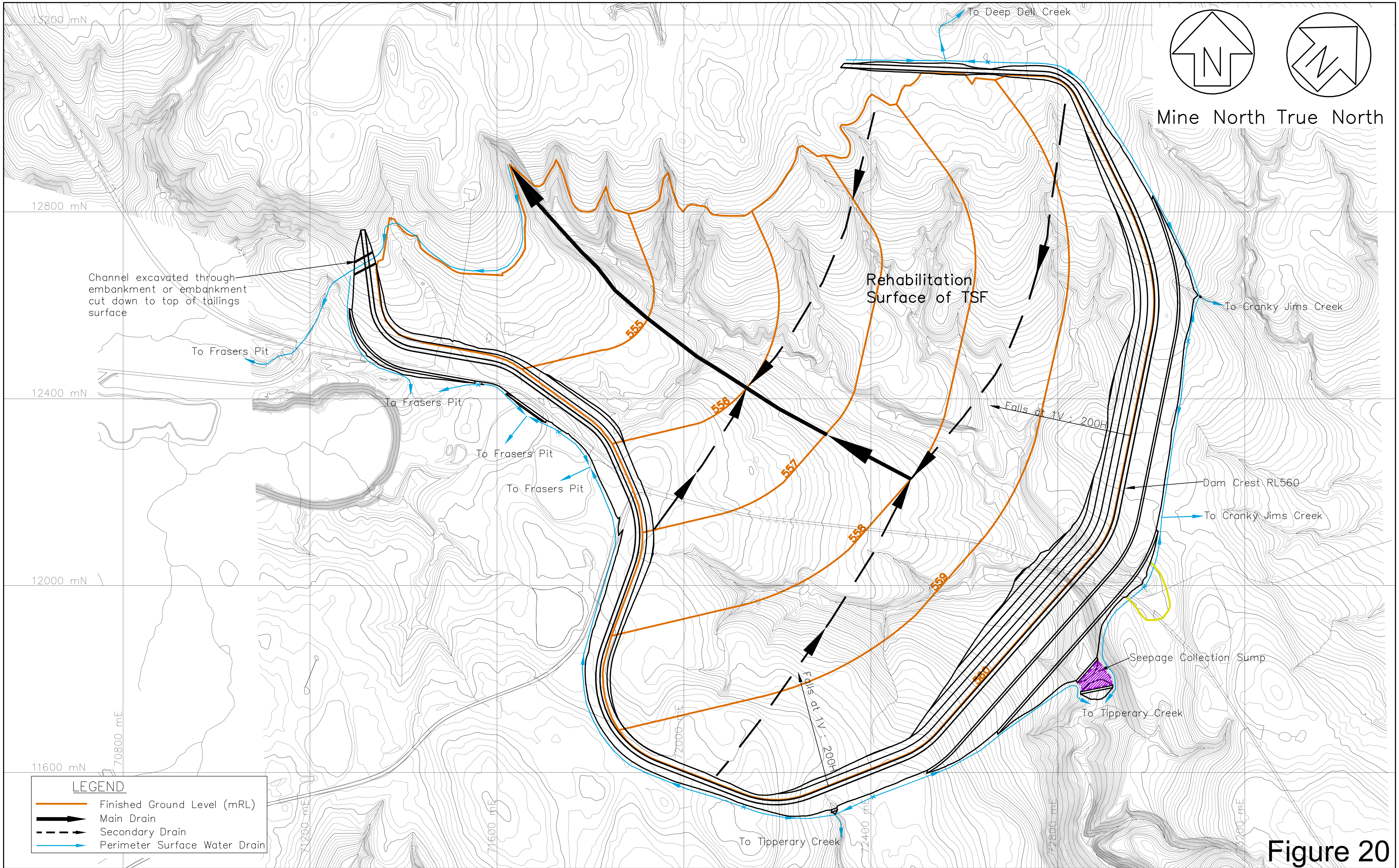

Figure 20

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Rehabilitation Plan Concepts

Drawing No.	6846-Fig 20
Date:	13 Jan 2011
Drawn:	BL
Scale:	1:7500 (@A3)
Filename:	6846-Fig 20-21.dwg

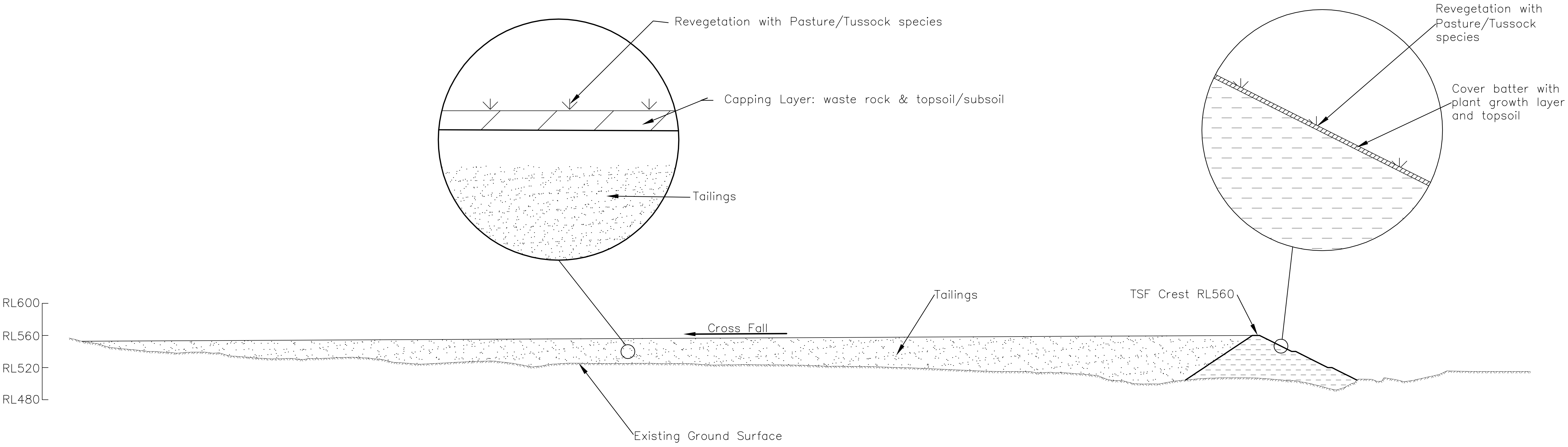

Figure 21

ENGINEERING GEOLOGY LTD
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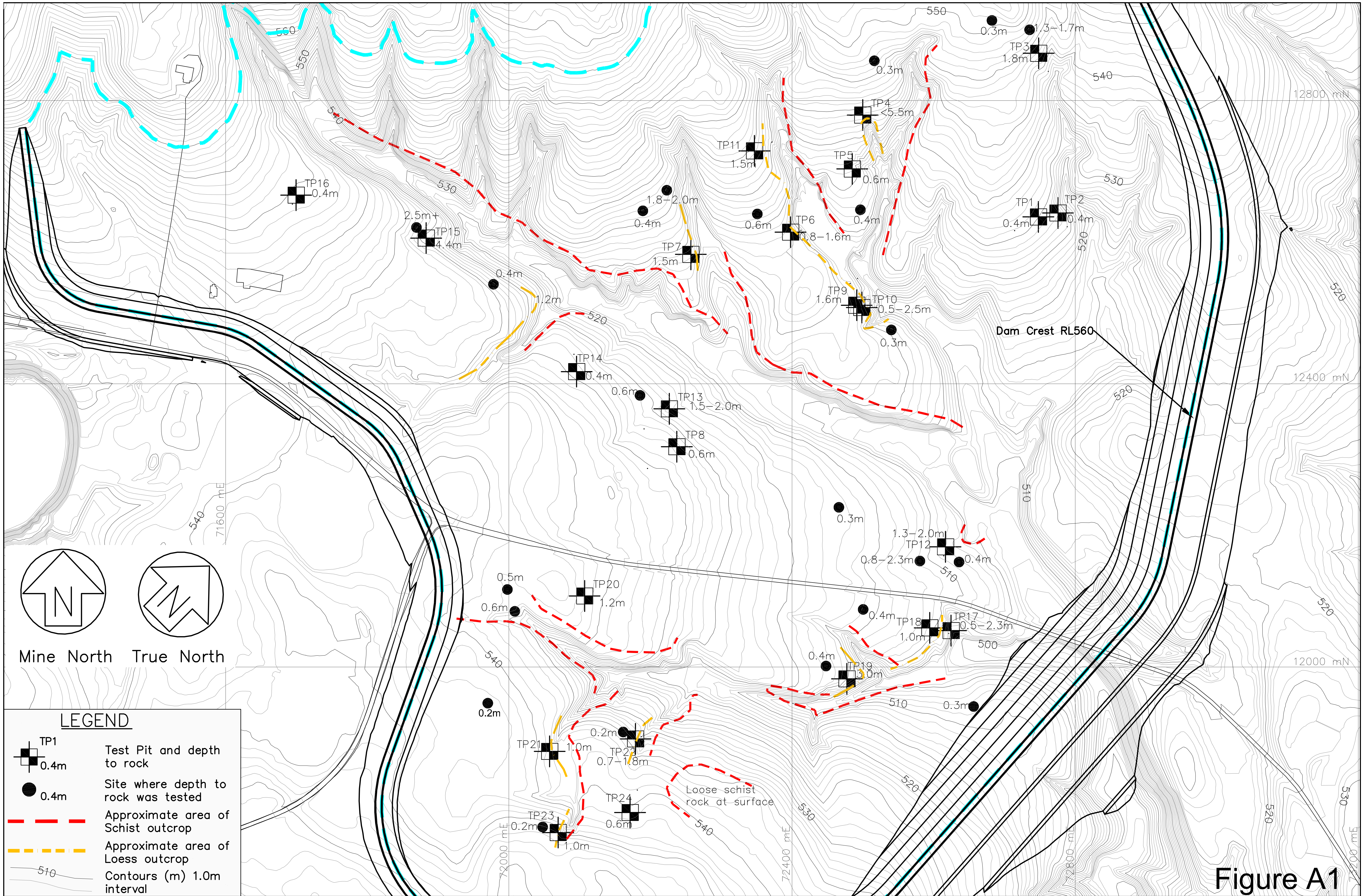
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Section Through Rehabilitated TSF

Drawing No.	6846-Fig 21
Date:	13 Jan 2011
Drawn:	BL
Scale:	1:5000 (@A3)
Filename:	6846-Fig 20-21.dwg

APPENDIX A

TEST PIT LOGS



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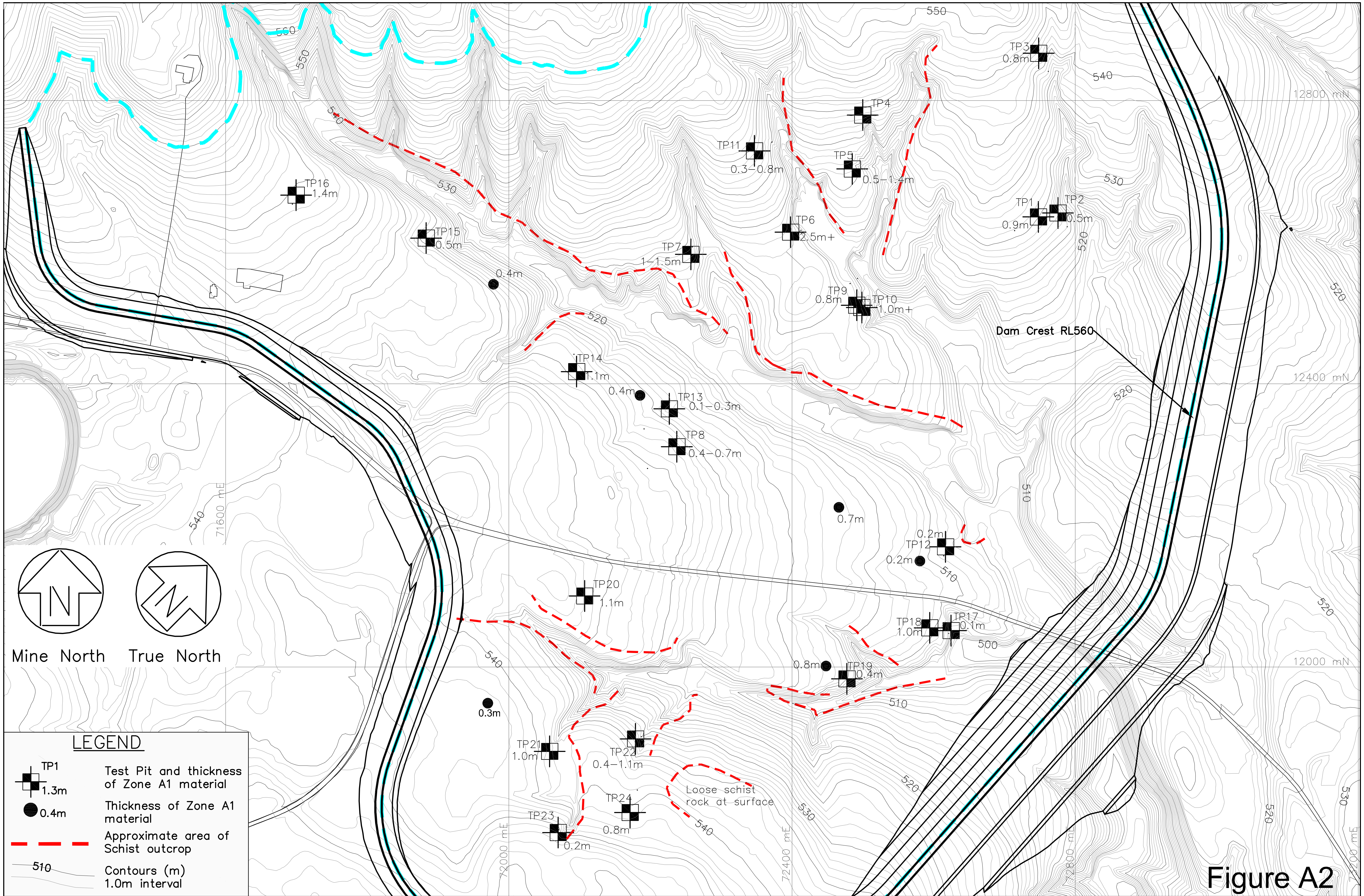
Ph (09)486-2546, Fax (09)486-2556

OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Test Pit Location Plan

Drawing No.	6846-Fig 5
Date:	Nov 2010
Drawn:	DM
Scale:	1:5000 @ A3
Filename:	6846-Fig 5-6.dwg



ENGINEERING GEOLOGY LTD
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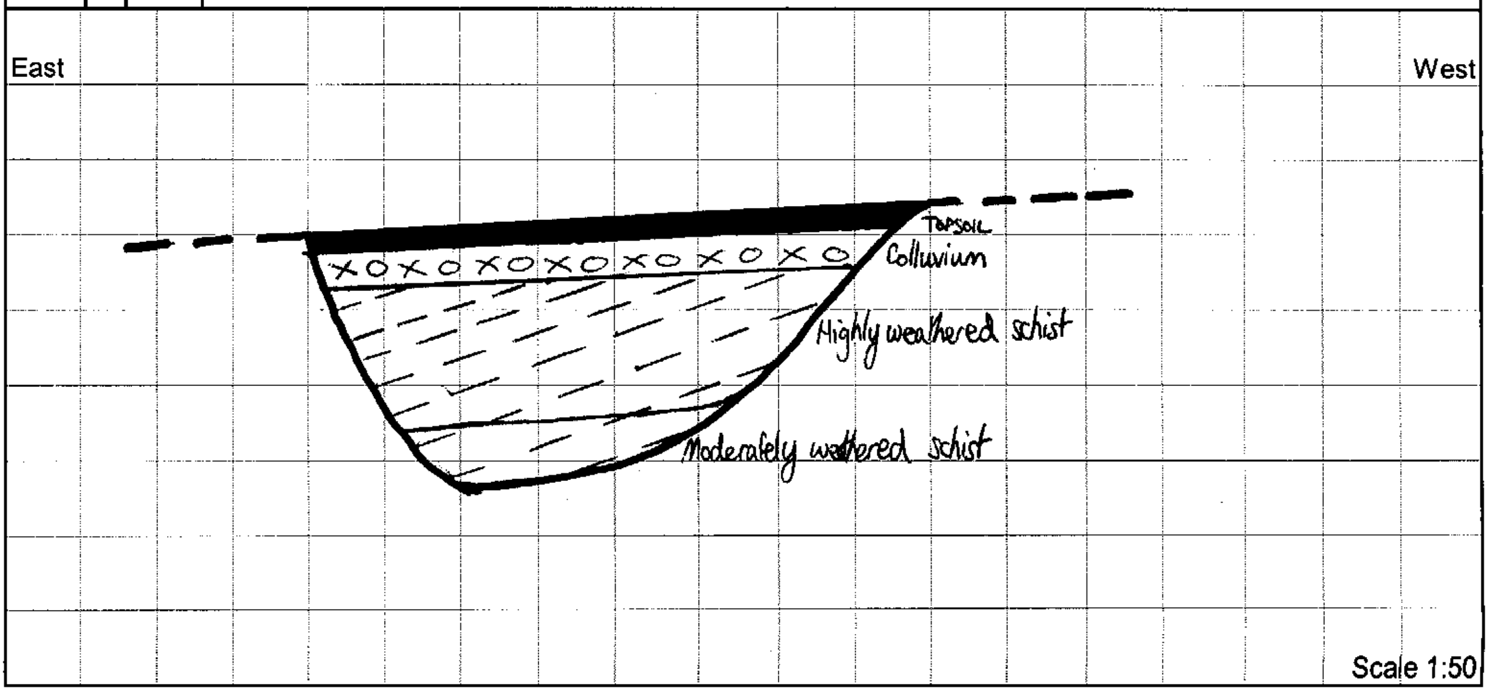
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Approximate thickness of Zone A1 Material

Drawing No.	6846–Fig 6
Date:	Nov 2010
Drawn:	DM
Scale:	1:5000 @ A3
Filename:	6846–Fig 5–6.dwg

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP1 SHEET: 1 of 1 Job No: 6846
PROJECT: Top Tipperary TSF	RL (m): 529.677	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12635.730 N 72748.034	OPERATOR: Joyces Contracting	DATE: 2/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 2/11/2010		TOPSOIL (150mm); greyish brown, dry-moist
Colvm			Mixture of orange brown SILT, grey brown TOPSOIL and loose gravel to cobble sized angular clasts of highly weathered SCHIST
Haast Schist (TZIII)		1	Highly weathered, light grey, dark orange brown, foliated, SEMI-PSAMMITIC SCHIST; very weak, joints very steeply inclined, very closely spaced and tight moderately weathered, very weak to weak, foliation moderately inclined, well developed; joints closely spaced and tight Orientation of foliation: 186°/18° E Orientation of Joints: 289°/80° S
		2	E.O.P. @ 1.7m (Too hard to excavate)
			NOTES: Sample list; Grad 1 and Bulk 1 0.5-1.3m

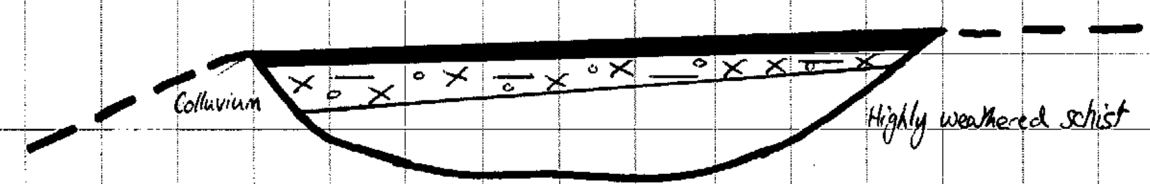


ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP2 SHEET: 1 of 1 Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 527.748	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12641.393 N 72775.557	OPERATOR: Joyces Contracting	DATE: 2/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 2/11/2010		TOPSOIL; greyish brown
Colvm			Sl. gravelly (f-c), SILT, tr. clay; orange brown, moist
Haast Schist (TZIII)			Highly weathered, light grey, dark orange brown, foliated SEMI-PSAMMITIC SCHIST; very weak, moderately inclined foliation; joints very steeply inclined, very closely spaced and tight
		1	E.O.P. @ 0.9m
			NOTES: Sample list; Grad 1 0.2-0.4m
		2	

North South



Scale 1:50

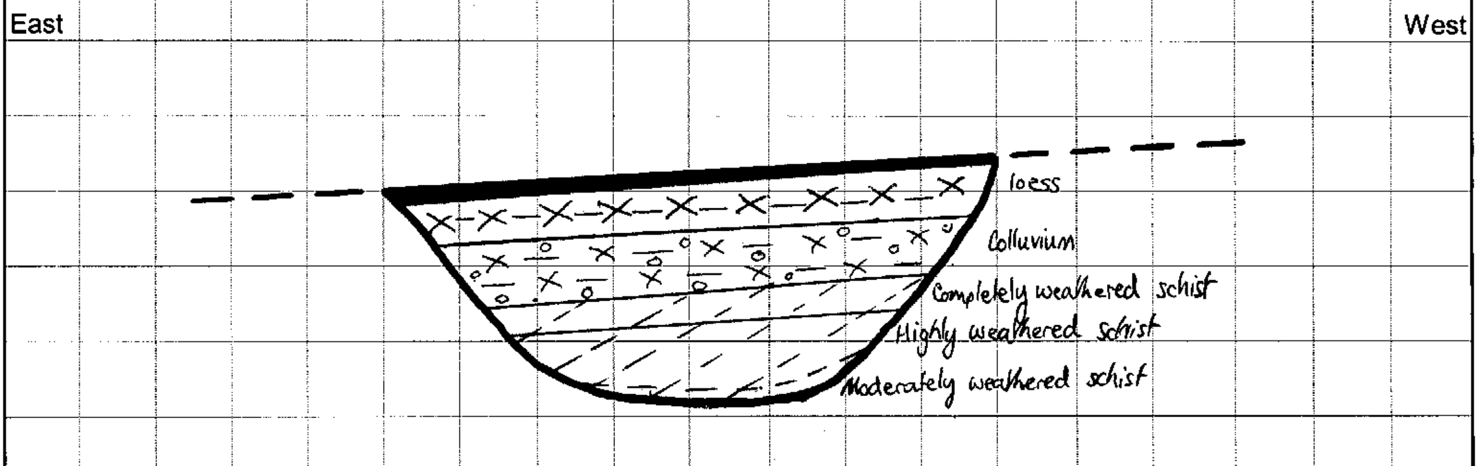
ENGINEERING GEOLOGY LTD

Testpit Log

Testpit No. TP3
SHEET: 1 of 1
Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 542.398	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12866.906 N 72748.422	OPERATOR: Joyces Contracting	DATE: 2/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 2/11/2010		TOPSOIL (100-200mm); greyish brown, dry, friable
Loess			Sl. clayey, SILT; orange brown, orange, moist, v. stiff
Colvm		1	Sl. clayey, sl. gravelly (f-m), SILT; orange brown, grey mottles, moist, v. stiff; gravel consists of highly weathered very weak angular schist clasts up to 10mm
Haast Schist (TZIII)		2	Completely weathered, orange brown, orange, light grey, SEMI-PSAMMITIC SCHIST; extremely weak, weathered to a clayey silt highly weathered, foliated, very weak, dark orange brown staining along foliation, highly to moderately weathered, weak, foliation well developed, orientation of foliation: 122°/38° NE
		3	E.O.P. @ 2.9m (Very hard to excavate)
		4	
		5	NOTES: Sample list; Mst 1, Grad 1, Bulk 1 0.2-0.8m Mst 2, Grad 2, Bulk 2 0.8-1.8m Grad 3, Bulk 3 2.1-2.9m Shear vane readings; at 0.5m 122 kPa, at 1.0m 144 kPa
		6	



Scale 1:100

ENGINEERING GEOLOGY LTD

Testpit Log

Testpit No. TP4
SHEET: 1 of 1
Job No: 6846

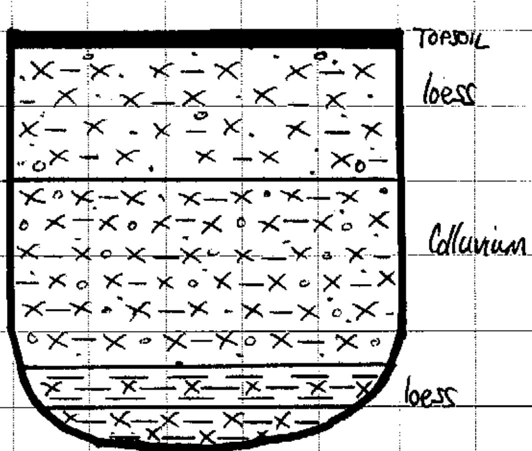
PROJECT: Top Tipperary TSF	RL (m): 538.533	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12779.621 N 72499.890	OPERATOR: Joyces Contracting	DATE: 2/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 2/11/2010	0–0.2	TOPSOIL; greyish brown, moist
Loess		0.2–2.0	Sl. sandy (f), SILT, minor clay, tr. gravel (f); orange brown, moist, sl. friable, v. stiff
Colluvium		2.0–4.4	Gravelly (f-m), sl. sandy (f), SILT, minor clay; orange brown, moist; gravel consists of thin sheets of highly weathered schist clasts up to 20mm long moist-wet
Loess		4.4–5.0	Silty, CLAY; orange brown, light grey, moist-wet, mod. plastic
Loess		5.0–5.5	Clayey, SILT; orange, light grey, moist

E.O.P. @ 5.5m (Maximum reach of excavator)

NOTES: Sample list; Mst 1 0.5m; Mst 2 1.0m; Grad 1, Bulk 1 0.2-2.0m
Mst 3, Grad 2, Bulk 2 2.0-4.0m; Mst 4, Grad 3, Bulk 3 4.0-4.4m
Mst 5, Grad 4, Bulk 4 4.4-5.0m; Grad 5 5.0-5.5m
Shear vane readings; at 0.5m 117 kPa, at 1.1m 103 kPa

North — South

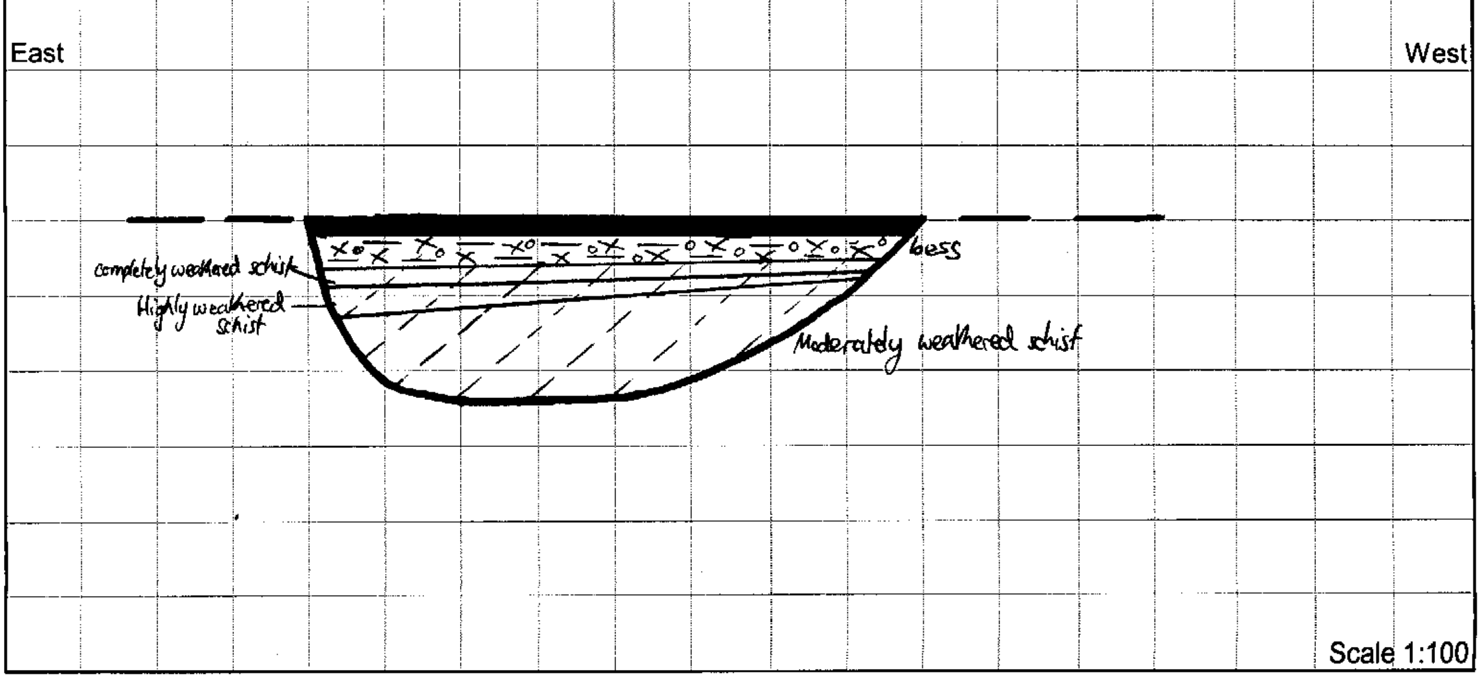


Scale 1:100

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP5
		SHEET: 1 of 1
		Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 530.923	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12703.490 N 72485.094	OPERATOR: Joyces Contracting	DATE: 2/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 2/11/2010		TOPSOIL; dark greyish brown, dry-moist, friable
Loess			Sl. clayey, sl. gravelly (f), SILT, minor topsoil; orange brown, greyish brown, moist no topsoil, v. stiff
Haast Schist (TZIII)			Completely weathered, orange brown, light grey, SCHIST; extremely weak, schist has weathered to a clayey silt; depth of weathering varies across the pit from 0.8 to 1.4m depth (west to east)
		1	Highly weathered, light grey, dark orange brown, foliated SEMI-PSAMMITIC SCHIST; very weak, depth of weathering varies across the pit from 1.1 to 2.0m depth from west to east, iron staining on joints and along foliation planes moderately weathered, weak, foliation is well developed and moderately inclined; joints very steeply inclined, closely spaced and tight; top of mod. weathered rock varies from 1.2 to 2m depth along the pit from west to east Orientation of foliation:157°/40° ENE
		2	
			E.O.P. @ 2.3m (Very hard to excavate)
		3	NOTES: Sample list; Mst 1, Grad 1, 0.3-0.6m Grad 2, Bulk 1 0.6-2.0m Shear vane readings; at 0.4m 176 kPa



