Engineering Geology Ltd
CONSULTING GEOTECHNICAL, GEOLOGICAL AND EARTHQUAKE ENGINEERS

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Ref: 6965

OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
MACRAES PHASE III PROJECT
EROSION AND SEDIMENT CONTROL

Prepared for:

29 April 2011

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

CONTENTS

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MACRAES PHASE III PROJECT
EROSION AND SEDIMENT CONTROL

1.0 INTRODUCTION

Oceana Gold (NZ) Ltd (OceanaGold) operates a gold mine, known as the Macraes Gold Project (MGP), at Macraes Flat in East Otago located between Middlemarch and Palmerston as shown in Figure 1. The current mining operations involve mining of a large open pit and underground mine. Associated with the MGP are waste rock stacks for disposal of pit overburden material and tailings storage facilities for disposal of tailings. The current layouts of these various features are shown in Figure 2. OceanaGold is proposing to extend its current operations. The Macraes Phase III Project will take the consented life through to 2020. The proposed key elements are shown in Figure 3 and are summarised below:

- Redevelopment and extension of Frasers Pit, Round Hill – Southern Pit and Innes Mills Pit.
- Construction of new waste rock stacks (WRS) at Frasers North and Frasers South.
- Significant expansion of the existing Back Road Waste Rock Stack (BRWRS)
- Construction of the Top Tipperary Tailings Storage Facility (TTTSF).

The new and expanded WRSs and TTTSF will require erosion and sediment control throughout their lives until they are completed and rehabilitated. It is proposed the erosion and sediment control plans (ESCP) be prepared prior to construction commencing. Construction of the WRSs and the TTTSF extends over a number of years.

This report outlines the proposed concepts for managing erosion and sediment control to support the Assessment of Environmental Effects (AEE) for consents for the Macraes Phase III Project. It identifies the practises and procedures to minimise erosion and sedimentation associated with the Macraes Phase III project, and the treatment of runoff prior to discharge into the tributaries of the Tipperary, Deepdell and Cranky Jims Creeks. Erosion and sediment control associated with runoff from the existing Frasers West and Frasers East WRSs into the North Branch Waikouaiti River and Murphys Creek and from the MTI and SP11 TSFs and various WRSs to Deepdell Creek are covered by existing Resource Consent conditions. The purpose of this report is to provide information on the proposed erosion and sediment control approach and mitigation so that the Otago Regional Council (ORC) can be confident that any effects from activities will be no greater than minor. It is the intention to develop appropriate ESCPs for individual elements of the Phase III Project following procurement of resource consents. The ESCPs will form part of the documentation provided at the time of application for Building Consents.

2.0 EROSION AND SEDIMENT CONTROL PLANS

Erosion and sediment control plans (ESCP) will be developed for individual project elements following procurement of consents. The ESCPs will follow the principles embodied in the Environment Canterbury's Erosion and Sediment Control Guideline (Ref. 1), but adapted to suit local conditions and experience, in particular anticipated rainfall and soil type.

The ESCPs will detail the design of specific erosion and sediment control devices, responsibilities for implementation, construction details and standards, construction timetable, maintenance, monitoring and reporting procedures, response to storm events and contingency measures.

3.0 SITE DESCRIPTION

The locations of the proposed TTTSF, Frasers North WRS, Frasers South WRS and expanded Back Road WRS are shown in Figure 3. They extend from approximately 440 to 650m above sea level and cover the catchments of the Tipperary Creek, Cranky Jims Creek, Deepdell Creek, North Branch Waikouaiti River, and Murphy's Creek. The locations of these creeks are shown in Figure 4. The TTTSF is located east of Frasers Pit and the natural drainage is mostly to the southeast to Tipperary Creek with some to the east to Cranky Jims Creek. The Frasers North and South WRSs are located north and south of the existing Frasers Pit, and within the catchment of the North Branch Waikouaiti River and Murphy's Creek respectively. The Back Road WRS is located north of the TTTSF within the catchment of Deepdell Creek.

The Tipperary, Cranky Jims and Deepdell Creeks are tributaries to the Shag River which is east of the MGP. The Shag River flows to the south-east, past Palmerston to the east coast of the South Island. Murphys Creek is a tributary to the North Branch Waikaouiti River which flows southeast out to the ocean at Waikouaiti.

4.0 SITE SOILS AND EROSION POTENTIAL

Soils at the site consist of a sequence of:

- topsoil
- loess (silt) that varies in depth from less than 0.1m up to 3m locally, but is generally less than 1m thick. These soils are fine and erodible
- colluvium (gravel sized rock with some sand/silt) located near the base of slopes
- schist rock which outcrops in places but is generally present at shallow depth (typically less than 1m)

Waste rock is predominantly overburden material from the Pits and is mostly disposed of in the WRSs. It is rockfill varying from gravel to boulders in size (typically 10mm to 0.5m). It is also the largest quantity of fill used in the construction of water and tailings retaining embankments.

The surficial soils that blanket the site are erodible (i.e. loess). The waste rock is coarse in nature and is low risk with respect to erosion and sediment loads. Stripping of the surficial soils is the main risk and so management of this activity and the use of appropriate erosion and sediment controls are necessary.

5.0 EXISTING EROSION AND SEDIMENT CONTROL

OceanaGold have been operating the MGP for 20 years. Management of erosion and sediment control has been an important part of the operation and has followed the principles embodied in the Guidelines prepared by the Auckland Regional Council (Ref.2), modified where appropriate based on operating experience. Runoff from pits and associated haul roads generally collects in the base of the pits and is pumped to the Process Plant where it is used in the processing of ore or used for dust control. Runoff and seepage water from the WRSs reports to silt ponds. Water is decanted and discharged downstream to existing watercourses, pumped back to the Process Plant or used for dust control. Runoff from TSFs during construction has either been directed to silt ponds or pits. Photographs of some existing silt ponds (Clydesdale, Deepdell North, Deepdell South, Frasers West and Murphy's Creek) are shown in Plates 1-5 respectively.

The existing erosion and sediment control practice includes:

- silt ponds to allow time for settlement of suspended solids associated with runoff from disturbed areas
- diversion drains to divert runoff from disturbed areas to silt ponds
- cleanwater diversion drains to divert runoff from undisturbed areas away from disturbed areas
- progressive stripping of WRS footprints only as required
- steep gullies are not stripped beneath WRSs, except in the base of gullies at the toe of the WRSs, so as to leave a buffer that acts to intercept sediment from areas stripped above
- stripping of topsoil and loess soils only undertaken in dry weather conditions with most over summer months
- management of surface water on the surface of the WRSs including preventing runoff from discharging over the outside shoulder, excavation of soak pits to allow surface runoff to soak into the waste rock (which acts to filter out fines) and end-tipping to create coarser rock in gullies which act as underdrains
- progressive rehabilitation of WRS and TSF embankments consisting of 0.3m of oxidised waste rock and 0.2m of topsoil and grassing to minimise bare areas
- benches provided on shoulders of WRSs and TSF embankments at 20m vertical intervals to control runoff
- adoption of appropriate sediment control practise (e.g. silt fences, decanting bunds) in accordance with the Auckland Regional Council (ARC) Technical Publication No 2 'Erosion and Sediment Control Guidelines for Earthworks' (Ref. 2)
- monitoring of discharges as required by consent conditions
- regular inspections of silt ponds and diversion drains to check condition and undertake maintenance if required

Silt ponds have been constructed in advance of placement of waste rock in WRSs or construction of TSFs. In all cases the silt ponds have been created by construction of dams across gullies or streams immediately downstream of the disturbed areas. Typically the dams have been zoned embankments consisting of a central core of low permeability fill with rockfill shoulders. The low permeability fill has either been sourced locally from loess and colluvium or from overburden material from the pits. The rockfill has largely been sourced from Pit overburden material. The design criteria for the silt ponds have changed with time. The initial silt pond in Maori Tommy Gully, downstream of the MTI, was designed to store the runoff from a 2 year – 7 day storm event from a 150ha catchment, allowing for pump back to the Process Plant at $162m^3$/hr. Other smaller silt ponds associated with the initial project development were designed to store the runoff from either a 10 year-1 hour or 2 year - 1 hour storm. Runoff was calculated with runoff coefficients that varied between 0.6 and 0.7 depending on whether catchments were undisturbed or disturbed. The spillway for the Maori Tommy Silt Pond was designed to pass the 100 year flood event while the smaller ponds that had limited life were designed to pass the 10 year flood event.

