



Environmental & Social Management System

Acid Rock Drainage Management Plan

Acid Rock Drainage Management Plan		
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1 INTRODUCTION

1.1 Document Number

This document is the Acid Rock Drainage Management Plan (ARDMP) for the Gatsuurt Gold Project ('Gatsuurt' or 'the Project'). The document reference number for this Management Plan is Gatsuurt-ARD-Ver. 1.

1.2 Purpose

This Management Plan is as a first version of the ARD Management Plan and describes a framework within which the Gatsuurt Project will operate to ensure environmental and social impacts are effectively managed. This Management Plan will be further developed and updated prior to commencement of operations to incorporate the findings of future scheduled ARD studies and resulting detailed operational management relevant to ARD management at Gatsuurt.

This ARD Management Plan has been developed for the exclusive application at the Gatsuurt Gold Project site. This Management Plan is one of a series of Management Plans that outline how Centerra Gold Inc. (Centerra) through its subsidiary, Boroo Gold Company (BGC), manages the environmental aspects of its Gatsuurt operations. The purpose of this Management Plan is to:

- Define the scope of ARD Management and set out applicable management interfaces;
- Define roles and responsibilities;
- Outline the applicable standards and obligations relevant to ARD management;
- Define Project commitments, operational procedures and guidance relevant to ARD Management;
- Define monitoring and reporting procedures, including Key Performance Indicators;
- Defined training requirements; and
- Set out references for supporting materials and information.

1.3 Application

The requirements set out in this Management Plan apply to all Gatsuurt operations and personnel, including contractors.

This Management Plan is based on the BGC Health Safety and Environmental Management System (HSEMS), which is implemented for all Centerra operations in Mongolia and will provide the framework for the management of health, safety, environment and social aspects of the Gatsuurt Project. Any subsequent changes to the BGC Environmental and Social Management System Framework may result in the changes to this Management Plan.

1.4 Commencement

This Management Plan applies from the commencement of construction of the Gatsuurt Project.

1.5 Authority and Management

This Management Plan is owned by the BGC Director Environment. This Management Plan will be reviewed on a two-yearly basis to determine whether any changes or updates are required to the plan unless a more frequent update is required to reflect changing project design or procedures.

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Any requests for changes to this Management Plan must be addressed to the owner of this management plan and will be subject to appropriate review and approval processes.

2 SCOPE

2.1 Scope of this Management Plan

This Management Plan applies to all activities at the Gatsuurt Mine that may result in the generation of acid from ore, mine waste or exposed mined surfaces. These activities include drilling, mining, blasting, excavations, construction related activities, road maintenance, placement of mine waste and ore, mine reclamation and mine closure. This management plan will apply during construction, mining and during the mine closure phase of the Project. The requirements of this Plan apply for the excavation, handling, storage and disposal of waste and ore that is potentially acid generating as defined in the Plan.

2.2 Overlaps with other Management Plans

This Management Plan is part of the overall suite of Management Plans developed for the Gatsuurt Project and as described in the BGC HSEMS:

- Surface Water Management Plan;
- Biodiversity Management Plan; and
- Gatsuurt Mine Closure Plan.

3 BGC ROLES AND RESPONSIBILITIES

3.1 Key Roles and Responsibilities for Management Plan Implementation

Principal roles and responsibilities for the implementation of this plan are outlined below.

Table 1: Key Roles and Responsibilities

Role	Responsibilities
BGC Executive Director	Ensuring compliance with the Project Standards and other requirements set out in this Plan. Approval of this Plan and resources required for implementation.
Director Environment	Overall responsibility for Plan scope and implementation. Development, monitoring and revision of this Plan.
Environmental Superintendent	Timely implementation of this Plan, including coordination with implementing organisations and other stakeholders. Plan implementation.
Contractors	Ensuring all assets under their control comply with BGC policies and procedures. Supplying certification and/or licenses in accordance with statutory requirements. Complying with BGC's requirements for environmental management.

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Role	Responsibilities
	Reporting of all actual and potential environmental impacts to relevant supervisor or managing body.
Employees	<p>Minimise the impact of their activities on the environment wherever practical and reasonable.</p> <p>Complying with the obligations outlined in this Management Plan, as well as any other relevant BGC environmental policies and procedures.</p> <p>Reporting of all actual and potential environmental impacts to relevant supervisor or managing body.</p>

3.2 Key Interfaces

Key interfaces in the implementation of this Management Plan (i.e. roles with responsibility for delivering elements of this Management Plan) include:

- General Manager Operations, particularly in relation to mine planning, mine reclamation and closure planning, and provision of resources for the effective implementation of the HSEMS;
- Geology Manager in regards to the ongoing geochemical characterisation of the Gatuurt orebody and the provision of inputs to the ARD model;
- Mine Manager for implementation of mine plan, mine reclamation and closure plan and maintenance of an operational ARD model; and
- Mine laboratory manager to ensure availability of accurate validation data during operations.

