Audit Addendum 2009

Contents

1. List of Documentation for Disclosure

No	Title	Issued by	Year
1	Environmental Impact Study	Ross Mining	1996
2	Social Impact Study	Ross Mining	1996
3	Community Economic Development Plan 2009	Gold Ridge Mining Limited	2009
4	Integrated Management System	Gold Ridge Mining Limited	2009
5	Environmental Management Plan	Gold Ridge Mining Limited	2009
6	Resettlement Action Plan	Gold Ridge Mining Limited	2009
7	Community Relations Management Action Plan	Gold Ridge Mining Limited	2009
8	Stakeholder Engagement Plan	Gold Ridge Mining Limited	2009
9	Audit Addendum 2009	Gold Ridge Mining Limited	2009

2. Capacity and Staff Resources

GRML is progressively putting in place the capacity to implement the environmental, social and human resources aspects of the project with a view to ensuring that the necessary staffing and management systems are in place to the commencement of large scale mining.

Key milestones for the recommencement of mining are shown in the following table. The timing of these milestones is indicative depending on the availability of finance for the project.

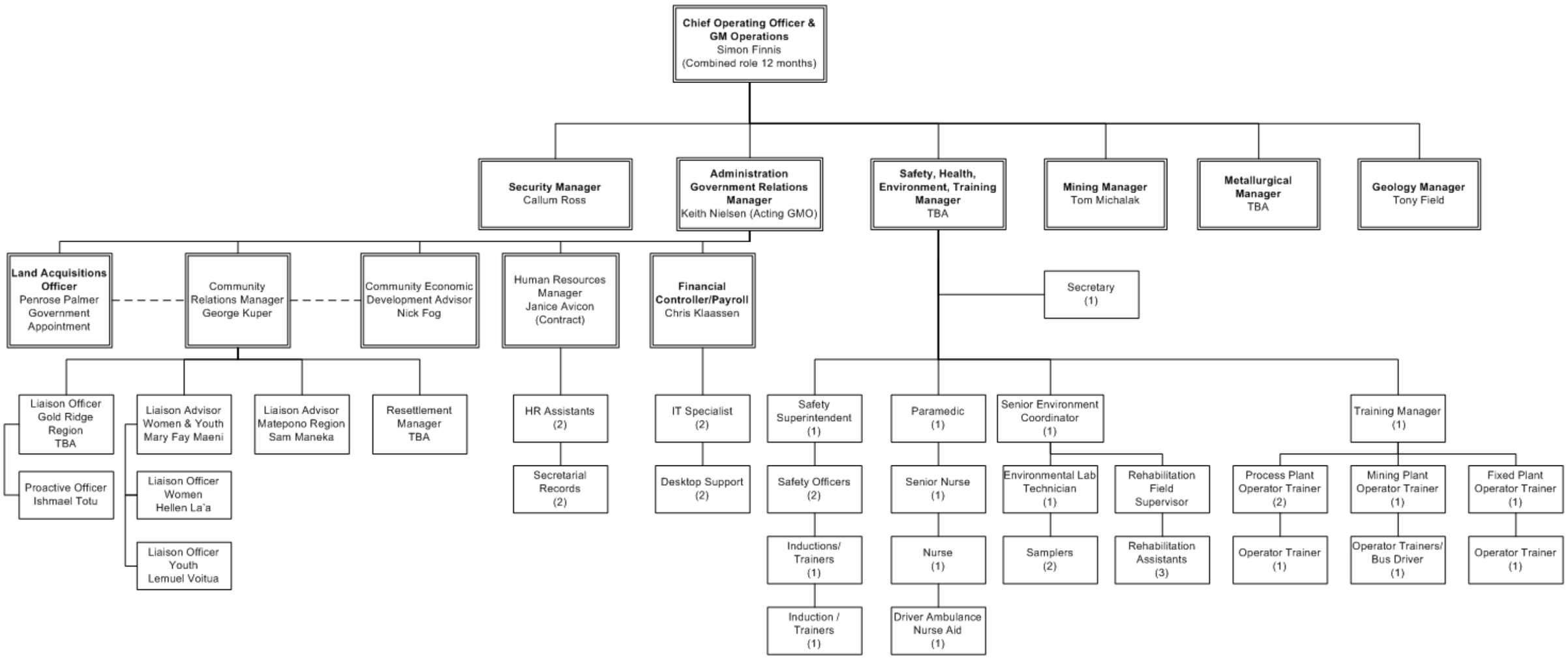
Table 2.1 Target Milestones for Recommencement of Mining

Date	Action
June 2009	Commence manufacture of resettlement houses (offshore location)
July 2009	Commence TSF Dewatering
November 2009	Commence erection of Dwellings
January 2010	Commence relocation of persons and their effects from the mine site
February 2010	Complete relocation for Namachamata (first ore body)
July 2010	Commence large scale mining works
October 2010	Complete refurbishment of processing plant

The program for staffing appointments for key environmental, social and human resources staff consistent with these milestones is as follows:

Appointment	Date
Community Relations Manager and Community Relations Department staff	**In Place**
Community Economic Development Advisor	**In Place**
Resettlement Manager Construction of resettlement villages and related works Management of physical relocation	**September 2009**
Human Resources Manager *Position filled on contract basis pending confirmation of financing in place* Development of HR Management System Implementation of HR management for resettlement construction staff and mining workforce.	**May 2009**
Health Safety Environment and Training Manager Development of H&S Management System Implementation of H&S management for resettlement construction staff and mining workforce. Implementation of the EMP and IMS (IMS Coordinator)	**September 2009**

The Organisation Chart (organogram) shown below shows planned staffing for the environmental, social and human resources functions. Staffing of the Community Relations Department (excluding the position of Resettlement Manager) is already in place. Staffing for the Human Resources, Health and Safety, and Environmental functions is subject to review when the relevant managers are appointed.