Scale 1:100

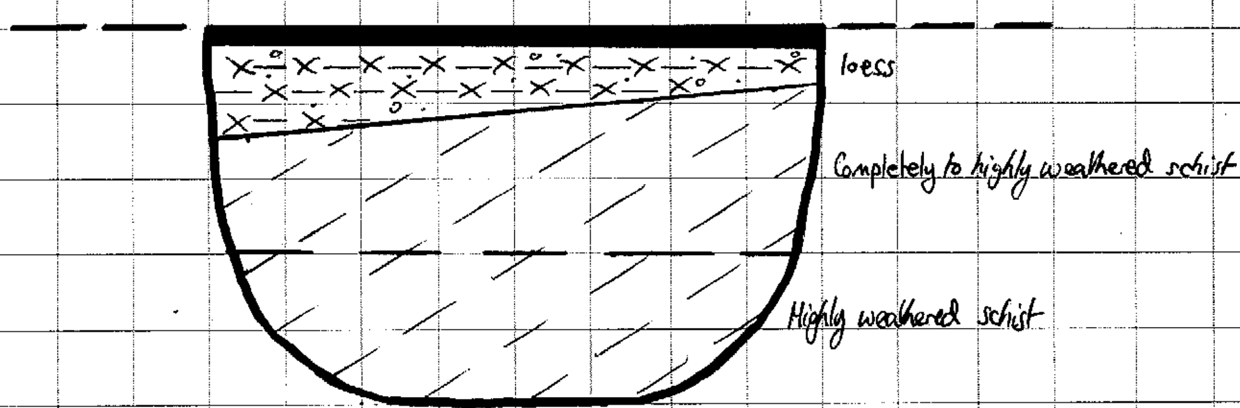
ENGINEERING GEOLOGY LTD

Testpit Log	Testpit No. TP6
	SHEET: 1 of 1
	Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 527.314	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12614.183 N 72397.988	OPERATOR: Joyces Contracting	DATE: 2/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
			TOPSOIL; greyish brown, dry-moist, sl. friable
Loess		1	Sl. clayey, SILT, tr. sand (f), tr. gravel (f); orange brown, light grey, moist, v. stiff; depth of loess varies from 0.8 to 1.5m along the pit from west to east
Haast Schist (TZIII)	Dry 2/11/2010	2, 3, 4	Completely to highly weathered, orange brown, SEMI-PSAMMITIC SCHIST; extremely to very weak, highly weathered, very weak foliation is well developed and moderately inclined to the east; joints very steeply inclined and closely spaced
		5	E.O.P. @ 5.0m (Hard to excavate because close to maximum reach of excavator)
		6	NOTES: Sample list; Mst 1, Grad 1, Bulk 1, 0.3-1.4m Grad 2, Bulk 2, 1.5-4.0m Shear vane readings; at 0.5m 169 kPa, at 1.0m 139 kPa

East | West



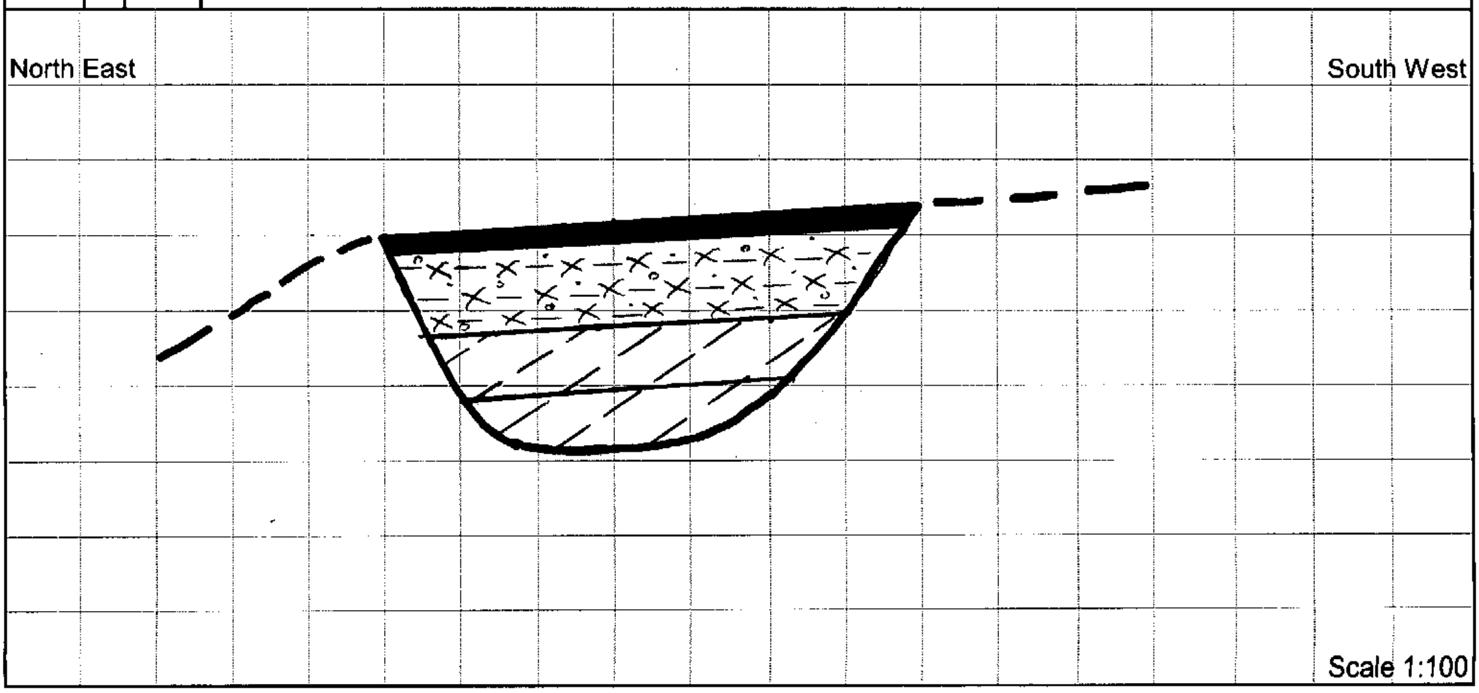
Scale 1:100

ENGINEERING GEOLOGY LTD

Testpit Log	Testpit No. TP7	
	SHEET: 1 of 1	
	Job No: 6846	

PROJECT: Top Tipperary TSF	RL (m): 528.614	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12582.855 N 72257.126	OPERATOR: Joyces Contracting	DATE: 2/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 2/11/2010		TOPSOIL (250mm); greyish brown, dry-moist, sl. friable
Loess		1	Sl. clayey, SILT, tr. sand (c), tr. gravel (f); orange brown, moist, mod. friable, v. stiff
Haast Schist (TZIII)		2	Completely to highly weathered, orange brown, light grey, SEMI-PSAMMITIC SCHIST; extremely weak to very weak, significant proportion of schist weathered to a clayey silt highly weathered, light grey, orange brown staining of joints and foliation, very weak, foliation is well developed and steeply inclined; joints subvertical, closely spaced and tight Orientation of foliation: 172°/38° E Orientation of Joints: 273°/82° S, 078°/85° N
		3	E.O.P. @ 3.0m (Hard excavating)
		4	NOTES: Sample list; Mst 1, 0.5m; Mst 2, 1.1m; Grad 1, Bulk 1, 0.3-1.4m Grad 2, Bulk 2, 1.5-2.5m Shear vane readings; at 0.5m 147 kPa, at 1.0m 103 kPa
		5	
		6	

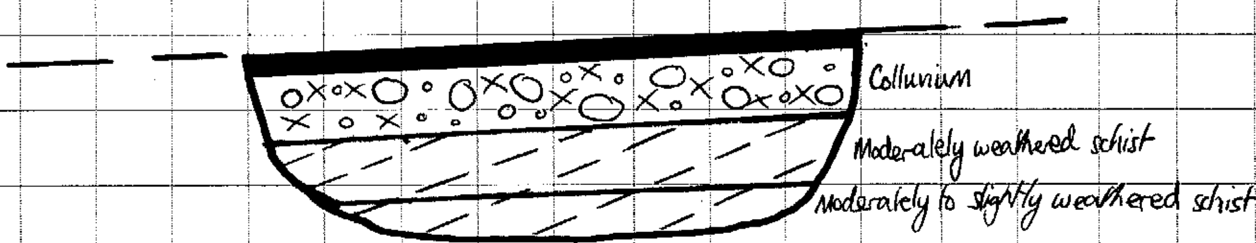


ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP8 SHEET: 1 of 1 Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 527.548	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12311.174 N 72237.300	OPERATOR: Joyces Contracting	DATE: 2/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 2/11/2010		TOPSOIL; dark grey brown, dry, friable
Colluvium			Highly weathered angular clasts of SCHIST mixed with LOESS and TOPSOIL, clast supported
Haast Schist (TZIII)		1	Moderately weathered, light grey, orange brown staining, foliated, SEMI-PSAMMITIC SCHIST; very weak mod. to sl. weathered, weak, foliation well developed and moderately inclined; joints, very steeply inclined, v. closely to closely spaced and tight Orientation of foliation: 158°/20° ENE; Orientation of Joints: 232°/80° SE, 324°/66° SW
			E.O.P. @ 1.3m (Too hard to excavate)
		2	NOTES: Sample list; Grad 1, Bulk 1, 0.6-1.0m
		3	

North South

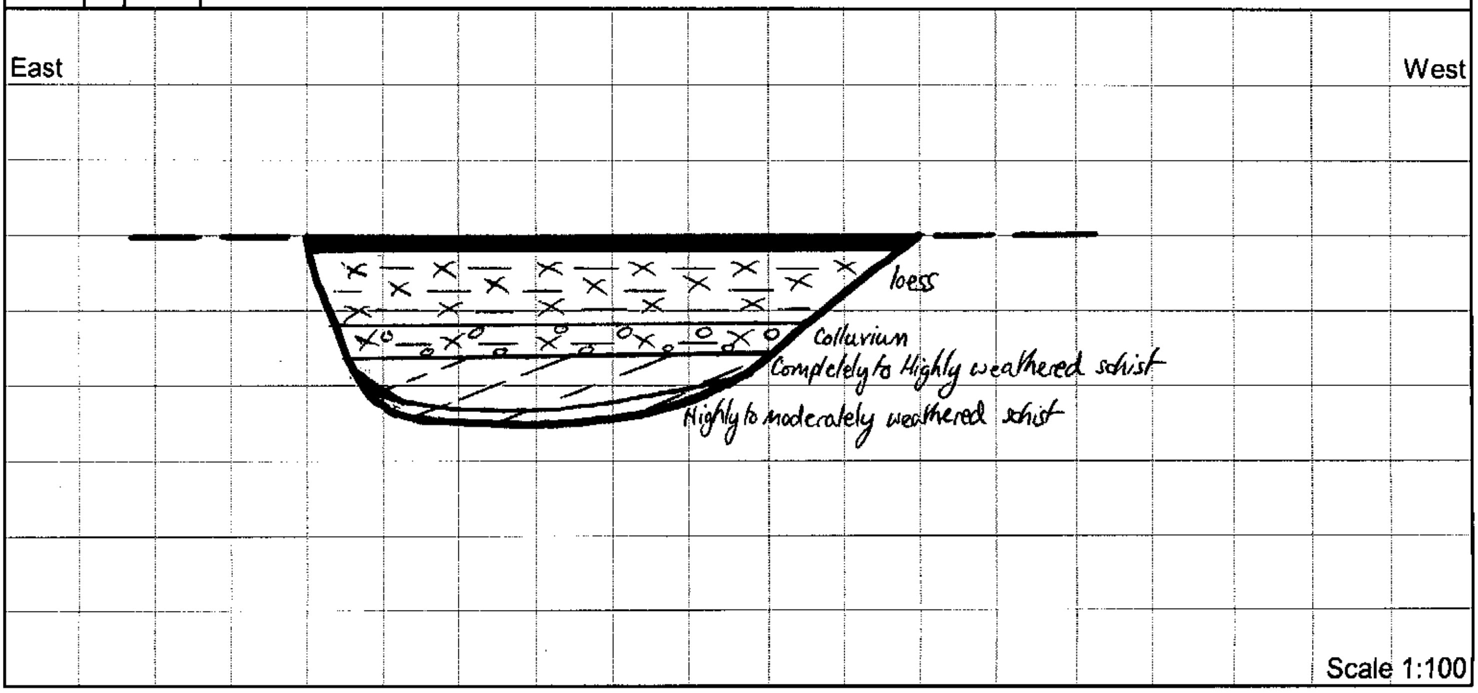


Scale 1:50

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP9
		SHEET: 1 of 1
		Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 522.814	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12511.050 N 72491.416	OPERATOR: Joyces Contracting	DATE: 3/11/2010

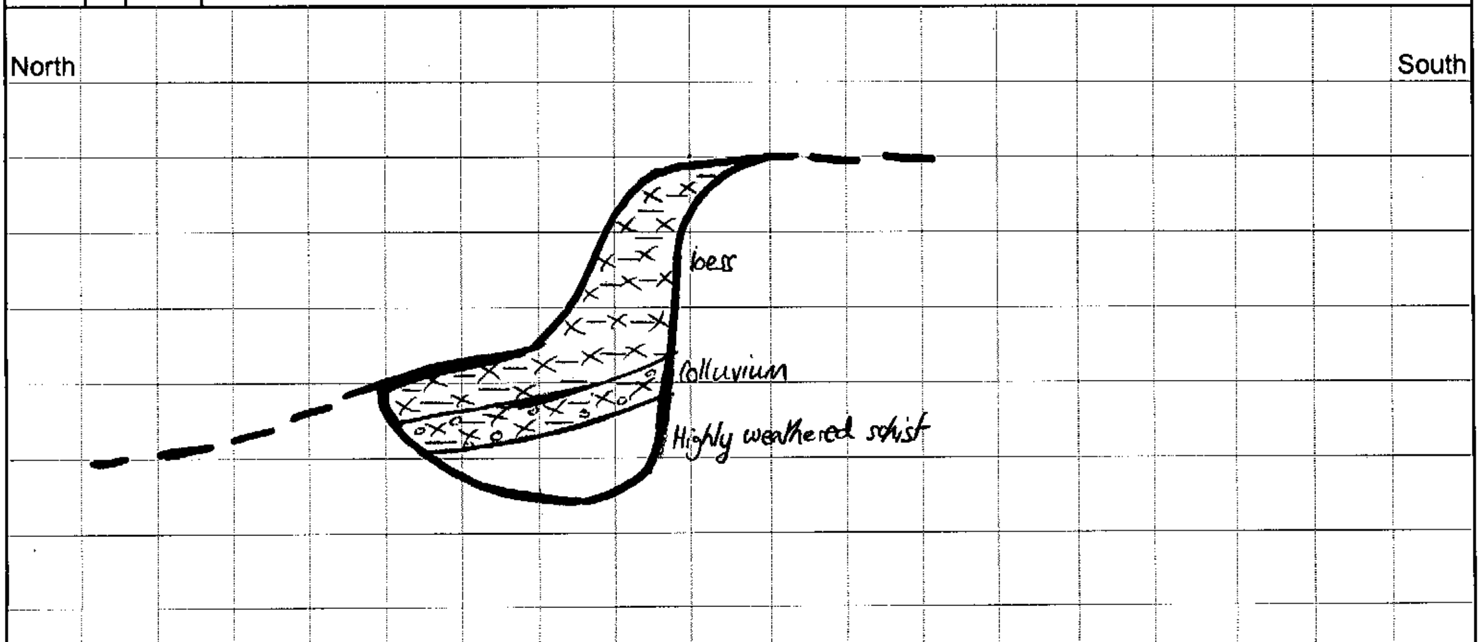
GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 3/11/2010		TOPSOIL; greyish brown, dry-moist, sl. friable mixed wih loess
Loess		1	Sl. clayey, SILT; orange brown, moist, sl. friable, v. stiff
Colvm			Gravelly (f-m), sl. clayey, SILT; orange brown, v. stiff; gravel consists of angular completely to highly weathered schist clasts
Haast Schist (TZIII)		2	Completely to highly weathered, light grey, orange brown, SEMI-PSAMMITIC SCHIST; extremely to very weak; large proportion of schist weathered to a clayey silt highly to moderately weathered, weak, foliation is well developed and moderately inclined; joints stepply inclined, closely spaced and tight Orientation of foliation: 150°/23° ENE; Orientation of Joints: 085°/70° N, 307°/77° SW
			E.O.P. @ 2.4m (Too hard to excavate)
		3	NOTES: Sample list; Mst 1, Grad 1, Bulk 1, 0.3-1.2m Grad 2, Bulk 2, 1.6-2.2m Shear vane readings; at 0.5m 160 kPa, at 1.0m 136 kPa



ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP10
		SHEET: 1 of 1
		Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 521.982	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12507.793 N 72498.604	OPERATOR: Joyces Contracting	DATE: 3/11/2010

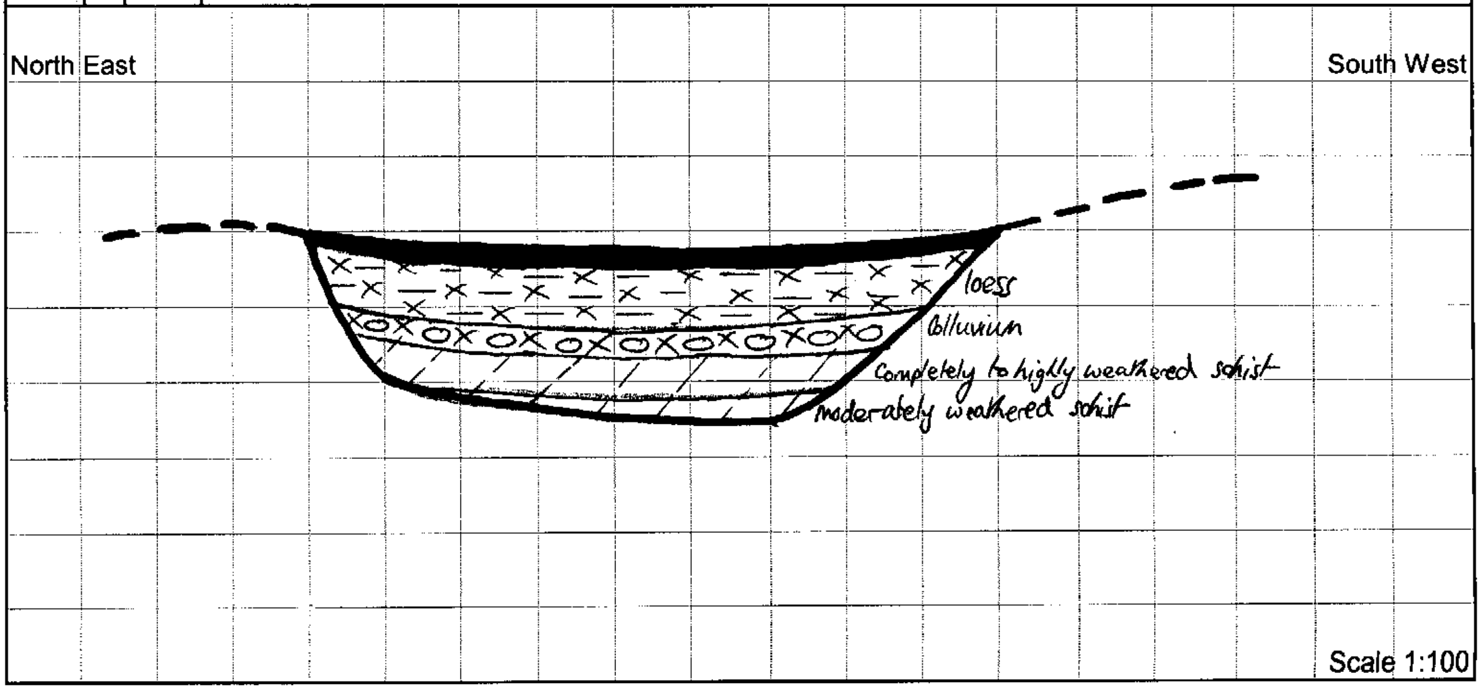
GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 3/11/2010		TOPSOIL; greyish brown, dry
Loess		1, 2	Sl. clayey, SILT; orange brown, dry-moist, sl. friable
Clvm		3	Gravelly (f), sl. clayey, SILT; light grey, orange brown; gravel consists of completely weathered to highly weathered schist clasts
Haast Schist (TZIII)		4	Highly weathered, orange brown, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak; joints very steeply inclined, closely spaced and tight
		5, 6	E.O.P. @ 1.5-4.5m (Hard to excavate due to the excavator's position above the outcrop)



Scale 1:100

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP11 SHEET: 1 of 1 Job No: 6846
PROJECT: Top Tipperary TSF	RL (m): 538.792	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12729.065 N 72346.942	OPERATOR: Joyces Contracting	DATE: 3/11/2010

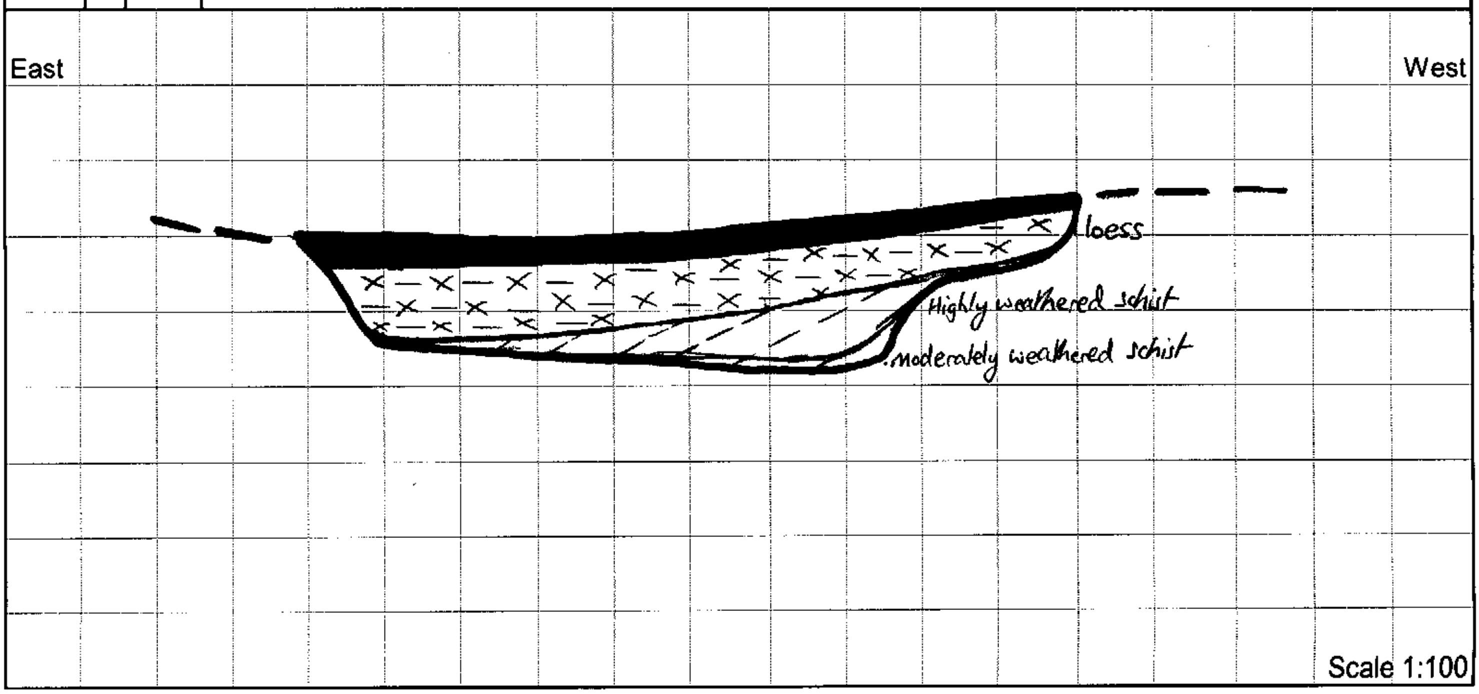
GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 3/11/2010		TOPSOIL; greyish brown, dry, friable
Loess			Sl. clayey, SILT; orange brown, moist, friable, v. stiff
Colluvium		1	Mixture of sl. clayey SILT (LOESS) and highly weathered angular pebble to cobble sized SCHIST clasts
Haast Schist (TZIII)		2	Completely to highly weathered, dark orange brown, light grey, SEMI-PSAMMITIC SCHIST; extremely to very weak, large proportion of schist weathered to a clayey silt moderately weathered, very weak, foliation well developed and steeply inclined; joints very steeply inclined, closely spaced and tight Orientation of foliation: 186°/48° E; Orientation of Joints: 268°/84° S, 350°/68° W
			E.O.P. @ 1.8-2.3m (Very hard to excavate)
		3	NOTES: Sample list; Mst 1, Grad 1, Bulk 1, 0.3-0.9m Mst 2, Grad 2, Bulk 2, 1.0-1.4m Shear vane reading; at 0.5m 185kPa



ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP12
		SHEET: 1 of 1
		Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 507.520	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12169.715 N 72616.813	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 3/11/2010		TOPSOIL (200-400mm west to east);
Loess		1	Sl. clayey, SILT, tr. sand (f), occasional very fine plant fibres; orange brown, light grey, moist, stiff, depth of loess varies across the pit from 1.3 to 1.8m depth (east to west) v. stiff
Haast Schist (TZIII)		2	Highly weathered, orange brown, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak, foliation well developed and moderately inclined; orientation of foliation: 140°/28° NE moderately weathered, iron staining along joints and foliation
			E.O.P. @ 1.3-2.0m (east to west) (Too hard to excavate)
		3	NOTES: Sample list; Mst 1, Grad 1, Bulk 1, 0.5-1.4m Shear vane readings; at 0.5m 94 kPa, at 1.0m 122 kPa



