

# Key mechanisms for successful reclamation - Golden Cross Mine, Coromandel, New Zealand – September, 2000

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## Abstract

The Golden Cross Mine is located on the North Island of New Zealand, at the base of the Coromandel Peninsula, approximately 8 km northwest of Waihi. The project is operated as a Joint Venture with Coeur Gold New Zealand holding 80% and Viking Mining Limited with a 20% interest. The past open-pit and underground gold and silver producer has been in the reclamation phase of the operation for approximately 2.5 years and this phase is now nearing completion. Although rehabilitation of the site is a regulatory requirement, the Closure Plan has been enhanced by the ongoing commitment of the Joint Venture to establish a sustainable land use for the site by commissioning engineered facilities designed to last for perpetuity.

The Joint Venture identified six significant design features that were key to successful rehabilitation. These were the controlled placement of acid-generating waste rock into engineered disposal sites; the design and placement of sealing layers over the waste rock disposal sites; the design and construction of diversion drains; the establishment and management of vegetation to protect the rehabilitation layers; a partial capping of the tailings to accelerate consolidation adjacent to the tailings dam embankment, and the implementation of a recovery circuit to recycle cyanide from the tailings prior to disposal.

Another key to success for the project involved genuine consultation with all parties participating in the planning, evaluation, and consenting of the closure process at Golden Cross. The local and regulatory community has been widely represented in the Joint Venture's operating and closure planning throughout the history of the mine. Participants include: Regional and District Councilors and staff members, professional peer reviewers, environmental groups, local residents of the valley, and Iwi.

This overall commitment to the project has resulted in a world-class rehabilitation program for the first modern metal-mine closure in New Zealand and we believe that collectively, the work done at Golden Cross is helping to set a standard for the success of future programs within the extractive industry.

## Introduction

The Golden Cross Mine, a Joint Venture between Coeur Gold New Zealand Ltd. (80%) and Viking Mining Limited (20%), is located on the North Island of New Zealand, at the base of the Coromandel Peninsula, approximately 8 km northwest of Waihi.

The history of mining at Golden Cross dates back to 1892. During the period 1893 to 1917, Moore and Ritchie (1996)

estimate that 155,000 tons of ore were mined, averaging 0.5 ounces of gold and 2 ounces of silver per ton. The site reverted from the Golden Cross mining township to farmland until the early-1980s when Cyprus Gold acquired the property and obtained the necessary permits for the Golden Cross Mine. The Mining License was secured in April 1990, construction was initiated, and production commenced in December 1991. In March 1993 Coeur D'Alene Mines Corporation purchased the assets of Cyprus Gold in New Zealand.