Chief Operating Officer & GM Operations
Simon Finnis
(Combined role 12 months)
Security Manager
Callum Ross
Administration Government Relations Manager
Keith Nielsen (Acting GMO)
Safety, Health, Environment, Training Manager
TBA
Mining Manager
Tom Michalak
Metallurgical Manager
TBA
Geology Manager
Tony Field
Land Acquisitions Officer
Penrose Palmer
Government Appointment
Community Relations Manager
George Kuper
Community Economic Development Advisor
Nick Fog
Human Resources Manager
Janice Avicon
(Contract)
Financial Controller/Payroll
Chris Klaassen
Secretary
(1)
Liaison Officer Gold Ridge Region
TBA
Proactive Officer
Ishmael Totu
Liaison Advisor Women & Youth
Mary Fay Maeni
Liaison Officer Women
Hellen La'a
Liaison Officer Youth
Lemuel Voitua
Liaison Advisor Matepono Region
Sam Maneka
Resettlement Manager
TBA
HR Assistants
(2)
Secretarial Records
(2)
IT Specialist
(2)
Desktop Support
(2)
Safety Superintendent
(1)
Safety Officers
(2)
Inductions/ Trainers
(1)
Induction / Trainers
(1)
Paramedic
(1)
Senior Nurse
(1)
Nurse
(1)
Driver Ambulance Nurse Aid
(1)
Senior Environment Coordinator
(1)
Environmental Lab Technician
(1)
Samplers
(2)
Rehabilitation Field Supervisor
Rehabilitation Assistants
(3)
Training Manager
(1)
Process Plant Operator Trainer
(2)
Operator Trainer
(1)
Mining Plant Operator Trainer
(1)
Operator Trainers/ Bus Driver
(1)
Fixed Plant Operator Trainer
(1)
Operator Trainer
(1)

3. Performance Standard 2 – Labor and Working Conditions

GRML is currently preparing for recommencement of operations. Preparation is primarily focused on:

- The voluntary resettlement of people currently residing on or near the Mining Lease area,
- Dewatering of the Return Water Dam and Tailings Storage Facility
- Refurbishment of the processing plant; and
- Recommencement of mining activities.

Staffing requirements for the project will increase progressively as these steps in the project are undertaken.

Recruitment action has already taken place and resulted in the appointment of a Human Resources (HR) Manager, initially on a contract basis (pending confirmation of project financing), who commenced in May 2009.. The HR Manager will be responsible for establishing working conditions and managing worker relationships on a basis consistent with IFC Performance Standard 2, Solomon Islands law, and industry best practice in the Australia/Oceania region.

Human Resources Policy

The HR Manager will develop a Human Resources Management System (HRMS) suitable for the recommencement of mining. Guidance for the HRMS will be given by a *Human Resources Policy*, which will also be developed by the HR Manager. The Policy will include GRML's commitment to protecting employee rights under relevant Solomon Island legislation and will be available to all employees in English and Pidgin.

GRML has developed an Integrated Management System (IMS). A *Recruitment and Engagement Charter (IMS-001-POL-012)* is being prepared as part of the IMS. This Charter will include GRML's approach to the employment of Solomon Islands staff including:

- Employment preference for the landowner community and other Solomon Islands people in accordance with the 1996 Mining Agreement and the 2006 Subsidiary Agreement (target of 80% sourced locally);
- Training of employees and prospective employees recognising the lack of education and training in Solomon Islands over the past decade; and
- Employment practices to ensure a harmonious workforce having regard to community relations issues in the Solomon Island.

Working Relationship

All employees and contractors are supplied with Contracts of Employment which provide full details of their conditions of work. This information is communicated during inductions, as directed in the IMS Procedure *Training and Competency (IMS-007-SYS-001)*, which states:

- All employees, contractors and visitors to a site shall attend induction training prior to entering the site or commencing work. The inductions shall outline their roles and responsibilities and the SHEC requirements for the site.
- Employees and contractors shall complete the *General Induction (IMS-007-TRA-001)* and the *Cultural Induction (IMS-007-TRA-002)* prior to commencing work on site or completing a worksite specific induction.

- The Human Resources (HR) Manager shall complete the *Employee Induction Checklist (IMS-007-CHL-001)* for each employee before commencement of work.
- All employees and contractors shall be re-inducted every two years or when significant changes to the induction procedure are made.

Working Conditions and Terms of Employment

GRML will significantly increase its current workforce (approximately 150 employees and contractors) during the resettlement, dewatering and refurbishment tasks prior to mine recommencement. This number will again increase to approximately 600 when the mine is fully operational. GRML have a commitment to try to fill 80% of the unskilled and semi-skilled positions with people from the local area (Clause 13 – 2006 Subsidiary Agreement).

Community Relations System Procedure *Community Development and Investment (CRD-002-SYS-001)* provides instructions on local employment issues:

- GRML shall develop and maintain a statement of commitment to contribute to the community through preferential local employment and other factors, as per the *Recruitment and Engagement Charter.*
- The Human Resource Manager shall develop and maintain processes to maximise local employment and contributions to the community.
- The Human Resource Manager shall maintain records of the level of local employment and training programs. The Community Relations Manager shall maintain records relating to local livelihoods and business initiatives.
- GRML shall communicate and actively encourage community members to apply for employment with GRML.

Workers' salaries are currently above the regulated minimum wage in the Solomon Islands and GRML intends to maintain this relativity.