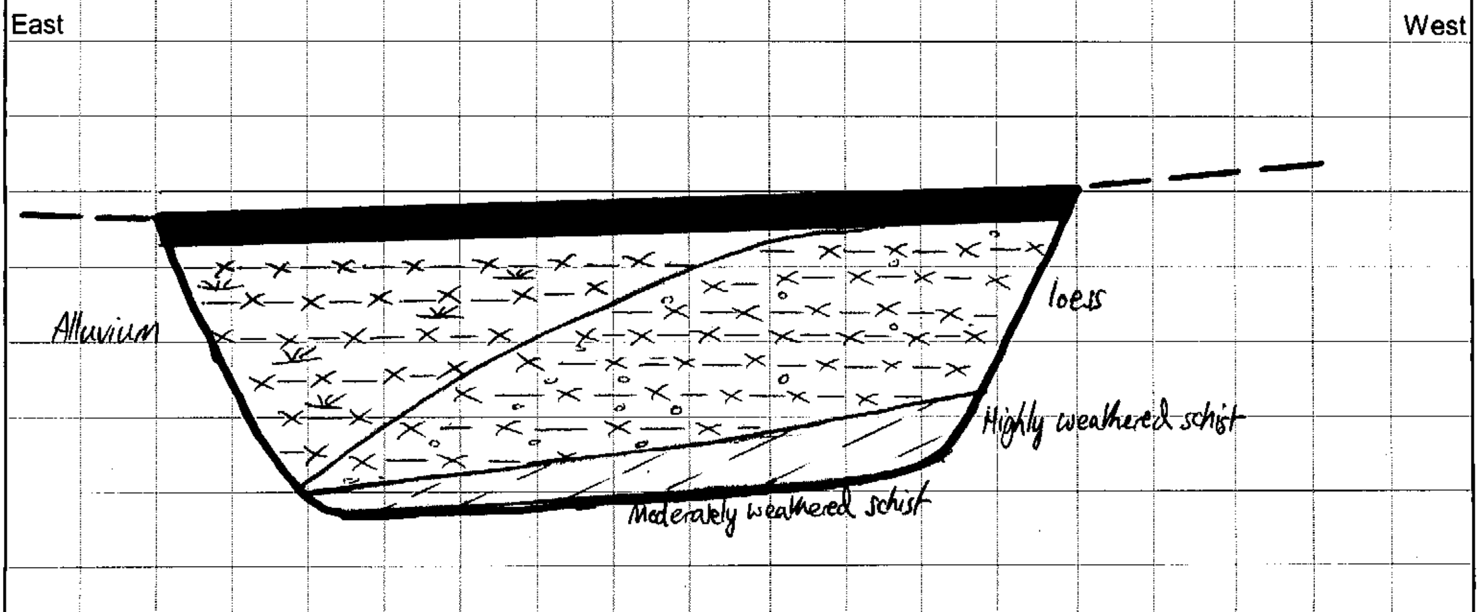
ENGINEERING GEOLOGY LTD

Testpit Log

Testpit No. TP13
SHEET: 1 of 1
Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 522.297	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12364.642 N 72226.686	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
Alluvium (east end) Loess (west end)	Dry 3/11/2010		TOPSOIL; greyish brown, dry-moist, sl. friable
			Sl. clayey, sl. organic, SILT, occasional plant fragments; orange, orange brown, dark grey brown zones moist, stiff (ALLUVIUM on east side of pit down to 1.8m depth)
		1	Sl. clayey, sl. gravelly (f), SILT; orange brown, moist, friable, stiff (LOESS on west side of pit down to 1.5m depth)
Haast Schist (TZIII)			Highly weathered, orange brown, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak
		2	moderately weathered, weak
			E.O.P. @ 1.8-2.0m west to east (Very hard to excavate)
		3	NOTES: Sample list; Mst 1, Grad 1, Bulk 1, 0.3-1.4m (on westside of pit) Grad 2, Bulk 2, 1.5-1.8m (on westside of pit) Shear vane reading; at 0.5m 92 kPa, at 1.1m 95 kPa



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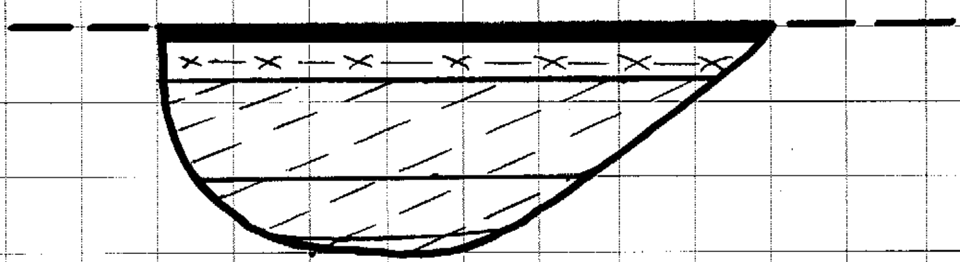
ENGINEERING GEOLOGY LTD

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP14 SHEET: 1 of 1 Job No:6846

PROJECT: Top Tipperary TSF	RL (m): 529.239	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12417.281 N 72095.792	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 3/11/2010		TOPSOIL; greyish brown, dry, friable
Loess			Sl. clayey, SILT; orange brown, dry-moist, mod. friable
Haast Schist (TZIII)			Completely to highly weathered, dark orange brown, light grey, SEMI-PSAMMITIC SCHIST; extremely to very weak, large proportion of schist weathered to a clayey silt
		1	highly weathered, very weak, foliation is well developed and moderately inclined; joints steeply inclined, very closely to closely spaced and tight, iron staining along joints Orientation of foliation: 145°/18° ENE
			moderately weathered, weak
			E.O.P. @ 1.5m (Very hard to excavate)
		2	NOTES: Sample list; Grad 1, Bulk 1, 0.4-1.4m
		3	

North | South



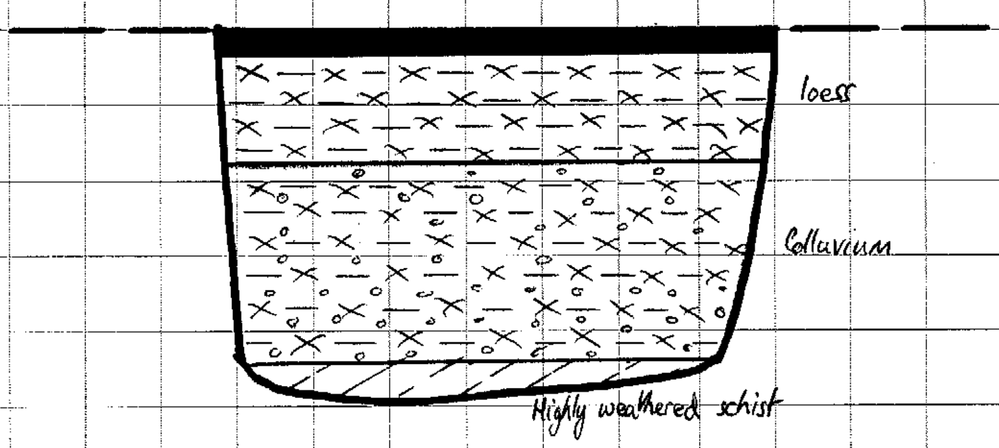
Scale 1:50

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP15 SHEET: 1 of 1 Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 534.360	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12605.852 N 71883.206	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
			TOPSOIL (300mm); dark greyish brown, moist, sl. friable
Loess		1	Sl. clayey, SILT; orange brown, orange, light grey, moist tr. gravel (f)
Colluvium		2 3 4	Sl. clayey, sl. gravelly (f-m), SILT; orange brown, orange, light grey, moist, gravel consists of highly weathered angular clasts of schist up to 10mm sl. sandy (f-c), tr. clay gravelly (f-c), schist clasts up to 30mm
Haast Schist (TZIII)	Dry 3/11/2010	5	Highly weathered, orange brown, light grey, SEMI-PSAMMITIC SCHIST; very weak
			E.O.P. @ 4.9m (Very hard to excavate because close to maximum reach of excavator)
		6	NOTES: Sample list; Mst 1, Grad 1, Bulk 1 0.4-1.7m Mst 2, Grad 2, Bulk 2 1.8-2.5m; Mst 3, Grad 3, Bulk 3 2.6-3.4m Mst 4, Grad 4, Bulk 4 3.5-4.3m; Grad 5, Bulk 5 4.4-4.9m

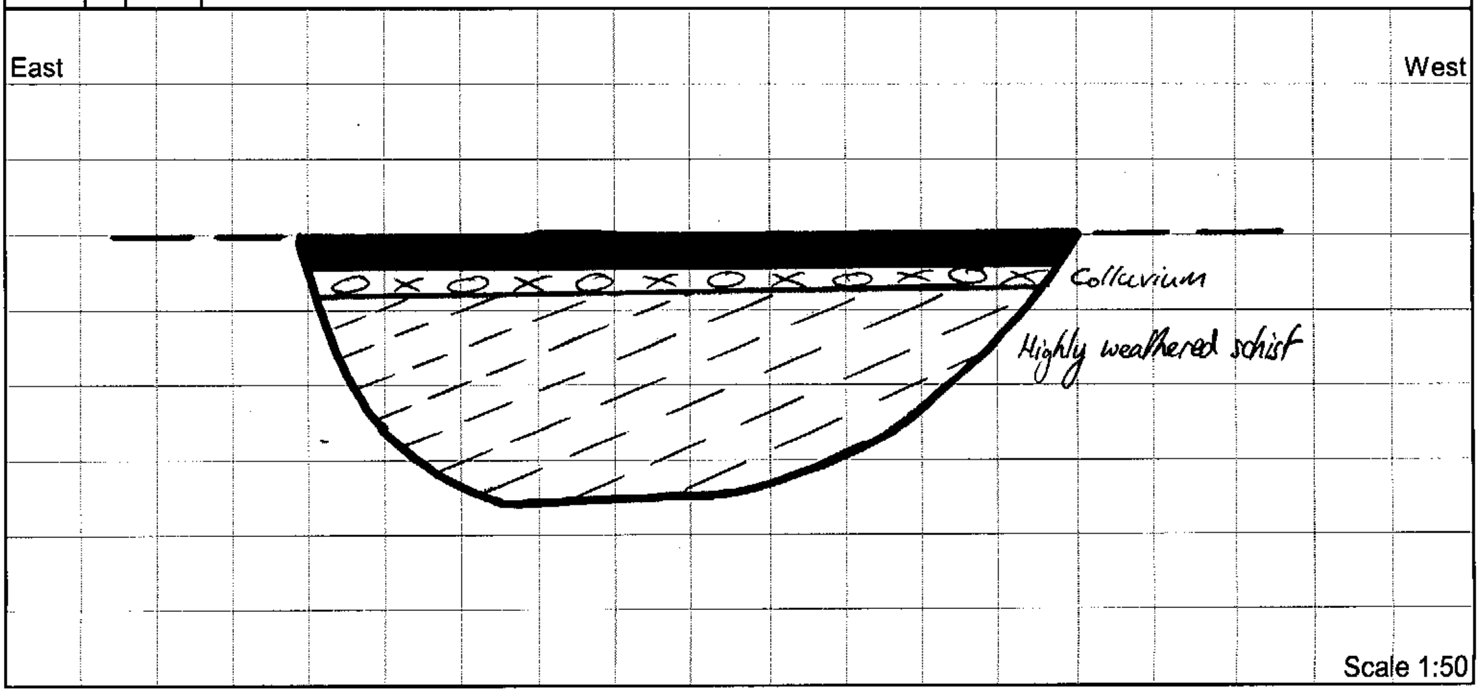
East West



Scale 1:100

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP16 SHEET: 1 of 1 Job No: 6846
PROJECT: Top Tipperary TSF	RL (m): 549.682	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12666.500 N 71699.565	OPERATOR: Joyces Contracting	DATE: 3/11/2010

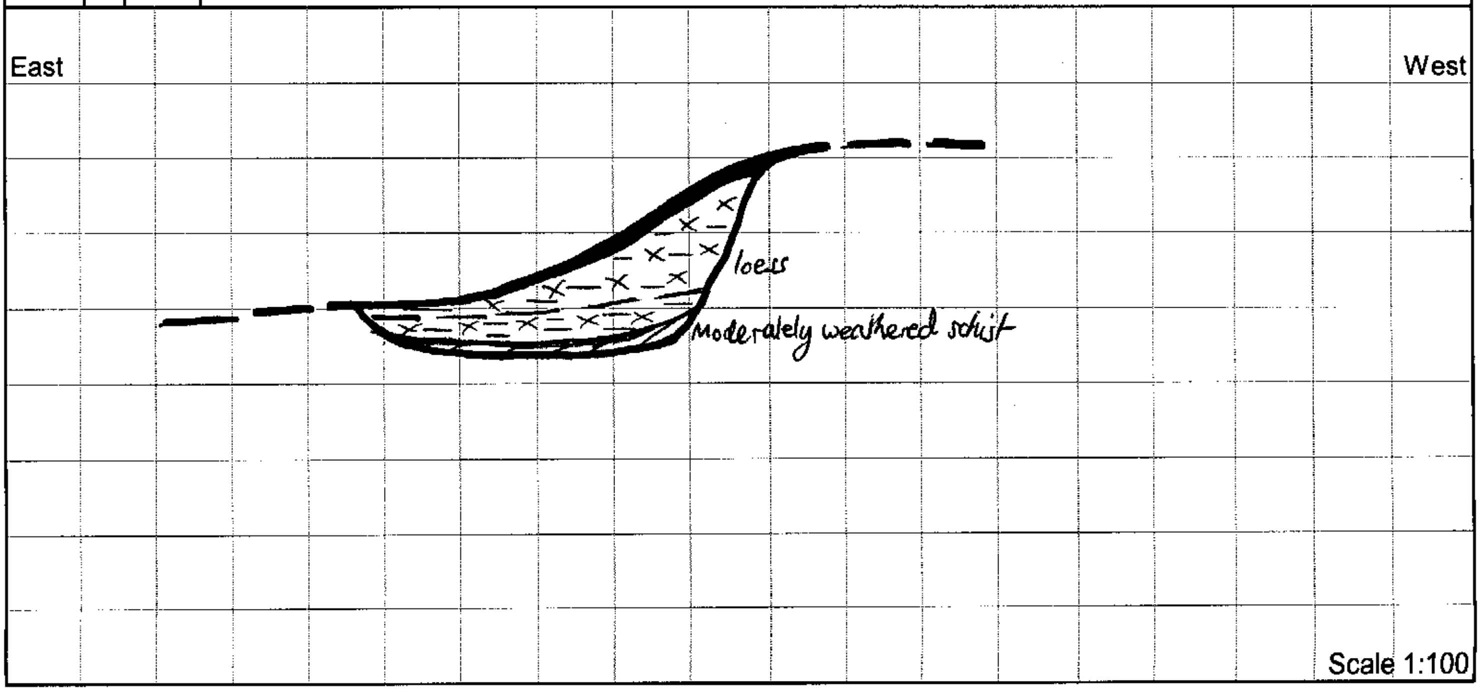
GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 3/11/2010		TOPSOIL; dark greyish brown, dry
Colv			Mixture of Sl. clayey SILT (LOESS) and highly weathered schist clasts
Haast Schist (TZIII)		1	Highly weathered, orange brown, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak, foliation is well developed and moderately inclined; joints very steeply inclined, very closely to closely spaced and tight Orientation of foliation: 130°/22° NE
		2	E.O.P. @ 1.8m (Very hard to excavate)
		3	NOTES: Sample list; Grad 1, Bulk 1, 0.5-1.8m



ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP17 SHEET: 1 of 1 Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 503.081	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12050.802 N 72630.135	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
			TOPSOIL; greyish brown, dry-moist
Loess		1	Sl. clayey, SILT; orange brown, moist, sl. friable clayey, non friable
Haast Schist (TZIII)	Dry 3/11/2010	2	Moderately weathered, grey, orange brown, foliated, SEMI-PSAMMITIC SCHIST; very weak, foliation is well developed and moderately inclined; orientation of foliation: 172°/25° E
			E.O.P. @ 2.4m (Very hard to excavate)
		3	NOTES: Sample list; Mst 1, Grad 1, Bulk 1 0.3-1.3m Mst 2, Grad 2, Bulk 2 1.4-2.3m;



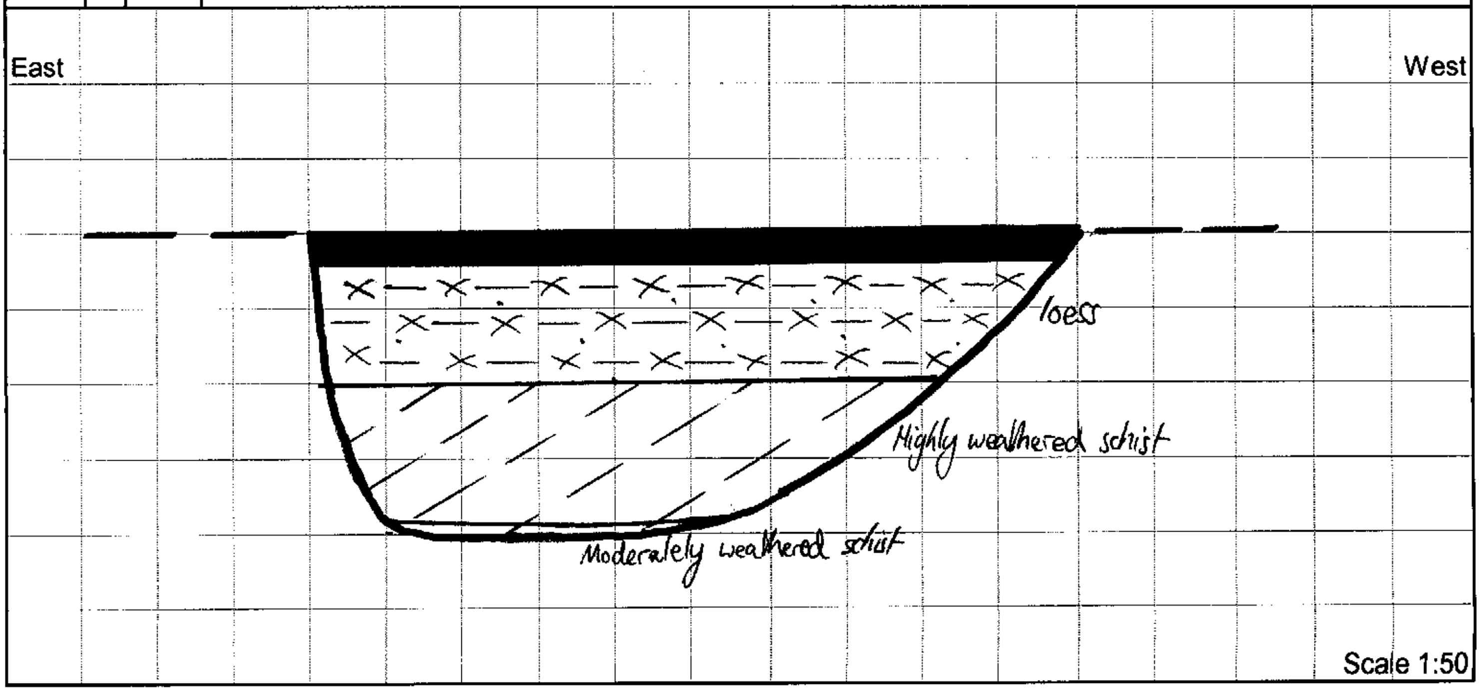
ENGINEERING GEOLOGY LTD

Testpit Log

Testpit No. TP18	
SHEET: 1 of 1	
Job No: 6846	

PROJECT: Top Tipperary TSF	RL (m): 510.743	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12055.323 N 72594.525	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 3/11/2010		TOPSOIL; dark greyish brown, dry, friable
Loess			Sl. clayey, SILT, tr. sand (f); orange brown, moist, sl. friable
Haast Schist (TZIII)		1	Highly weathered, orange brown, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak, foliation is well developeded; joints, very steeply inclined, very closely spaced and tight moderately weathered, weak
		2	E.O.P. @ 2.0m (Very hard to excavate)
		3	NOTES: Sample list; Grad 1, Bulk 1 1.0-1.9m

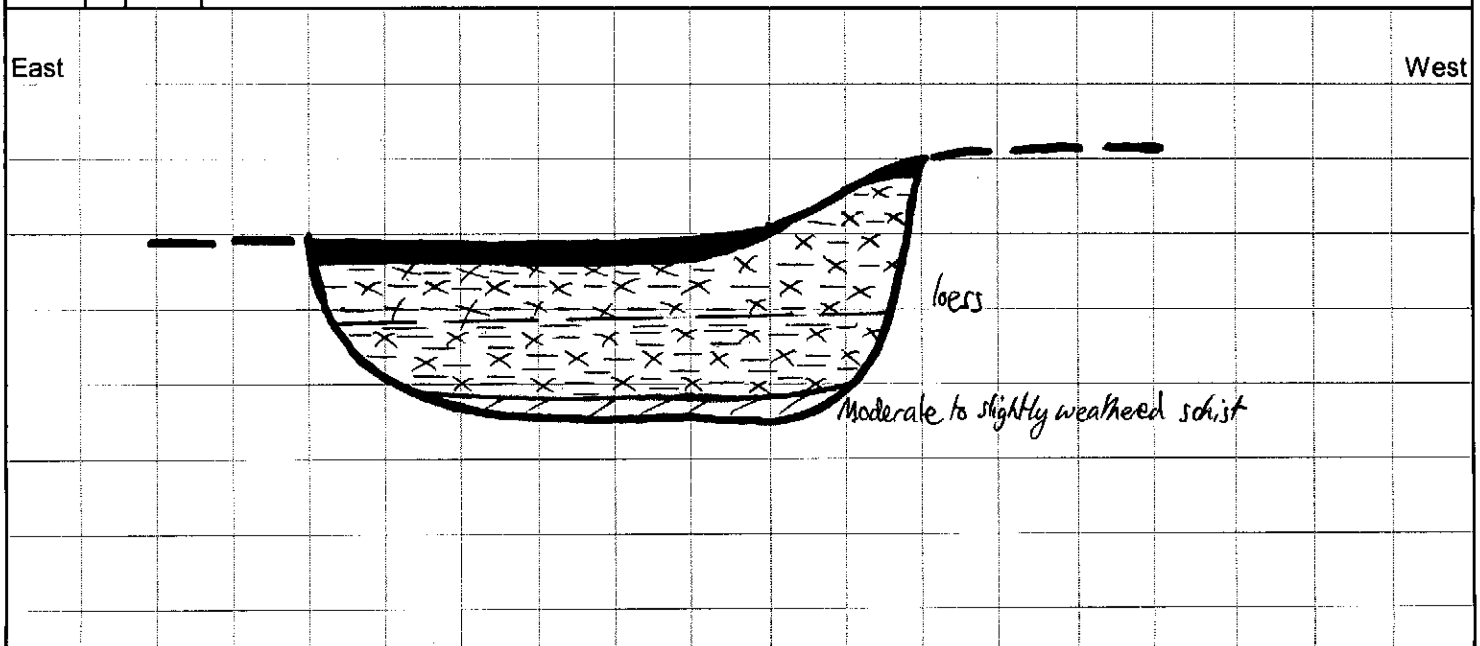


ENGINEERING GEOLOGY LTD

Testpit Log	Testpit No. TP19
	SHEET: 1 of 1
	Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 515.269	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 11983.280 N 72477.629	OPERATOR: Joyces Contracting	DATE: 3/11/2010

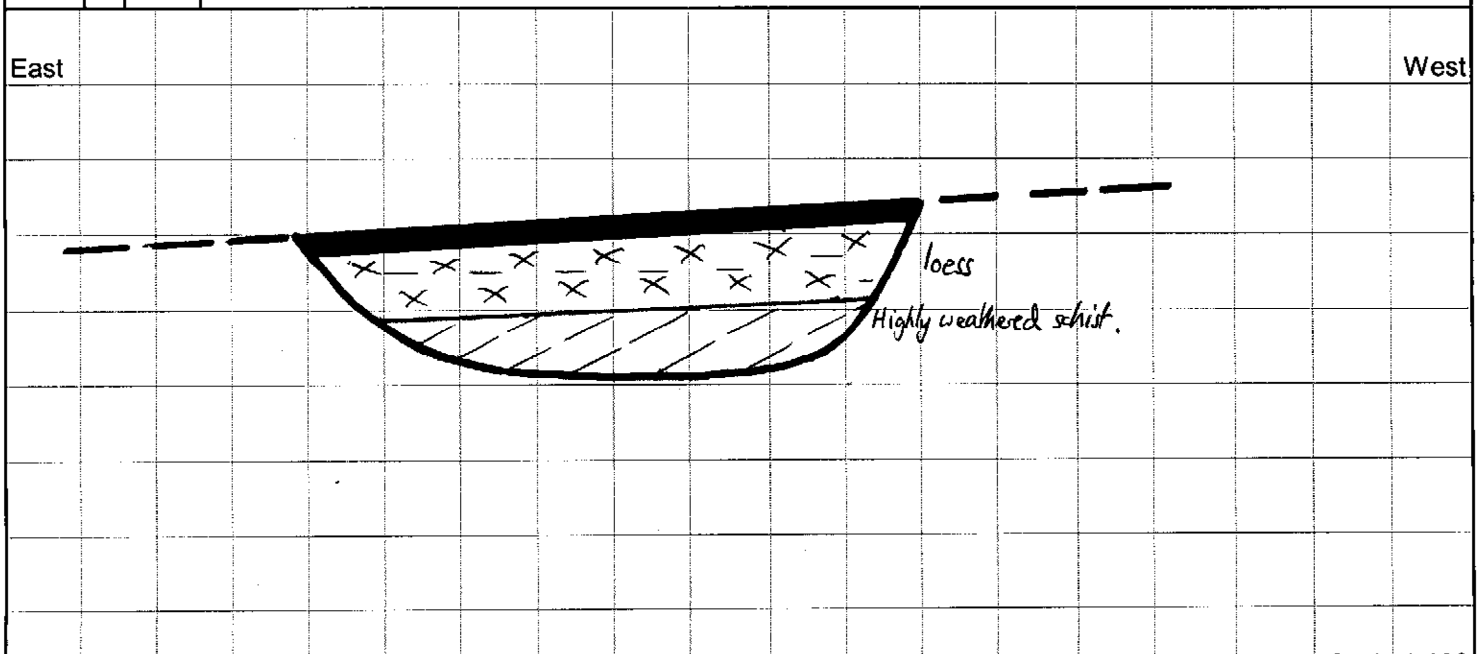
GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 3/11/2010		TOPSOIL; greyish brown, dry-moist
Loess			Sl. clayey, SILT, minor topsoil; orange brown, greyish brown, dry-moist, sl. friable no topsoil
		1	clayey, non friable
		2	
Haast Schist (TZIII)		3	Moderately to slightly weathered, grey, orange brown stained, foliated, SEMI-PSAMMITIC SCHIST; very weak to weak
			E.O.P. @ 3.4m (Too hard to excavate)
		4	NOTES: Sample list; Mst 1, Grad 1 0.4-1.0m Mst 2 1.8m Grad 3 1.0-3.0m Bulk 1 0.4-3.0m
		5	
		6	



Scale 1:100

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP20 SHEET: 1 of 1 Job No: 6846
PROJECT: Top Tipperary TSF	RL (m): 537.000	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 12100.26 N 72107.08	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 4/11/2010		TOPSOIL (250mm); greyish brown, dry-moist, friable
Loess		1	SILT, minor clay; orange brown, moist, friable
Haast Schist (TZIII)		2	Highly weathered, dark orange brown, orange, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak foliation is well developed and moderately inclined; joints very steeply inclined, closely spaced and tight Orientation of foliation: 186°/26° E Orientation of Joints: 270°/79° S
			E.O.P. @ 2.4m (Too hard to excavate)
		3	NOTES: Sample list; Mst 1, Grad 1, Bulk 1 0.3-1.2m Grad 2, Bulk 2 1.3-2.3m