Silt ponds designed later in the life of the project for WRSs (Deepdell South and North, Frasers West, Clydesdale Creek, Murphys Creek) were designed according to the criteria summarised in Table 1.

Table 1. Silt Pond Design Criteria

No.	Criteria
1.	Storage sufficient to contain at least the initial 24 hour rainfall from a 2year-72hour rainfall event (70mm rainfall)
2.	Service and emergency spillways capable of passing flows from 10year and 100year return period rainfall events respectively
3.	Ponds provided with either pump-back facilities or a constricted flow outlet to decant impounded water. Pump or decant designed to recover the minimum live storage in no more than 5 days
4.	Dam, spillway and associated structures designed, constructed, operated and maintained for the life of the dam in accordance with the general principles of New Zealand Society of Large Dams (NZSOLD) Dam Safety Guidelines (Ref. 3)

Storage volumes have typically been calculated using runoff coefficients of between C=0.32 and 0.7. Higher runoff coefficients have been adopted for small catchments. Experience is that a large proportion of rainfall either infiltrates or evaporates and that this is more significant for larger rock stacks and justifies lower runoff coefficients. The existing Murphys Creek silt pond was designed with a runoff coefficient of C=0.32 and operating experience indicates that this has been more than sufficient.

The decant facility adopted for most silt ponds has been a perforated manhole structure as shown in Plate 6. This simple design has proven to work effectively at the Macraes Gold Project rather than floating decants which were tried in the early stage of the project but were found to require considerably greater ongoing maintenance and were prone to damage. The manhole also acts as the service spillway. The perforated holes have typically been set at a level which provides generous dead storage and water is sometimes drawn-down further by pumping for dust control.

Experience to date is that stormwater runoff is typically low in suspended solids. This is apparent in the small volumes of silt that have been collected in silt ponds, the clarity of discharge and measurements of the suspended solids content of the discharge by OceanaGold. It is due to a combination of the low rainfall, the limited exposure of fine soils and the permeable nature of the waste rock in the WRS and in the downstream shoulders of the TSF embankments. This last factor is of particular importance as the permeable nature of the waste rock results in a high proportion of rainfall infiltrating the

WRSs and TSF embankments. The runoff from the waste rock does not have a particularly high sediment load, but as it drains through the waste rock most sediment is trapped and filtered out. The waste rock is typically end dumped in high lifts. This results in segregation with coarse rock at the base of each lift as shown in Plates 7 and 8 which acts as an underdrain beneath. High volumes of water can percolate through such material. The surface of the WRSs is sloped away from the outside shoulder so that runoff flows back to the contact with natural ground as shown in the schematic in Figure 5. Infiltration of runoff into the WRSs is actively encouraged by the digging of sumps as necessary if water begins to pond on the active fill surface.

The critical time for generation of sediment is at the initial stage of construction of WRSs and TSF embankments. Typically the foundations will be stripped, except where the ground is too steep to be practical, and this can expose loess. Until waste rock is placed above, these soils can be moderately erodible. Steep gullies are not stripped beneath WRSs, except in the base at the downstream toe, and the remaining vegetation acts to assist in intercepting and retaining sediment from higher ground. It is, however, necessary to construct initial silt ponds in gullies downstream of the disturbed areas. Once waste rock is placed then the potential for generation of sediment is significantly reduced.

OceanaGold have been operating the MGP for 20 years. The existing erosion and sediment control practices have worked well throughout the life of the mine to date and no known issues have been identified.

6.0 MACRAES PHASE III EARTHWORKS

The areas of disturbed land associated with the Macraes Phase III project that will require erosion and sediment control are summarised in Table 1.

Table 2. Summary of Areas Requiring Erosion and Sediment Control

Area	Disturbed Area (ha)
Frasers South WRS	60
Frasers North WRS	25
Back Road WRS	215
TTTSF embankment - initial	38
TTTSF embankment - downstream shoulder	20
Camp Creek Dam - embankment and spillway	0.7
Camp Creek Dam - borrow area	10

It is noted that areas that report to pits are not included as runoff is pumped back from the pits to be used in the Process Plant.

7.0 PROPOSED EROSION AND SEDIMENT CONTROL PRACTICE

7.1. General

Prior to commencement of construction Erosion and Sediment Control Plans will be prepared. The Plans will incorporate modern erosion and sediment control practices that are documented in the Environment Canterbury Guidelines (Ref.1) except that site specific design criteria will be adopted for sizing silt ponds that are based on experience at the site. In general terms the design of erosion and sediment control measures will follow existing practice which is summarised in section 5.0. Specific erosion and sediment control measures will include:

- Cleanwater diversion drains with small dams located in gullies where necessary to divert runoff into the diversion drains. Such dams will contain less than 3m depth of water and the storage capacity will be less than 20,000m^3. Where necessary gullies will be in-filled to ensure retained water depths are less than 3m. Cleanwater diversion drains will be designed for a 1 in 20 AEP storm with 0.25m freeboard. Any permanent cleanwater diversion drains will be designed for a 1 in 100 AEP storm with 0.25m freeboard. Where necessary (e.g. steeper ground, erosive soils) the drains will be lined (e.g. rockfill, geotextile) and energy dissipation will also be provided at high energy locations (i.e. at the bottom of steep sections of drain where velocities are high).
- Silt ponds downstream of disturbed areas. Permanent silt ponds will be designed according to existing criteria that are summarised in Table 1. The sizing depends on the catchment area and runoff coefficient. Decants similar to those currently on site will be adopted, but will be designed to allow for attachment of floating decants. Service and emergency spillways will be provided and designed to pass the flows from 10year and 100year return period rainfall events.
- Shoulders of WRSs and TSF embankments will have benches every 20m vertical height to control runoff.
- Perimeter surface water drains located around the perimeter of WRSs and TSF embankments where appropriate, to ensure runoff is conveyed to the base of gullies without erosion. Temporary drains will be designed for a 1 in 20 AEP storm with 0.25m freeboard. Permanent drains will be designed for a 1 in 100 AEP storm with 0.25m freeboard. Such drains will be lined where necessary and energy dissipation will be provided at high energy locations (i.e. at the bottom of steeper sections of the drains where velocities are high).

Comments on proposed erosion and sediment controls for the WRSs and TTTSF are discussed in more detail in the following sections.

7.2. Waste Rock Stacks

Erosion and sediment control concepts for WRSs are shown in Figure 5. They have previously been described in section 5.0. The critical stage is the initial stage of filling (referred to as Initial Toe Fill in Figure 5). The toe silt pond will be designed for a high runoff coefficient from the initial disturbed footprint (C=0.6). It will also be designed for the ultimate disturbed catchment but using a lower coefficient to reflect the practice of diverting much of the surface water into the coarse rock underdrain's beneath the WRS.

The proposed erosion and sediment control concepts for the Back Road WRS are shown in Figure 6. Clean water diversion drains divert clean water away from disturbed areas. Small dams will be located in gullies where required to divert water into the cleanwater drains. Toe silt ponds are located in gullies downstream of the initial toe fills. The maximum initial catchment area for the silt ponds is no greater than 20ha and the maximum final catchment area for any pond will be less than 50ha. Consequently silt ponds will store less than 20,000m^3. The maximum depth of water will be less than 3m and this will be achieved, if necessary, by infilling the gully floors as shown in Figure 5. Perimeter surface water drains are located where required to safely divert runoff to gullies downstream. At times additional silt ponds may be constructed on the surface of the WRS if required (e.g. if 'underdrains' beneath WRSs have insufficient capacity). The need for and locations of such ponds would be determined during construction.

