Golden Bar Area

- Further development of the Golden Bar Pit.
- Expansion of the Golden Bar WRS to store waste rock from the Golden Bar Pit.

Most of the planned MP4 expansion lies within the consented areas for MP3. Figure 3 (attached) provides an overall plan of the proposed MP4 developments.

5.0 EROSION AND SEDIMENT CONTROL PLANS

The existing site-specific Erosion and Sediment Control Plans (ESCP) will be developed or updated by OGNZL for the individual MP4 Project elements following the procurement of consents. This ESCP documentation will follow the principles which are embodied in the Environment Canterbury (ECAN) Erosion and Sediment Control Guidelines (Ref. 1) but will be tailored to suit local conditions and experience, in particular the anticipated rainfall and soil type. The Auckland Council GD05 publication (Ref. 2) will also be referenced as appropriate during review and updating of the relevant ESCP document packs.

The site-specific 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.

6.0 SITE SOILS AND EROSION POTENTIAL

The unmodified natural ground profile at the site is expected to comprise the following sequence of material types (listed in order from the ground surface down):

- Topsoil (if present)
- Loess (silt – if present) varying in thickness from less than 0.1 m up to 3 m locally, but generally less than 1 m thick. These soils are fine and erodible.
- Colluvium (gravel-sized rock with some sand/silt – if present) near the base of slopes.
- Schist rock which is exposed in places but is generally present at shallow depths typically less than 1 m below the natural ground surface.

Waste rock is predominantly an overburden material excavated from the pits and is mostly disposed of in the WRS sites or used to construct the TSF embankments. It typically varies in particle size from gravel to boulders (typically 10 to 500 mm size). It is also the largest quantity of fill used in construction of the water and tailings retaining embankments.

The surficial soils that blanket the site, in particular the loess soils, are erodible. The waste rock is generally coarse in nature and is assessed to have a low risk with respect to erosion and sediment loads.

In terms of erosion and sediment risk, stripping of the surficial soils is considered to be the main risk activity. As such robust management of this process, and the use of appropriate erosion and sediment controls, are necessary.

7.0 EXISTING EROSION AND SEDIMENT CONTROL

Stormwater runoff from the pits and the associated haul roads generally collects in the base of the pits and is pumped to the Process Plant where it is used during the processing of ore or for dust control purposes. Runoff and seepage water from the WRS areas is collected by channels and directed into silt ponds. The collected stormwater is either:

- decanted and discharged to existing watercourses.
- pumped back to the Process Plant or
- used for dust control.

During construction, runoff from the TSF areas is directed to silt ponds and/or the pits.

The existing erosion and sediment control practice incorporates the following features and attributes:

- Clean water diversions divert runoff from undisturbed areas away from disturbed areas.
- Diversion drains collect and direct storm water runoff from the disturbed areas to the silt ponds.
- The silt ponds allow for the settlement of suspended solids from the collected water.
- Stripping of topsoil and loess soils is only undertaken in the summer months.
- Progressive stripping of the WRS footprints is undertaken to minimise the exposed ground surface area that is at risk of eroding and generating sediment.
- Steep gullies are not stripped beneath the WRS areas, except in the base of gullies at the toe of the WRS areas, to result in the creation of a buffer zone that intercepts sediment from the stripped areas above.
- Careful design and management of the storm water flow paths across the WRS surface to prevent runoff from discharging over the outside shoulders.
- The design and excavation of soak pits across the WRS surface to facilitate the soakage of stormwater into the underlying waste rock (which acts to filter out fines).
- The adoption of a carefully staged end-tipped construction sequence which creates a layer of coarser rock in the gullies which subsequently acts as an underdrain layer.
- Progressive surface rehabilitation of all WRS, Backfill, and TSF embankment areas. Such rehabilitation comprises the placement of oxidised waste rock followed by the placement of topsoil which is immediately seeded with grass to minimise the footprint area and exposure time of bare soil.
- The timely construction of appropriate and robust sediment control measures (e.g., silt fences, decanting bunds) in accordance with the relevant recommendations that are published by ECAN and Auckland Council (Refs. 1 and 2).
- Water discharge points are routinely monitored as required under the consent conditions.
- Regular inspection of the silt ponds and diversion drains is undertaken by OGNZL personnel to check their condition and confirm the need, or otherwise, to undertake maintenance works.

The silt ponds have been constructed, as appropriate, in advance of placing waste rock in the WRS areas or commencing the construction of a TSF embankment. In all cases, the silt ponds have been created by the construction of dams across gullies or streams immediately downstream of the disturbed areas. Typically, the dams are 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 overburden material from the pits. The rockfill has largely been sourced from the pit overburden material.