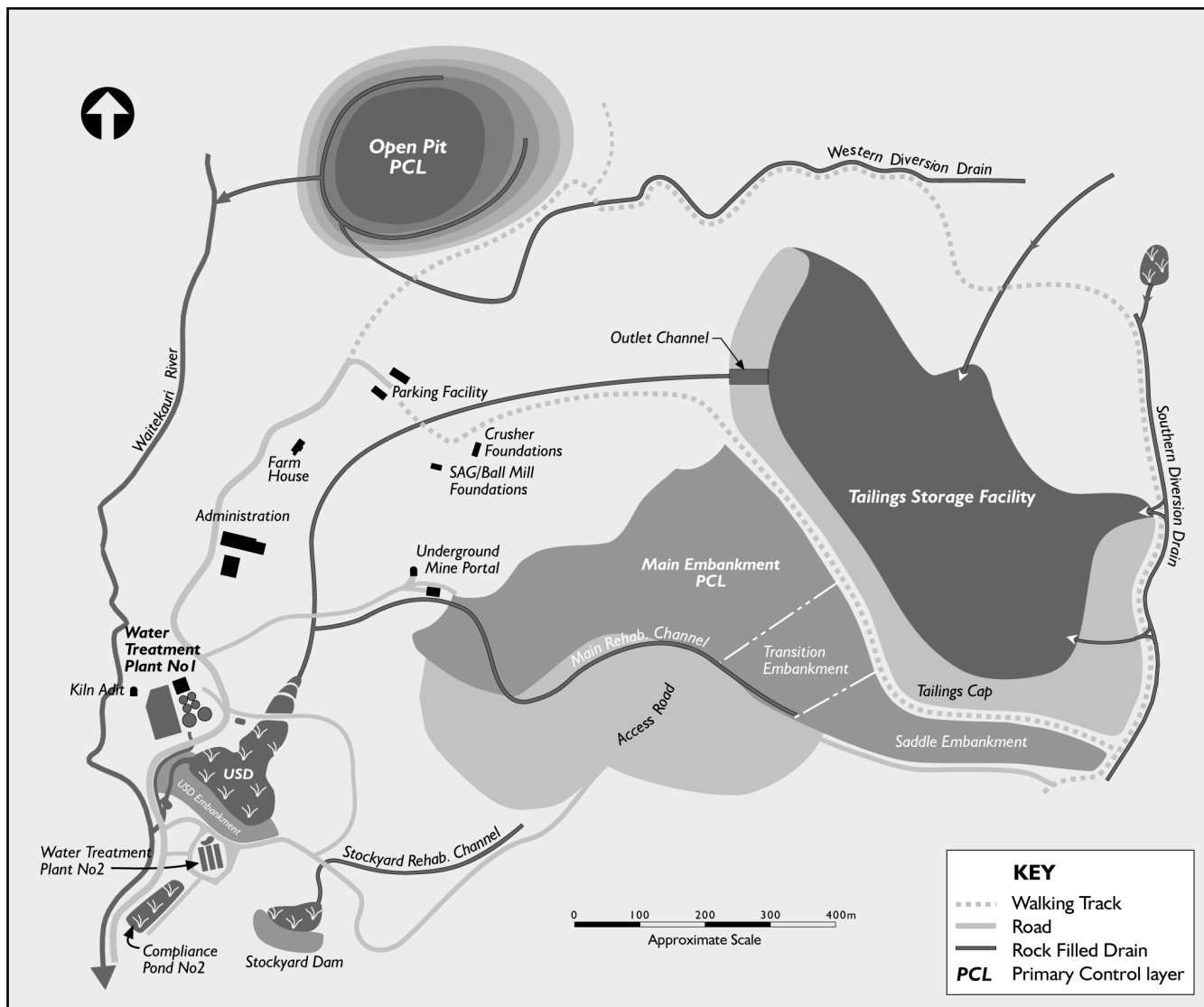


Figure 1. Site plan - Golden Cross mine.

The geology at Golden Cross is characterized by hydrothermally altered andesitic to rhyolitic flows, breccias, and tuffs of the Coromandel group which is the host rock to the mineralized system. This group is unconformably overlain by post-mineralization andesitic to dacitic units that are known locally as the Omahia Andesite (Keall et al, 1993). Major structures include the Empire and associated footwall veins, and the Western Boundary fault and associated hangingwall structures. These major structures trend north – northeast within the open-pit and underground workings (Keall et al., 1993).

The Golden Cross mine was an open-pit and underground gold and silver operation from December 1991 to April 1998. During this period the project produced approximately 584,000 ounces of gold and 1,675,000 ounces of silver from approximately 5 million tons of ore. The underground vein system was mined at a 4.0 g/t cut off grade and provided 1.7 million tons grading 6.7 g/t while 3.4 million tons at an average

grade of 2.5 g/t, using a cut-off grade of 1.0 g/t, were extracted from the open-pit (Maton, 1999).

The project is situated near the southern end of the Coromandel Range at the headwaters of the Waitekauri River (Figure 1). The site rises from around 270 m above sea level near the site entrance of the mine to around 480 m above sea level on its upper boundary. Topography is generally rolling to steep farmland with small scattered pockets of native bush and forest. The site is bounded on the west, north, and east by the Coromandel Forest Park and to the south by 200 hectares of 3-year-old Radiata pine.

Rainfall has been recorded at the mine site since 1956. Long-term mean annual rainfall in the area is 2.9 m, and annual total rainfall varies between recorded extremes of 4.0 and 1.7 m. The intensity of rainfall at Golden Cross has dictated the necessity for a stringent water management system and was the key element that determined the planning and engineering goals through operations to closure.

## Project goals

Site works for closure focused on the issues of handling the site stormwater, compacting and sealing acid generating waste and creating long-term stable structures. The most extensive site works comprised the controlled placement of acid-generating waste rock into engineered disposal sites, the design and placement of sealing layers over the waste rock disposal sites, establishing a vegetative cover to protect the sealing layer, the design and construction of diversion drains, and the partial capping of the tailings impoundment. An important part of the closure process was the procedures and practices adopted through the construction period and mining operation to provide a sound basis for the closure works.

## Controlled placement of acid-generating rock into engineered disposal sites

Materials for the construction of the tailings dam were sourced from the initial open pit excavation while the waste embankments received waste material extracted from the open pit and underground mine development. The waste rock stockpiles were incorporated into the tailings dam structure to provide downstream buttressing which enhanced the stability of the facility overall. At closure the waste embankments and tailings dam comprised approximately 9 million cubic metres. A cross section through the tailings dam and waste embankment is shown in Figure 2.

Construction of the waste embankments and tailings dam followed a combination of engineering rules developed by both Tonkin & Taylor Ltd. of Auckland (to achieve stability of the structures), and EGI Consulting of Sydney, Australia (to minimise the acid leaching potential). All designs were subject to both engineering and geochemical peer reviews.

The control of acid generation has always been a fundamental objective of material specification at Golden Cross. Control has been achieved through minimising the passage of atmospheric oxygen and groundwater, by ensuring low

permeability and a low percentage of air voids within the placed material, similar to the surrounding bedrock. The acid-leaching potential of the soil and rock material was recognised early in the environmental impact studies, and engineering rules were developed for the site prior to construction which were employed through operations and into the closure phase. These rules for site selection of soils have fallen into three main categories: the acid leaching potential of the soils, the geologic classification of the soil material, and the specification of material properties for zones within the dam and waste embankments.