Scale 1:100

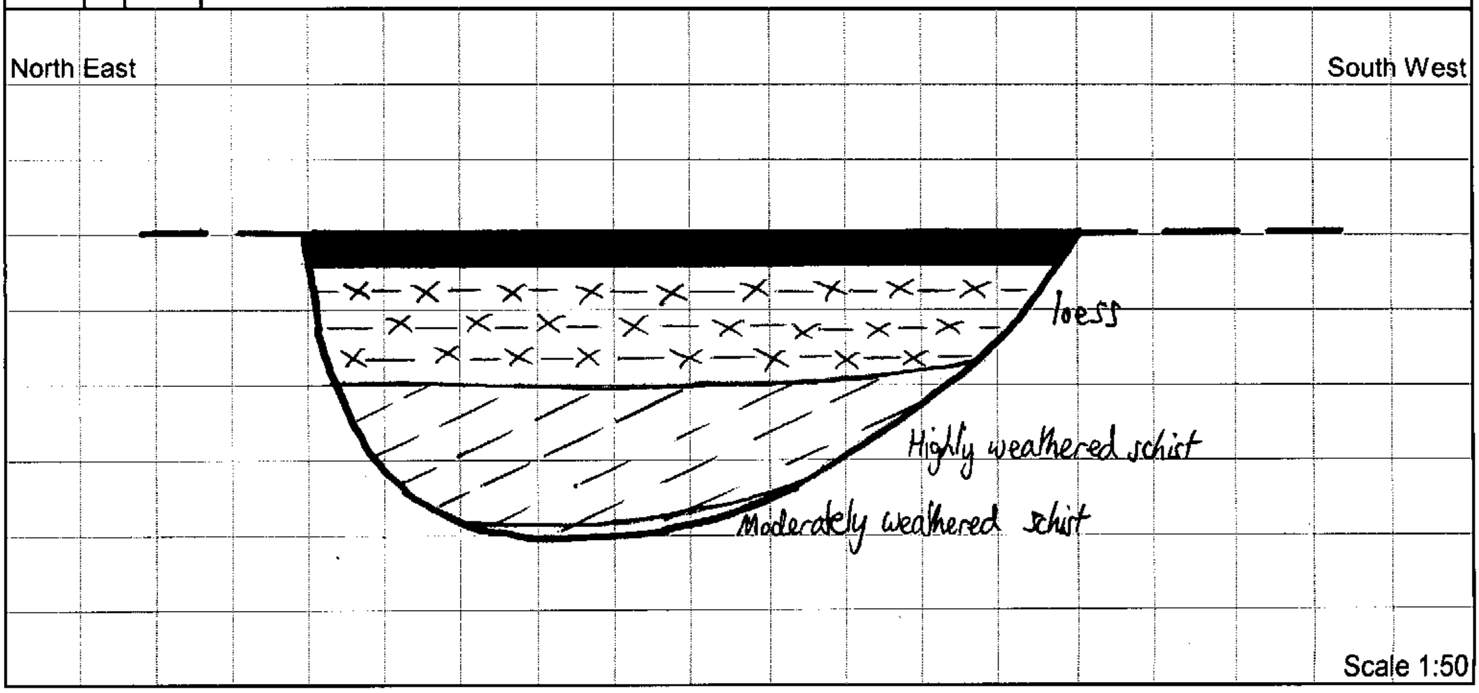
ENGINEERING GEOLOGY LTD

Testpit Log

Testpit No. TP21
SHEET: 1 of 1
Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 538.837	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 11880.845 N 72057.675	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 4/11/2010		TOPSOIL; greyish brown, dry-moist, friable
Loess			Sl. clayey, SILT; orange brown, moist, friable
Haast Schist (TZIII)		1	Highly weathered, orange brown, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak,foliation is well developed and moderately incliined; joints very steeply inclined, closely spaced and tight Orientation of foliation: 159°/26° ENE Orientation of Joints: 270°/70° S, 330°/60° SW
			moderately weathered, iron staining along joints and foliation
		2	E.O.P. @ 2.0m (Too hard to excavate)
			NOTES: Sample list; Mst 1, Grad 1, Bulk 1 0.3-1.0m Grad 2, Bulk 2 1.0-2.0m
		3	



ENGINEERING GEOLOGY LTD

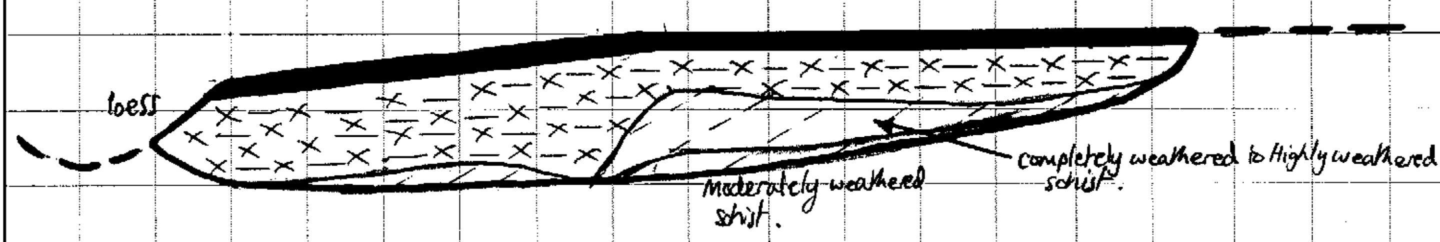
Testpit Log

Testpit No. TP22
SHEET: 1 of 1
Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 533.580	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 11898.336 N 72178.985	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 4/11/2010		TOPSOIL; greyish brown, dry, friable
Loess		1	Sl. clayey, SILT; orange brown, orange, light grey, dry-moist, sl. friable (0.7-1.5m deep)
Haast Schist (TZIII)			Completely to highly weathered, orange brown, light grey, SEMI-PSAMMITIC SCHIST; extremely to very weak, large proportion of schist weathered to a clayey silt (0.7-1.5m depth 7m along pit) moderately weathered, weak (1.4-1.8m depth along the base of the pit), foliation is well developed and moderately inclined; orientation of foliation: 146°/30° ENE
		2	E.O.P. @ 1.4-1.8m (Very hard to excavate)
		3	NOTES: Sample list; Mst 1, Grad 1, Bulk 1 0.3-1.0m (10m along pit) Grad 2 0.7-1.5m (7m along pit) Bulk 2 1.4-1.8m (all along the base of the pit)

North East | South West

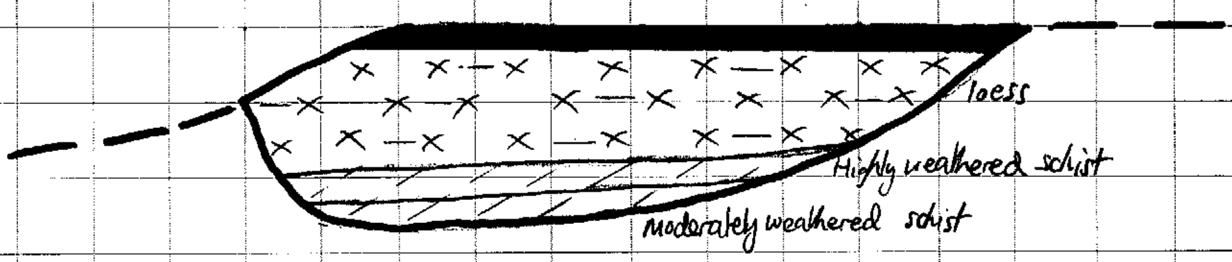


Scale 1:100

ENGINEERING GEOLOGY LTD	Testpit Log	Testpit No. TP23 SHEET: 1 of 1 Job No: 6846
PROJECT: Top Tipperary TSF	RL (m): 545.882	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 11766.199 N 72069.645	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 4/11/2010		TOPSOIL (150mm); greyish brown, dry, friable
Loess			SILT, minor clay; orange brown, orange, light grey, dry-moist, friable sl. gravelly (f-m)
Haast Schist (TZIII)		1	Highly weathered, orange brown, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak moderately weathered, weak, joints steeply inclined, closely spaced to moderately widely spaced Orientation of foliation: 160°/32° ENE; Orientation of Joints: 010°/63° WNW, 288°/54° SSW
			E.O.P. @ 1.2m (Very hard to excavate)
		2	NOTES: Sample list; Mst 1, Grad 1, Bulk 1 0.2-0.8m
		3	

North East | South West



Scale 1:50

ENGINEERING GEOLOGY LTD

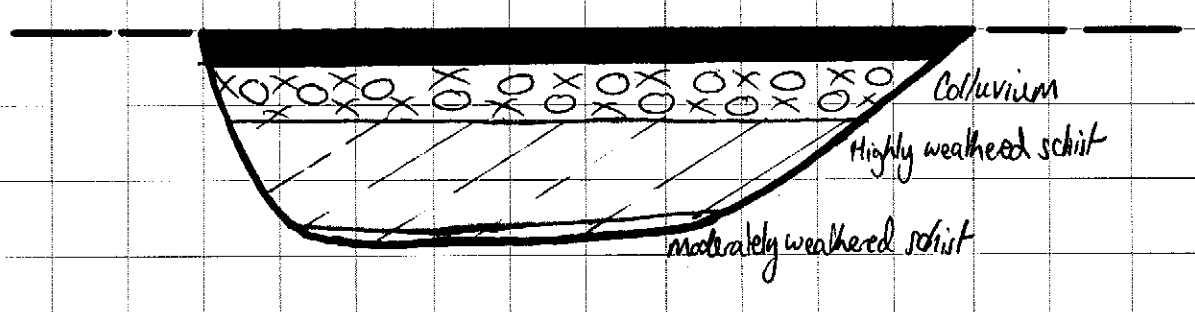
Testpit Log

Testpit No. TP24
SHEET: 1 of 1
Job No: 6846

PROJECT: Top Tipperary TSF	RL (m): 540.543	CHECKED: CPG
LOCATION: Macraes Gold Mine, Macraes Road	EQUIPMENT: 20 Tonne Excavator	LOGGED: D Lorier-May
COORDINATES: E 11794.467 N 72171.259	OPERATOR: Joyces Contracting	DATE: 3/11/2010

GEOLOGICAL UNIT	WATER LEVEL	DEPTH (m)	SOIL/ROCK MATERIAL DESCRIPTION
	Dry 4/11/2010		TOPSOIL; greyish brown, dry, friable
Colvm			Mixture of SILT (LOESS), TOPSOIL and angular highly weathered SCHIST clasts
Haast Schist (TZIII)		1	Highly weathered, orange brown, light grey, foliated, SEMI-PSAMMITIC SCHIST; very weak
			moderately weathered, weak
			E.O.P. @ 1.4m (Very hard to excavate)
		2	NOTES: Sample list; Grad 1, Bulk 1 0.6-1.4m
		3	

North South



Scale 1:50

APPENDIX B

LABORATORY TEST RESULTS

Central Testing Services
18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 10/2163

Date: 12 January 2011

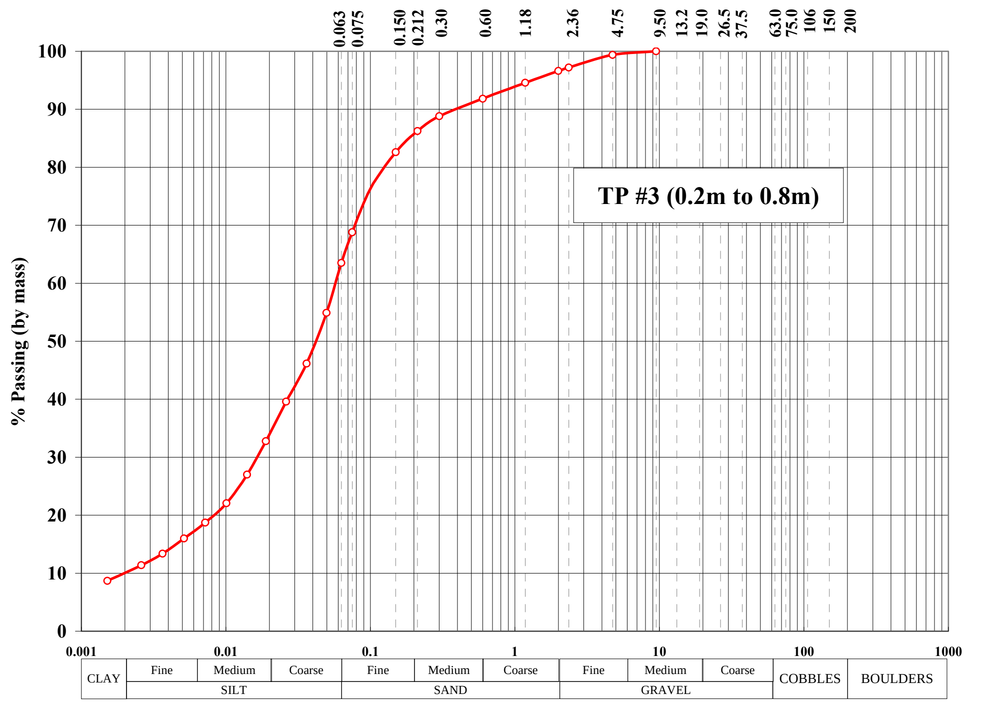
TEST REPORT – TOP TIPPERARY INVESTIGATIONS

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	Sandy SILT with minor clay and trace of gravel	Sample Source:	TP#3 (0.2m to 0.8m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	2-Nov-10	Sample Method:	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	100
4.75	99
2.00	97
1.18	95
0.60	92
0.30	89
0.212	86
0.150	83
0.075	69
0.063	64

Fraction Size	Interpolated % Passing
60 µm	62
20 µm	34
6 µm	17
2 µm	10



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.7. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 µm to 60 µm	24
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 µm to 20 µm	28
Fine Gravel	6.0mm to 2.00 mm	3	Medium Silt	20 µm to 6 µm	17
Coarse Sand	2.00mm to 600 µm	5	Fine Silt	6 µm to 2 µm	7
Medium Sand	600 µm to 200 µm	6	Clay	< 2 µm	10

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: (As Received)	19.3 %
Liquid Limit: (LL)	27
Plastic Limit: (PL)	22
Plasticity Index: (PI)	5
Note: The sample received was in a natural state. The plasticity index test sample was the fraction passing the 425 µm test sieve.	

General Notes:

- *IANZ endorsement of this report applies to the sample as received.*
- *IANZ endorsement of this report does not apply to the sample description.*
- *This report may not be reproduced except in full.*

Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

Transcriptions Checked By:

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

434 new zealand accredited laboratory

Central Testing Services
18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 10/2163

Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Sandy SILT with minor clay and trace of gravel**	**Sample Source:**	**TP#3 (0.2m to 0.8m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**2-Nov-10**	**Sample Method:**	**Test Pit**

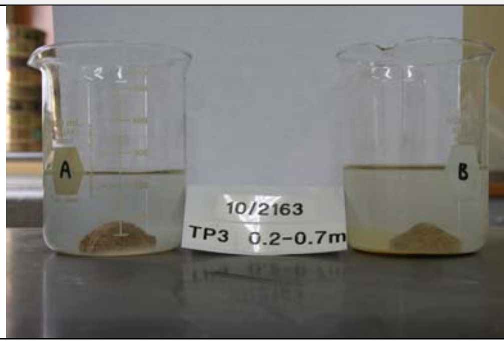
TP#3 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	**TP#3 (0.2m to 0.8m)**	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	**1.39**	**Dark**
50	**-**	-
180	**-**	-
380	**-**	-
1020	**-**	-

Diameter of Hole at Start of Test:	**1.0 mm**
Diameter of Hole at End of Test:	**2.5 mm**
Water Content Prior to Test:	**20.2 %**
Dry Density of Sample Tested:	**1.77 t/m^3**
Pinhole Dispersion Classification:	**D1 - Dispersive (Method A)**

TP#3 - CRUMB TEST: ASTM D6572-06

Elapsed Time	**Estimated Slaking**	**Observations Recorded**
2 min	**< 5 %**	**Very minor colloid cloud**
1 hr	**100 %**	**Visible cloud evident**
6 hr	**100 %**	**Visible cloud evident**
Crumb Test Classification:	**Grade 3 (Dispersive)**	



Note:

- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:17.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:

- *IANZ endorsement of this report applies to the sample as received.*
- *IANZ endorsement of this report does not apply to the sample description.*
- *This report may not be reproduced except in full.*

Tested By: **L.T. Smith, P.R. Gibson & L.S. Gibson** **Date: 24-Nov-10 to 5-Jan-11**

Transcriptions Checked By:

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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Reference No: 10/2163

Date: 12 January 2011

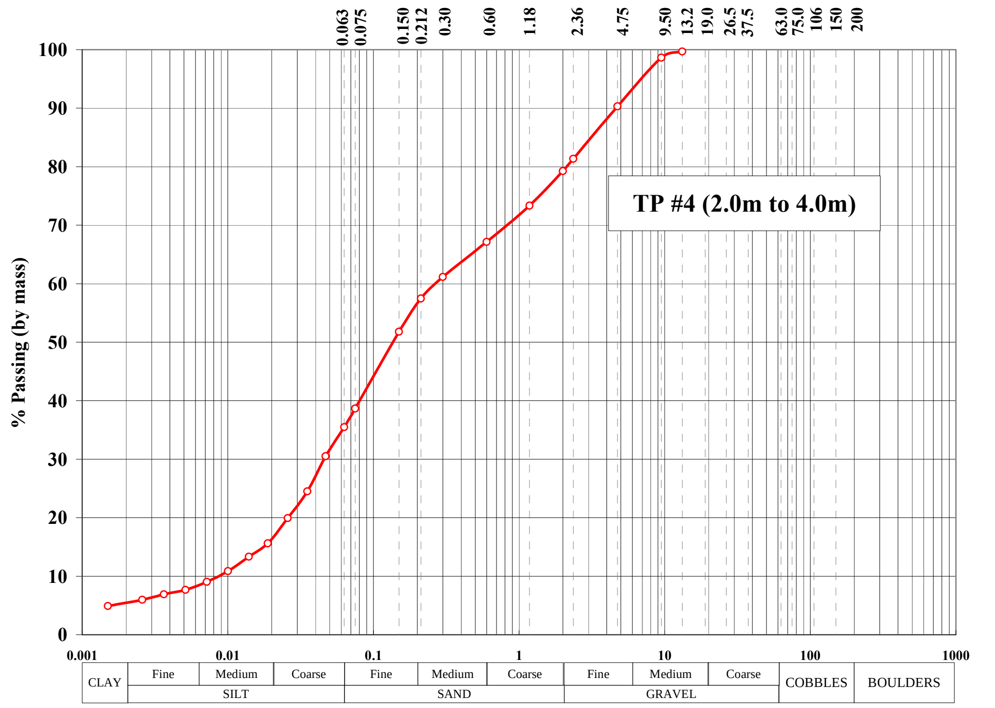
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Gravelly Silty SAND with trace of / minor clay**	**Sample Source:**	**TP#4 (2.0m to 4.0m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**2-Nov-10**	**Sample Method:**	**Test Pit**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	100
9.50	99
4.75	90
2.00	79
1.18	73
0.60	67
0.30	61
0.212	57
0.150	52
0.075	39
0.063	35

Fraction Size	Interpolated % Passing
60 μm	34
20 μm	16
6 μm	8
2 μm	5



The material was received in a natural state. The percentage passing the 63μm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 μm to 60 μm	22
Medium Gravel	20.0mm to 6.0mm	7	Coarse Silt	60 μm to 20 μm	18
Fine Gravel	6.0mm to 2.00 mm	14	Medium Silt	20 μm to 6 μm	8
Coarse Sand	2.00mm to 600 μm	12	Fine Silt	6 μm to 2 μm	3
Medium Sand	600 μm to 200 μm	11	Clay	< 2 μm	5

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

Water Content: (As Received)	15.4 %
Liquid Limit: (LL)	21
Plastic Limit: (PL)	Non Plastic (NP)
Plasticity Index: (PI)	Non Plastic (NP)

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

General Notes:

- *IANZ endorsement of this report applies to the sample as received.*
- *IANZ endorsement of this report does not apply to the sample description.*
- *This report may not be reproduced except in full.*

Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

Transcriptions Checked By:

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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new zealand accredited laboratory

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18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 10/2163

Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	Gravelly Silty SAND with trace of / minor clay	**Sample Source:**	TP#4 (2.0m to 4.0m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	2-Nov-10	**Sample Method:**	Test Pit

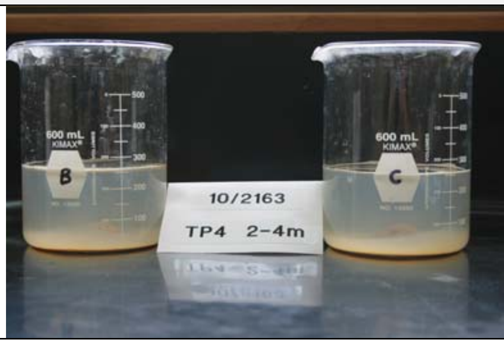
TP#4 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	TP#4 (2.0m to 4.0m)	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	0.82	Slightly Dark
50	0.82	Slightly Dark
180	-	-
380	-	-
1020	-	-

Diameter of Hole at Start of Test:	1.0 mm
Diameter of Hole at End of Test:	1.0 mm
Water Content Prior to Test:	11.5 %
Dry Density of Sample Tested:	1.88 t/m^3
Pinhole Dispersion Classification:	ND4 – Moderately Dispersive (Method A)

TP#4 - CRUMB TEST: ASTM D6572-06

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	≈ 5 %	Visible cloud over entire base
1 hr	100 %	Visible cloud ≈ 10mm high over entire base
6 hr	100 %	Visible cloud ≈ 5mm high over entire base
Crumb Test Classification:	Grade 4 (Highly Dispersive)	



Note:

- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:4.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

Transcriptions Checked By:

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434 new zealand accredited laboratory

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Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 10/2163

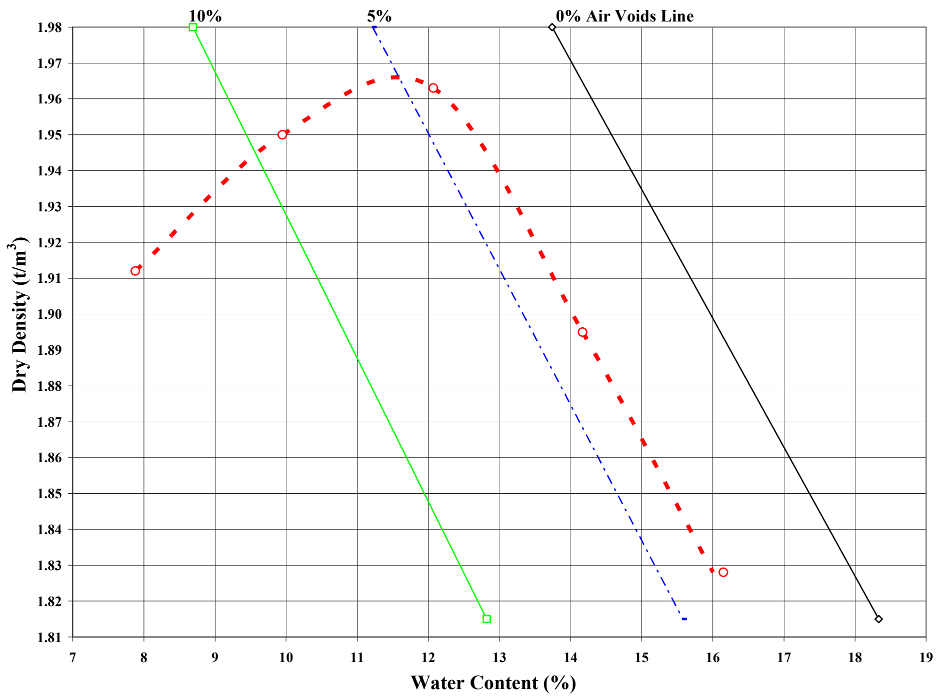
Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Gravelly Silty SAND with trace of / minor clay**	**Sample Source:**	**TP#4 (2.0m to 4.0m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**2-Nov-10**	**Sample Method:**	**Test Pit**

SOLID DENSITY & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.7.1 & 4.1.1

% Retained: (+19.0mm Test Sieve)	**0.0 %**
Solid Dry Density: (+19.0mm Fraction)	**-**
Absorption: (+19.0mm Fraction)	**-**
Solid Dry Density: (-19.0mm Fraction)	**2.72 t/m^3**
Maximum Dry Density: (-19.0mm Fraction)	**1.97 t/m^3**
Optimum Water Content: (-19.0mm Fraction)	**11.5 %**



Notes:

- ***The sample received was in a natural state.***
- ***The material tested in the NZ Standard Compaction test was whole soil.***
- ***The air voids lines were calculated from the tested solid dry density stated above.***

General Notes:

- ***IANZ endorsement of this report applies to the sample as received.***
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Tested By: **L.T. Smith, P.R. Gibson & L.S. Gibson** **Date: 24-Nov-10 to 5-Jan-11**

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Reference No: 10/2163

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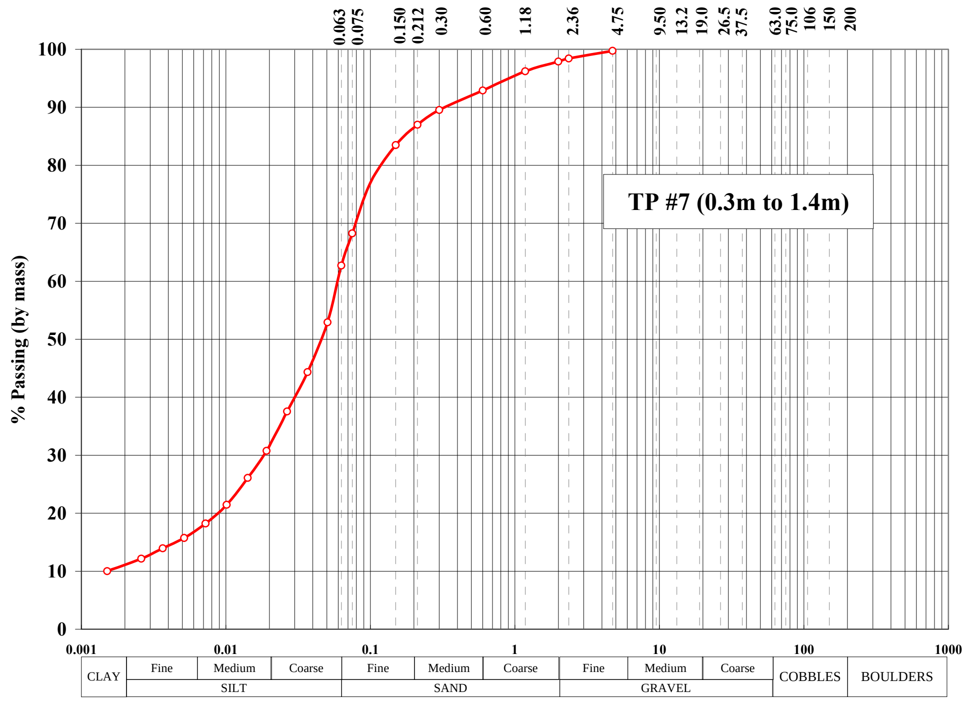
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	Sandy SILT with minor clay and trace of gravel	Sample Source:	TP#7 (0.3m to 1.4m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	2-Nov-10	Sample Method:	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	100
2.00	98
1.18	96
0.60	93
0.30	90
0.212	87
0.150	83
0.075	68
0.063	63

Fraction Size	Interpolated % Passing
60 µm	60
20 µm	32
6 µm	17
2 µm	11



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.7. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 µm to 60 µm	26
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 µm to 20 µm	28
Fine Gravel	6.0mm to 2.00 mm	2	Medium Silt	20 µm to 6 µm	15
Coarse Sand	2.00mm to 600 µm	5	Fine Silt	6 µm to 2 µm	6
Medium Sand	600 µm to 200 µm	7	Clay	< 2 µm	11

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

Water Content: (As Received)	12.7 %
Liquid Limit: (LL)	22
Plastic Limit: (PL)	21
Plasticity Index: (PI)	1

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

General Notes:

- *IANZ endorsement of this report applies to the sample as received.*
- *IANZ endorsement of this report does not apply to the sample description.*
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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson   Date: 24-Nov-10 to 5-Jan-11

Transcriptions Checked By: [signature]

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TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Sandy SILT with minor clay and trace of gravel**	**Sample Source:**	**TP#7 (0.3m to 1.4m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**2-Nov-10**	**Sample Method:**	**Test Pit**

TP#7 - PINHOLE DISPERSION TEST: ASTM D4647-06e1		
Sample Source:	**TP#7 (0.3m to 1.4m)**	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	**1.85**	**Very Dark**
50	**-**	**-**
180	**-**	**-**
380	**-**	**-**
1020	**-**	**-**

Diameter of Hole at Start of Test:	**1.0 mm**
Diameter of Hole at End of Test:	**4.0 mm**
Water Content Prior to Test:	**16.6 %**
Dry Density of Sample Tested:	**1.77 t/m^3**
Pinhole Dispersion Classification:	**D1 – Highly Dispersive (Method A)**

TP#7 - CRUMB TEST: ASTM D6572-06		
Elapsed Time	**Estimated Slaking**	**Observations Recorded**
2 min	**< 5 %**	**Visible cloud over entire base**
1 hr	**≈ 80 %**	**Visible cloud ≈ 20mm high over entire base**
6 hr	**100 %**	**Visible cloud ≈ 20mm high over entire base**
Crumb Test Classification:	**Grade 4 (Highly Dispersive)**	

Note:

- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:17.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:

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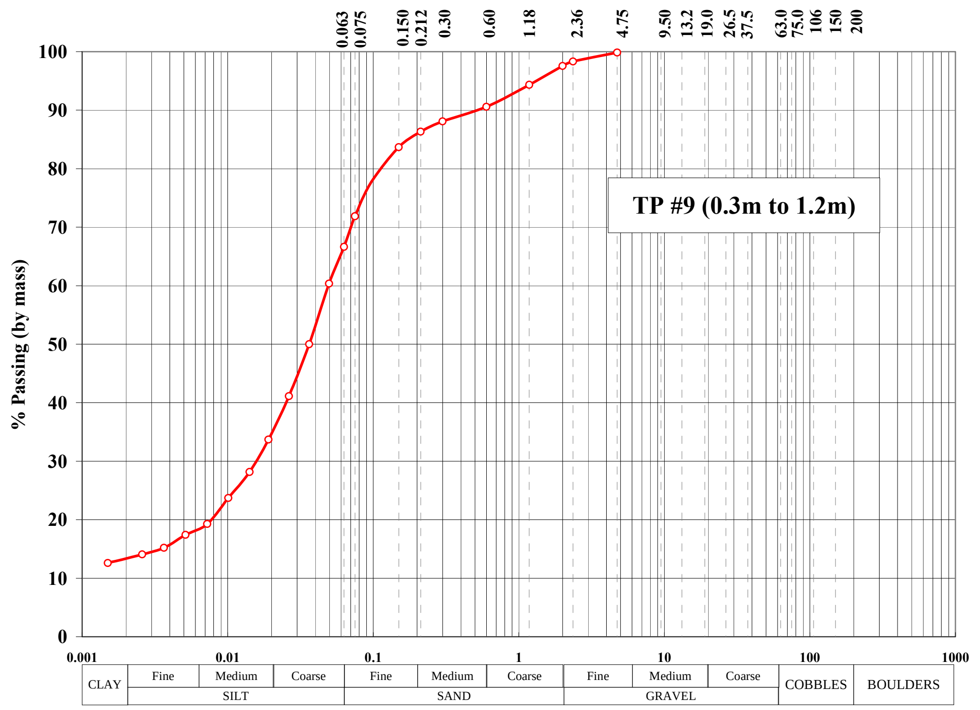
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	Sandy SILT with some clay and trace of gravel	**Sample Source:**	TP#9 (0.3m to 1.2m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	2-Nov-10	**Sample Method:**	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	100
2.00	98
1.18	94
0.60	91
0.30	88
0.212	86
0.150	84
0.075	72
0.063	67

Fraction Size	Interpolated % Passing
60 μm	65
20 μm	35
6 μm	18
2 μm	13



The material was received in a natural state. The percentage passing the 63μm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.7. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 μm to 60 μm	21
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 μm to 20 μm	30
Fine Gravel	6.0mm to 2.00 mm	2	Medium Silt	20 μm to 6 μm	17
Coarse Sand	2.00mm to 600 μm	7	Fine Silt	6 μm to 2 μm	5
Medium Sand	600 μm to 200 μm	5	Clay	< 2 μm	13

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

Water Content: (As Received)	17.2 %
Liquid Limit: (LL)	24
Plastic Limit: (PL)	21
Plasticity Index: (PI)	3

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

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

Transcriptions Checked By:

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Reference No: 10/2163

Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Sandy SILT with minor clay and trace of gravel**	**Sample Source:**	**TP#9 (0.3m to 1.2m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**2-Nov-10**	**Sample Method:**	**Test Pit**

TP#9 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	TP#9 (0.3m to 1.2m)	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	1.42	Very Dark
50	-	-
180	-	-
380	-	-
1020	-	-

Diameter of Hole at Start of Test:	**1.0 mm**
Diameter of Hole at End of Test:	**4.0 mm**
Water Content Prior to Test:	**16.8 %**
Dry Density of Sample Tested:	**1.76 t/m^3**
Pinhole Dispersion Classification:	**D1 – Highly Dispersive (Method A)**

TP#9 - CRUMB TEST: ASTM D6572-06

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	< 5 %	Visible cloud over entire base
1 hr	≈ 50 %	Visible cloud ≈ 25mm high over entire base
6 hr	100 %	Visible cloud ≈ 25mm high over entire base
Crumb Test Classification:	Grade 4 (Highly Dispersive)	

Note:
- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:11.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:
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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

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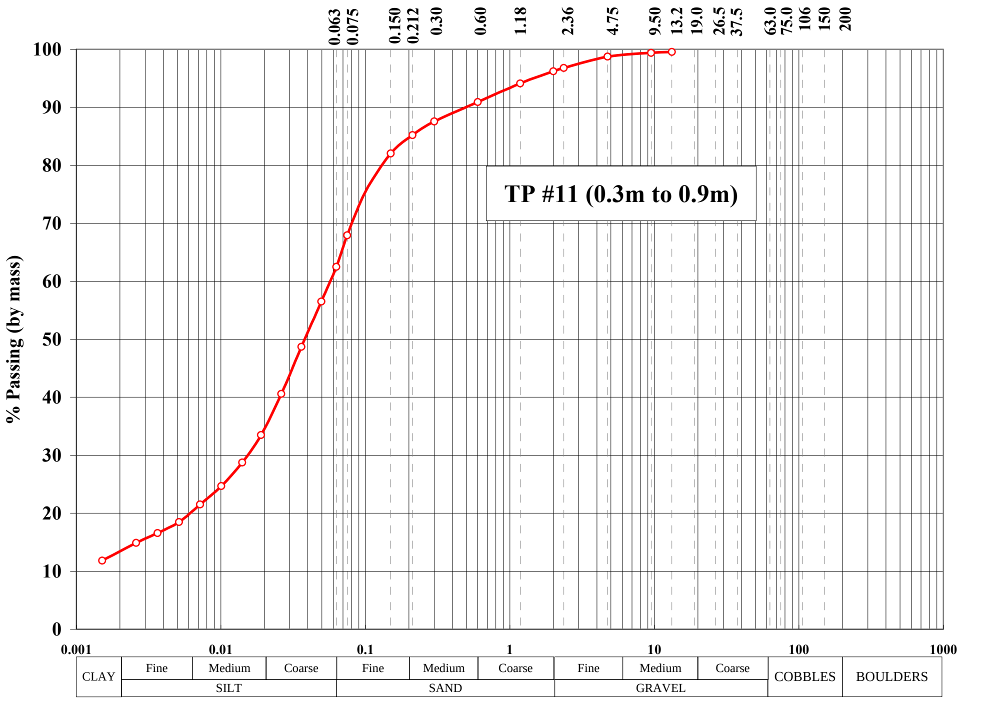
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	Sandy SILT with some clay and trace of gravel	Sample Source:	TP#11 (0.3m to 0.9m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	3-Nov-10	Sample Method:	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	100
9.50	99
4.75	99
2.00	96
1.18	94
0.60	91
0.30	88
0.212	85
0.150	82
0.075	68
0.063	62

Fraction Size	Interpolated % Passing
60 µm	61
20 µm	34
6 µm	19
2 µm	13



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 µm to 60 µm	24
Medium Gravel	20.0mm to 6.0mm	1	Coarse Silt	60 µm to 20 µm	27
Fine Gravel	6.0mm to 2.00 mm	3	Medium Silt	20 µm to 6 µm	15
Coarse Sand	2.00mm to 600 µm	5	Fine Silt	6 µm to 2 µm	6
Medium Sand	600 µm to 200 µm	6	Clay	< 2 µm	13

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

Water Content: (As Received)	18.6 %
Liquid Limit: (LL)	23
Plastic Limit: (PL)	22
Plasticity Index: (PI)	1

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

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson   Date: 24-Nov-10 to 5-Jan-11

Transcriptions Checked By: [signature]

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Reference No: 10/2163

Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Sandy SILT with minor clay and trace of gravel**	**Sample Source:**	**TP#11 (0.3m to 0.9m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**3-Nov-10**	**Sample Method:**	**Test Pit**

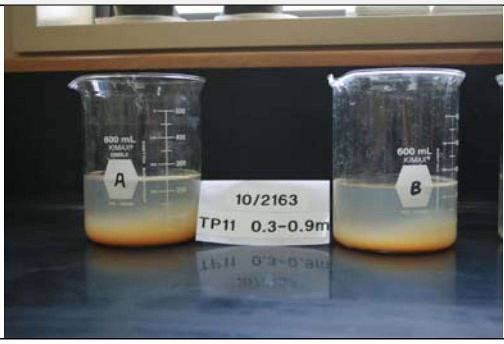
TP#11 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	**TP#4 (2.0m to 4.0m)**	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	**0.62**	**Dark**
50	**0.61**	**Dark**
180	**-**	**-**
380	**-**	**-**
1020	**-**	**-**

Diameter of Hole at Start of Test:	**1.0 mm**
Diameter of Hole at End of Test:	**1.1 mm up to 10mm at exit**
Water Content Prior to Test:	**15.2 %**
Dry Density of Sample Tested:	**1.74 t/m^3**
Pinhole Dispersion Classification:	**ND4 – Moderately Dispersive (Method A)**

TP#11 - CRUMB TEST: ASTM D6572-06

Elapsed Time	**Estimated Slaking**	**Observations Recorded**
2 min	**≈ 2 %**	**Visible cloud over entire base**
1 hr	**100 %**	**Visible cloud ≈ 20mm high over entire base**
6 hr	**100 %**	**Visible cloud ≈ 20mm high over entire base**
Crumb Test Classification:	**Grade 4 (Highly Dispersive)**	



Note:

- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:11.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:

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Tested By: **L.T. Smith, P.R. Gibson & L.S. Gibson** **Date: 24-Nov-10 to 5-Jan-11**

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Reference No: 10/2163

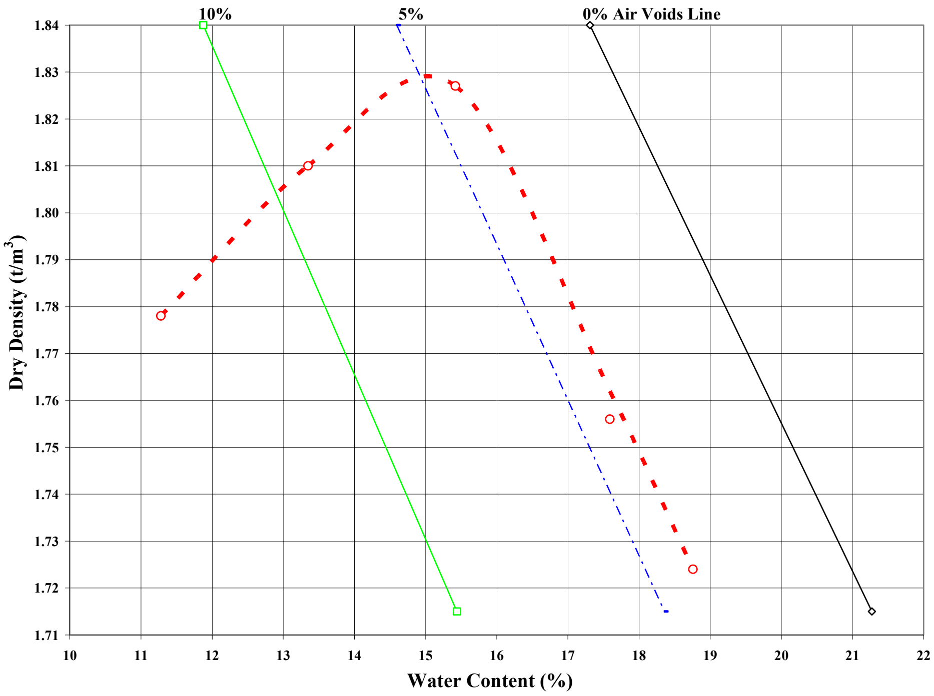
Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	Sandy SILT with minor clay and trace of gravel	**Sample Source:**	TP#11 (0.3m to 0.9m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	3-Nov-10	**Sample Method:**	Test Pit

SOLID DENSITY & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.7.1 & 4.1.1

% Retained: (+19.0mm Test Sieve)	0.0 %
Solid Dry Density: (+19.0mm Fraction)	-
Absorption: (+19.0mm Fraction)	-
Solid Dry Density: (-19.0mm Fraction)	2.70 t/m^3
Maximum Dry Density: (-19.0mm Fraction)	1.83 t/m^3
Optimum Water Content: (-19.0mm Fraction)	15.0 %



Notes:

- *The sample received was in a natural state.*
- *The material tested in the NZ Standard Compaction test was whole soil.*
- *The air voids lines were calculated from the tested solid dry density stated above.*

General Notes:

- *IANZ endorsement of this report applies to the sample as received.*
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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

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Reference No: 10/2163

Date: 12 January 2011

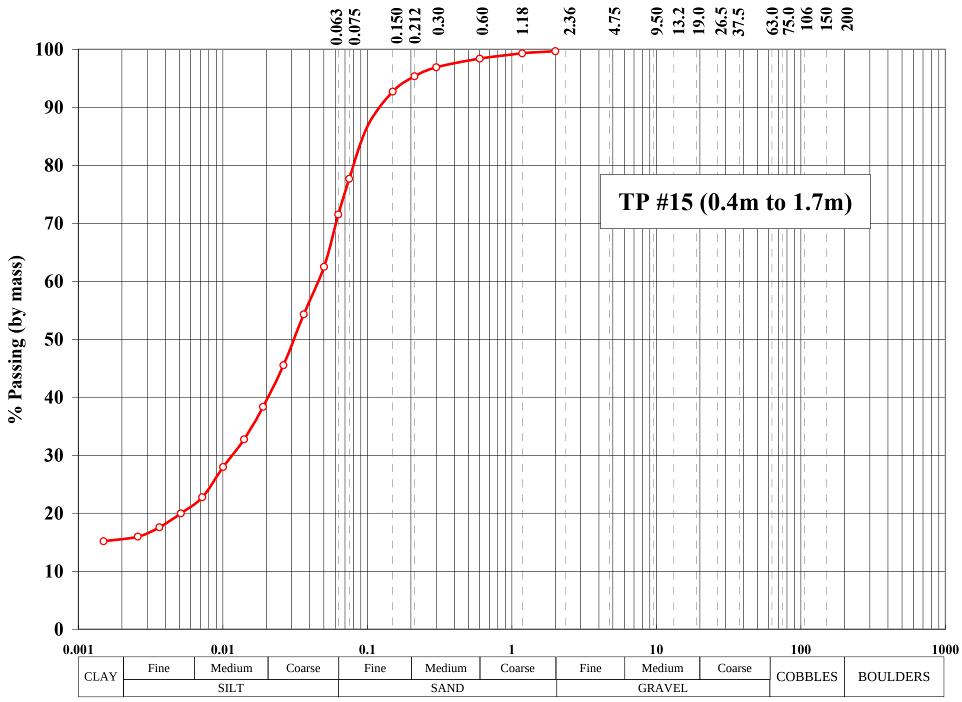
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	Sandy SILT with some clay	**Sample Source:**	TP#15 (0.4m to 1.7m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	3-Nov-10	**Sample Method:**	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	
2.00	100
1.18	99
0.60	98
0.30	97
0.212	95
0.150	93
0.075	78
0.063	71

Fraction Size	Interpolated % Passing
60 µm	69
20 µm	39
6 µm	21
2 µm	16



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 µm to 60 µm	26
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 µm to 20 µm	30
Fine Gravel	6.0mm to 2.00 mm	-	Medium Silt	20 µm to 6 µm	18
Coarse Sand	2.00mm to 600 µm	2	Fine Silt	6 µm to 2 µm	5
Medium Sand	600 µm to 200 µm	3	Clay	< 2 µm	16

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

Water Content: (As Received)	21.0 %
Liquid Limit: (LL)	25
Plastic Limit: (PL)	22
Plasticity Index: (PI)	3

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

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

Transcriptions Checked By: [signature]

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434 new zealand accredited laboratory

Central Testing Services
18 Ngapara Street, P.O. Box 397, ALEXANDRA, Central Otago, NZ
Telephone (03) 448 7644, Fax (03) 448 7401, Email alan.julius@xtra.co.nz

Reference No: 10/2163

Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	Sandy SILT with some clay	**Sample Source:**	TP#15 (0.4m to 1.7m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	2-Nov-10	**Sample Method:**	Test Pit

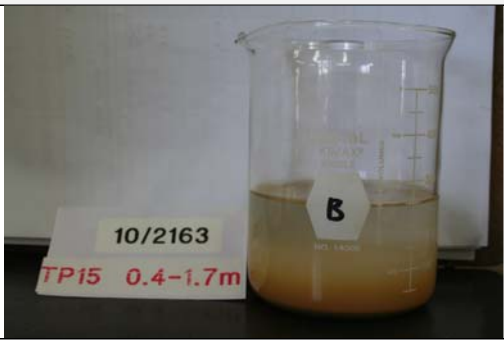
TP#15 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	TP#15 (0.4m to 1.7m)	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	1.57	Very Dark
50	-	-
180	-	-
380	-	-
1020	-	-

Diameter of Hole at Start of Test:	1.0 mm
Diameter of Hole at End of Test:	4.0 mm
Water Content Prior to Test:	18.3 %
Dry Density of Sample Tested:	1.74 t/m^3
Pinhole Dispersion Classification:	ND4 – Moderately Dispersive (Method A)

TP#15 - CRUMB TEST: ASTM D6572-06

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	< 5 %	Cloud surrounding sample
1 hr	≈ 75 %	Visible cloud ≈ 20mm high over entire base
6 hr	100 %	Visible cloud ≈ 20mm high over entire base
Crumb Test Classification:	Grade 4 (Highly Dispersive)	



Note:

- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:11.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

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Date: 12 January 2011

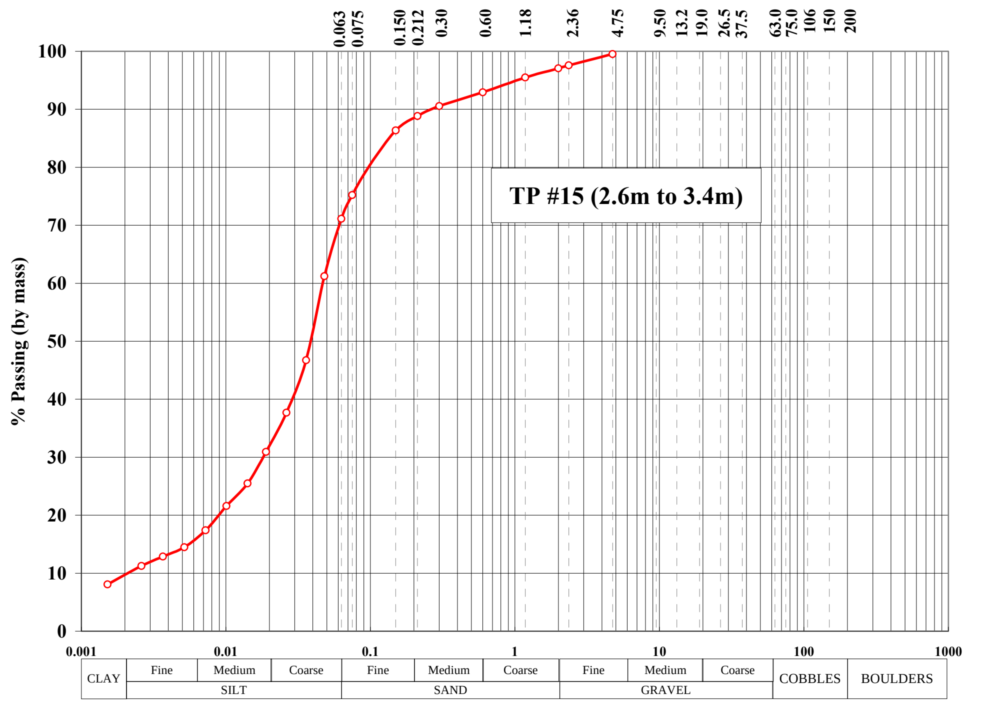
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Sandy SILT with minor clay and trace of gravel**	**Sample Source:**	**TP#15 (2.6m to 3.4m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**3-Nov-10**	**Sample Method:**	**Test Pit**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	100
2.00	97
1.18	95
0.60	93
0.30	91
0.212	89
0.150	86
0.075	75
0.063	71

Fraction Size	Interpolated % Passing
60 µm	69
20 µm	32
6 µm	16
2 µm	9



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 µm to 60 µm	19
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 µm to 20 µm	37
Fine Gravel	6.0mm to 2.00 mm	3	Medium Silt	20 µm to 6 µm	16
Coarse Sand	2.00mm to 600 µm	4	Fine Silt	6 µm to 2 µm	7
Medium Sand	600 µm to 200 µm	5	Clay	< 2 µm	9

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

Water Content: (As Received)	21.6 %
Liquid Limit: (LL)	25
Plastic Limit: (PL)	24
Plasticity Index: (PI)	1

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

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date: 24-Nov-10 to 5-Jan-11**

Transcriptions Checked By:

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Reference No: 10/2163

Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	Sandy SILT with minor clay and trace of gravel	Sample Source:	TP#15 (2.6m to 3.4m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	3-Nov-10	Sample Method:	Test Pit

TP#15 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	TP#15 (2.6m to 3.4m)	
Head (mm)	Flow Rate (ml/s)	Colour of Outflow (Cloudiness)
50	0.73	Dark
50	0.73	Dark
180	-	-
380	-	-
1020	-	-

Diameter of Hole at Start of Test:	1.0 mm
Diameter of Hole at End of Test:	1.1 mm up to 15mm at exit
Water Content Prior to Test:	14.2 %
Dry Density of Sample Tested:	1.76 t/m^3
Pinhole Dispersion Classification:	ND4 – Moderately Dispersive (Method A)

TP#15 - CRUMB TEST: ASTM D6572-06

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	≈ 5 %	Visible cloud over entire base
1 hr	100 %	Visible cloud ≈ 5mm high over entire base
6 hr	100 %	Slightly visible cloud over entire base
Crumb Test Classification:	Grade 3 (Moderately Dispersive)	

Note:
- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:15.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:
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TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

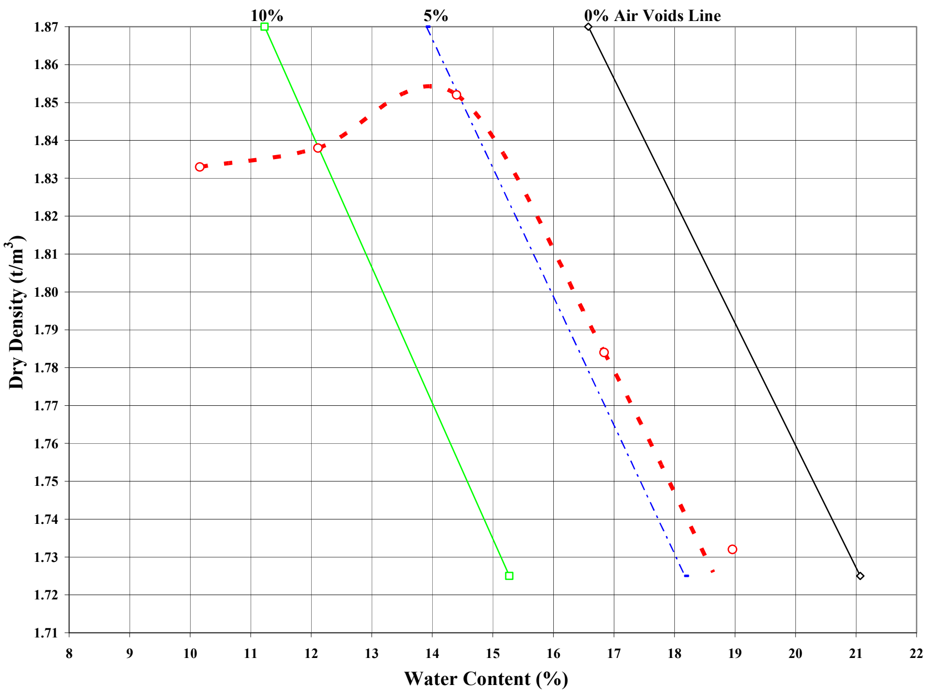
Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	Sandy SILT with minor clay and trace of gravel	**Sample Source:**	TP#15 (2.6m to 3.4m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	3-Nov-10	**Sample Method:**	Test Pit

SOLID DENSITY & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.7.1 & 4.1.1

% Retained: (+19.0mm Test Sieve)	0.0 %
Solid Dry Density: (+19.0mm Fraction)	-
Absorption: (+19.0mm Fraction)	-
Solid Dry Density: (-19.0mm Fraction)	2.71 t/m^3
Maximum Dry Density: (-19.0mm Fraction)	1.85 t/m^3
Optimum Water Content: (-19.0mm Fraction)	14.0 %

Notes:

- *The sample received was in a natural state.*
- *The material tested in the NZ Standard Compaction test was whole soil.*
- *The air voids lines were calculated from the tested solid dry density stated above.*



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Reference No: 10/2163

Date: 12 January 2011

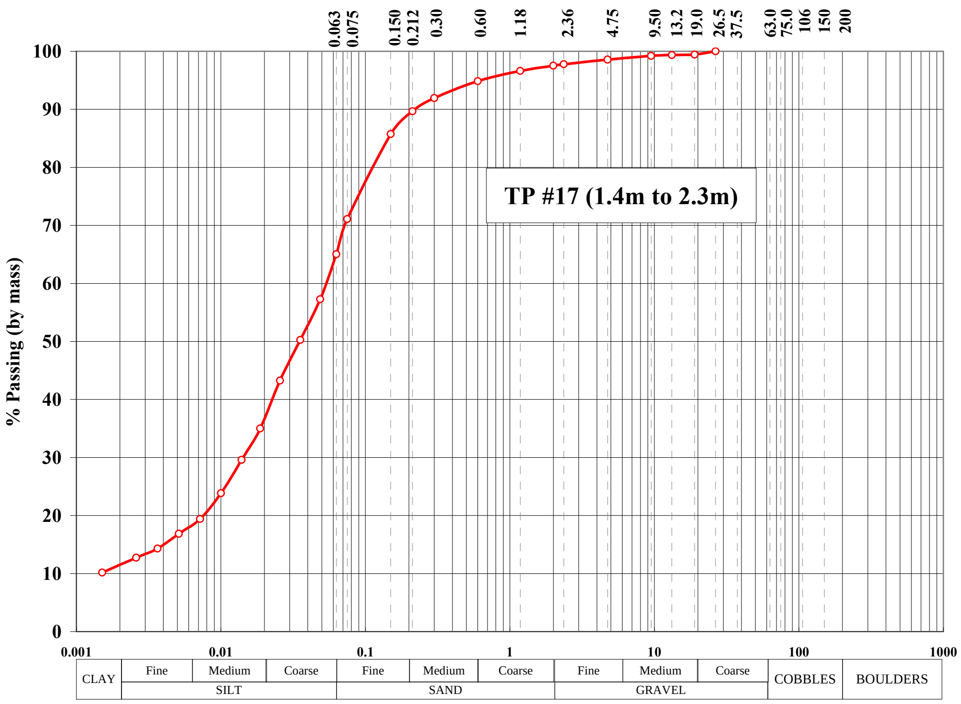
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	Sandy SILT with minor clay and trace of gravel	**Sample Source:**	TP#17 (1.4m to 2.3m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	3-Nov-10	**Sample Method:**	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
53.0	100
37.5	99
26.5	99
19.0	99
13.2	99
9.50	99
4.75	99
2.00	97
1.18	97
0.60	95
0.30	92
0.212	90
0.150	86
0.075	71
0.063	65

Fraction Size	Interpolated % Passing
60 µm	63
20 µm	37
6 µm	18
2 µm	11



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 µm to 60 µm	26
Medium Gravel	20.0mm to 6.0mm	1	Coarse Silt	60 µm to 20 µm	26
Fine Gravel	6.0mm to 2.00 mm	2	Medium Silt	20 µm to 6 µm	19
Coarse Sand	2.00mm to 600 µm	2	Fine Silt	6 µm to 2 µm	7
Medium Sand	600 µm to 200 µm	6	Clay	< 2 µm	11

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

Water Content: (As Received)	21.2 %
Liquid Limit: (LL)	28
Plastic Limit: (PL)	24
Plasticity Index: (PI)	4

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

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson   **Date:** 24-Nov-10 to 5-Jan-11

Transcriptions Checked By: [signature]

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Reference No: 10/2163

Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Sandy SILT with minor clay and trace of gravel**	**Sample Source:**	**TP#17 (1.4m to 2.3m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**3-Nov-10**	**Sample Method:**	**Test Pit**