Existing and proposed sediment control concepts for WRSs associated with the Frasers Pit area are shown in stage plans in Figures 7, 8 and 9. Figure 7 shows the existing situation. Figures 8 and 9 show the proposed concepts in 2016 and 2020 respectively. Figure 7 shows existing silt ponds (Frasers West, Redbank, Murphy's Creek and Frasers East). Diversion drains around the perimeter of the WRSs divert water to the silt ponds. Some of the diversion drains are located on benches at lower elevations on the WRSs. This is necessary to get water to the silt ponds. The Frasers East silt pond consists of two ponds with a connecting drain. Water drains to the northern pond and is pumped from here to the west of Frasers Pit into the headwaters of the North Branch Waikouaiti River. In large storm events water overflows from the ponds into Frasers Pit.

Figure 8 shows the Frasers Pit area in 2016. The same silt ponds as shown in Figure 7 are still present except for the Frasers East Silt pond which is relocated to the east to allow for expansion of Fraser Pit. Figure 8 also shows rock stack underdrains beneath the Frasers South WRS. These underdrains are coarse rockfill placed in existing gullies that naturally drain towards Frasers Pit. It is expected that a large proportion of runoff will travel through the underdrains during active placement of rockfill. It is possible the Redbank Road silt pond will need enlarging unless a higher level diversion drain is constructed at low elevation within the WRS footprint to divert more runoff to Murphy's Creek. Runoff collecting into the Frasers East silt pond will continue to be pumped to the west via a pipeline, but at times of large runoff some water will be diverted into Frasers Pit.

Figure 9 shows the Frasers Pit area in 2020 when mining is complete in this area. The Frasers West and Murphy's Creek silt ponds could be retained as permanent water storage ponds. Runoff from the south and east side of the Frasers East WRS will need to be piped beneath the WRS as shown in Figure 9. The underdrain will be constructed along the same alignment as the perimeter drain shown in Figure 8. The underdrain will consist of a pipe surrounded by selected coarse rockfill.

7.3. TTTSF

Sediment control concepts for the TTTSF are shown in Figure 10. 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 (Figures 10 and 11). 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 (refer to Figure 11) and by diverting runoff from the embankment into a gully to the north as indicated in Figure 10. The small embankment at the downstream toe of the TTTSF also forms the upstream wall of the Seepage Collection Sump. 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 10.

8.0 SUMMARY AND CONCLUSIONS

OceanaGold proposes to extend its existing operations at the Macraes Gold Project (Macraes Phase III Project). The proposed expansion includes redevelopment and extension of existing pits, construction of new and expansion of existing waste rock stacks (WRS) and construction of the Top Tipperary Tailings Storage Facility (TTTSF).

Erosion and sediment control plans will need to be developed to manage and control erosion and sediment associated with construction and operation of the WRSs and the TTTSF. Runoff from the pits is captured in the base of the pits and is pumped back for use in the Process Plant and so no specific sediment control is required.

OceanaGold have been operating the Macraes Gold Project for 20 years. Existing erosion and sediment control practices have worked well and so similar practices are proposed for the Macraes Phase III Project.

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Report Reviewed By

J A Yeats (CPEng)

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1. Environment Canterbury. (2007) 'Erosion and Sediment Control Guidelines for The Canterbury Region'.

2. Auckland Regional Council. (1999) 'Erosion and Sediment Control: Guidelines for Land Disturbing Activities in the Auckland Region', ARC Technical Publication No.90.

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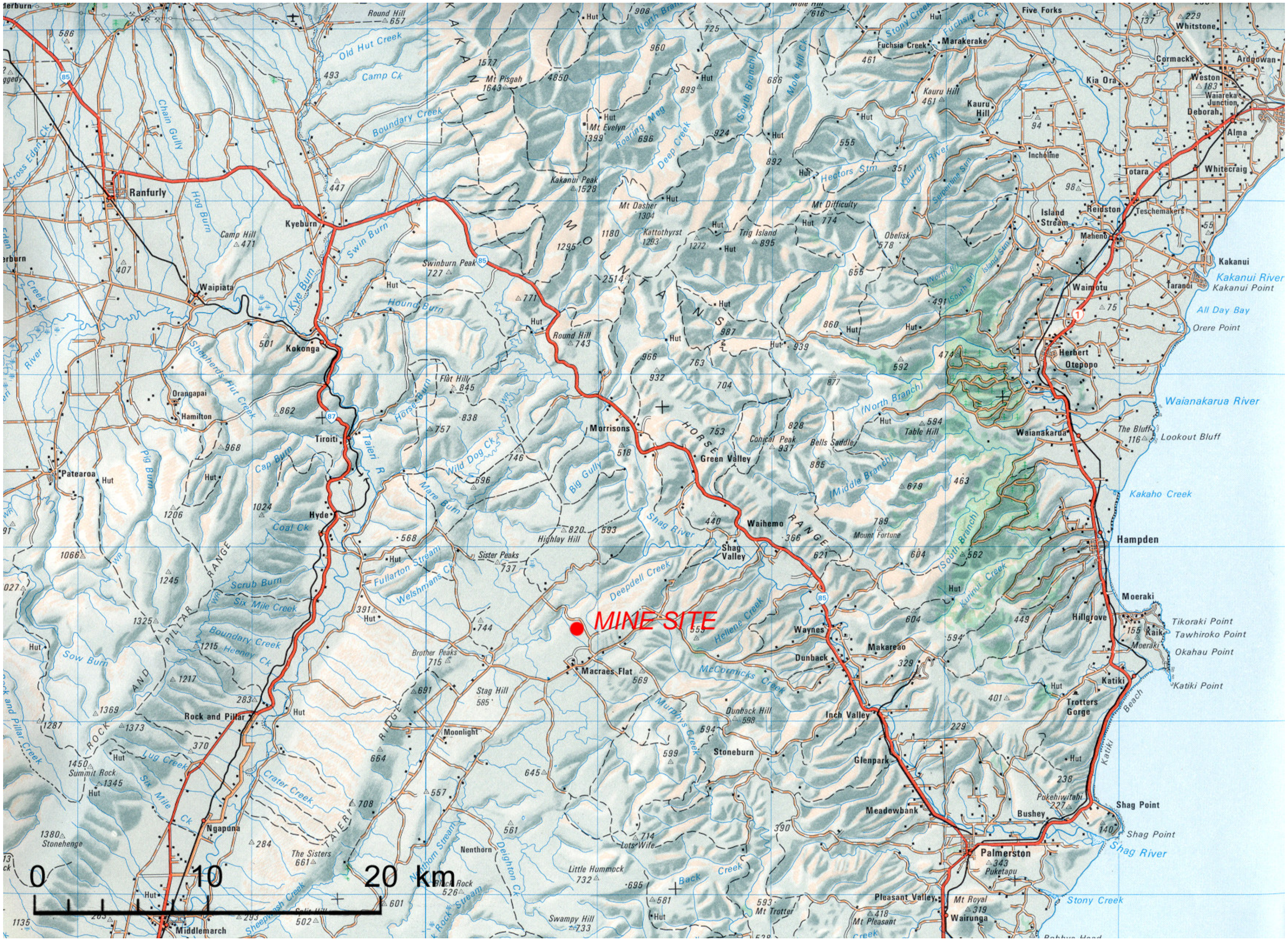
FIGURES



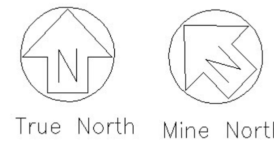


Figure 1

Source: NZMS Sheet 15 Waitaki.