Workers' Organisations

According to Solomon Islands law, workers are entitled to form trade unions. GRML will respect duly registered trade unions operating on the site and will participate, if required, in collective bargaining negotiations.

Non-Discrimination and Equal Opportunity

GRML will commit to non-discrimination and equal opportunities in the *Human Resources Policy* and the *Recruitment and Engagement Charter*.

Community Relations System Procedure *Cultural Awareness (CRD-001-SYS-001)* provides instructions on cultural issues regarding local employment:

- GRML shall undertake employment practices that ensure a harmonious workforce having regard for identified cross-cultural issues and human rights. These practices shall ensure that employee positions take in to account, but are not limited to, the following issues:
    - Tribal structure and customs;
    - Culturally related gender issues; and
    - Ethnic relationships.

- The Community Relations Manager shall identify these practices in the *Recruitment and Engagement Charter* in liaison with the Human Resources Manager and develop departmental Standard Operating Procedures as required.
- Any person who believes that a GRML employee or contractor has acted in a culturally insensitive or inappropriate way shall report such incidents to the Community Relations Manager.
- GRML shall report and investigate any incidents involving employee and/or contractor behaviour that may have a cultural impact on an individual or the local community. Incidents shall be treated as grievances and thus shall be redressed according to CRD Procedure *Grievance Redress (CRD-011-SYS-001)* including documenting the grievance in the *Grievance Register (IMS-003-REG-002).*
- Individuals in breach of GRML policy shall be subject to disciplinary action.

Retrenchment

As stated earlier, GRML expects to significantly increase its workforce prior to and during mining operations. No retrenchments are foreseeable at this time.

Grievance Mechanism

IMS Procedure *Internal Communication and Reporting (IMS-003-SYS-001)* details available avenues for employees and contractors to have grievances heard and redressed appropriately.

Child Labour

GRML do not employ minors (person under the age of 18). During the employment process, documentation establishing age is required and stringently verified.

Forced Labour

All employment is strictly voluntary and GRML does not endorse forced labour.

Occupational Health and Safety

A specialist Health and Safety Manager will be appointed prior to the commencement of any large scale construction and operational activities.

The *Safety and Health Policy* is pending approval and details GRML's commitment to the prevention of work related incidents, illnesses and injuries.

A Safety Management System (SMS) has been developed as part of the IMS. The SMS contains detailed procedures and associated documentation to best ensure the safest possible work environment for employees and contractors. The procedures are listed below:

- Hazardous Materials SAF-001-SYS-001
- Electrical Safety SAF-002-SYS-001
- Radiation Safety SAF-003-SYS-001
- Explosives SAF-004-SYS-001
- Fire Prevention SAF-005-SYS-001
- Isolation SAF-006-SYS-001
- Occupational Health and Hygiene SAF-007-SYS-001

- Manual Handling and Ergonomics SAF-008-SYS-001
- Fall Prevention and Working at Heights SAF-009-SYS-001
- Mobile Equipment and Vehicles SAF-010-SYS-001
- Permits to Work SAF-011-SYS-001
- Machine Guarding SAF-012-SYS-001
- Aviation SAF-013-SYS-001
- Fitness for Work SAF-014-SYS-001

Employees, contractors and visitors to the site will be required to undertake a safety induction process.

Employees and contractors are supplied with all necessary protective equipment during the induction process. Completion of the *Employee Induction Checklist* ensures that relevant equipment is supplied and signed off.

Non-Employee Workers

GRML generally accepts that similar rights and obligations apply to contractors as to employees. Contractor management is governed by IMS Procedure *Contractor Management (IMS-013-SYS-001).*

Supply Chain

GRML will endeavour to use local industries for supply of food, clothing and materials where possible. GRML will ensure that industries supplying goods do not employ forced labour and those who employ children (i.e. local family farms), do so without detriment to the child's mental, physical, spiritual, moral or social development.

4. Performance Standard 4 – Community Health, Safety and Security Requirements

The Solomon Islands is inhabited predominantly by Melanesians, who have resided on the islands for at least 50,000 years. The Gold Ridge area is occupied by the Malango linguistic-ethnic group. Local people belong to the Mbahomea people and the language they speak is one of 19 indigenous language groups present on Guadalcanal. The people were traditionally hunter-gatherers, but have been engaged in alluvial gold panning since the 1950s.

General Requirements

Potential social impacts of the Gold Ridge Project were identified and documented in the *Ross Mining Social Impact Assessment (1997)* and the *Preliminary Review of Social Activities of the Re-Commencement of Gold Ridge Gold Mine to Date (Golder Associates, 2007)*.

While the range of potential social impacts identified in the 1997 SIA have changed very little over subsequent years, GRML has initiated a number of processes to ensure that the identification of social risks remains current and addresses the requirements of relevant IFC Performance Standards. The planning of the resettlement process has required a thorough appraisal of social management and an identification of potential risks to the Gold Ridge community as well as to the neighbouring and downstream communities.

The GRML Community Relations Department has conducted extensive consultation within the communities (including specific consultations with vulnerable groups) which has also assisted in identifying emerging social risks. A series of social risk assessment workshops was conducted in late 2008 and early 2009, to build a consensus with the community on the range of social risks that need to be addressed.

Infrastructure and Equipment Safety

The Tailings Storage Facility (TSF) has been identified by GRML as the infrastructure with the greatest potential for harm to the health and safety of the neighbouring communities.

Due to the nature of the Solomon Island's existence and location, earthquakes and tropical cyclones are common. The TSF was specifically designed to withstand of these events without the release of contaminated materials.