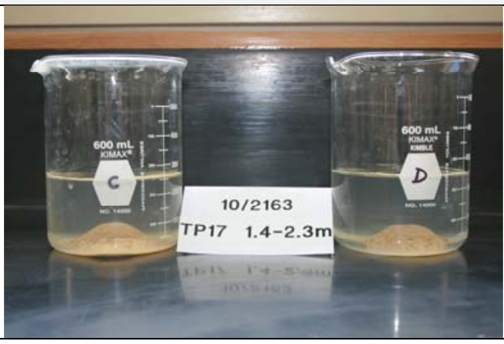
TP#17 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	TP#17 (1.4m to 2.3m)	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	0.53	Moderately Dark
50	0.75	Moderately Dark
180	0.86	Moderately / Slightly Dark
380	0.95	Very Dark
1020	-	-

Diameter of Hole at Start of Test:	1.0 mm
Diameter of Hole at End of Test:	1.1 mm up to 15mm at exit
Water Content Prior to Test:	14.5 %
Dry Density of Sample Tested:	1.77 t/m^3
Pinhole Dispersion Classification:	**ND3 – Slightly Dispersive (Method A)**

TP#17 - CRUMB TEST: ASTM D6572-06

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	≈ 10 %	Slight reaction around sample
1 hr	100 %	No colloidal cloud evident
6 hr	100 %	No colloidal cloud evident
Crumb Test Classification:	**Grade 1 (Non Dispersive)**	



Note:
- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:17.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:
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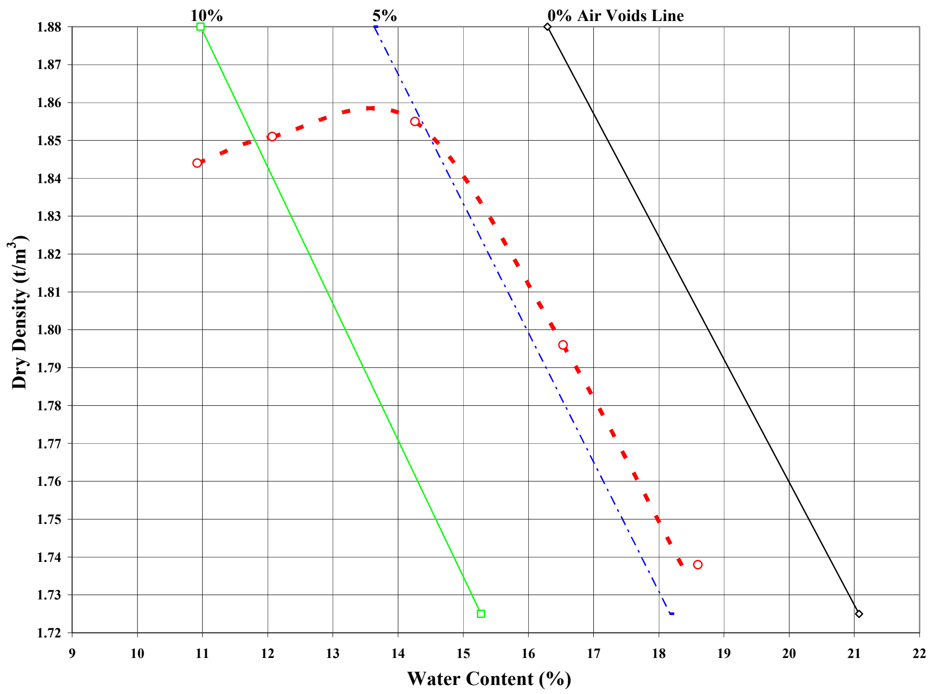
TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**Sandy SILT with minor clay and trace of gravel**	**Sample Source:**	**TP#17 (1.4m to 2.3m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**3-Nov-10**	**Sample Method:**	**Test Pit**

SOLID DENSITY & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.7.1 & 4.1.1

% Retained: (+19.0mm Test Sieve)	1.0 %
Solid Dry Density: (+19.0mm Fraction)	-
Absorption: (+19.0mm Fraction)	-
Solid Dry Density: (-19.0mm Fraction)	2.71 t/m^3
Maximum Dry Density: (-19.0mm Fraction)	1.86 t/m^3
Optimum Water Content: (-19.0mm Fraction)	14.0 %



Notes:

- *The sample received was in a natural state.*
- *The material tested in the NZ Standard Compaction test was the fraction passing a 19mm test sieve.*
- *The air voids lines were calculated from the tested solid dry density stated above.*

General Notes:

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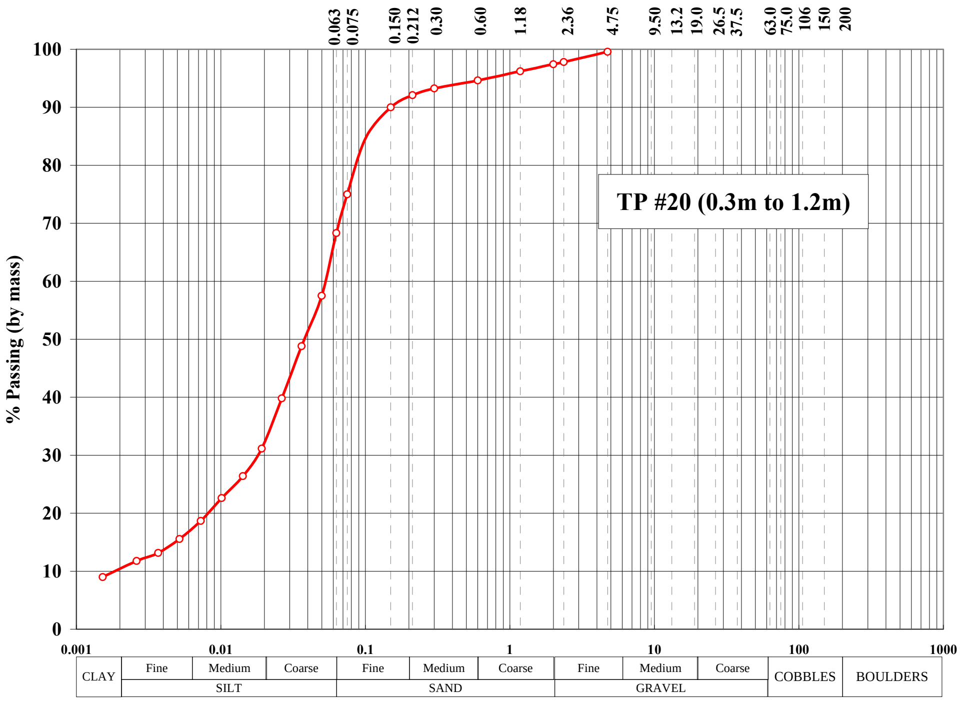
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	Sandy SILT with minor clay and trace of gravel	Sample Source:	TP#20 (0.3m to 1.2m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	3-Nov-10	Sample Method:	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	100
2.00	97
1.18	96
0.60	95
0.30	93
0.212	92
0.150	90
0.075	75
0.063	68

Fraction Size	Interpolated % Passing
60 µm	66
20 µm	32
6 µm	17
2 µm	10



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.7. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 µm to 60 µm	26
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 µm to 20 µm	34
Fine Gravel	6.0mm to 2.00 mm	3	Medium Silt	20 µm to 6 µm	15
Coarse Sand	2.00mm to 600 µm	2	Fine Silt	6 µm to 2 µm	7
Medium Sand	600 µm to 200 µm	3	Clay	< 2 µm	10

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

Water Content: (As Received)	21.4 %
Liquid Limit: (LL)	27
Plastic Limit: (PL)	24
Plasticity Index: (PI)	3

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

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson Date: 24-Nov-10 to 5-Jan-11

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TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	Sandy SILT with minor clay and trace of gravel	**Sample Source:**	TP#20 (0.3m to 1.2m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	3-Nov-10	**Sample Method:**	Test Pit

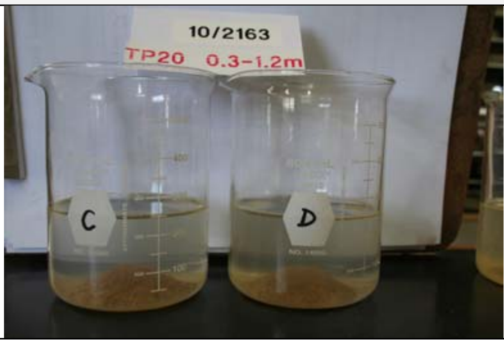
TP#15 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	TP#4 (2.0m to 4.0m)	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	0.88	Moderately Dark
50	1.38	Dark
180	-	-
380	-	-
1020	-	-

Diameter of Hole at Start of Test:	1.0 mm
Diameter of Hole at End of Test:	> 1.5 mm
Water Content Prior to Test:	15.1 %
Dry Density of Sample Tested:	1.78 t/m^3
Pinhole Dispersion Classification:	D2 – Dispersive (Method A)

TP#15 - CRUMB TEST: ASTM D6572-06

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	≈ 30 %	Visible cloud over entire base
1 hr	100 %	Barely visible colloidal cloud
6 hr	100 %	Barely visible colloidal cloud
Crumb Test Classification:	Grade 2 (Intermediate)	



Note:

- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:11.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:

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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson **Date:** 24-Nov-10 to 5-Jan-11

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Reference No: 10/2163

Date: 12 January 2011

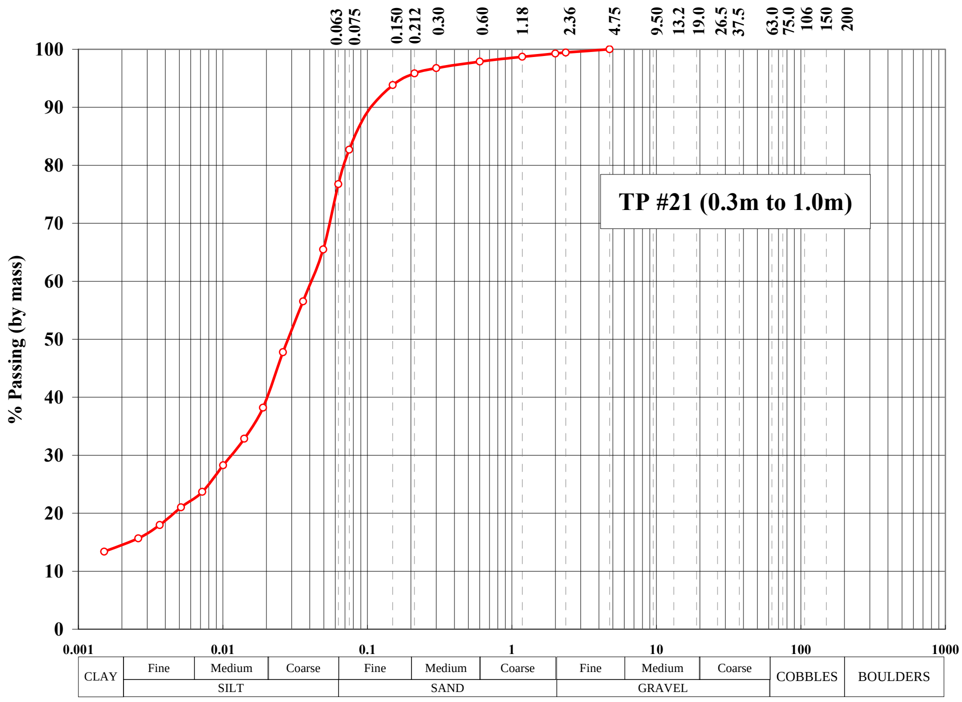
TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	Sandy SILT with some clay and trace of gravel	Sample Source:	TP#21 (0.3m to 1.0m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	3-Nov-10	Sample Method:	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	100
2.00	99
1.18	99
0.60	98
0.30	97
0.212	96
0.150	94
0.075	83
0.063	77

Fraction Size	Interpolated % Passing
60 µm	74
20 µm	40
6 µm	22
2 µm	14



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.3. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	-	Fine Sand	200 µm to 60 µm	21
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 µm to 20 µm	34
Fine Gravel	6.0mm to 2.00 mm	1	Medium Silt	20 µm to 6 µm	18
Coarse Sand	2.00mm to 600 µm	1	Fine Silt	6 µm to 2 µm	8
Medium Sand	600 µm to 200 µm	3	Clay	< 2 µm	14

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

Water Content: (As Received)	22.3 %
Liquid Limit: (LL)	30
Plastic Limit: (PL)	24
Plasticity Index: (PI)	6

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

General Notes:

- *IANZ endorsement of this report applies to the sample as received.*
- *IANZ endorsement of this report does not apply to the sample description.*
- *This report may not be reproduced except in full.*

Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson   Date: 24-Nov-10 to 5-Jan-11

Transcriptions Checked By:

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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Reference No: 10/2163

Date: 12 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	Sandy SILT with some clay and trace of gravel	Sample Source:	TP#21 (0.3m to 1.0m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	3-Nov-10	Sample Method:	Test Pit

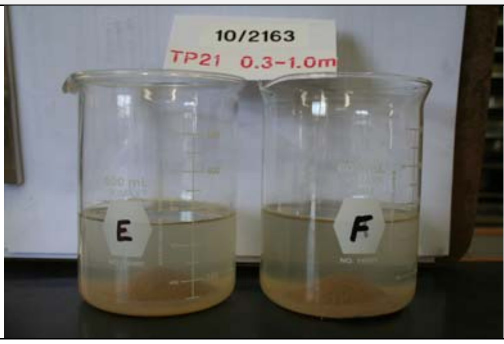
TP#21 - PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	TP#21 (0.3m to 1.0m)	
Head (mm)	Flow Rate (ml/s)	Colour of Outflow (Cloudiness)
50	2.70	Very Dark
50	-	-
180	-	-
380	-	-
1020	-	-

Diameter of Hole at Start of Test:	1.0 mm
Diameter of Hole at End of Test:	5.5 mm
Water Content Prior to Test:	14.8 %
Dry Density of Sample Tested:	1.77 t/m^3
Pinhole Dispersion Classification:	D1 – Highly Dispersive (Method A)

TP#21 - CRUMB TEST: ASTM D6572-06

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	≈ 20 %	Visible cloud over entire base
1 hr	100 %	Visible cloud ≈ 5mm high over entire base
6 hr	100 %	Visible cloud < 5mm high over entire base
Crumb Test Classification:	Grade 3/4 (Highly Dispersive)	



Note:

- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ standard compaction – see TP:11.*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:

- *IANZ endorsement of this report applies to the sample as received.*
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Tested By: L.T. Smith, P.R. Gibson & L.S. Gibson

Date: 24-Nov-10 to 5-Jan-11

Transcriptions Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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Reference No: 10/2163-A

Date: 17 January 2011

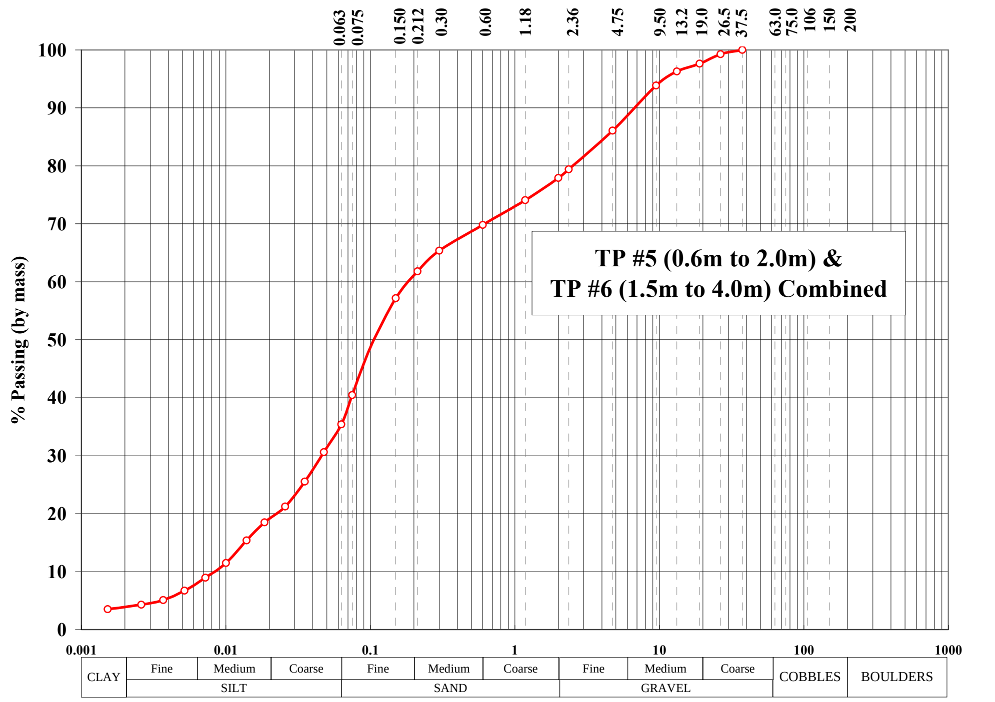
TEST REPORT – TOP TIPPERARY INVESTIGATIONS

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	After NZ Vibrating Hammer Compaction Permeability; Gravelly Silty SAND with trace of clay	**Sample Source:**	TP#5 (0.6m to 2.0m) & TP#6 (1.5m to 4.0m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	2-Nov-10	**Sample Method:**	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	100
26.5	99
19.0	98
13.2	96
9.50	94
4.75	86
2.00	78
1.18	74
0.60	70
0.30	65
0.212	62
0.150	57
0.075	40
0.063	35

Fraction Size	Interpolated % Passing
60 µm	34
20 µm	19
6 µm	8
2 µm	4



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.0. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	2	Fine Sand	200 µm to 60 µm	27
Medium Gravel	20.0mm to 6.0mm	10	Coarse Silt	60 µm to 20 µm	15
Fine Gravel	6.0mm to 2.00 mm	10	Medium Silt	20 µm to 6 µm	11
Coarse Sand	2.00mm to 600 µm	8	Fine Silt	6 µm to 2 µm	4
Medium Sand	600 µm to 200 µm	9	Clay	< 2 µm	4

WATER CONTENT - NZS 4402:1986, Test 2.1

Sample Description:	TP#5 (0.6m to 2.0m)	TP#6 (1.5m to 4.0m)
Water Content: (As Received)	17.4 %	12.7 %
Note: The sample received was in a natural state.		

General Notes:

- *IANZ endorsement of this report applies to the samples as received.*
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- *This report may not be reproduced except in full.*

Tested By: L.T. Smith & L.S. Gibson

Date: 24-Nov-10 to 11-Jan-11

Transcriptions Checked By:

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TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**After NZ Vibrating Hammer Compaction Permeability; Gravelly Silty SAND with trace of clay**	**Sample Source:**	**TP#5 (0.6m to 2.0m) & TP#6 (1.5m to 4.0m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**2-Nov-10**	**Sample Method:**	**Test Pit**

PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	**TP#5 (0.6m to 2.0m) & TP #6 (1.5m to 4.0m)**	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	**0.63**	**Very Dark**
50	**0.56**	**Dark**
180	**-**	**-**
380	**-**	**-**
1020	**-**	**-**

Diameter of Hole at Start of Test:	**1.0mm**
Diameter of Hole at End of Test:	**< 1.5mm (blown out at exit to 8.0mm)**
Water Content Prior to Test:	**18.2 %**
Dry Density of Sample Tested:	**1.56 t/m^3**
Pinhole Dispersion Classification:	**ND4 – Moderately Dispersive (Method A)**

TP#5 & TP#6 - CRUMB TEST: ASTM D6572-06

Elapsed Time	**Estimated Slaking**	**Observations Recorded**
2 min	**< 2 %**	**Visible colloid cloud around sample**
1 hr	**100 %**	**Visible cloud evident ≈ 5mm over entire base**
6 hr	**100 %**	**Visible cloud evident ≈ 5mm over entire base**
Crumb Test Classification:	**Grade 3 (Dispersive)**	

Note:

- *Distilled water was used in the pinhole dispersion and crumb test.*
- *The pinhole dispersion test sample was compacted to a target 95% of NZ vibrating hammer compaction (corrected for +2mm fraction).*
- *The crumb test was carried out on a remoulded sample. Photograph at completion of test.*
- *The sample tested was the fraction passing a 2.00mm test sieve.*

General Notes:

- *IANZ endorsement of this report applies to the samples as received.*
- *IANZ endorsement of this report does not apply to the sample description.*
- *This report may not be reproduced except in full.*

Tested By: **L.T. Smith & L.S. Gibson** **Date: 24-Nov-11 to 11 -Jan-11**

Transcriptions Checked By:

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Reference No: 10/2163-A

Date: 17 January 2011

TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

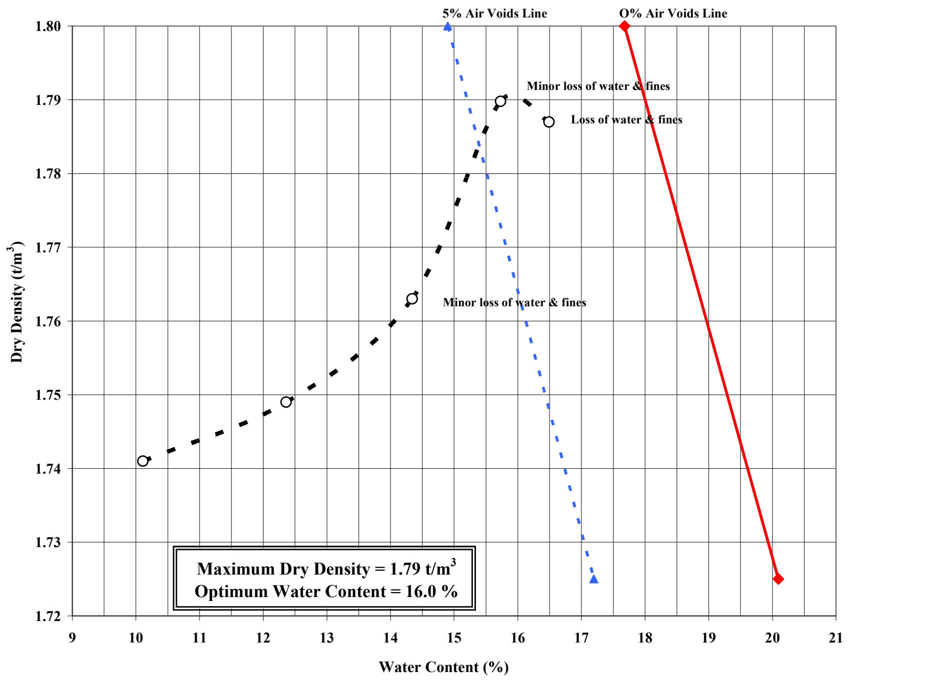
Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	After NZ Vibrating Hammer Compaction Permeability; Gravelly Silty SAND with trace of clay	Sample Source:	TP#5 (0.6m to 2.0m) & TP#6 (1.5m to 4.0m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	2-Nov-10	Sample Method:	Test Pit

SOLID DENSITY & NZ VIBRATING HAMMER COMPACTION - NZS 4402:1986, Test 2.7.1 & 4.1.3

% Retained: (+37.5mm Test Sieve)	0.0 %
Solid Dry Density: (-37.5mm Fraction)	2.64 t/m^3
Maximum Dry Density: (-37.5mm Fraction)	1.79 t/m^3
Optimum Water Content: (-37.5mm Fraction)	16.0 %

Notes:

- *The sample received was in a natural state.*
- *The material tested in the NZ Vibrating Hammer Compaction test was whole soil.*
- *The air voids lines were calculated from the tested solid dry density stated above.*



FALLING HEAD PERMEABILITY: AS 1289.6.7.2-2001 (Not IANZ Accredited)		
Compaction Used:	NZ Vibrating Hammer Compaction	
Sample Length: (mm)	143.1	
Sample Diameter: (mm)	388.7	
Initial Water Content: (%)	14.2	
Wet Density: (t/m^3)	2.04	
Dry Density: (t/m^3)	1.79	
Final Water Content: (%)	18.3	
Initial Head: (m)	0.55	1.26
Test Temperature: (^{o}C)	22.0	21.0
Permeability $k_{(20)}$	5.46 x 10^{-9} m/s	6.18 x 10^{-9} m/s

General Notes:

- *IANZ endorsement of this report applies to the sample as received.*
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Tested By: L.T. Smith & L.S. Gibson   Date: 24-Nov-10 to 11-Jan-11

Transcriptions Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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Specialist Quality Assurance Service in Aggregate, Concrete and Soils Testing

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Reference No: 10/2163-B

Date: 18 January 2011

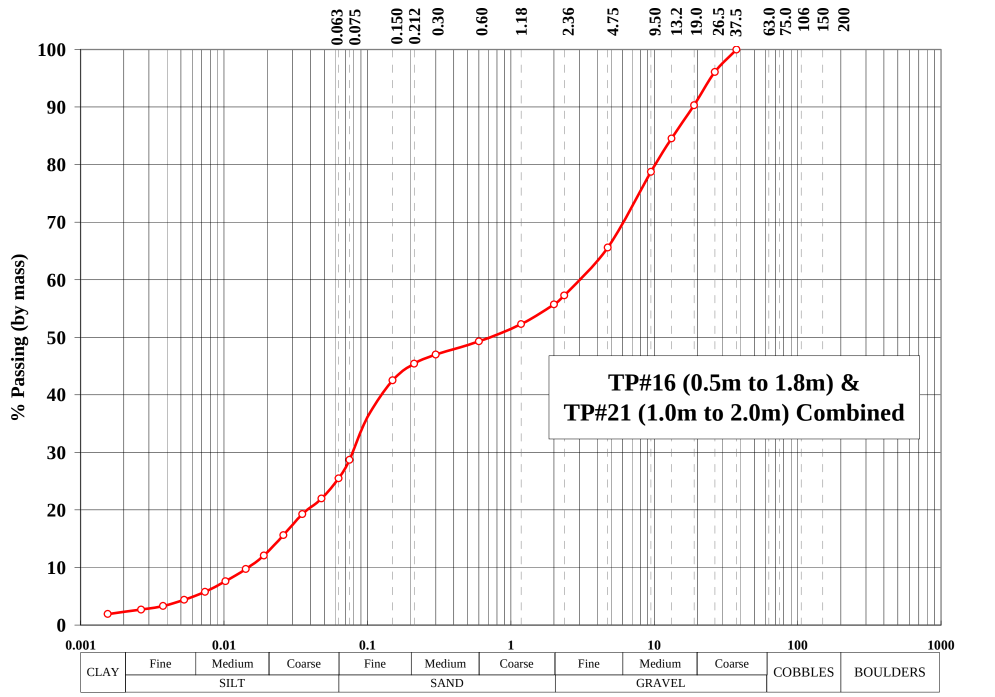
TEST REPORT – TOP TIPPERARY INVESTIGATIONS

Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	**Attention:**	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	**Client Order No:**	145437
Sample Description:	After NZ Vibrating Hammer Compaction Permeability; Silty Sandy GRAVEL with trace of clay	**Sample Source:**	TP#16 (0.5m to 1.8m) & TP#21 (1.0m to 2.0m)
Sampled By:	Unknown	**Date Received:**	22-Nov-10
Date & Time Sampled:	3 & 4-Nov-10	**Sample Method:**	Test Pit

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	100
26.5	96
19.0	90
13.2	85
9.50	79
4.75	66
2.00	56
1.18	52
0.60	49
0.30	47
0.212	45
0.150	43
0.075	29
0.063	25

Fraction Size	Interpolated % Passing
60 µm	25
20 µm	13
6 µm	5
2 µm	2



The material was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	> 20.0mm	9	Fine Sand	200 µm to 60 µm	20
Medium Gravel	20.0mm to 6.0mm	22	Coarse Silt	60 µm to 20 µm	12
Fine Gravel	6.0mm to 2.00 mm	13	Medium Silt	20 µm to 6 µm	8
Coarse Sand	2.00mm to 600 µm	7	Fine Silt	6 µm to 2 µm	3
Medium Sand	600 µm to 200 µm	4	Clay	< 2 µm	2

WATER CONTENT - NZS 4402:1986, Test 2.1

Sample Description:	TP#16 (0.5m to 1.8m)	TP#21 (1.0m to 2.0m)
Water Content: (As Received)	8.1 %	11.9 %

Note: The sample received was in a natural state.

General Notes:

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Tested By: L.T. Smith & L.S. Gibson

Date: 24-Nov-10 to 17-Jan-11

Transcriptions Checked By:

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Reference No: 10/2163-B

Date: 18 January 2011

TEST REPORT - TOP TIPPERARY INVESTIGATIONS (cont.)