The acid-leaching potential classification system comprised four main groups of materials based on the leaching potential of the soils and was determined from simple field and laboratory tests. These categories were:

- Geochemical Type X material is non-mineralised and almost entirely comprises Omahia and Ash. This material has a natural pH in the neutral range (6 to 8) and does not present a risk of acid leaching.
- Geochemical Type Y material is mineralised (Argillic or Non-Argillic) but has zero or low potential to generate acid.
- Geochemical Type Z1 material is mineralised (Argillic or Non-Argillic) and has moderate to high potential to generate acid.
- Type Z2 exhibits a paste pH < 4.5 which is already acid or would produce acid quickly.

The classification of materials by geological type was developed prior to construction and was improved upon as site knowledge grew. The geological classifications are listed below:

- Type 1 comprises fine-grained Ash or Omahia which is naturally non-acid producing, is capable of being compacted to achieve low permeability, will achieve the specified strength after conditioning and/or blending as required, and is sufficiently free of included stones.

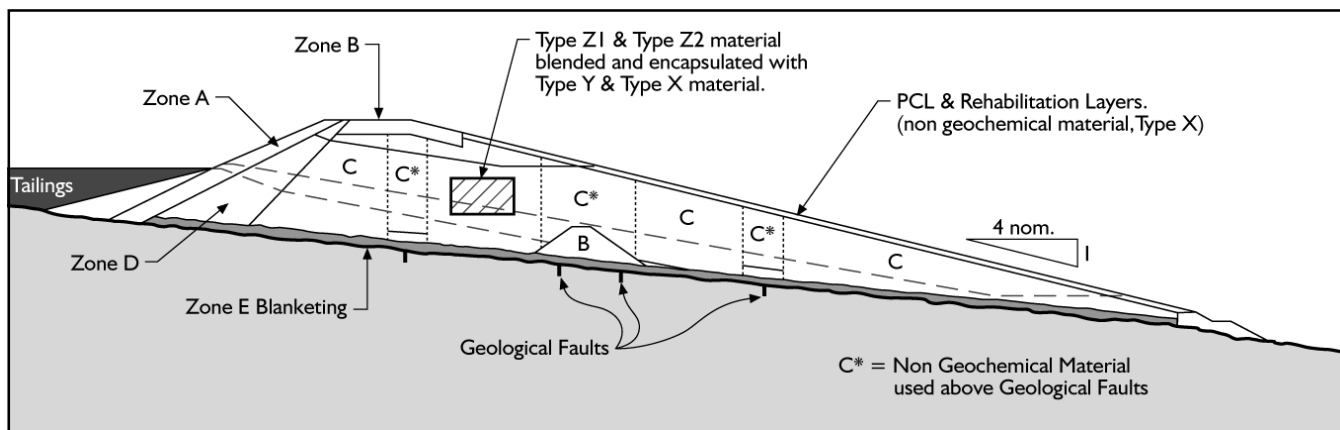


Figure 2. Cross section through tailings dam and waste embankment.

- Type 2 comprises Argillic of low to moderate acid producing potential, capable of being compacted to achieve low permeability and specified strength after conditioning as required.
- Type 3 comprises Omahia, principally as slightly weathered to unweathered rock, such that after final placement, adjacent rock fragments are in close contact and any weathered or soft material constitutes less than 25% of the total and is located within voids between the rock fragments.
- Type 4 comprises all Non-Argillic of low to moderate acid producing potential.
- Type 5 comprises all Ash and Omahia irrespective of grain size.

Engineering zones within the dam and waste embankments were described by letter A to E and specified the geologic classification, the acid leaching classification, and various material property requirements for that zone (Figure 2). The material property requirements included the undrained shear strength, permeability, air voids, and, for the oxygen diffusion layer, saturation ratio. The soils had to be compacted to a particular target density, which varied according to material type, to achieve the specified design requirements. In addition to these classifications the Joint Venture adopted procedures to further reduce acid leaching potential as follows:

- Type Y material was not placed within 1 m of any final surface or any underdrain or internal drain. It was not subject to geochemical control in areas where the permeability of the placed waste was continuously less than  $10^{-8}$ m/s. Where the permeability exceeded  $10^{-8}$ m/s the depth of placement was limited to 5 m and/or 25,000 cubic metres and completely surrounded by at least 1m thickness of waste of X or Y Type, compacted to a permeability of less than  $10^{-8}$ m/s.
- Type Z1 material was not placed within 6 m of any final surface or 3 m of any underdrain or internal drain. The material was compacted and mixed with other waste, to achieve permeability not exceeding  $10^{-8}$ m/s, where possible. Where this was not achievable the depth of placement was limited to 5 metres and/or 25,000 cubic metres and completely surrounded by at least 1.5 metre thickness of waste of X or Y Type, compacted to a permeability of less than  $10^{-8}$ m/s.
- Type Z2 material was not placed within 6 m of any final surface or any underdrain or internal drain or within 1 metre of any intermediate working surface exposed for longer than two weeks. The Type Z2 material was mixed with material of lesser acidity during placement in a ratio that reduces the NAG to the equivalent of Type Y (generally 1 to 3) and compacted to achieve a permeability not exceeding  $10^{-8}$ m/s. Generally Type Z2 material was covered with 500 mm of type X or Y waste within 24 hours of placement and wherever practicable, excavation campaigns for Z2 waste arranged to be handled in dry weather.