TSF and tailings management, independent expert review and the proposed dewatering process is covered in Section 5.

Hazardous Materials Safety

The gold extraction process at Gold Ridge will use cyanide. The process will involve:

- Solid cyanide delivery (by an approved transporter);
- Dissolution in dedicated tanks;
- Leaching of gold (a carbon-in-leach process); and
- Recycling and/or destruction of cyanide during tailings processing.

GRML are currently finalising the Environment Procedure *Cyanide Management (ENV-003-SYS-001)*. *Cyanide Management* contains detailed instructions to ensure health and safety to the employees, the community and the environment. The Procedure covers:

- Planning (including, where practicable, conformance with the International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the Production of Gold);
- Operations;
- Emergency Response;
- Mine Closure; and
- Monitoring.

The use of hazardous materials other than cyanide will be governed by the Environmental Procedure *Hazardous Materials Management (ENV-002-SYS-001)*.

Environmental and Natural Resource Issues

Natural resources assessments undertaken as part of the environmental investigations of the mine site indicate that the vegetation of the area has been extensively degraded by mining operations and by commercial logging over the past 30 years. There are some small areas of remnant rainforest in inaccessible areas. Some timber trees remain which are used or sold by the landowners. Natural resource assessments of the resettlement sites, including suitability of soils for gardening, are being undertaken as part of resettlement planning.

GRML has endorsed a *Native Timber Utilisation Policy* which commits to the principles under IFC Performance Standard 6 *Biodiversity Conservation and Sustainable Natural Resource Management*.

Community Exposure to Disease

Community health is a major concern in the Gold Ridge and surrounding communities. There are many health issues on Guadalcanal including malaria, hook worm and ring worm infections, HIV-AIDS, dengue fever and other tropical fevers. Water quality and sanitation is a major concern in the Mining Lease area and other parts of the region.

GRML addresses health issues through:

- Community water supply projects;
- Health and hygiene awareness (ongoing);
- Distribution of hook and ring worm medication (2007) – World Vision and Guadalcanal Provincial Health Division;
- Clinics – facilitated by SWIM (ongoing);
- HIV-AIDS Survey/awareness – Save the Children Australia and Pasifiki Services 2008 - 2009;
- Sanitation Survey for implementation from 2009 onwards;
- Anti-malaria fogging conducted by GRML in surrounding villages; and
- Daily bus and emergency runs to the clinics for employees and surrounding communities mostly for malaria, pneumonia, diarrhoea and sometimes women in labour.

Emergency Preparedness and Response

Emergency planning, response and reporting instructions are detailed in the IMS Procedures *Accident, Incident and Emergency Preparedness and Response (IMS-009-SYS-002)* and *Accident, Incident and Emergency Reporting (IMS-009-SYS-001)*. The Procedures combine to cover:

- Accidents, incidents and emergencies identification;
- Accident/incident and emergency actions;
- Accident/incident and emergency investigation;
- Emergency planning (including the contents of the *Emergency Response Plan*);
- Emergency equipment and procedures;
- Emergency power supply;
- Inspections and drills;
- Training;
- Post emergency activities;
- Reporting schedule; and
- Record keeping.

GRML will develop a detailed *Emergency Response Plan (IMS-009-MPL-001)* as described in *Accident, Incident and Emergency Preparedness and Response*.

Security Personnel Requirements

The Security Department is in the process of finalising its departmental policies and procedures such as the *Security Management Plan*, *Standing Orders* and standard operating procedures.

Both the GRML Community Relations and Security Departments understand the importance of working together to ensure that security needs are met without jeopardising the health and safety of the community as well as the goodwill and reputation of the company. The Community Relations Procedure *Security Liaison (CRD-007-SYS-001)* provides:

- The Community Relations Department shall encourage public support for the Security Department through effective community liaison and communication.
- The Community Relations Manager, in collaboration with the Security Manager, shall identify and assess any hazards and associated community risks relevant to security and document them in the Security section of the *Risk Register (IMS-004-REG-001)*. A *Risk Assessment Workshop (IMS-004-FRM-003)* shall be conducted for identified risks rated high or extreme.

- The Community Relations Manager shall provide advice on community issues when developing and reviewing:
  - *Security Management Plan;*
  - *Standing Orders*;
  - Security Standard Operating Procedures; and
  - Security Accident/Incident and Emergency Procedures.

Security Liaison also provides for the investigation into public concerns and grievances as well as personnel screening for prior records of human rights abuses and other previous offences.

GRML has made a commitment to the Voluntary *Principles on Security and Human Rights* and intends to train senior management and Security personnel on the associated policies and procedures.

GRML Security *Use of Force Policy* states:

> *"This policy is designed to provide Gold Ridge Mining Limited - Security Officers assigned to GRML Mining Operations with clear restrictions and guidelines regarding the justifiable use of physical force and use of security personal protection equipment, such as extendable batons where issued. The GRML Security Section and the Company Legal Advisor should be consulted in case of any doubt concerning the potential or actual application of any national or local laws in connection with this policy."*

The Solomon Islands Police Force will be consulted so that the *Use of Force Policy* is effectively communicated prior to any instances requiring public security.

5. Tailings Storage Facility Management

The Gold Ridge Tailings Storage Facility (TSF) and Return Water Dam have accumulated a volume of water estimated to be 4.2 gigalitres and 0.5 gigalitres respectively, from rainfall and runoff in the period since mine closure in June 2000. GRML will implement a recommendation from Golder Associates Pty Ltd that the accumulated water be discharged prior to further tailings deposition or further dam construction.