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Macraes Gold Project- Locality Plan

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Date: 26 June 2002
Drawn: SP
File: local.grf

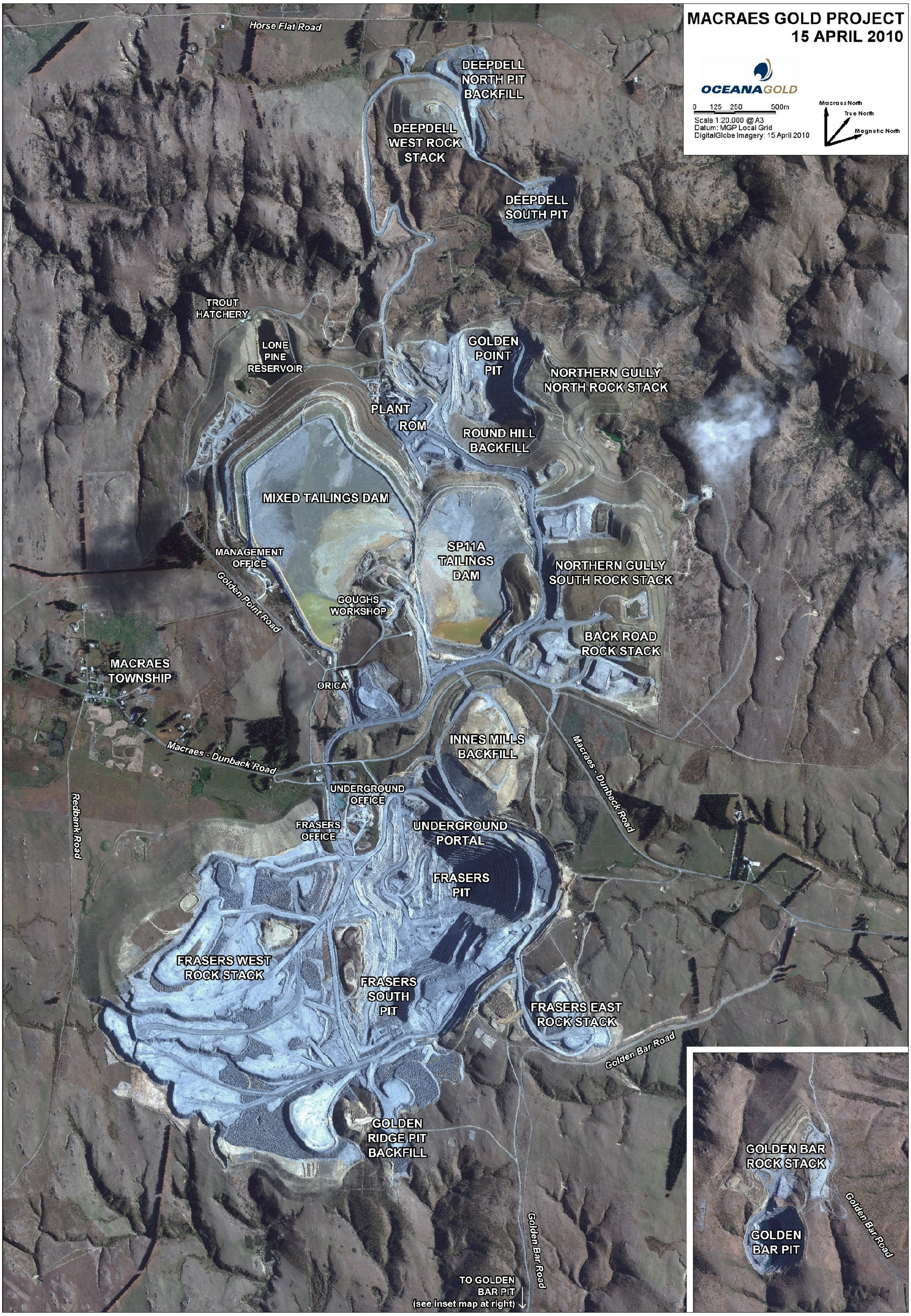

Figure 2

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 Macraes Phase III *Current Site Layout*	Drawing No. Date: Drawn: Filename:	6965-Fig 2 21 Mar 2011 BL 6965-Fig2.dwg