This complex material classification systems required major staffing commitments from the Joint Venture in the form of field management, quality control, and testing. Throughout the life of the mine, there were no major issues associated with the correct placement of material types or achieving the appropriate material property requirements.

Geotechnics, a registered laboratory and testing service, maintained a site based laboratory and a field staff, under the control of Tonkin & Taylor, for the purpose of measuring material properties for the dam and buttress construction. Geochemical types were designated in the Open Pit through blasthole and channel sampling, and waste blocks marked out in terms of their geochemical classification, X, Y, Z1, and Z2. All earthmoving used a flag system when excavating waste, on both trucks and excavator. The flags used both symbols and colors to designate geochemical and structural material types. This flagging system allowed an easy visual identification that correct geochemical types were going to the correct location within the embankment. 3D computer models of the geochemical and material types within the Open Pit were maintained and updated with the blasthole sampling.

## The design and placement of sealing layers over the waste rock disposal sites

In order to ensure that the quality of the surface runoff from the engineered waste rock disposal areas and the tailings dam was not degraded by acid forming material, closure planning has involved designing principles for three layers of cover. These are the primary control layer, the subsoil layer and the topsoil layer. The primary control layer (PCL) for sealing the potentially acid forming (PAF) waste in the embankment was designed by EGI, by assessing the sulfate generation rate for various thicknesses of cover. Studies of the material showed that increasing the thickness of the oxygen diffusion layer beyond one metre thick did not significantly improve performance as long as the material remained nearly saturated. The final design specifications for the PCL are listed in Table 1.

In addition to the PCL, rehabilitation required the placement of an overlying rehabilitation layer and topsoil layer averaging 0.75 m thickness above the PCL. These layers comprised non-geochemical Omahia material, which is predominantly fine grained and has only random inclusions of rock up to a maximum size of 200 mm.

Quality control for the placement of the PCL occurred throughout the rehabilitation period and involved in situ testing to determine the material properties specified in Table 1. Testing was carried out in trial pits excavated following fill placement. Non-complying material was either replaced or made good by further compaction. In situ testing carried out comprised vane shear strength, nuclear densometer, and moisture content. All tests were standard field tests covered by Australian or New Zealand standards.

Parameter	Ten test average	Any test
Undrained shear strength	80 kPa min.	70 kPa min.
Air voids	8% max.	10% max.
Permeability	10 <sup>-8</sup> m/s max.	10 <sup>-8</sup> m/s max.
Thickness	1 metre min.	1 metre min.
Saturation ratio	95% min.	90% min.

Table 1. Design Specifications for the Primary Control Layer

In order to ensure that the depth of the PCL and rehabilitation layers met the minimum requirements, surveyed stakes giving fill lines were installed on a closely spaced grid, as well as surveying the pre and post placement surfaces. Final surveys showed that the average thickness of the PCL and rehabilitation layers placed was 2.0 m, compared to the minimum design criteria of 1.75 m. A total volume of 852,000 cubic metres comprising mainly fine-grained Omahia, a non acid forming (NAF) material, was mined from a quarry above the Open Pit to provide suitable material for the PCL and rehabilitation layers.

The same practices and methods that were employed for the placement of the engineered PCL and rehabilitation layers in the Waste Embankment were also used to encapsulate geochemically active material contained within the exposed Open Pit walls above the 350 mRL, and for sealing the lower section of the open pit which was infilled with PAF material below the 350 mRL. In addition, the scheduling of materials to the Open Pit allowed the PAF material with high acid-forming potential to be encapsulated in PAF material with lower acid-forming potential and lower permeability to further reduce any likelihood of acid mine drainage seeping into the groundwater aquifer. The final profile of the Open Pit cover is similar to the surrounding topography, which is largely governed by the stable natural angle of the fine-grained Omahia material.

## Diversion drain construction

The mine site is in a high rainfall area and is subject to intense rainfall events, which combined with the steep topography results in “peaky” hydro-graphs. Drainage of the mine site has always been a major consideration and final design of site drainage required extensive study.

The agreed design philosophy dictated that all major drainage channels were to be sized to handle the runoff from a 1000-year rainfall event (715 mm in 2 days) and that drain design was to be focused on using naturally occurring materials such as the locally available Omahia boulders. Each drain has been sized based on its 1000-year event flow and the width, depth, maximum, minimum and average boulder size was specified accordingly. Boulders for the drain construction were excavated at the same time as the Omahia for the PCL was

being excavated which involved sorting and grading of the quarried material. A typical cross section of the final rehabilitation drain is shown in Figure 3.

An important requirement of the drain construction was to ensure that the design criteria of the PCL were not compromised by the drain invert. In this situation, underlying PAF material was over-excavated and Omahia placed to provide the required thickness of PCL capping below the constructed drain. The thickness of the PCL capping was increased to 1.75 m for drain inverts constructed over placed PAF material, as shown in Figure 3. Geotechnics provided quality control and quality assurance generally on a daily basis on the embankment drains which involved visual inspection and measurement of the in situ boulders.