TSF Dewatering

On May 4 2007, GRML submitted a proposal to the office of the Prime Minister seeking approval to chemically treat and discharge the accumulated rainfall and runoff water in the TSF.

The proposal involved the controlled application and in-line mixing of reagents, including ferric chloride and calcium hydroxide, to the TSF water to remove a range of contaminants. Following addition and mixing of reagents the water is passed through a floc settlement pit within the TSF catchment area where the precipitate (including metals of concern such as arsenic, cadmium, molybdenum, iron and manganese) will form a sludge that settles in the floc settlement pit for storage. The resultant treated water, which will comply with the approved water quality objective (WQO) standards, will be discharged into the Tinahulu River. The Return Water Dam contains water with a quality that meets the approved WQO Standard and will be discharged directly to the Tinahulu River during the dewatering operation.

The Solomon Islands Government, through the Commonwealth Secretariat, retained the services of Knight Piesold (KPC) to review the above mentioned GRML proposal and to provide technical opinions and recommendations. KPC presented the results of the review in a letter dated May 24, 2007. In summary, the findings and recommendations of the KPC review were:

- The proposed treatment process is commonly used and meets international best practices.
- Discharges from the settlement pit into the Tinahulu River should be protective of human health as well as ecological systems; meaning acceptable discharge standards are the lesser of the $ANZECC_{AE95\%TLR}$ and the WHO 2004 drinking water guidelines.
- The proposal indicates that the treatment chemistry should be sufficient to precipitate the metal contaminants of concern and the equipment and process should be able to meet the required water quality standards.

Following a significant additional investigation, design, and review process, GRML revised the TSF dewatering proposal which satisfied the strict guidelines proposed by the Solomon Island Government and KPC. The proposal was detailed in an October 11 2007 letter to the Minister – Mines and Energy. The letter described the revised dewatering proposal in more detail and presented a response to the specific queries identified by KPC. The proposal is summarised in Attachment 1.

The Solomon Islands Government gave its approval for this approach on November 12 2007. This approval was endorsed by the new Solomon Islands Government on October 31 2008. The endorsement removed clauses 7 and 8 of the original approval relating to the provisions of alternative water supply for downstream communities (part of which GRML had already completed); and the clearing of a log jam in the Matepono River (for which GRML had no responsibility or authority).

GRML currently plans to install water treatment equipment in June 2009 and commence the dewatering process in July 2009. Higher than usual rainfall over the past few months has made it increasingly desirable that this process be commenced during July 2009.

TSF Management

GRML will implement a comprehensive TSF management regime prior to mine operation. TSF management will be controlled by documented plans and procedures. The *GRML Environmental Management Plan* (prepared by Golders Associates) includes:

- Element 16 – TSF Management and Remediation;
- Element 9 – Pipelines;
- Element 13 – Cyanide Management; and
- Element 18 – Mine Closure and Reclamation.

GRML has prepared an Integrated Management System (IMS) which involves Environmental Department Procedures *Tailings Management*, *Water Management* and *Cyanide Management*. In addition the IMS will include management manuals for:

- TSF and Tailings Pipelines;
- Cyanide;
- Water Management (Surface and Groundwater);
- Erosion and Sedimentation Control; and
- Mine Closure.

These manuals are to be developed prior to commencement of mining activities.

Independent Geotechnical Engineer

GRML have retained the services of Dr Neil Mattes from URS to review the TSF dam design, current status, and to perform ongoing independent monitoring through the redevelopment and operational phase.

Dr Mattes has wide experience in the investigation, design, construction and operation of tailings storages, and more particularly he was the independent peer reviewer of the Gold Ridge TSF design and construction for Ross Mining, the original developers of the mine. He visited the mine on several occasions between 1996 and 2000 to observe and review the investigation, design, construction and operation of the TSF.

6. Attachments

Attachment 1 – Summary of Discharge Procedure

1. Water Quality Objectives during Discharge of Treated Tailings Water Approach

GRML agrees with Knight Piesold that the protection of human health as well as ecological systems should be considered when determining Water Quality Objectives (WQO) for the Tinahulu River during the discharge of treated water that has accumulated in the TSF.

The 1996 Environmental Impact Study which was approved by the SIG and is still in effect utilised the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Accordingly, GRML has adopted the framework described in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) for determining WQOs. The framework includes for the identification of all environmental values, one of which is drinking water quality. Hence, the ANZECC 2000 approach applies to both the protection of aquatic ecosystems and human health (drinking water) and is appropriate to this program.

ANZECC 2000 recommends that when two environmental values are identified for a water body, that the more conservative associated guideline be used for defining a particular WQO. This is the basis for the methodology that GRML has used to determine the proposed WQOs for the Tinahulu River during the discharge of treated tailings water, and is consistent with KPC's comments (May 2007).

ANZECC 2000 indicates that the most appropriate guidelines be used to determine WQOs. The Solomon Islands does not have a comprehensive country-specific guideline for water quality. For the protection of human health (drinking water quality), the accepted international guideline by the World Health Organisation (WHO), *Guidelines for Drinking-water Quality* Third Edition (WHO 2004) has been used. For protection of aquatic ecosystems, the ANZECC 2000 guideline for Australia and New Zealand has been used, since it is a comprehensive guideline for two countries located in the same region as the Solomon Islands.