Client Details:	**Oceana Gold Ltd, P.O. Box 84, Palmerston**	**Attention:**	**A. O'Meara**
Job Description:	**Top Tipperary TSF Investigations – Job No. 6846**	**Client Order No:**	**145437**
Sample Description:	**After NZ Vibrating Hammer Compaction Permeability; Silty Sandy GRAVEL with trace of clay**	**Sample Source:**	**TP#16 (0.5m to 1.8m) & TP#21 (1.0m to 2.0m)**
Sampled By:	**Unknown**	**Date Received:**	**22-Nov-10**
Date & Time Sampled:	**3 & 4-Nov-10**	**Sample Method:**	**Test Pit**

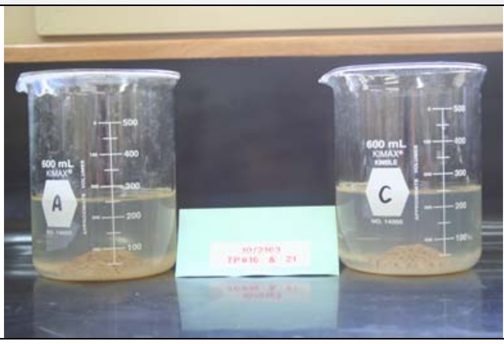
PINHOLE DISPERSION TEST: ASTM D4647-06e1

Sample Source:	**TP#16 (0.5m to 1.8m) & TP #21 (1.0m to 2.0m)**	
Head (mm)	**Flow Rate (ml/s)**	**Colour of Outflow (Cloudiness)**
50	**0.28**	**Slightly Dark**
50	**0.26**	**Slightly Dark**
180	**0.65**	**Moderately Dark / Dark**
380	**1.08**	**Very Dark**
1020	**-**	**-**

Diameter of Hole at Start of Test:	**1.0mm**
Diameter of Hole at End of Test:	**1.5mm (blown out at exit)**
Water Content Prior to Test:	**14.9 %**
Dry Density of Sample Tested:	**1.81 t/m^3**
Pinhole Dispersion Classification:	**ND3 – Slightly to Moderately Dispersive (Method A)**

TP#16 & TP#21 - CRUMB TEST: ASTM D6572-06

Elapsed Time	**Estimated Slaking**	**Observations Recorded**
2 min	**> 50 %**	**Visible colloid cloud around sample**
1 hr	**100 %**	**Visible cloud evident over entire base**
6 hr	**100 %**	**Slightly visible cloud evident**
Crumb Test Classification:	**Grade 2/3 (Intermediate to Dispersive)**	



Note:

- ***Distilled water was used in the pinhole dispersion and crumb test.***
- ***The pinhole dispersion test sample was compacted to a target 95% of NZ vibrating hammer compaction (corrected for +2mm fraction).***
- ***The crumb test was carried out on a remoulded sample. Photograph at completion of test.***
- ***The sample tested was the fraction passing a 2.00mm test sieve.***

General Notes:

- ***IANZ endorsement of this report applies to the samples as received.***
- ***IANZ endorsement of this report does not apply to the sample description.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith & L.S. Gibson** **Date: 24-Nov-11 to 17-Jan-11**

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Reference No: 10/2163-B

Date: 18 January 2011

TEST REPORT – TOP TIPPERARY INVESTIGATIONS (cont.)

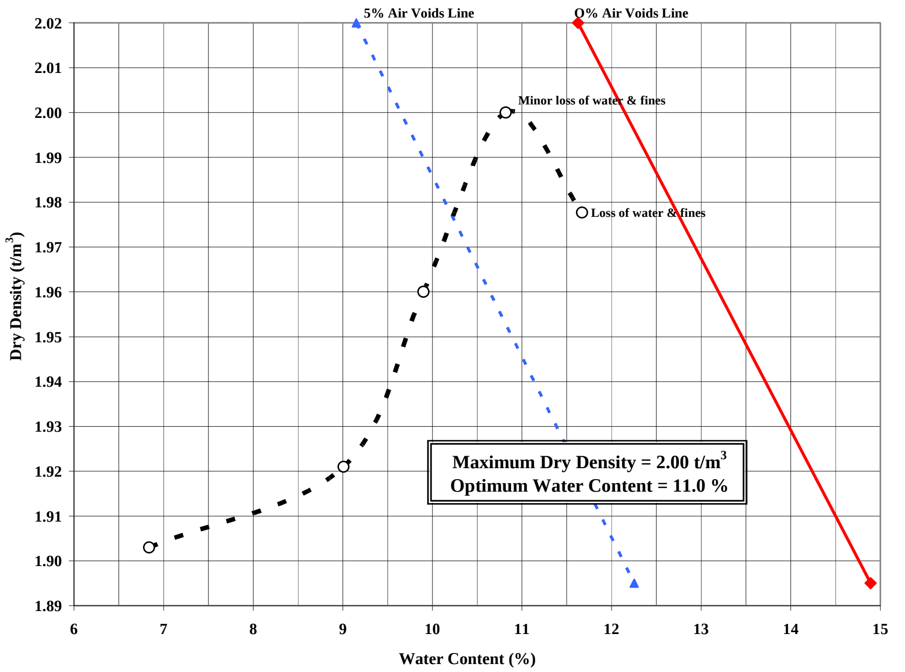
Client Details:	Oceana Gold Ltd, P.O. Box 84, Palmerston	Attention:	A. O'Meara
Job Description:	Top Tipperary TSF Investigations – Job No. 6846	Client Order No:	145437
Sample Description:	After NZ Vibrating Hammer Compaction Permeability; Silty Sandy GRAVEL with trace of clay	Sample Source:	TP#16 (0.5m to 1.8m) & TP#21 (1.0m to 2.0m)
Sampled By:	Unknown	Date Received:	22-Nov-10
Date & Time Sampled:	3 & 4-Nov-10	Sample Method:	Test Pit

SOLID DENSITY & NZ VIBRATING HAMMER COMPACTION - NZS 4402:1986, Test 2.7.1 & 4.1.3

% Retained: (+37.5mm Test Sieve)	0.0 %
Solid Dry Density: (-37.5mm Fraction)	2.64 t/m^3
Maximum Dry Density: (-37.5mm Fraction)	2.00 t/m^3
Optimum Water Content: (-37.5mm Fraction)	11.0 %

Notes:

- *The sample received was in a natural state.*
- *The material tested in the NZ Vibrating Hammer Compaction test was whole soil.*
- *The air voids lines were calculated from the tested solid dry density stated above.*



FALLING HEAD PERMEABILITY: AS 1289.6.7.2-2001 (Not IANZ Accredited)		
Compaction Used:	NZ Vibrating Hammer Compaction	
Sample Length: (mm)	161.4	
Sample Diameter: (mm)	388.7	
Initial Water Content: (%)	12.3	
Wet Density: (t/m^3)	2.14	
Dry Density: (t/m^3)	1.90	
Final Water Content: (%)	14.4	
Initial Head: (m)	1.07	1.22
Test Temperature: (^{o}C)	21.5	20.0
Permeability $k_{(20)}$	3.23 x 10^{-7} m/s	3.29x 10^{-7} m/s

General Notes:

- *IANZ endorsement of this report applies to the samples as received.*
- *IANZ endorsement of this report does not apply to the sample description.*
- *This report may not be reproduced except in full.*

Tested By: L.T. Smith & L.S. Gibson **Date:** 24-Nov-10 to 17-Jan-11

Transcriptions Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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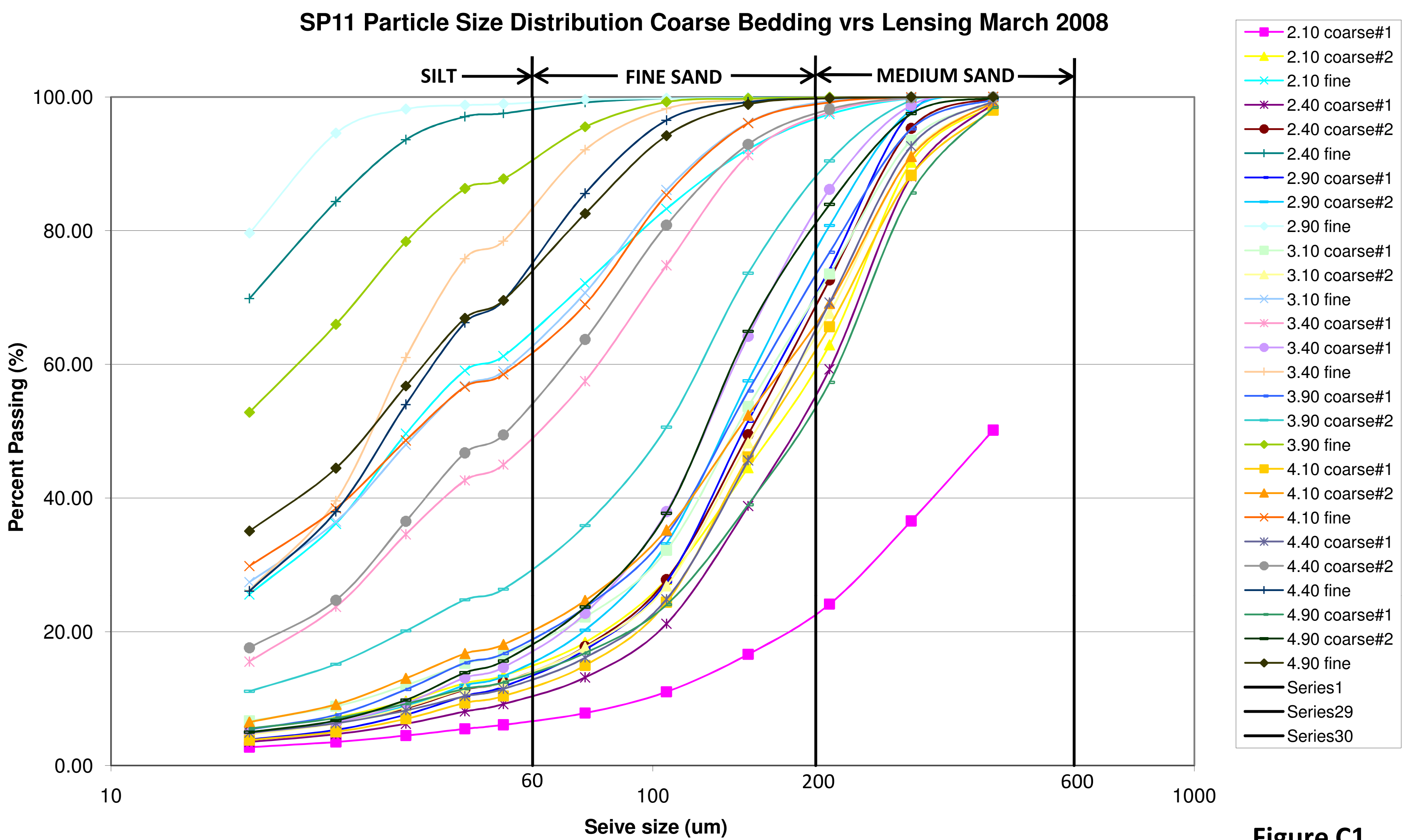
APPENDIX C

TAILINGS PARTICLES SIZE ANALYSES



SP11 Particle Size Distribution Coarse Bedding vrs Lensing March 2008
SILT
FINE SAND
MEDIUM SAND
Percent Passing (%)
100.00
80.00
60.00
40.00
20.00
0.00
10
60
100
200
600
1000
Seive size (um)
2.10 coarse#1
2.10 coarse#2
2.10 fine
2.40 coarse#1
2.40 coarse#2
2.40 fine
2.90 coarse#1
2.90 coarse#2
2.90 fine
3.10 coarse#1
3.10 coarse#2
3.10 fine
3.40 coarse#1
3.40 coarse#1
3.40 fine
3.90 coarse#1
3.90 coarse#2
3.90 fine
4.10 coarse#1
4.10 coarse#2
4.10 fine
4.40 coarse#1
4.40 coarse#2
4.40 fine
4.90 coarse#1
4.90 coarse#2
4.90 fine
Series1
Series29
Series30

Figure C1

APPENDIX D

SLOPE STABILITY ANALYSES

APPENDIX D

SLOPE STABILITY ANALYSES

D1. Summary

Results of stability analyses for the proposed TTTSF embankment are presented in this Appendix. A plan of the proposed TTTSF embankment is shown in Figure D1. Analyses have been undertaken for the highest section of the embankment. This is shown as Section X-X on Figure D1 and this cross-section is shown in Figure D2. Details of the assumptions adopted for the analyses are presented in the Main Report (refer Section 10.9). The assumed strengths for the embankment and foundations are summarised in Table D1. Results of the static stability analyses are presented in Figures D2 to D6 and are summarised in Table D2. Results of the seismic stability analyses are presented in Figures D7 to D12 and are summarised in Table D3.

TABLE D1

SUMMARY OF PROPERTIES FOR STABILITY ANALYSES

Zone	Density (kN/m3)	c' (kPa)	ϕ' (°)	Notes / Phreatic Surface
Ground	23.5	50	40	Refer SLOPE/W figures
Zone A1[1]	22.5	$\tau=2.43\sigma'^{0.83}$		Refer SLOPE/W figures
Zone B[1]	22.5	$\tau=2.43\sigma'^{0.83}$		Refer SLOPE/W figures
Zone C[1]	21.5	$\tau=1.29\sigma'^{0.91}$		Refer SLOPE/W figures
Insitu Rock				
• 0 to 5m depth	26	50	40	Failure through intact rock. Refer SLOPE/W figures for phreatic surface
• greater than 5m	26	150	45	
• Macraes Fault Zone	26	50	40	
Tailings				
- Static	18.6	0	35	Phreatic surface at tailings surface level
- OBE (150 Year)	18.6	$\tau/\sigma' = 0.13$		Phreatic surface at tailing surface level
- 475 year	18.6	$\tau/\sigma' = 0.13$		Phreatic surface at tailings surface level
MDE (2500 Year)	18.6	$\tau/\sigma' = 0.13$		Phreatic surface at tailings surface level. (conservative as long term level will be much lower)

[1] Strength function plotted below

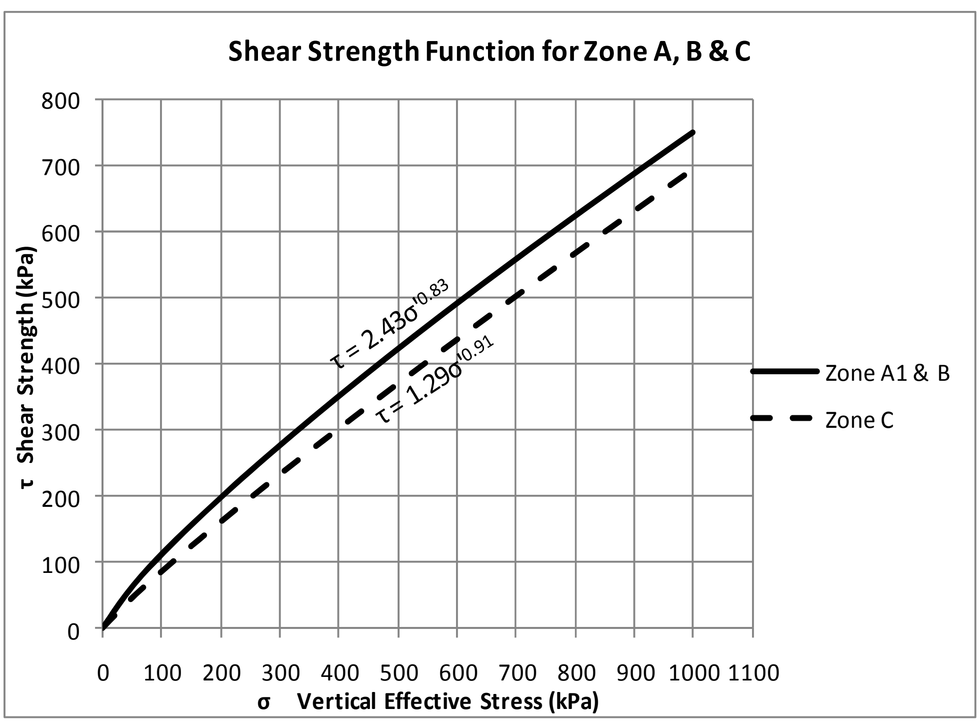


TABLE D2

SUMMARY OF RESULTS FOR STABILITY ANALYSES

Figure No.	Circle Location	Factor of Safety	Notes
D3	US	1.96	Initial Embankment RL 530
D4	DS	2.08	Initial Embankment RL 530
D5	US	1.87	Embankment with crest RL560
D6	DS	1.92	Embankment with crest RL560

US = Upstream DS = Downstream

TABLE D3

SIMPLIFIED DEFORMATION ANALYSIS DURING EARTHQUAKE SHAKING USING PSEUDOSTATIC STABILITY ANALYSES

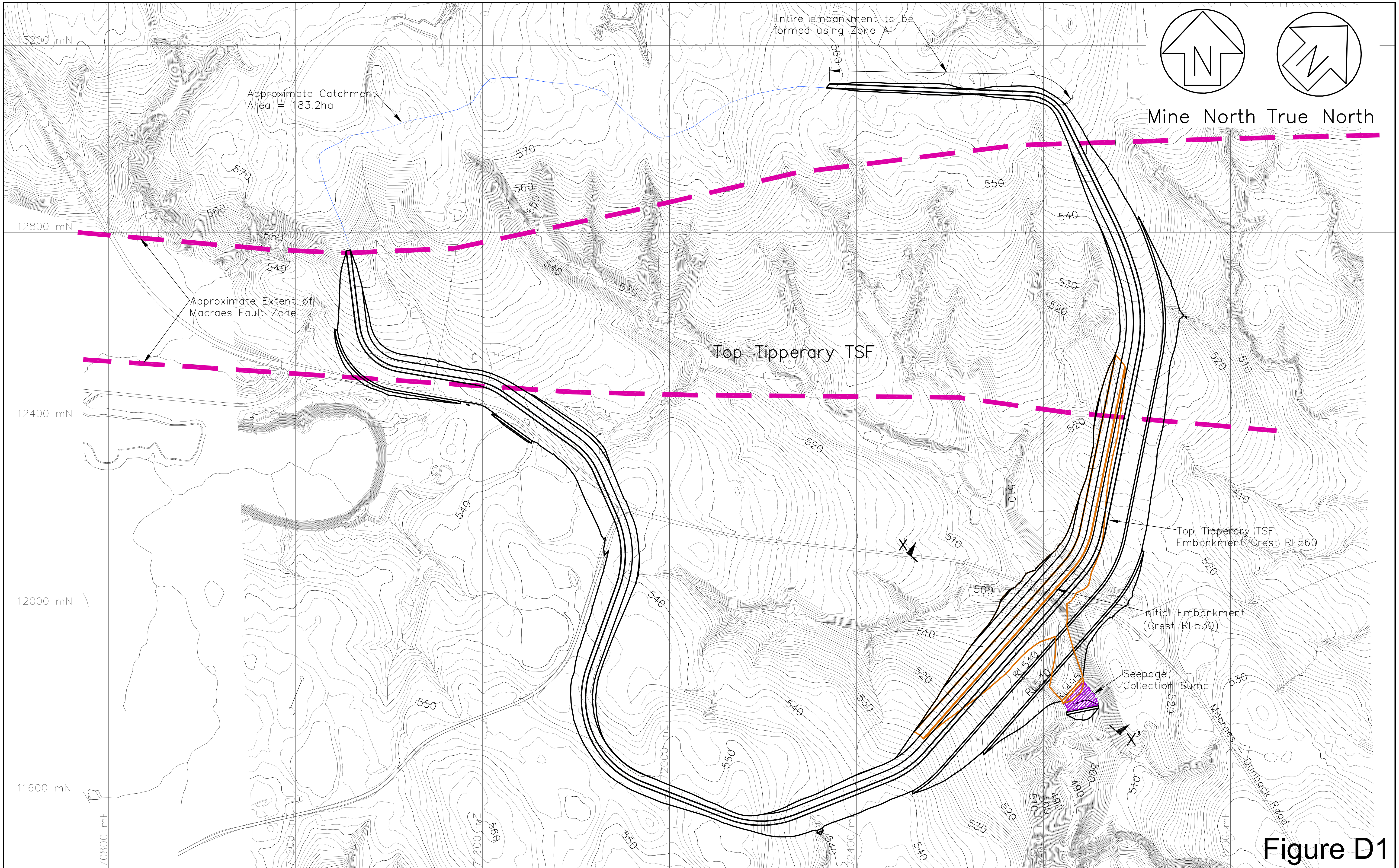
Loading	kh (g)[(1)]	kc (g)[(2)]	Predicted Permanent Deformation [(3)] (cm)		Depth of Failure Surface	Figure No.
			u_{50}	u_5		
475 year	0.33	0.27	0.01	0.1	H	D7
475 year	0.36	0.31	0.01	0.05	⅔H	D8
475 year	0.36	-	-	-	⅓H	D9
MDE	0.72	0.27	2.6	21	H	D10
MDE	0.72	0.31	1.6	13	⅔H	D11
MDE	0.8	0.46	0.6	4.7	⅓H	D12

Note: Three cases considered for each loading. Failure through top 1/3 and 2/3 of embankment and failure full depth through embankment to determine most critical displacement.

(1). kh (g) = average acceleration within the potential failure mass for various return period earthquakes (determined from QUAKE/W analyses)

(2). kc (g) = yield acceleration within the potential failure mass for a FOS = 1.0, determined using pseudostatic stability analyses.

(3). Simplified permanent deformation determined using Jibson (2007). u_{50} and u_5 are displacements with 50% and 5% probably of exceedance respectively.



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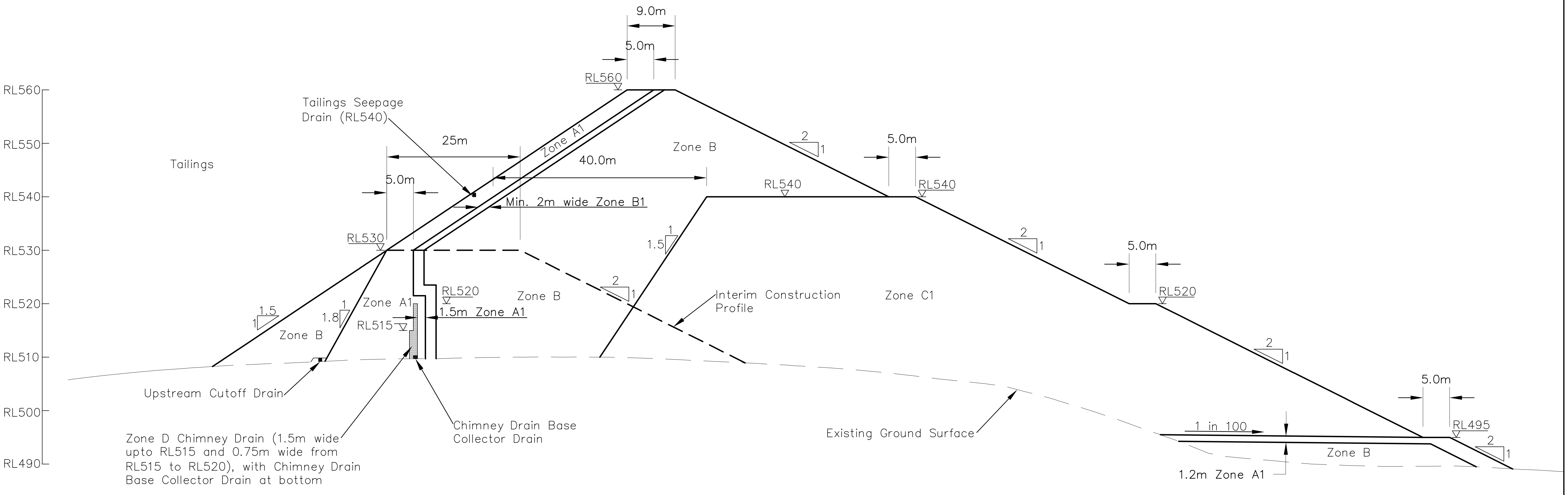
OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Top Tipperary TSF
Site Plan

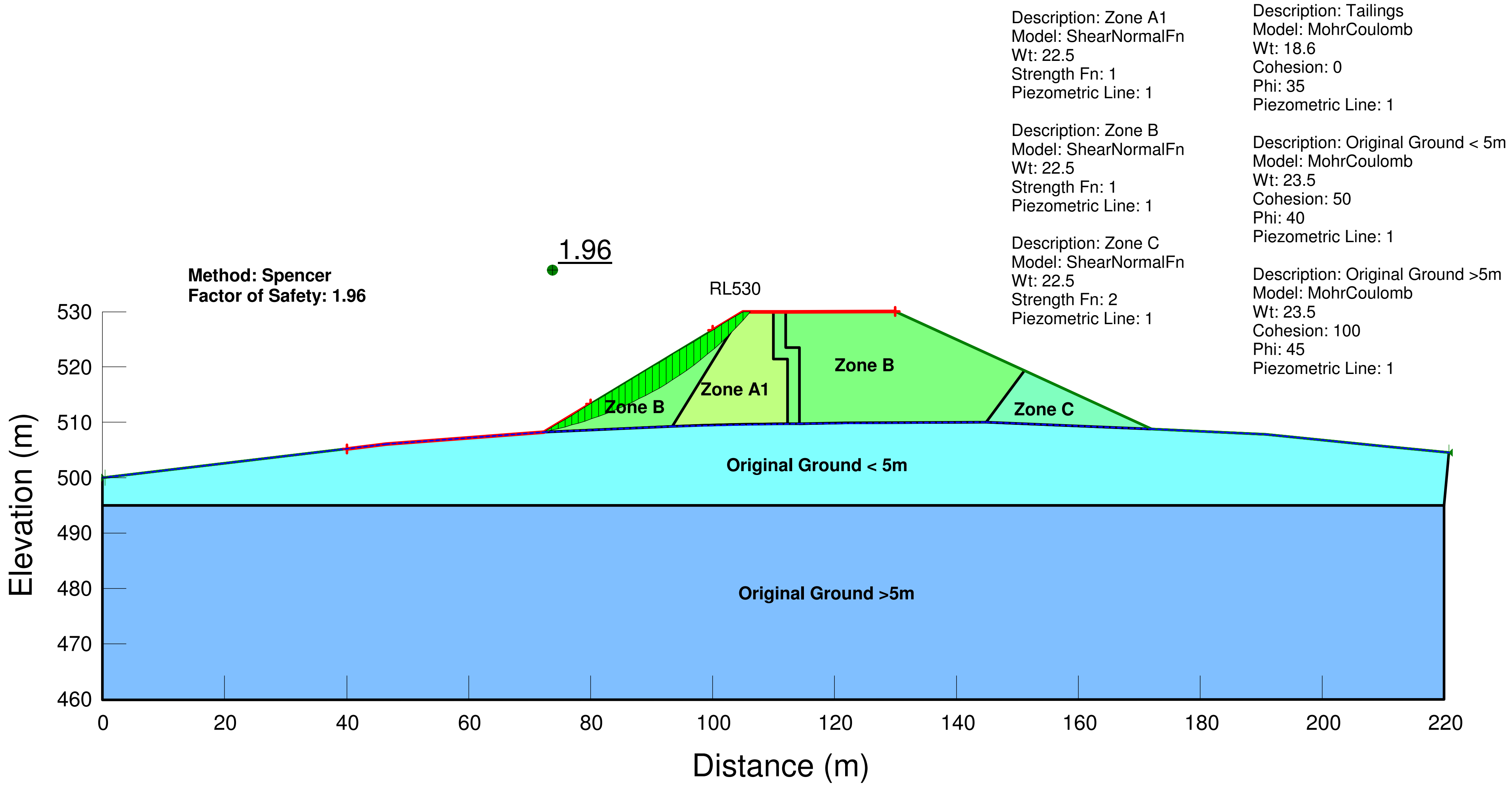
Drawing No.	6846–Fig 3
Date:	13 Jan 2011
Drawn:	BL
Scale:	1:7500 (@A3)
Filename:	6846–Fig 3.dwg



Embankment Cross Section X – X'