The drains have performed well to date, with no sign of scouring or erosion of the filter bed. Approximately 3.0 km of permanent rock-lined drains varying in width from 3 to 18 m have been constructed on site since rehabilitation commenced.

The tailings dam impoundment spillway employs a low-level culvert to throttle outlet flows to reduce the water discharge rate from the tailings impoundment while maintaining a pond on top of the tailings. A high-level rock lined spillway will pass storm events greater than the 1000-year return period up to the probable maximum flood.

## Revegetation of the primary control layer

The establishment and management of a vegetative cover was critical for the long-term protection of the PCL from sheet and wind erosion. Soil type, depth, seed mixture, and initial fertilizer application rates for the revegetation program were determined from a two-year trial conducted by DSIR Landcare in 1992 at Golden Cross. This study identified the most successful application of growth media materials that were locally available, or had been stockpiled during the initial construction phase at site, as well as the best methods for ground preparation by evaluating the dry matter production yield from 12 separate test plots. As identified in the study, 150 mm of depth represented the most efficient use of topsoil. The recommended seed mixture and application rate per hectare included: 20 kg perennial ryegrass (Ellets), 5 kg short

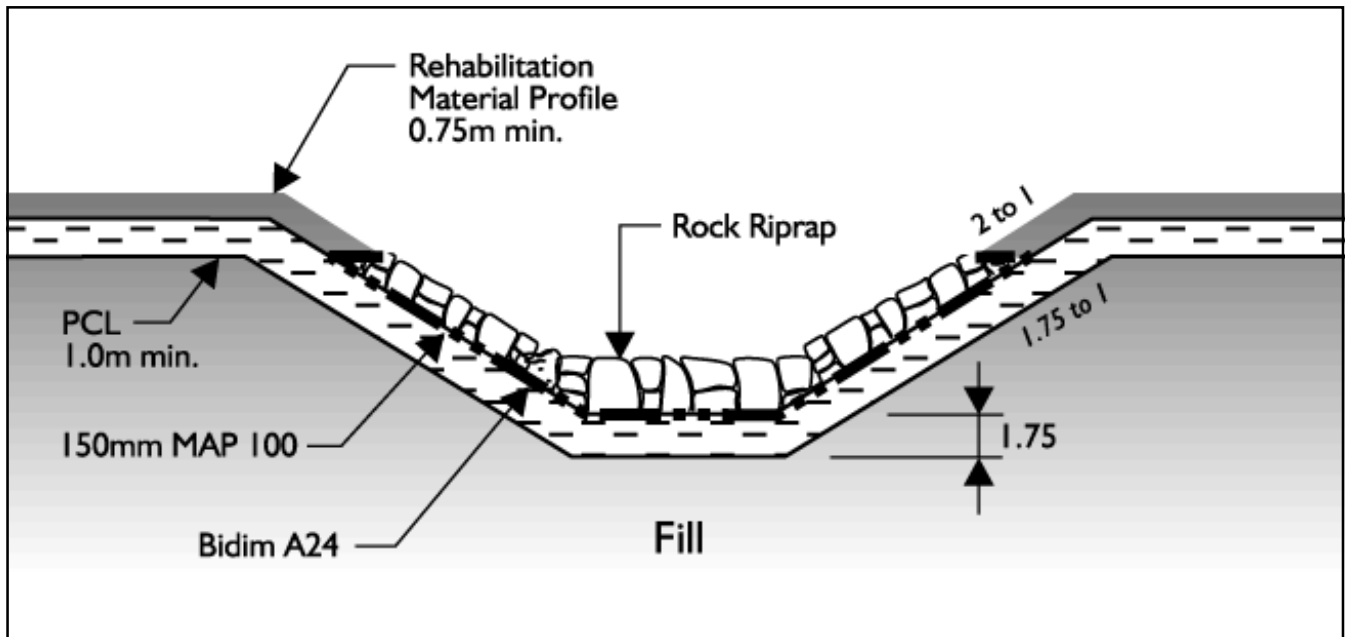


Figure 3. Typical diversion drain cross section - Golden Cross mine.

rotation ryegrass (Manawa), 5 kg cocksfoot (Wana), 3 kg white clover (Huia), and 2 kg lotus (Maku). The findings from this early trial have been fundamental to establishing a successful pasture covering the waste rock stacks, tailings embankment, and the open-pit which are managed through a grazing plan that will provide revenue for the ongoing maintenance requirements (Figure 4).

Soil sampling and analysis are ongoing at Golden Cross to maximize the potential for successful pasture establishment by ensuring that the most cost-effective fertilizer program is developed. Based on field results, fertilizer application rates are adjusted to achieve optimum pH, phosphate, potassium, and nitrogen levels in the re-established growth media.

In addition to developing pasture for the protection of the PCL, the Joint Venture has also invested in the re-establishment of native vegetation in areas adjacent to the PCL which had previously been cleared for farmland. The mining companies have financed the re-introduction of over 100,000 native plants of various wetland and colonizing tree species along waterways and the fringes of existing native bush of the Coromandel Forest Park to enhance wildlife habitat. The potential for successfully establishing native wetland plantings at the margins of the tailings lake was based on work carried out at the Waihi Gold Mine (Mason, 1993; Gregg and Stewart, 2000). All of the seeds for the starter plants used at Golden Cross were 'eco-sourced' from the Waitekauri Valley to preserve the local vegetation's distinct genealogy.