The design criteria for the silt ponds have been amended, as appropriate, with time. Those silt ponds which were constructed more recently as part of the Macraes Project program of works (e.g., for the Deepdell South and North WRS, Frasers West WRS, Clydesdale Creek, Murphys Creek) were designed using the following criteria:

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

The stormwater detention pond storage volume has typically been estimated using runoff coefficients (C) between 0.32 and 0.70. Higher runoff coefficients have been adopted for small catchment areas. Local experience is that a large proportion of rainfall either infiltrates or evaporates and this observation is more significant for larger WRS areas. This justifies the use of lower runoff coefficients.

The decant facility which has been provided for most silt ponds comprises a perforated manhole structure. This simple design has proven to work effectively at the Macraes Project site rather than floating decants which were trialled in the early stages of the project development. The floating decants were found to require a significantly higher level of ongoing maintenance and were prone to damage. The current perforated manhole design 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 and the recovered water used for dust control purposes.

The experience on site to date is that the stormwater runoff is typically low in suspended solids. This 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 areas 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 WRS mass 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 and this results in segregation with coarse rock at the base of each lift as shown in Figure 4 (attached). This subsequently acts as an underdrain. High volumes of water can percolate through such material. The surface of the WRS areas are sloped away from the outside shoulder so that stormwater runoff flows back to contact with the natural ground as shown in Figure 4. Infiltration of runoff into the WRS mass is actively encouraged by the of digging of sumps, as necessary, if water is observed to pond on the active fill surface.

The critical time for the generation of sediment is at the initial stage of WRS and TSF embankment construction. Typically, the foundations will be stripped, and this can expose loess. Until waste rock material is placed above, these soils can be quite erodible. Steep gullies are not stripped beneath the WRS footprints, 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.

To date the current erosion and sediment control practices have worked well throughout the life of the mine and no significant erosion or sediment related issues have been observed.

8.0 MP4 EARTHWORKS

The erosion and sediment control (ESC) considerations for MP4 comprise:

- The proposed further development of Coronation Stage 6, Innes Mills Stage 9 and Golden Bar Stage 2 Pits are all self-contained and do not pose an erosion and/or sediment risk. No individual ESCP is required for these project elements.
- The Coronation North Backfill is bounded by existing ESC measures. The existing ESCP for Coronation North should be reviewed to confirm that the existing ESC measures will still be adequate to cater for the MP4 Project.
- The North Gully WRS is bounded by existing ESC measures. The existing ESCP for the North Gulley WRS should be reviewed to confirm that the existing ESC measures will be adequate to cater for the MP4 Project.
- Backfilling of Golden Point Pit will be within the existing ESC controls which are already in place for the Process Plant and Round Hill areas.
- The Frasers Backfill is located within existing pits and as such do not pose an erosion and/or sediment risk as long as the fill surfaces are appropriately rehabilitated prior to discharge in closure. No individual ESCP is required for this project element.
- Frasers East WRS and Frasers South Backfill/ Waste Rock Stack are bounded by existing ESC measures. The existing ESCP for the Frasers Area should be reviewed to confirm that the existing ESC measures will still be adequate to cater for the MP4 Project.
- The Golden Bar WRS Stage 2 will require an individual ESCP to be developed prior to commencing the MP4 construction.

As shown on Figure 5 (attached), the MP4 Coronation elements lie within existing ESC measures.

As shown on Figures 6 and 7 (attached), the MP4 Innes Mills, Frasers Pit Backfill, Northern Gully, and Golden Point Pit Backfill elements all lie within existing ESC measures.

Figure 8 (attached) shows that the Golden Bar area with the existing and proposed ESC measures.

The Golden Bar WRS is assessed to pose the primary erosion and sediment control risk for the MP4 Project. However, this statement being made, experience has demonstrated that the waste rock stacks result in relatively low levels of erosion and sediment risk as the waste rock is self-filtering and the way the rock stacks are constructed limits direct runoff to the existing silt controls. The existing silt pond may be preserved and used to control silt runoff from the Golden Bar WRS and extension.

Figure 4 (attached) summarises the typical staging for WRS construction. The main risk of erosion and sediment generation is during foundation excavation and placement of the outer rehabilitation layers.

The proposed Coronation Stage 6 (CO6) Open Pit extends the existing pit 250 m to the south-east. The proposed MP4 Coronation North Backfill (refer to attached Figure 3 for location and Figure 5 for detail) will fill the existing Coronation North pit to its rim. The infilling operation will therefore be contained within the pit.