Water Quality Objectives Selection Methodology

WQOs were selected based on the following methodology:

1. The WHO 2004 value was selected if available and the ANZECC 2000 default trigger value for the protection of 95% of aquatic ecosystems in tropical lowland rivers ($ANZECC_{AE95\%TLR}$) was either not available or was above the WHO 2004 value.
2. The $ANZECC_{AE95\%TLR}$ value was selected if available and both of the following conditions applied:
   - WHO 2004 value was not available or was above the $ANZECC_{AE95\%TLR}$; and
   - background water quality (80^{th} percentile) was below the $ANZECC_{AE95\%TLR}$ value.
3. The value of the 80^{th} percentile of monitoring data was selected for other metal toxicants where the background quality exceeds the $ANZECC_{AE95\%TLR}$ value. This is consistent with ANZECC 2000 (Section 7.4.4.2), which states that when surface waters contain concentrations of toxicants that may naturally exceed the default guideline trigger value, than the 80^{th} percentile based on a

minimum of ten observations should be used as the WQO. Where this method has been used for the WQOs, the value is based on toxicant concentration as analysed at the Tinahulu Bridge, selected because of its proximity to the proposed discharge location. More than ten samples from this location were taken during the period July 2005 to November 2006.

Proposed Water Quality Objectives

GRML agrees with KPC that the primary constituents of interest for the tailings water discharge campaign are arsenic, cadmium, molybdenum, iron and manganese. Table 1 provides the proposed WQOs for these metals in the Tinahula River during the discharge of treated tailings water. These WQOs, with the exception of molybdenum, have been selected based on the methodology described above.

Table 1. Water Quality Objectives for the Tinahulu River During the Discharge of Treated Tailings Water

Parameter	Water Quality Objective (mg/L)	Basis of WQO	Source Guideline	Comments
Arsenic	0.0100	Total	WHO 2004	WHO 2004 Table 8.18
Cadmium	0.0008	Dissolved	80th percentile of monitoring data	Monitoring data: Jul 05 - Nov 06, Tinahulu Bridge
Molybdenum	0.1000	Total	TSF monitoring data	Monitoring data: Jul 05 - Nov 06. Dilution ratio of 1.4 required to achieve WHO 2004 guideline value of 0.070 mg/L (total)
Iron	0.3000	Dissolved	$ANZECC_{AE95\%LTR}$	ANZECC 2000 Section 8.3.7.1 - Interim guideline value based on Canadian guideline level.
Manganese	0.4000	Total	WHO 2004	WHO 2004 Table 8.18

It is noted that the proposed WQOs based on $ANZECC_{AE95\%TLR}$ and the 80^{th} percentile of monitoring data, are expressed as dissolved concentrations. This is because ANZECC 2000 default trigger values for ecological protection are based on bioavailable concentrations and are therefore relatively conservative when compared with total concentrations. As the major toxic effect of metals on aquatic ecosystems comes from the dissolved fraction, it is valid to compare the dissolved concentration only against the guideline value (ANZECC 2000, Section 3.4.3.2). For WQOs based on WHO 2004, the values are expressed as total concentration. This is because these guideline values have been derived based on a human's Tolerable Daily Intake (TDI), which includes intake from liquids and solids (food).

In the case of molybdenum, monitoring data for the tailings water indicates that the molybdenum concentration can equal or exceed the WHO 2004 guideline value of 0.070 mg/L, although this is only the case for about 35% of the measurements in the period July 2005 to November 2006.

GRML agrees with KPC that molybdenum is difficult to remove using the proposed treatment process. However, it is expected that some molybdenum will be co-precipitated and adsorbed onto

the ferric hydroxide floc during treatment. Treatment processes that are designed to remove molybdenum from water such as ion exchange tend to need to be specifically designed for molybdenum removal and hence, would not be appropriate for the removal of arsenic and cadmium, two of the other primary constituents of interest. GRML is therefore proposing that the WQO for molybdenum be set at 0.100 mg/L based on the following risk reduction measures:

- Dilution of the treated tailings water will occur in the Tinahulu River. Measurement of river flowrate during the last 12 months has shown that the mean daily river flowrate in December 2006 (4,018 L/s) is more than 10 times the maximum proposed treated tailings water discharge rate (400 L/s). The mean daily river flowrate during the seasonally low flow period (1,327 L/s mean daily river flowrate in June 2007) is still more than 3 times the maximum treated tailings water discharge rate. Monitoring data indicates that the ambient dissolved molybdenum concentration in the river water is very low, such that dilution to the WHO 2004 guideline value of 0.070 mg/L (dilution ratio of 1.4) can be achieved in a relatively short mixing length.
- Existing commitments remain for the provision of potable water to affected downstream communities within the immediate area of the discharge point.
- Treated tailings water will be discharged for a relatively short period compared to the timeframe applicable to WHO 2004 guideline values. WHO 2004 states that the guideline values are conservative because these are based on a level of exposure that is regarded as tolerable throughout a lifetime. Further, WHO states that the exceedence of guideline values may not result in a significant or increased risk to health, and deviations above the guideline values may not mean that the water is unsuitable for drinking.

Environmental Monitoring

In regard to monitoring of the parameters against the WQOs, it is proposed that during commissioning the treatment process will be operated such that treated water will be sampled and then returned back to the TSF without discharge until such time as confirmatory lab testing shows the WQOs are being met.

Once discharge into the river commences the discharge will be initially measured four-hourly on-site using a HACH spectrophotometer. It is anticipated that analysis at a four-hourly frequency will be required for about one week of operation. Additionally, during this time all parameters will be determined from daily samples.

GRML investigations have shown that real-time monitoring is not practically achievable and that risk reduction measures in the design and operation of the treatment plant (described below) are more effective in ensuring that arsenic levels meet the WQO for the Tinahulu River.

After the first week and subject to steady treatment operations and the WQOs consistently being met, the frequency of on-site measurement of arsenic and analysis of all parameters will be reduced. If at any time during the tailings water discharge campaign, monitoring indicates that treatment conditions or tailings water chemistry has changed, monitoring frequency will be increased so that any potential adverse issue will be identified and rectified as soon as possible.