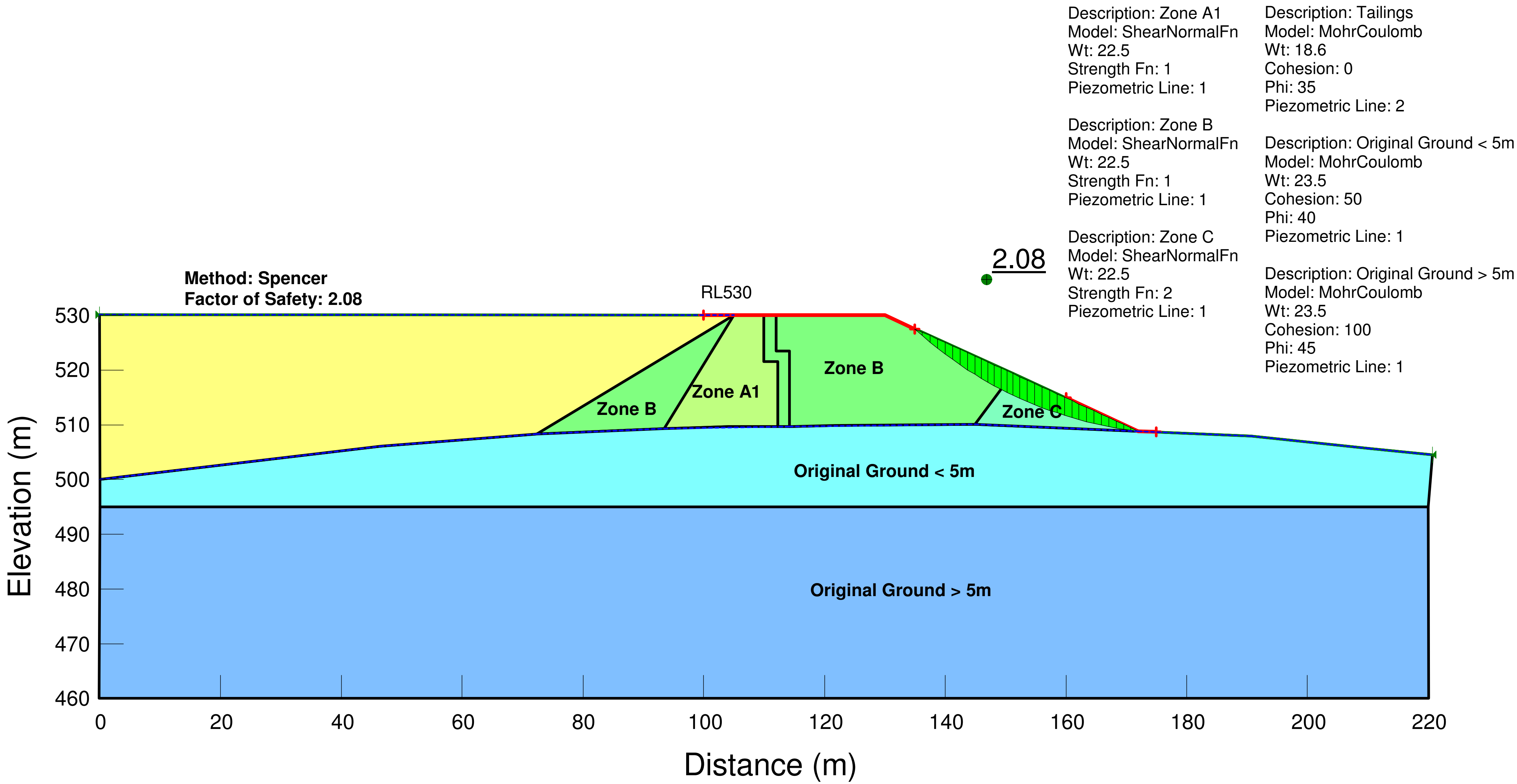
Figure D2

ENGINEERING GEOLOGY LTD Unit 7C, 331 Rosedale Rd, PO Box 301054, Albany Ph (09)486–2546, Fax (09)486–2556	OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT Top Tipperary TSF *Embankment Cross Section X - X'*	Drawing No. 6846–Fig 8 Date: 13 Jan 2011 Drawn: BL Scale: 1:750 (@A3) Filename: 6846–Fig 8.dwg



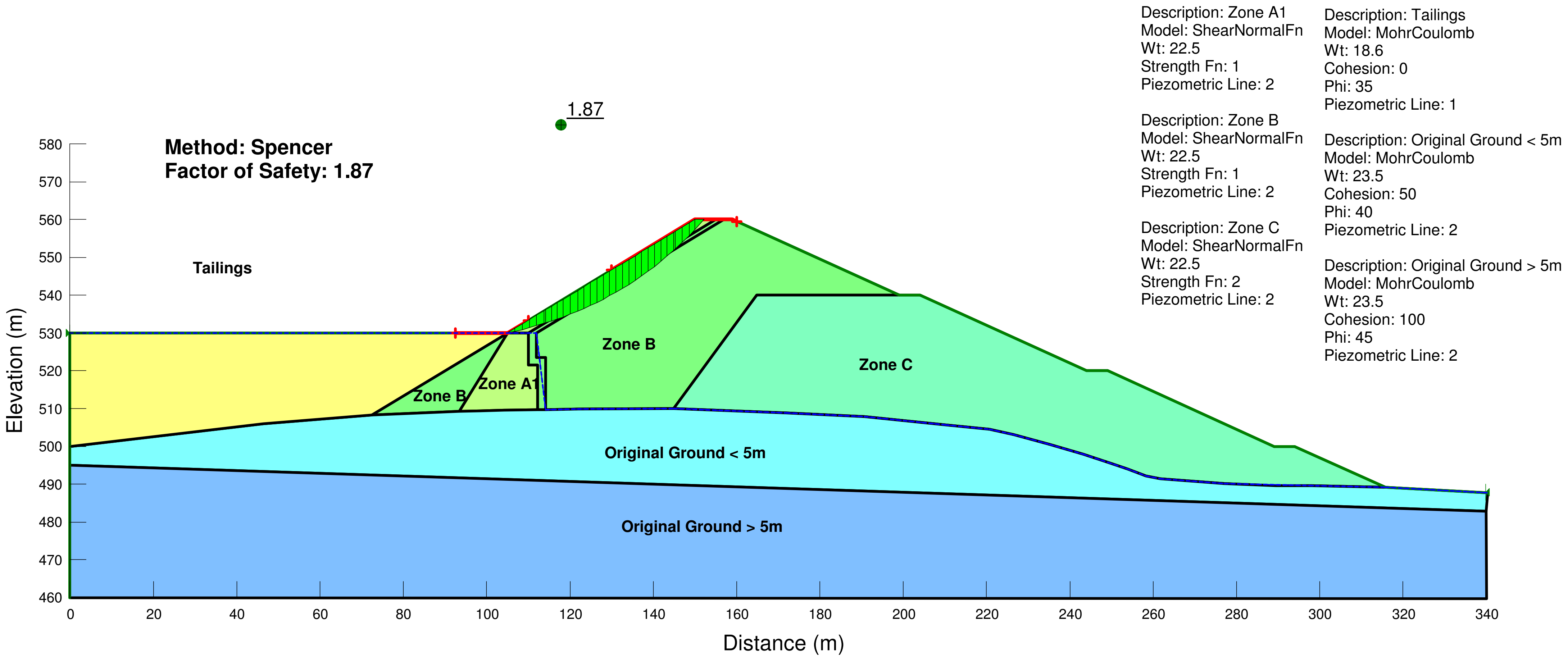
Oceana Gold Mine - Top Tipperary TSF RL530 - Typical Section
Long Term - Static Analysis for Upstream Shoulder

Figure D3



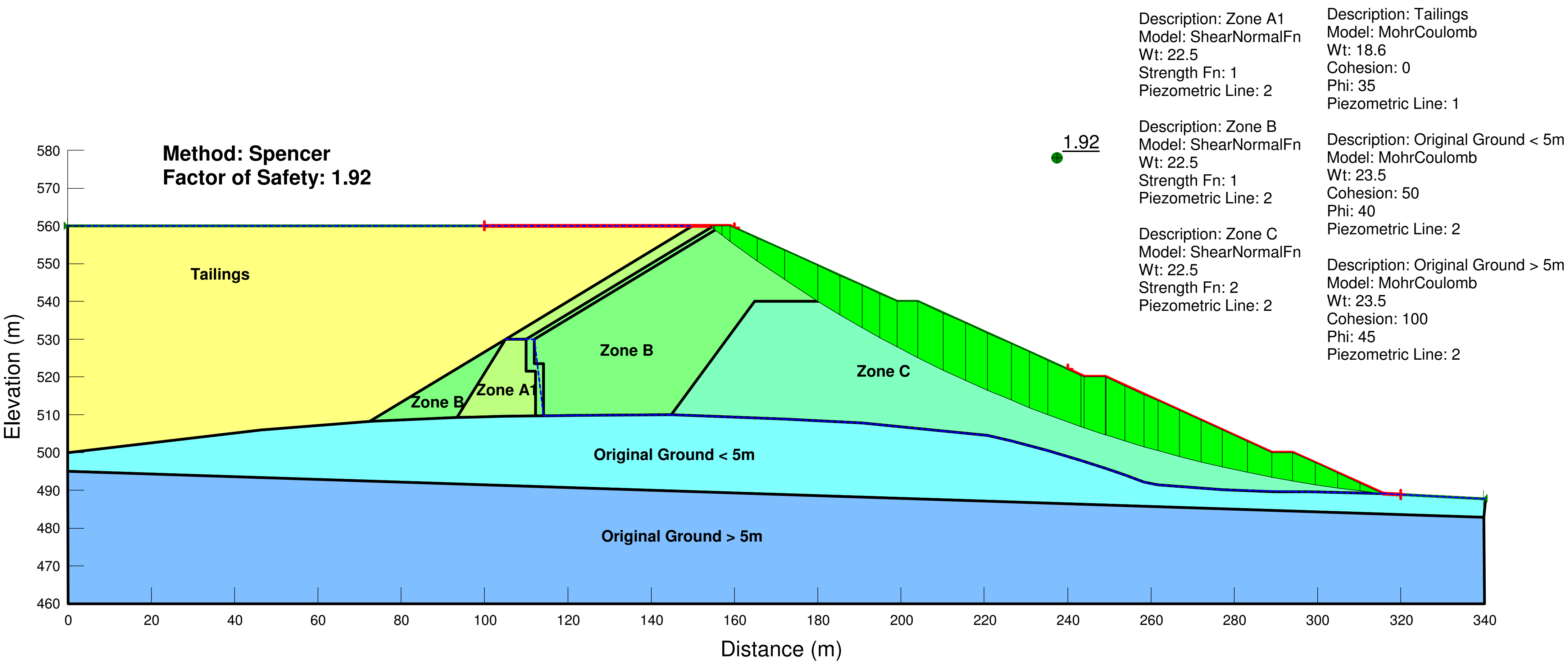
Oceana Gold Mine - Top Tipperary TSF RL530 - Typical Section
Long Term - Static Analysis for Downstream Shoulder

Figure D4



Oceana Gold Mine - Top Tipperary TSF RL560 - Typical Section
Long Term - Static Analysis for Upstream Shoulder

Figure D5

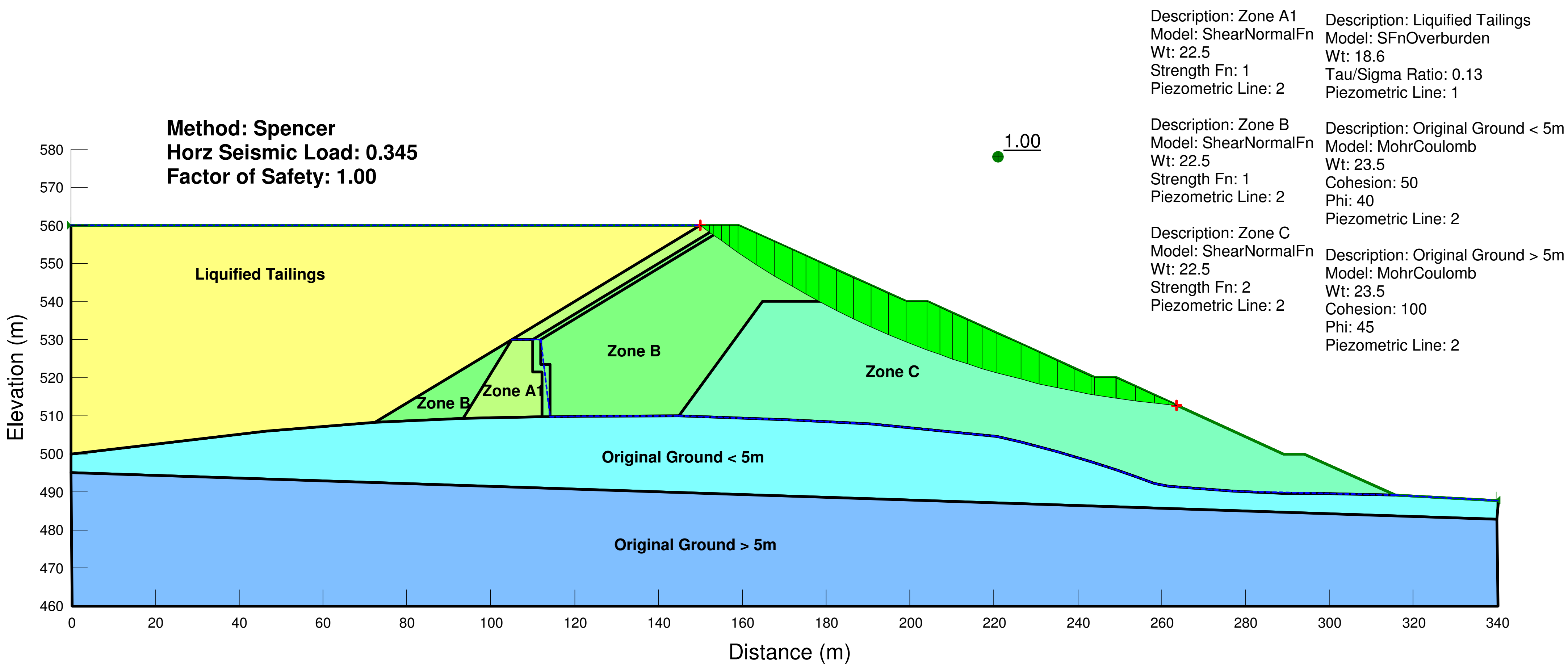


Oceana Gold Mine - Top Tipperary TSF RL560 - Typical Section
Long Term - Static Analysis for Downstream Shoulder

Figure D6

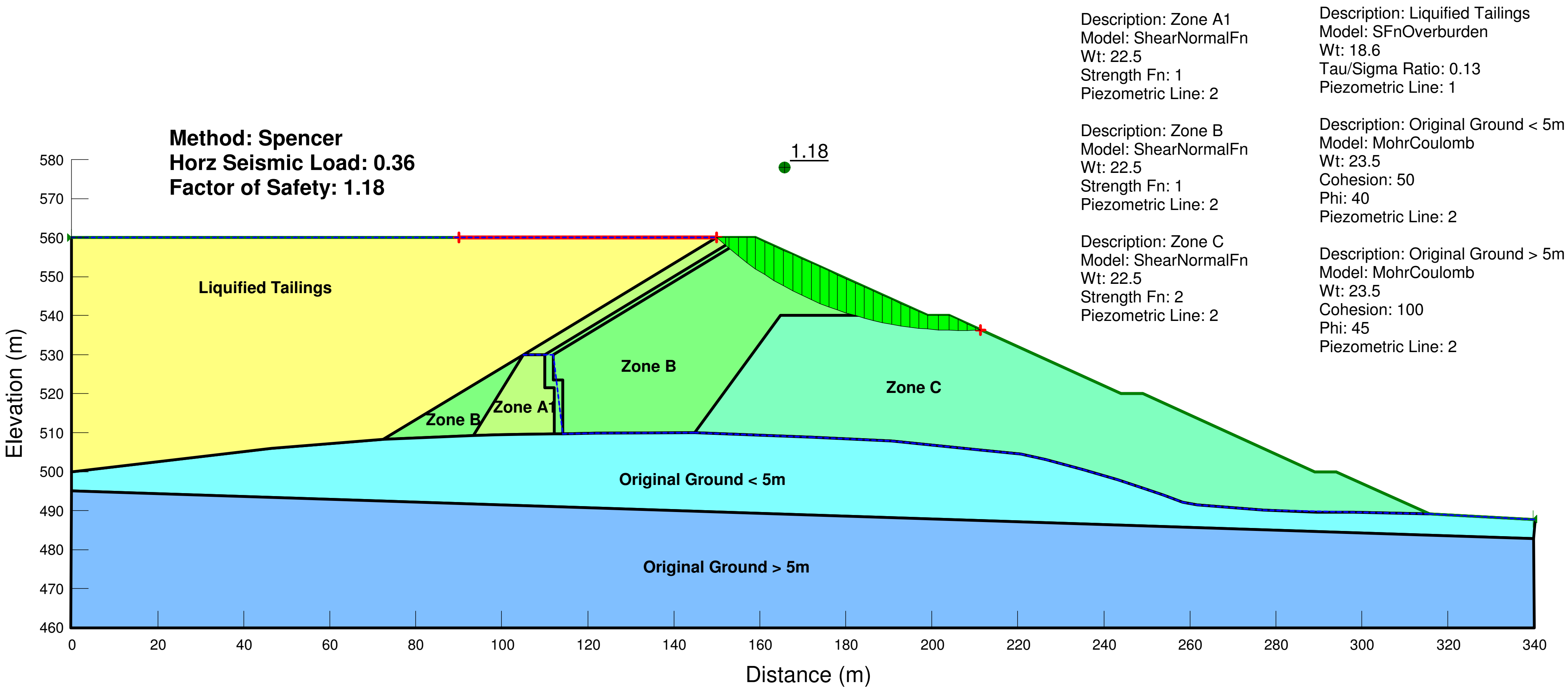
Oceana Gold Mine - Top Tipperary TSF RL560 - Typical Section
Earthquake 475 Yr Return Period - Full Dam Height (Yield Acceleration)

Figure D7



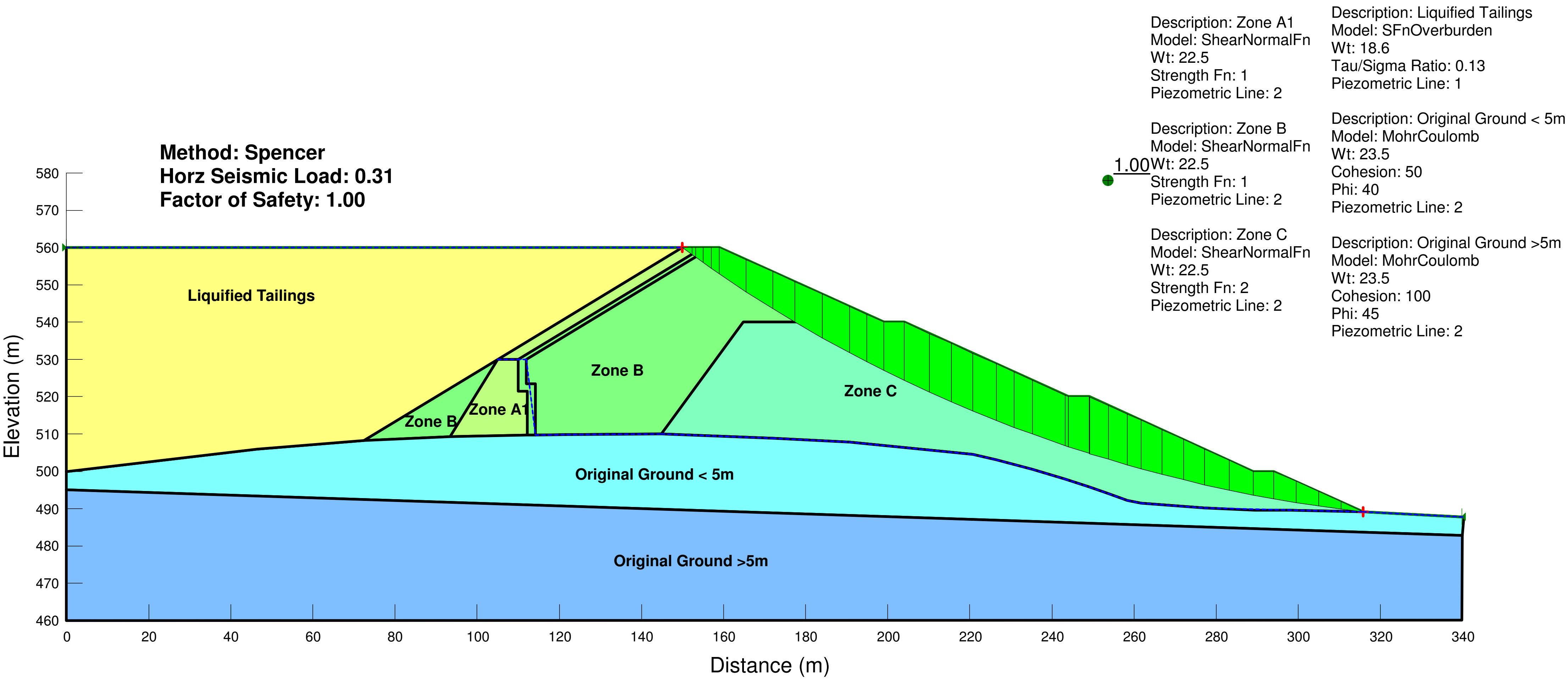
Oceana Gold Mine - Top Tipperary TSF RL560 - Typical Section
Earthquake 475 Yr Return Period - Two Thirds of Dam Height (Yield Acceleration)

Figure D8



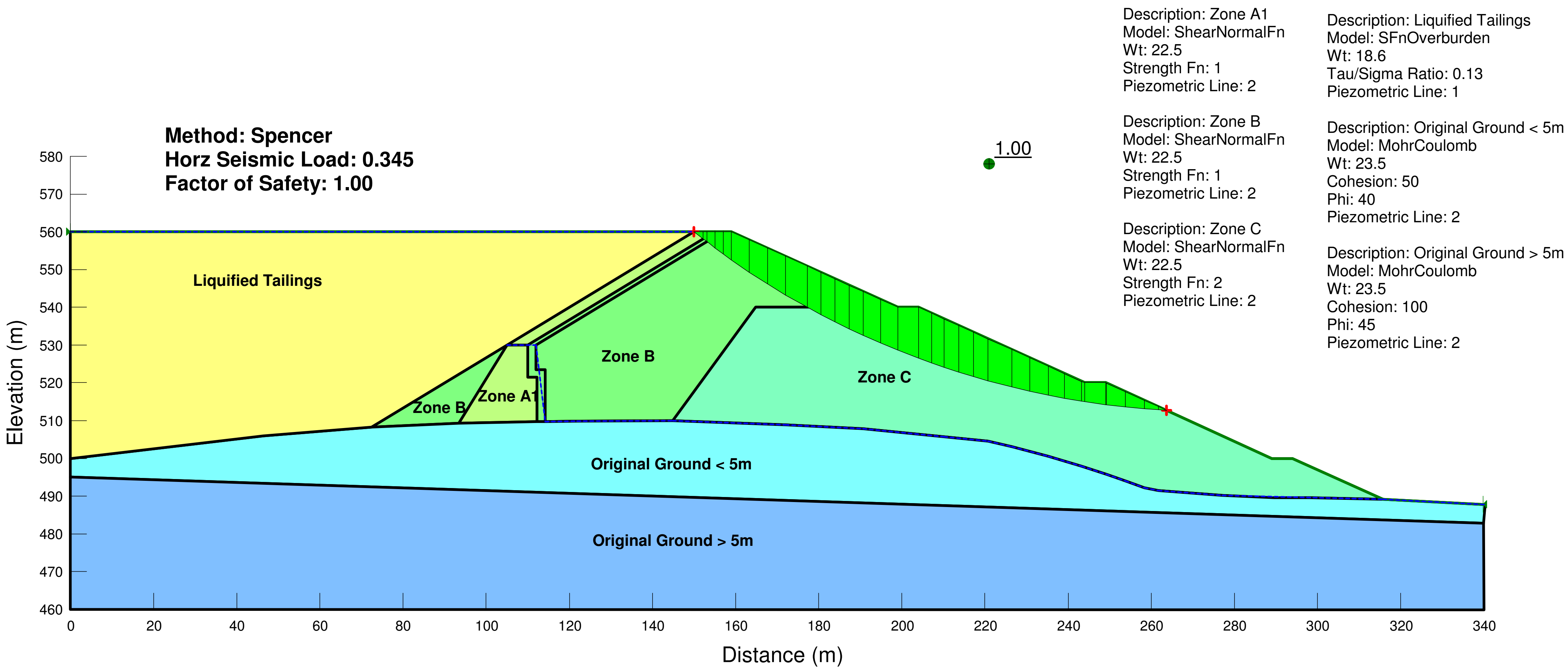
Oceana Gold Mine - Top Tipperary TSF RL560 - Typical Section
Earthquake 475 Yr Return Period - One Third of Dam Height

Figure D9



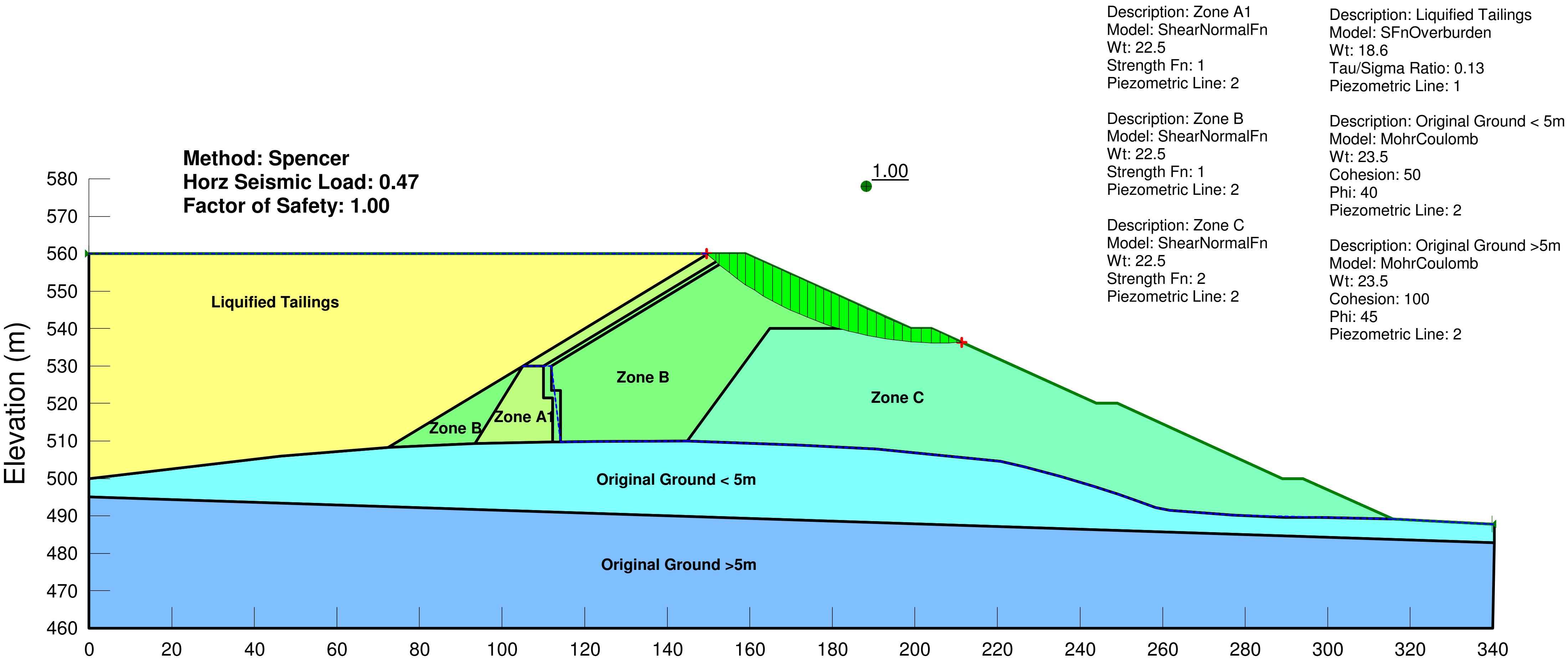
Oceana Gold Mine - Top Tipperary TSF RL560 - Typical Section
Earthquake 2500 Yr Return Period - Full Dam Height (Yield Acceleration)

Figure D10



Oceana Gold Mine - Top Tipperary TSF RL560 - Typical Section
Earthquake 2500 Yr Return Period - Two Thirds of Dam Height (Yield Acceleration)

Figure D11



Oceana Gold Mine - Top Tipperary TSF RL560 - Typical Section
Earthquake 2500 Yr Return Period - One Third of Dam Height (Yield Acceleration)

Figure D12