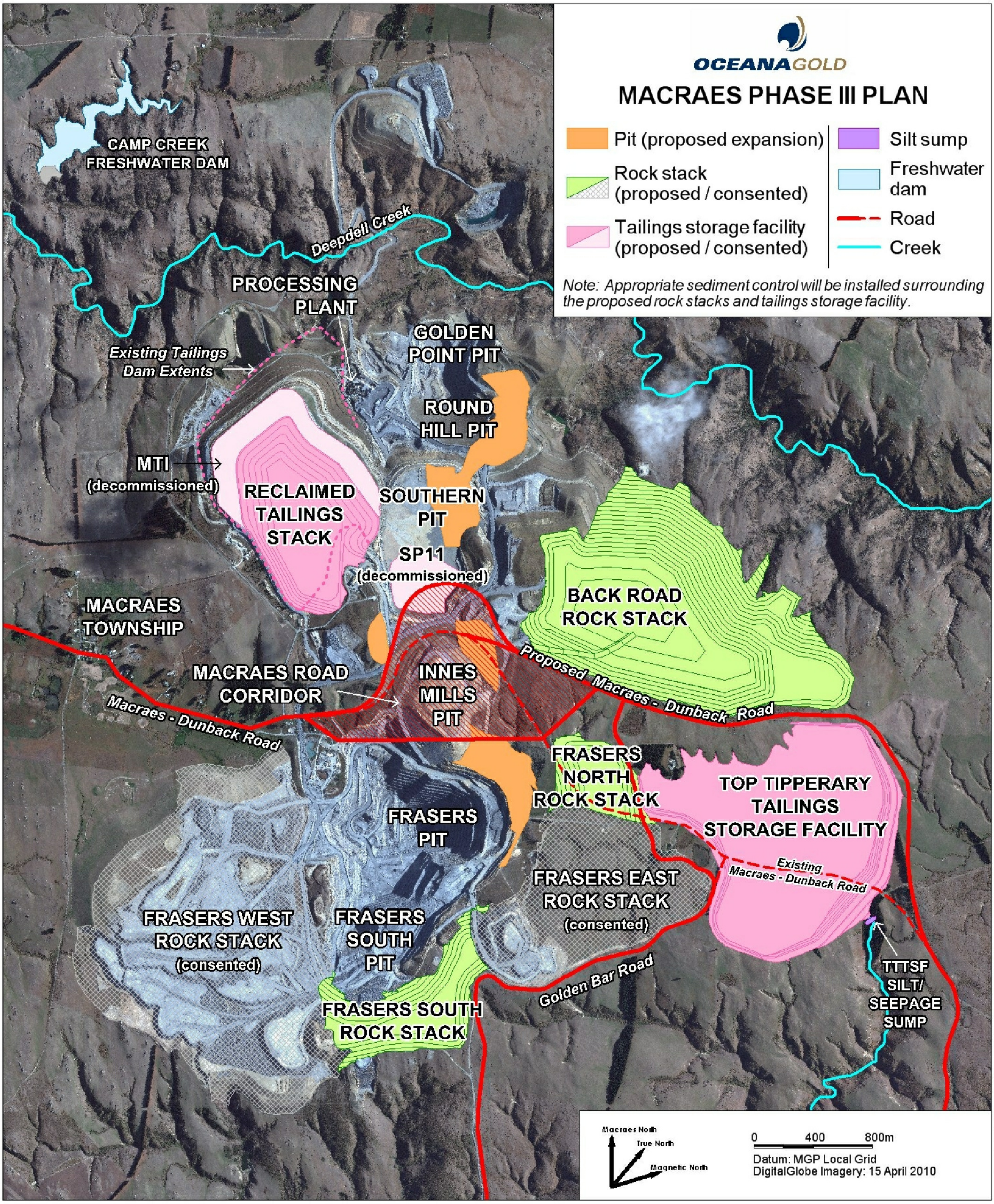

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Figure 3

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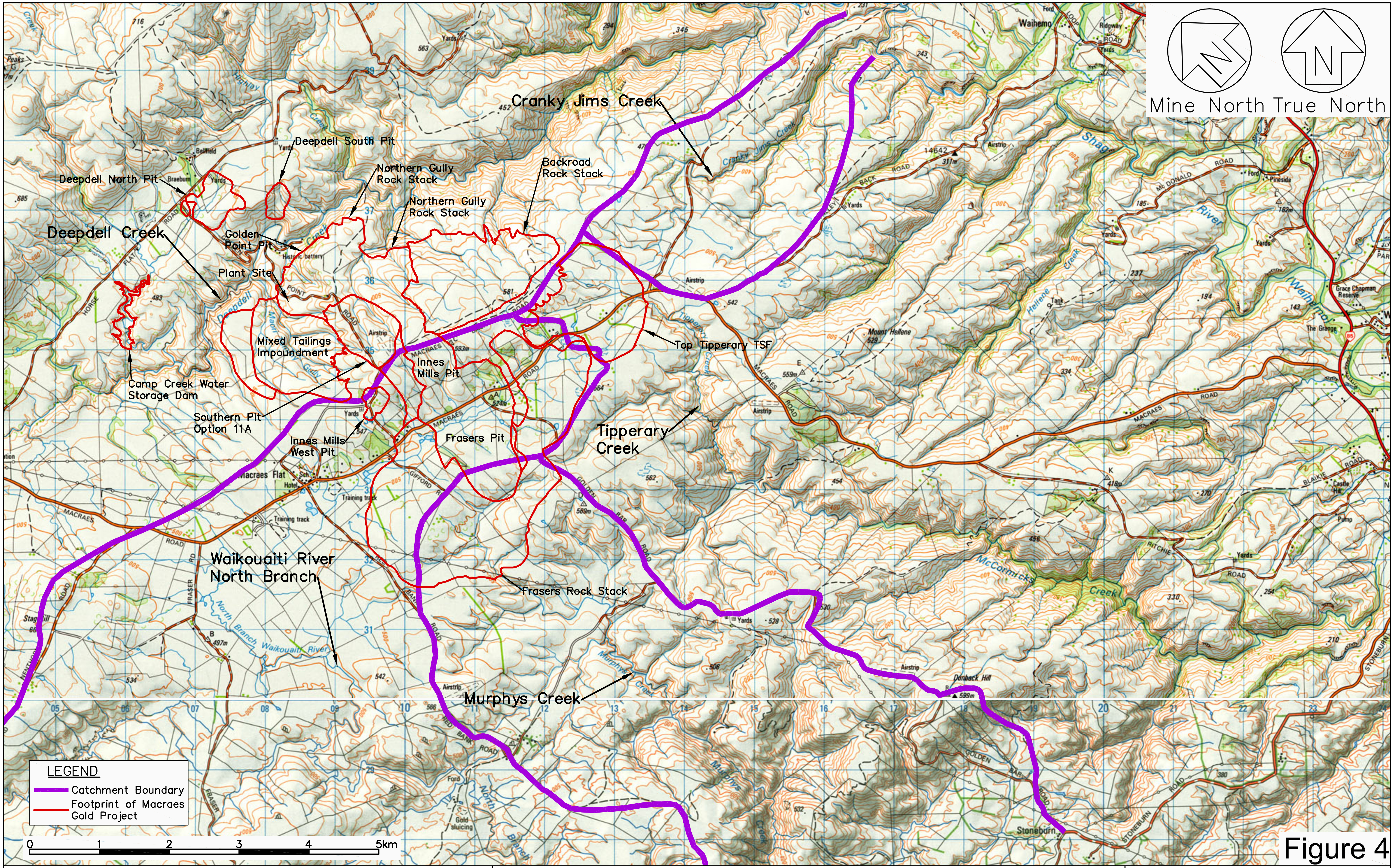

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Macraes Phase III
Major Creeks and Catchments

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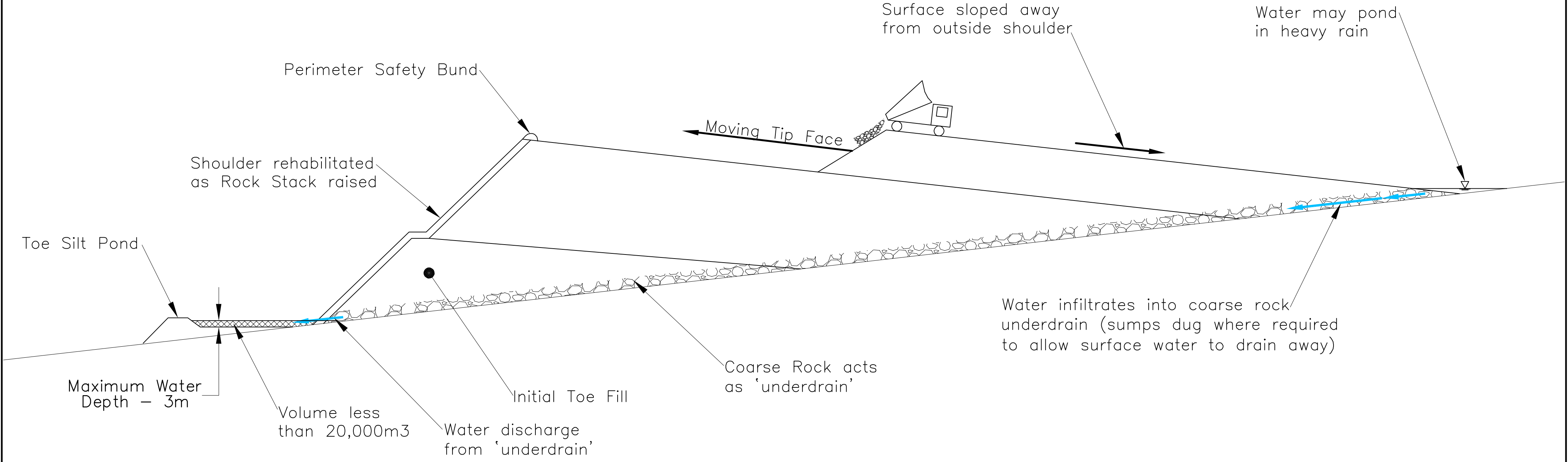

Rock Stack – Schematic of Erosion and Sediment Control Features

Figure 5

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Macraes Phase III
Rock Stack Schematic of Erosion and Sediment Control Features