## Partial capping of tailings adjacent to the tailings dam

Capping of tailings immediately adjacent to the perimeter of the tailings dam varied in width from 50 m in the Main

Embankment to 80 m in the Saddle Dam. Capping of the tailings was undertaken in order to accelerate consolidation of the tailings, provide an oxygen diffusion layer to the tailings that would lie above the closure water level, and to minimize the volume of water stored in the tailings lake.

Almost all the capping material was sourced and quarried from Omaha material, which is non-acid forming. When potentially acid-forming material was used, the PCL was placed to encapsulate the material. Approximately 150,000

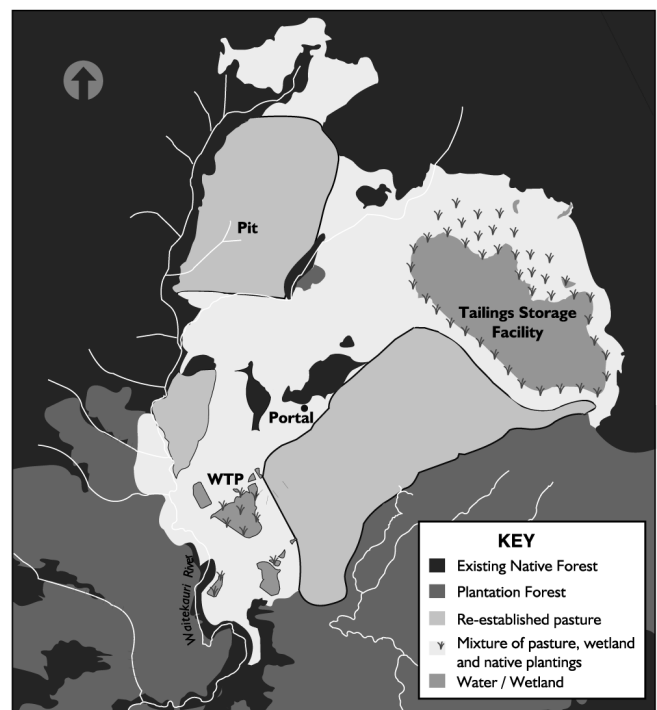


Figure 4. Closure revegetation plan for Golden Cross mine site.

cubic metres of material has been placed as capping varying in thickness from 4 m to 1.5 m. Placement of capping has involved innovative techniques due to the extremely soft nature of the underlying material (shear strengths as low as 7 kPa.). These techniques were developed on site and involved small earthmoving equipment, combinations of geogrid and geofabric material, pre-loading and construction sequencing. The final product allowed for loaded Cat 777 dump trucks with a gross weight of 140 tonnes to run directly on top of the tailings capping with no adverse effects.

Throughout the rehabilitation period, the tailing's impoundment has been surveyed quarterly to determine tailings consolidation and settlement. Since the cessation of milling in May 1998, the average dry solids density of the tailings has increased from 1.14 tonnes per cubic metre to 1.28 tonnes per cubic metre. The uncapped tailings have shown significant consolidation over this period as the rate of settlement of the tailings has been measured at 1.55 m over 631 days.

## Final water chemistry and cyanide recovery in tailings

A key indicator of performance of the concurrent and closure rehabilitation strategies is the post closure chemistry of the water draining from the site. The aim has been to ensure that the best possible water chemistry is achieved at closure, or as soon as possible thereafter, so that direct discharge to receiving water is possible. The experience at Golden Cross has been that the runoff and drainage water chemistry has met the expectations of the Joint Venture and the regulatory authorities (Russell et al., 2000; Kingett Mitchell and Associates, 1999; Environment Waikato, 2000). Post-closure trends indicate that surface water draining from the site will be discharged directly into receiving water in a high quality stream environment which supports a diverse aquatic community and a small trout fishery, without the need of further treatment.

Management of waste rock disposal operations, the use of geotechnical and geochemical controls, and appropriate design principals, as noted above, have been the key elements of the strategy to achieve the desired environmental outcome of drainage water chemistry which meets receiving water discharge chemistry criteria. However a significant proportion of the waste generated was process tailings and one of the key issues with this material is residual or excess process chemical particularly cyanide and the metals that it can continue to leach and/or keep in solution. During the operating life of the mine this issue was dealt with by a sophisticated water management system and a peroxide oxidation/metals coagulation and removal treatment system on the final discharge (Williams and Goldstone, 1988; Russell et al., 2000; Goldstone and Peterson, 1991). However, to enable the discharge of water without treatment following mine closure and to keep the load off of the water treatment system during operations, a further treatment step was added at Golden Cross whereby cyanide was removed from tailings for re-use.