The proposed Golden Bar Stage 2 (GB2) Open Pit will extend the existing mined pit approximately 200 m to the east and north-east (refer to Figures 3 and 8 attached). The Golden Bar Stage 2 WRS extends the existing WRS 500 m to the west and south-west. The proposed site layout for the Golden Bar area is shown on Figure 8 (attached).

9.0 PROPOSED EROSION AND SEDIMENT CONTROL PRACTICE

9.1. General

Prior to the commencement of construction in any sub-area of MP4, the existing erosion and sediment control measures will be assessed for their appropriateness and if required a site-specific ESCP will be prepared or updated by OGNZL. Such documents will be submitted to ORC as the MP4 Project is advanced.

The above plans will describe the ESC practices, which are generally outlined in the ECAN and Auckland Council Guidelines (Refs. 1 and 2), that will be deployed as part of the MP4 project. Such ESC practices will be modified, as appropriate, to take due account of any relevant site-specific design criteria and experience at the Macraes Mine site.

In general terms, the design of the erosion and sediment control measures will follow the existing practice (which is summarised above in Section 7) and sediment control structures will include:

- Clean water diversion drains with small dams located in gullies, where necessary, to divert stormwater runoff into the diversion drains. Where necessary (e.g., in locations where steeper ground or erosive soils are present) these drains will be lined. Energy dissipation features will also be provided at high energy locations.
- Silt ponds downstream of disturbed areas. Permanent silt ponds will be designed according to the existing criteria that is summarised above in Section 5. The pond sizing depends on the catchment area and runoff coefficient. Decants will also be provided, as appropriate, which are expected to be of a design similar to those currently deployed on site. Service and emergency spillways will be designed and constructed to convey the storm water flows from 10 and 100-year return period rainfall events.
- Perimeter surface water drains will be constructed around the perimeter of WRS areas where appropriate, to ensure runoff is conveyed to the base of gullies without erosions. Such drains will be lined, where necessary, and energy dissipation will be provided at high energy locations.

Further comments on the proposed erosion and sediment controls for the WRS and TSF areas are discussed in more detail in the following sections.

9.2. Waste Rock Stacks

The concept designs for the erosion and sediment control measures within the WRS areas are shown in Figure 4 (attached). They are further described above in Section 5.

Drains will be constructed around the WRS areas to divert clean water away from the areas of disturbed ground. Small dams will be located in gullies, where required, to divert water into a clean water diversion drain.

With respect to ESC, the critical construction stage for the WRS areas is the initial stage of filling (referred to as initial toe fill in Figure 4). Silt ponds will be located in all gullies downstream of the initial toe fills to mitigate this ESC risk. 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 ultimately disturbed catchment but using a lower coefficient to reflect the practice of diverting much of the surface water into the coarse rock underdrains that are present beneath the WRS footprints.

If required, additional silt ponds will be constructed on the surface of an WRS area (e.g., if the underdrain system beneath a WRS area is suspected to have insufficient capacity). The need and locations of such additional silt ponds will be determined based on site observations during construction.

9.3. Tailings Storage Facilities

Erosion and sediment control concepts for the existing TSF components of MP3 are similar to those proposed for the MP4. Runoff from the downstream shoulder of the TSF embankment will be treated by a combination of a Silt Pond formed by the construction of a small embankment at the downstream toe of the TSF and by diverting clean water runoff from the embankment into natural water courses.

The only TSF that will be affected by the MP4 Project is the proposed Frasers TSF. At this location additional ESC measures are not expected to be required as the tailings will be discharged into the existing Frasers Pit and any runoff collected recycled back from the TSF to the Process Plant (via pumps) for reuse.

10.0 SUMMARY AND CONCLUSIONS

OGNZL proposes to expand and extend its existing operations at the Macraes Gold Mine site via implementation of the MP4 Project.

The proposed MP4 Project includes redevelopment and extension of existing pits, continued expansion of existing WRS areas, pit backfills, and construction of the new Frasers TSF.

Erosion and sediment control plans will need to be progressively reviewed and/or developed by OGNZL to manage and control the erosion and sediment risks that are associated with construction of the MP4 works and operation of the WRS and the TSF areas.

Runoff from the pits will be captured in the base of the pits and pumped back for reuse in the Process Plant. As such no specific sediment control is required in these areas.

OGNZL has been operating the Macraes Gold Project for over 30 years. The existing erosion and sediment control practices have worked well and the similar practices proposed for the MP4 Project are expected to be robust and effective.

REFERENCES

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3. Auckland Council (2016) '*Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region, Incorporating Amendment 1*' June 2016, Guideline Document 2016/005, ISBN 978-1-98-856465-4 (PDF).

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6. NIWA (2018) *'High Intensity Rainfall Design System'* https://niwa.co.nz/

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