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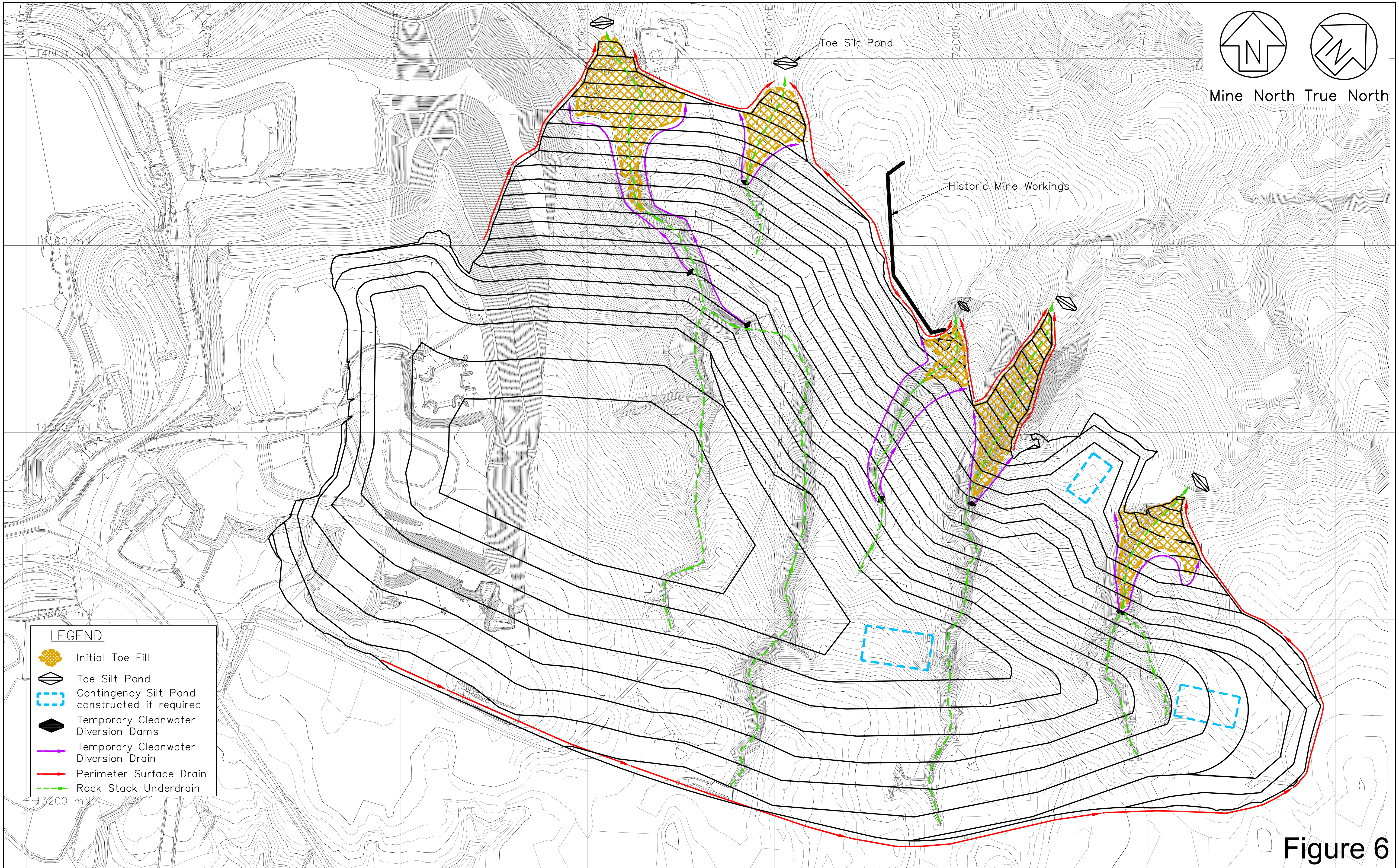

Figure 6

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Macraes Phase III
Back Road Rock Stack Erosion and Sediment Control Features

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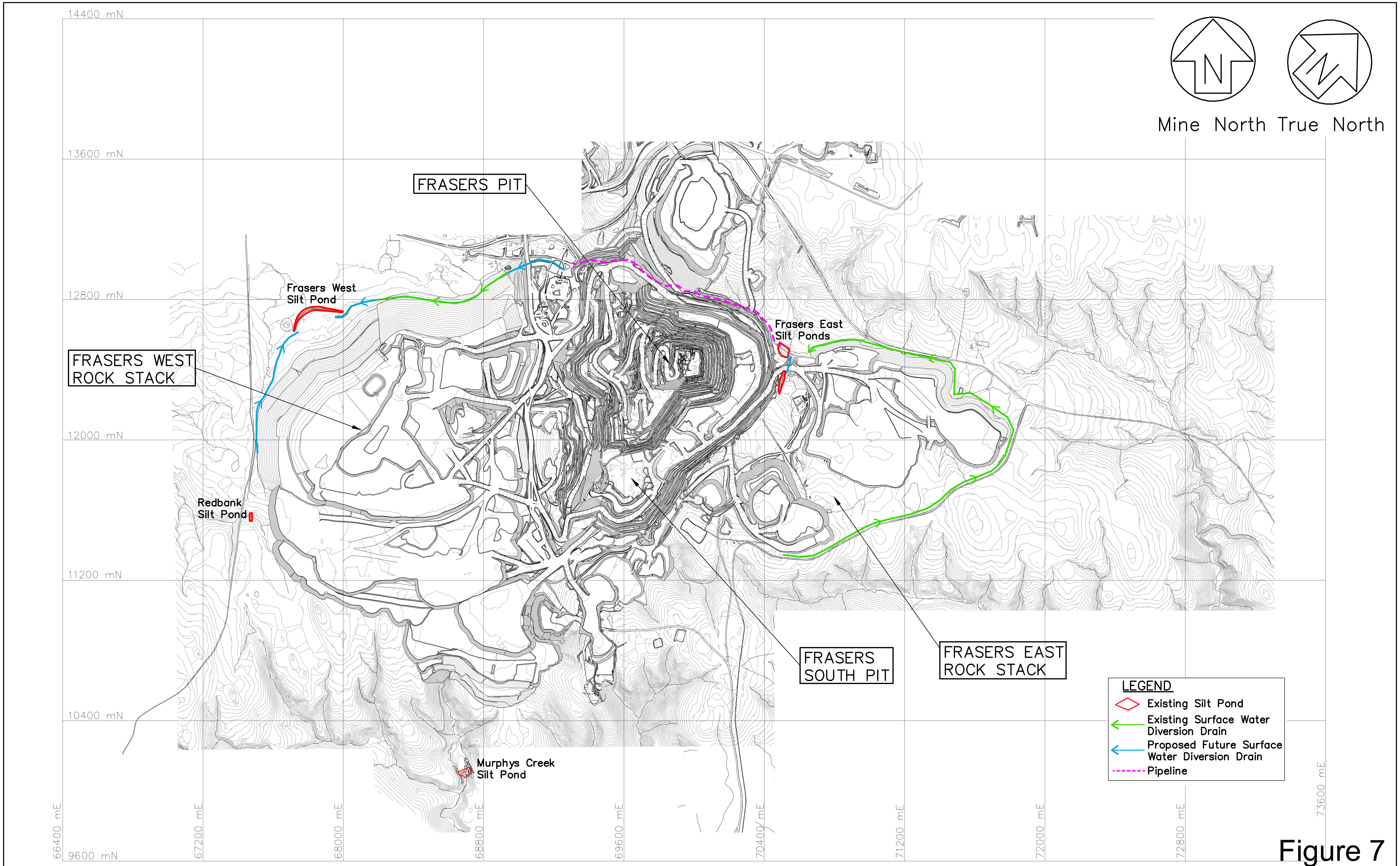

Figure 7

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
FRASERS PIT
Existing Erosion & Sediment Control Features