Monitoring of the Tinahulu River upstream and downstream of the discharge point will also be undertaken during the discharge campaign.

Further details of all proposed monitoring will be provided in the Environmental Management Plan (EMP), which will be updated before commencement of treatment operations.

Triggering of Action

In accordance with recommendations in ANZECC 2000, action will be triggered if the 95th percentile of data from monitoring exceeds a WQO. Based on the monitoring program proposed, a single result greater than a WQO is likely to trigger action in most cases. If monitoring shows that the WQOs are being exceeded, then the discharge of water will be stopped and the treatment parameters reviewed. Further detail will be provided in the revised EMP.

2. Water Treatment Process

Design Approach

GRML have undertaken a three stage design process to ensure that the proposal meets the required water quality objectives and is the most appropriate response to the specific requirements of the Gold Ridge TSF. The three stages of design include a preliminary test work program, followed by a bulk test work program, and finally a commissioning program. The staged approach ensures that all aspects of the proposal are progressed in a systematic, structured, and transparent manner. Additional details for each stage of the test work and design program are described below.

Initial selection of the treatment process was based on the results of preliminary test work undertaken on water extracted from the TSF in March 2007. For these tests, dissolved arsenic in the water was reduced from 0.109 mg/L to <0.005 mg/L using ferric chloride and hydrated lime reagents.

Bulk trials were carried out during March 2008 to validate the selection of reagents as well as to determine required dosage rates. Ferric chloride (42%) solution will be used to precipitate the arsenic salts with hydrated lime being slaked to adjust the pH.

Following installation of the water treatment plant on-site, the operational parameters will be refined during plant commissioning. During the commissioning stage, treated water will be sampled and returned back to the TSF without discharge until such time as confirmatory lab testing shows the WQOs are being met.

Design Details

The process that will be used for TSF water treatment and discharge is in all aspects in compliance with the Solomons Island Government approved method, with some design enhancements.

Dewatering of the TSF is based on standard water treatment technology using sequential dosing of ferric chloride and hydrated lime. Ferric chloride is widely used in the treatment of water containing arsenic as well as acting as a flocculent to remove suspended solids. Hydrous lime is added to maintain pH, enhance ferric chloride precipitation and removal of the arsenic.

Ferric chloride (42%) will be purchased in 1000 litre bulki-boxes and dosed via a variable speed pump. Lime is purchased as powder and requires slurrying to 10% solids for gravity transfer along a floating pipeline to the TSF dewatering pump intakes. Around two tonnes per day of lime is required.

The proposed system is depicted in Figure 1.

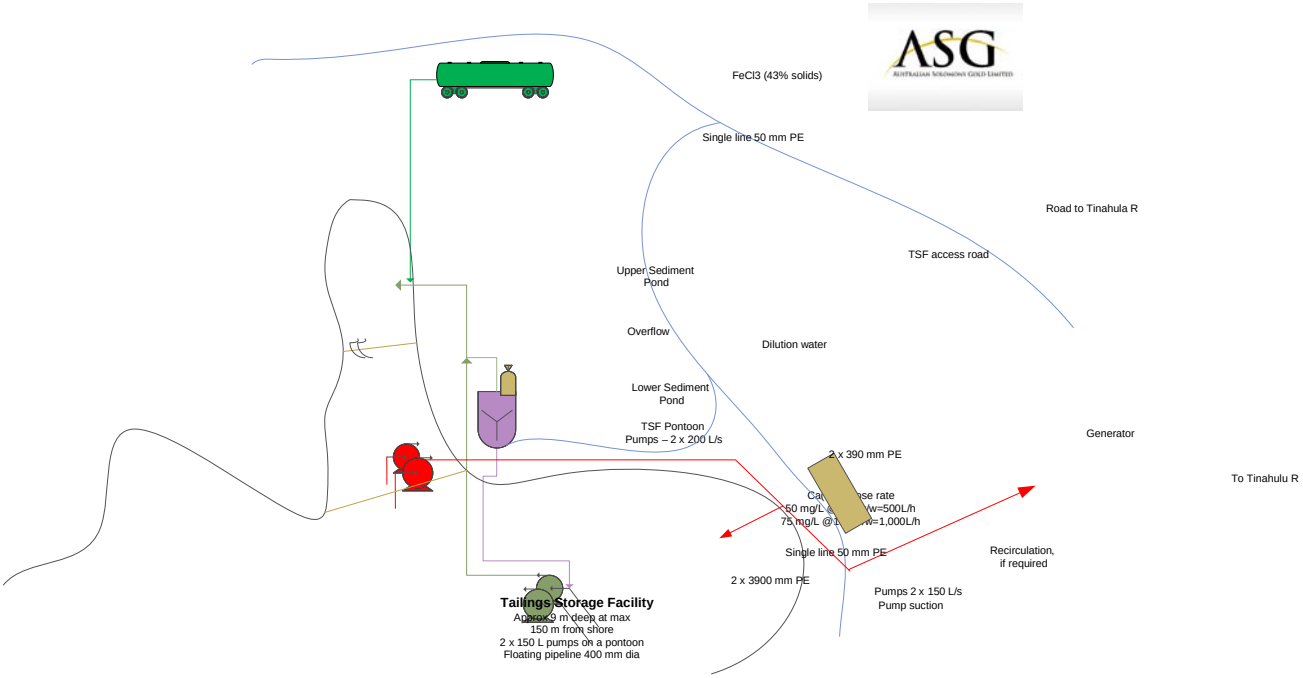


Figure 1 - System schematic

The main piping and equipment items comprising the dosing system include:

- Return Water Dam pontoon and associated equipment being two pumps (150 L/s);
- Lime makedown system delivering lime to the inlet of the pumps on the pontoon;
- Floating pipelines to (lime) and from (TSF water) the pontoon
- Ferric chloride dosing system (pump and pipeline) from the ferric chloride tanker (now 1000 litre bulki boxes are used given unavailability of tankers);
- TSF pontoon and pumps (200 L/s) located in the Lower Sediment Pond;
- Discharge pipeline to the Tinahulu River.