There are a number of conventional treatment routes for the destruction of cyanide in gold mill tailings which come with a number of advantages and disadvantages (Smith and Mudder, 1991). A principal disadvantage with destruction technology is that cyanide is converted to cyanate and a number of by-products with, for the most part, conservation of cyanide mass, and more significantly the economic disadvantage of loss of excess cyanide from the circuit. At Golden Cross a research and development program was implemented during the earliest stages of mine development and permitting to engineer a cyanide recovery system to be used directly on the tailings stream prior to discharge to the tailings impoundment.

The system eventually installed, described in Mudder and Goldstone (1989) and Goldstone and Mudder (1993), was patented and is now marketed by Coeur d'Alene Mines as the Cyanisorb system. It utilizes the pH dependent chemistry of cyanide by lowering pH and dissociating the cyanide ion from its metal complexes converting the cyanide ion to volatile HCN gas, stripping the gas into air, and then scrubbing the air with caustic, thereby recovering cyanide in the ionic form. The stripped tailings slurry is then re-neutralized to a pH of 9.5, creating a stable environment of carbonate-hydroxide minerals, for disposal into the tailings impoundment. A conceptual flow sheet is shown in Figure 5.

The performance of the system is described in Goldstone and Mudder (1993) and Russell et al. (2000) tailings discharged to the impoundment generally had solution  $CN_{wad}$  values in the range 15 to 30g/m<sup>3</sup> which represented an 85-90% rate of recovery. The drainage water from the tailings area is made up of the pond overlying the tailings and the water collected in the system of drains within the tailings embankment and the under the tailings themselves. Operational experience has indicated that the key parameters of interest in this area are cyanide and copper.

Immediately following closure, both the decant pond chemistry and underdrainage chemistry began to show signs of rapid improvement. The cyanide and copper concentrations in the tailings pond and the underdrains for the period following closure are shown in Figure 6. Table 2 shows the current chemistry of both decant pond and underdrains and the receiving water criteria established by Environment Waikato for the receiving water at the site which was approved in closure discharge consents granted to the Joint Venture in September 2000.

Extensive technical analyses have been carried out during the closure design and permitting process. This analysis has attributed the success of the closure program for the tailings facility and the ability to direct discharge water from the tailings to the local receiving environment directly to the Cyanisorb system used during the operating period.

## Consultation

Throughout the history of the operation, the Joint Venture has benefited from consultation involving both a peer review panel

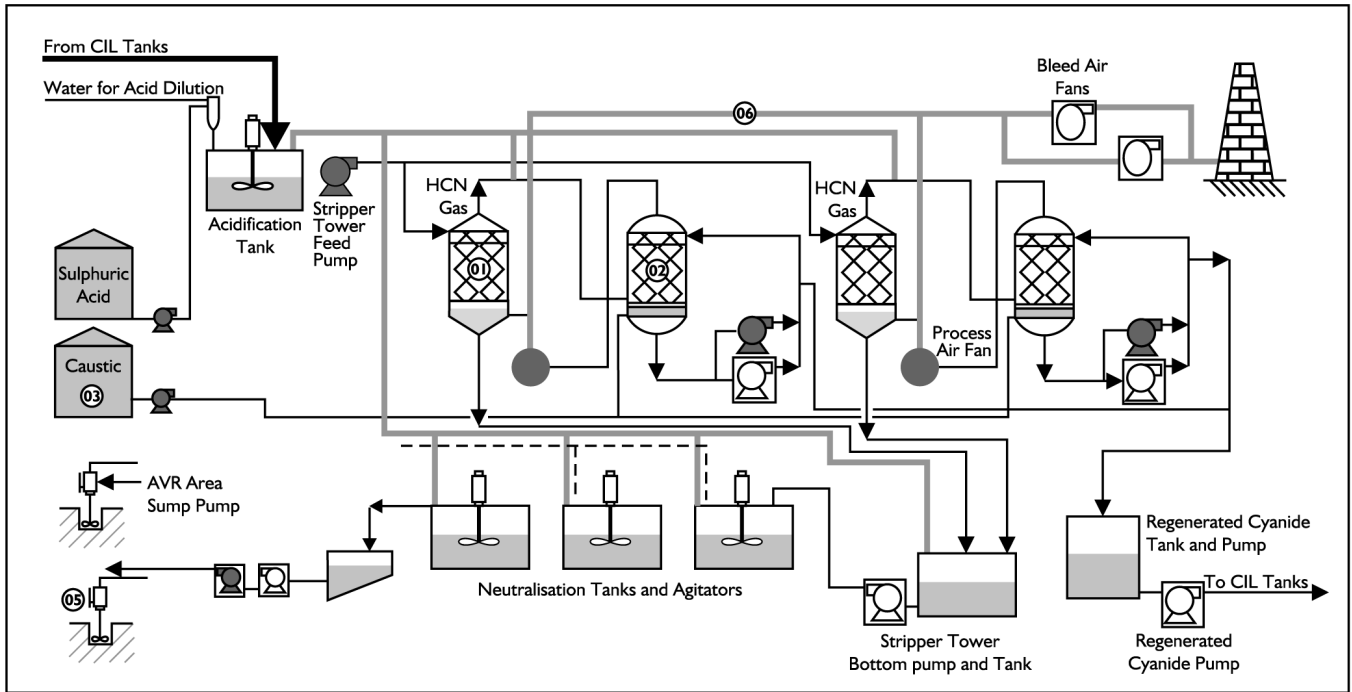


Figure 5. The AVR (Acidification/Volatilisation/Reneutralisation) process - Golden Cross mine.

and a local Community Consultative Group. These two bodies were developed during the operational period of the project, but have transitioned into the closure phase of the mine-life. This type of review and liaising is essential to maintain confidence in the progress of the closure works as the company's presence becomes increasingly limited onsite.