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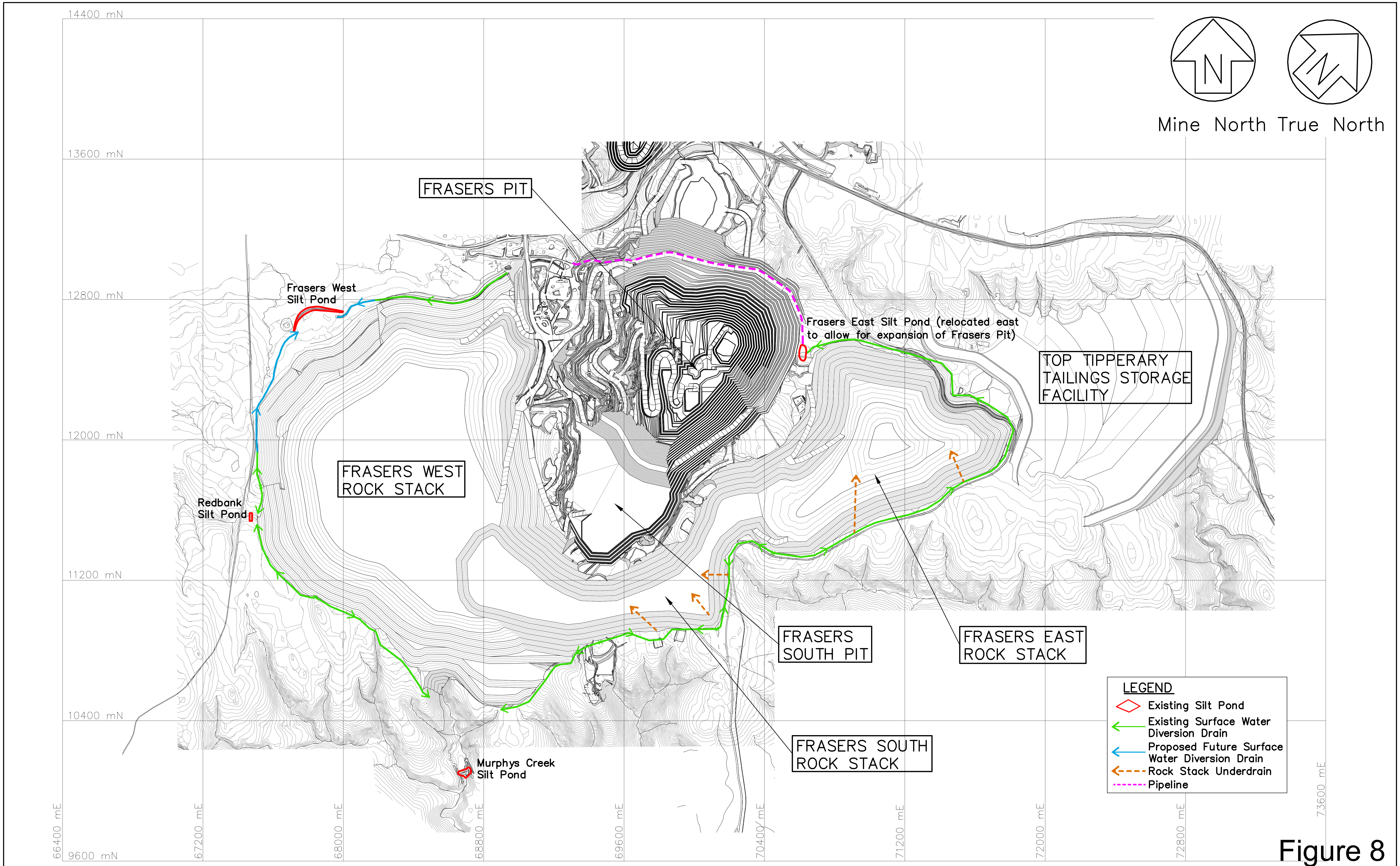

Figure 8

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
FRASERS PIT
Erosion & Sediment Control Features 2016

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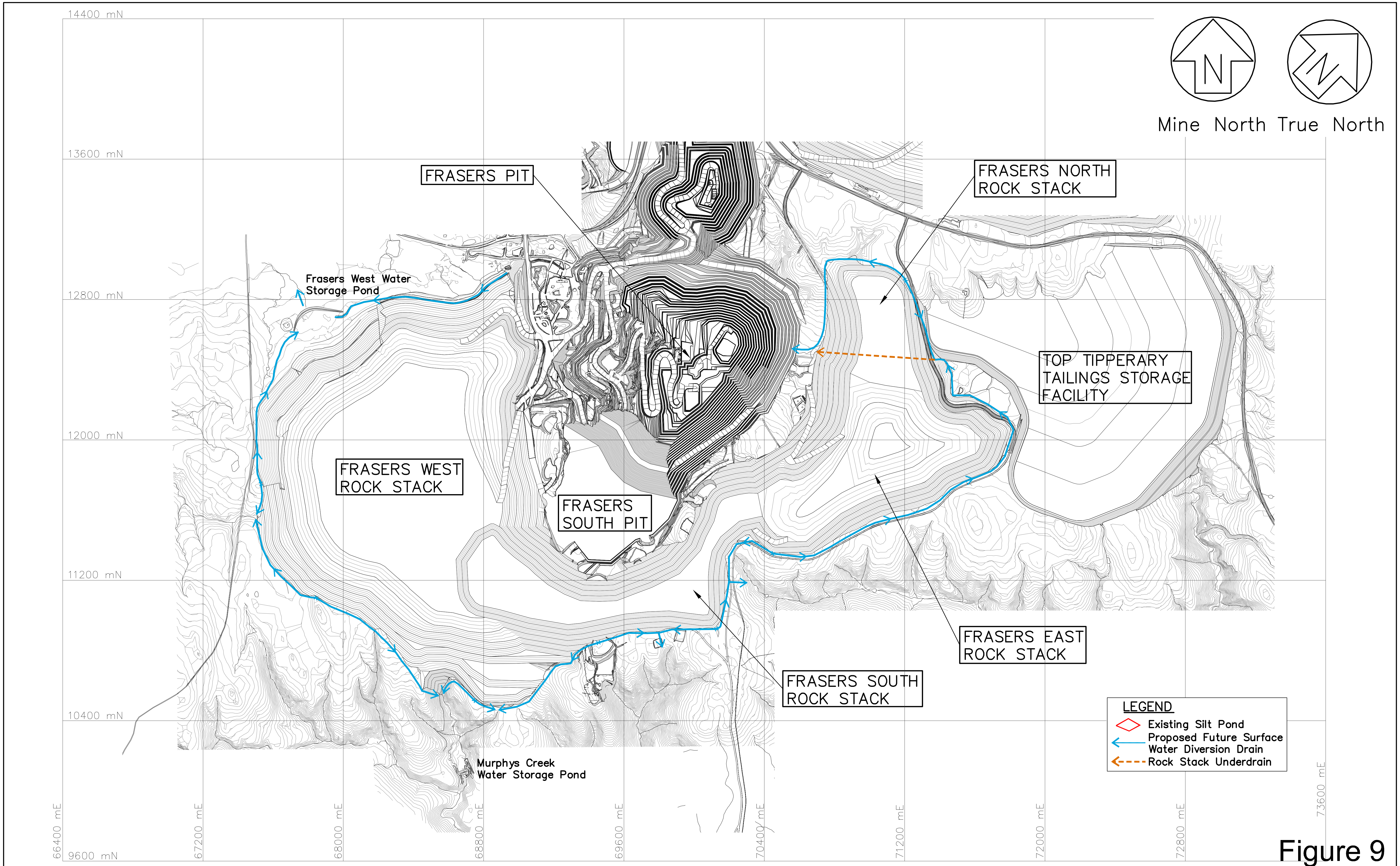

Figure 9

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
FRASERS PIT
Erosion & Sediment Control Features 2020