Equipment layout

Water is pumped from a deep area of the TSF (depth ~10 m) approximately 150 m from shore using the Return Water Dam pontoon. This pontoon carries two refurbished pumps capable of 300 L/s. TSF water is pumped to the Upper Sediment Pond and discharged and mixed with ferric chloride.

Lime is delivered from the makedown unit to each pontoon pump intake via variable speed pumps.

The lime makedown unit is located adjacent to the Lower Sediment Pond bund wall. Dilution water is supplied from the TSF using a small pipeline off the main TSF transfer line running to the Upper Sediment Pond.

The lime unit is manually filled using small bags (20 kg) added on an hourly basis or single large bags (500 kg or 1 tonne). Dilution water is added using water from the TSF. The target lime solids are to be maintained at 7 to 10% to aid gravity flow to the intake of the pontoon pumps located in the TSF.

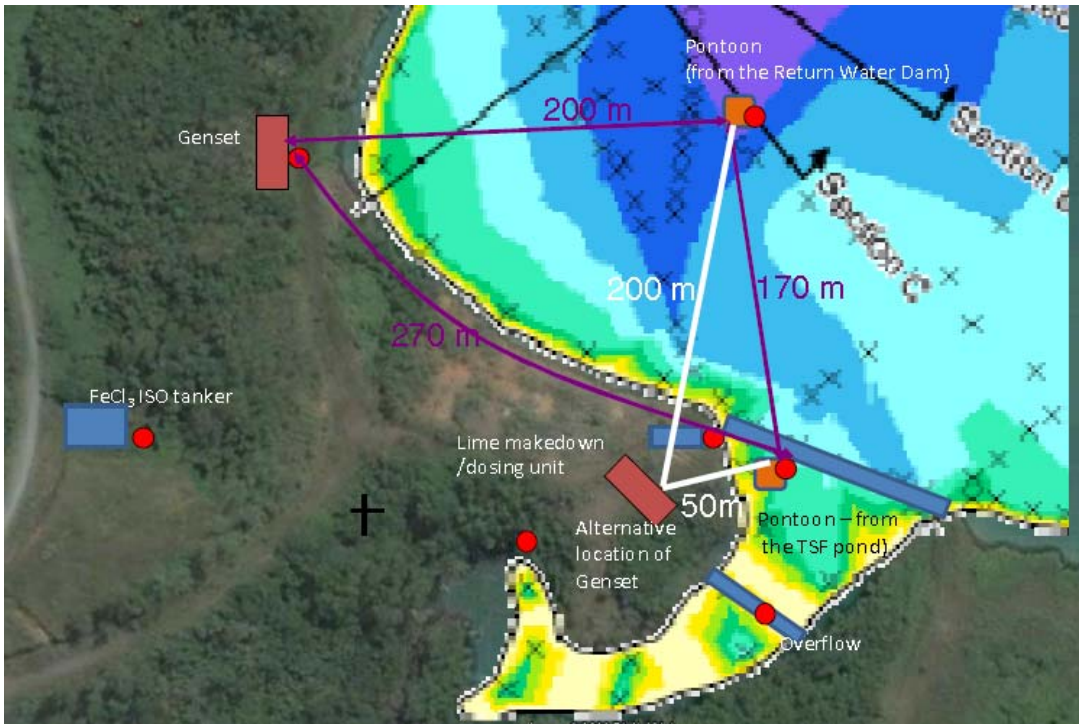


Figure 2 - System layout

Decant control system and design aspects

- The flow rate of reagent dosed TSF water into the floc pit is controlled by the pontoon mounted transfer pumps. The pump control system is such that all required systems are started in the correct sequence and operate in unison.
- The settling pit is designed to be of sufficient size to enable all floc to precipitate and settle out from the treated water prior to release. The floc remains in the settling pit.
- Level sensors installed will detect if the water level becomes too high / too low (eg due to pipe burst or blockage) and will shut down the entire system including the transfer pumps.
- During commissioning the treatment process will be operated such that treated water will be sampled and returned back to the TSF without discharge until such time as confirmatory lab testing shows the WQOs are being met.
- If at any time during the tailings water discharge campaign, monitoring indicates that treatment conditions or tailings water chemistry has changed, monitoring frequency will be increased so that any potential adverse issue will be identified and rectified as soon as possible.
- The water pH will be continually analysed during operation. The pH "over and under" correction system is continually checking pH every 5 seconds and the automatic shutdown limits can be set as close to the target pH as desired. The function will maintain constant treated water pH by adjusting reagent rates as required. Real time monitoring of pH ensures that discharge of treated water is stopped if a problem with the reagent dosing system, which could impact treated water quality, occurs.
- GRML investigations have shown that continual real-time monitoring of arsenic or other contaminants is not practically achievable and that risk reduction measures in the design and operation of the treatment plant are more effective in ensuring that WQOs are met.

- All water will be returned back to the TSF during commissioning trials.
- A spillway will be incorporated into the floc pit construction such that any overtopping of the floc pit would also return water back to the TSF rather than into the environment.