The peer review panel was established to provide assurance to the regulating authorities that the ongoing onsite works were of good industry practice from the perspective of an industry professional with no ownership in the design documents. The initial review panel consisted of a consulting geotechnical engineer and an environmental scientist specializing in land rehabilitation. They were advised by two geochemists on water quality and acid mine drainage issues. The panel was expanded at the appropriate instances to include a landslide expert and a specialist with experience in mine closure. These individuals were allowed to independently review and advise government regulators on the soundness of the company proposals without any potential of bias from the design engineers. At the same time the specialists of the peer review panel provided feedback to the company and contributed to the proposed plans.

The Community Consultative Group (CCG) has met on a regular basis for a period of approximately four years, the last three years of which have focused on closure activities from concepts through implementation and now into completion. The group is comprised of Regional Council staff members, District Councilors, environmental groups, Iwi, and the local residents of the Waitekauri Valley. Participation by members of this group is voluntary and remains steady which proves the level of commitment that the community has if

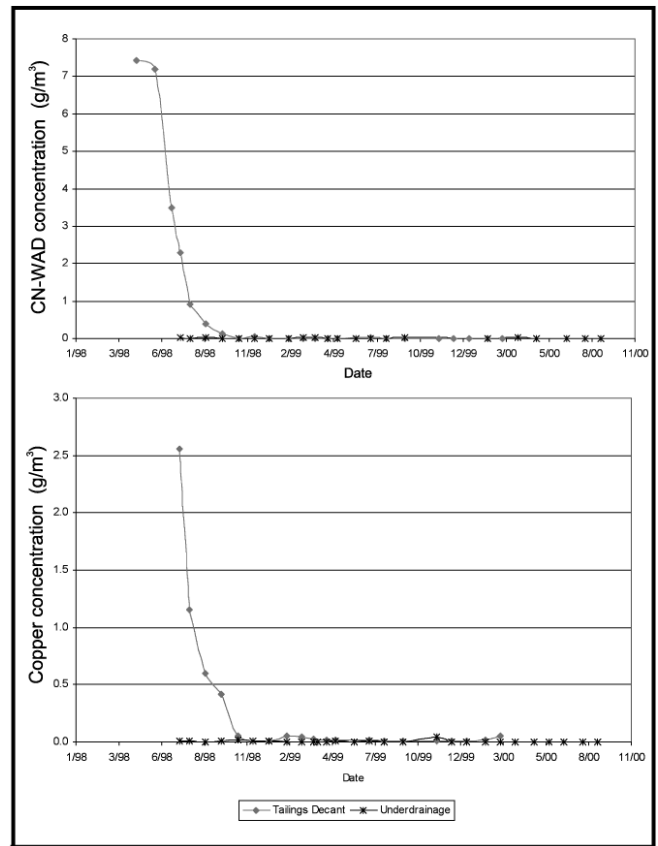


Figure 6. Cyanide and copper decay in tailings decant.

they are given the opportunity to participate. The active involvement of the peer review panel directly with the CCG, and routine site visits have been of great benefit to

Parameter	Typical underdrain concentration	Typical decant pond concentration	Receiving water criteria (EW 2000)*
WAD cyanide	<0.007	<0.007	0.10
Fe	1.60	0.28	2.0
Mn	1.60	0.043	0.96
Cu	0.002	0.006	0.007
Zn	0.011	0.007	0.037
SO <sub>4</sub>	114	123	-

\* hardness dependent criteria calculated at 50

Table 2. Current chemistry of decant pond and underdrains (median value January to September 2000).

communicating the proposed concepts to the group. This transparent planning strategy, with the help of the regulatory staff members, has transformed local tension into neutrality and support from those who have participated in the ongoing community consultation.

## Conclusion

Building confidence and support for a project's Closure Plan begins with a commitment to genuine peer review and community consultation while engineering and building a sound project during the construction, operation, and closure phases. The key design features that have been successful at the Golden Cross site, an area that receives 3 m of annual precipitation, include: strict engineering rules for the classification, placement, and compaction of mine waste material, the installation and revegetation of an oxygen diffusion control layer over the waste rock, the robust design of diversion drains to protect the capping, and the manipulation of process tailings to reduce and re-use the entrained cyanide while stabilizing the metals to accelerate the improvement in water quality for direct discharge to a sensitive receiving environment.

## Acknowledgements

The following people had key roles in the closure of the Golden Cross Mine:

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Rod Jacobs	former Coeur Gold New Zealand Ltd.
Grant Loney	Tonkin & Taylor
Peter Riley	Viking Mining Limited
Luke Russell	former Coeur D'Alene Mines Inc.

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