Drawing No. 6965-Fig 9
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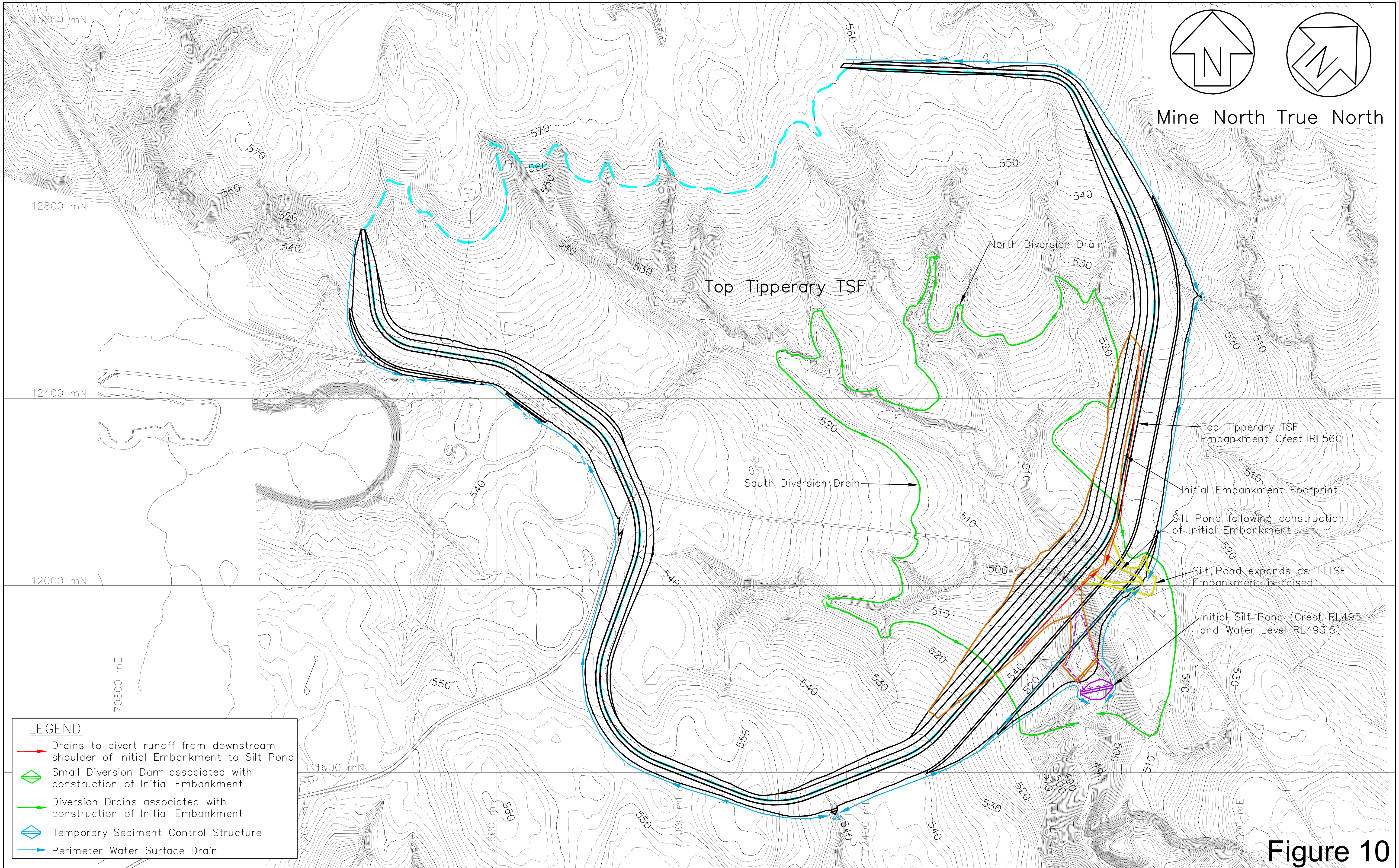

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Macraes Phase III
Top Tipperary TSF *Erosion and Sediment Control Features*

Drawing No.	6965–Fig 10
Date:	22 Mar 2011
Drawn:	BL
Scale:	1:7500 (@A3)
Filename:	6965–Fig 10.dwg

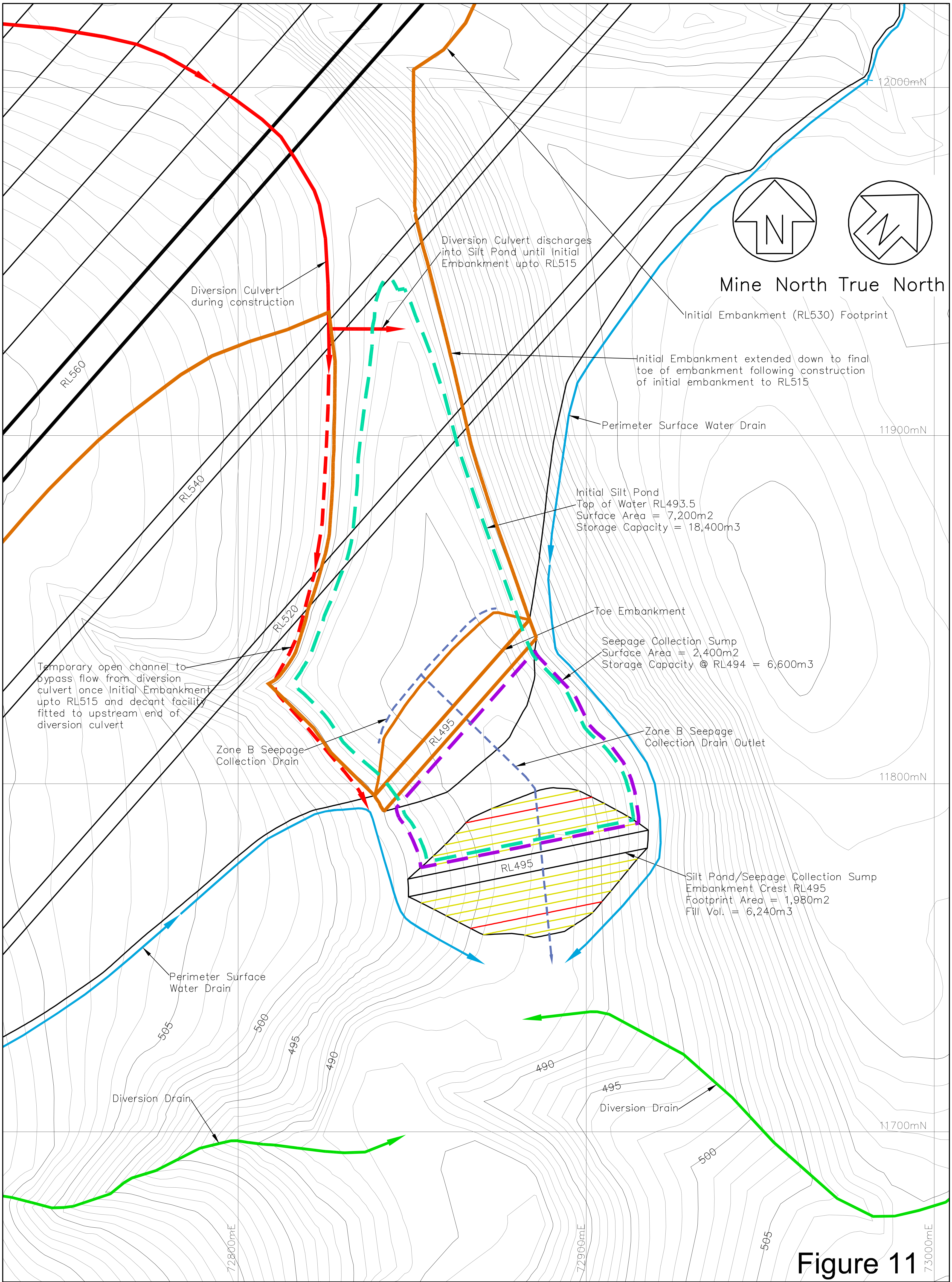

Figure 11

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OCEANA GOLD (NZ) LTD, MACRAES GOLD PROJECT
Macraes Phase III
Top Tipperary TSF Initial Silt Pond

Drawing No.	6965–Fig 11
Date:	31 Mar 2011
Drawn:	BL
Scale:	1:1000 (@A3)
Filename:	6965–Fig 11.dwg

PLATES

Plate 1. Clydesdale Silt Pond

Plate 2. Deepdell North Silt Pond

Plate 3. Deepdell South Silt Pond

Plate 4. Frasers West Silt Pond

Plate 5. Murphys Creek Silt Pond

Plate 6. Typical Silt Pond Decant Structure

Plate 7. Rock Stack Tip Face (initial lift)

Plate 8. Rock Stack showing segregation of waste with coarse rock at base of lift