4 PROJECT STANDARDS

Applicable Standards must be complied with for all Project activities (the "Project Standards").

4.1 Applicable Mongolian Legislation

- Law on Environmental Protection (1995);
- Law on Environmental Impact Assessment (2012);
- Law on Water (2012);
- Law on Water Resource Pollution Fee (2012);
- Law on Subsoil (1988);

4.2 Applicable Mongolian National Standards

Applicable Mongolian National Standards (MNS) related to this ARDMP include:

- MNS 3342 - 1982 Environmental protection. Hydrosphere. General requirement for protection of groundwater from pollution;
- MNS 2573:1978 Environmental protection. Hydrosphere. Water quality indicators.
- MNS 4586 - 1998 Water Quality. General requirements;
- MNS 5917 - 2008 Environment. Reclamation of land destroyed due to mining activities. General technical requirements.
- MNS 3297:1991 Soil. Permissible level for hygienic characteristics.

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4.3 DEIA requirements

Mongolian Detailed Environmental Impact Assessments (DEIAs) have been undertaken for this Project and outline required environmental management and monitoring requirements. Commitments made in the following DEIAs are applicable to this MP:

- BIOX® Plant DEIA (Nature Friendly LLC, 2010);
- Gatsuurt Mining DEIA (Nature Friendly LLC, 2009); and
- Boroo Gold Mine DEIA Addendum 2015 (Nature Capital 2015).

4.4 Applicable International Standards and Guidelines

Applicable International Standards that relate to the Gatsuurt Project are those set by the European Bank for Reconstruction and Development (EBRD), specifically:

- EBRD Performance Requirements (2014) (particularly Performance Requirement 1: *Environmental and Social Appraisal and Management* and Performance Requirement 3: *Pollution Prevention and Abatement*).

4.5 Applicable Centerra Policies

This Management Plan is developed within the Centerra corporate policies that include policies for worker health and safety, environmental protection and sustainable development.

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5 MITIGATION MEASURES AND MANAGEMENT CONTROLS

5.1 Summary

This document outlines BGC's commitment and approach to mitigating ARD risks that may arise as a direct or indirect result of the Gatsuurt project.

5.1.1 General Approach to Management of Acid Rock Drainage

The intent of this management plan is to ensure that the management of mining activities and the implementation of mine closure at the Gatsuurt Project is conducted according to best practice methodologies to eliminate the potential for contamination of the surrounding soil and water resources from the generation of ARD.

This will be achieved through ensuring:

- A high level of understanding of the ARD characteristics and potential of the various rock types encountered during mining to allow effective operational identification and management of ARD hazards;
- The appropriate design and construction of waste rock landforms and ore stockpiles;
- ARD management controls are integrated with mine planning and operational grade control;
- ARD management and mitigation measures are clearly communicated and understood by mine management, supervisors and operators;
- Monitoring programs are designed and implemented that allows for the performance of ARD controls to be measured, and corrective actions applied in a timely manner when monitoring indicates ineffective ARD control;
- Installation of appropriate water management features to ensure water captured from waste rock landform does not interact with natural water resources; and

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- The effective development and implementation of mine reclamation and closure plans that ensure ARD potential is minimised including the use of backfilling and flooding of mine pits upon cessation of mining activities.

5.1.2 Waste Rock Management Planning

BGC will implement a predictive ARD operational management plan based on data developed from a comprehensive waste rock and ore type characterization program commenced prior to mining. The characterization of waste rock and stockpiled ore during operations will be used to verify the predictive ARD model and will be accomplished using on-site testing methods combined with periodic laboratory analysis at a suitable facility.

The onsite test method that is to be used involves the use of the Leco Sulfur Analysis to assess the percentage of unoxidized sulfur in the test material. The value of the Leco Analyzer lies in the fact that it produces accurate results in a relatively short period of time. This would allow almost immediate knowledge of critical chemical values that the rock possesses and therefore allows suitable placement of the rock (to limit the potential for double handling of material). The use of onsite sulfur analysis represents Good International Industry Practice and provides a real time tool to validate ARD risk and confirm the appropriate management controls.

Previous evidence suggests that the cut-off measure that seems most reasonable for Gatsuurt rock defines Potentially Acid Forming (PAF) as rock that has 0.3% or more of sulfides. The final management option for the waste rock will be dependent on the outcomes of this testing program.

5.1.3 Operational Waste Rock Management

The desired PAF waste rock disposal location is within the Central Zone pit void upon cessation of mining activities. PAF waste rock will be stockpiled at a temporary storage location adjacent to the waste rock feature until mining activities are ceased. During operations the PAF waste stockpile shall be managed such that all water runoff and leachate from the stockpile will be collected and directed to the mine water treatment system as defined in the Surface Water Management Plan. At completion of mining from the Central Zone Pit the PAF material will be transported back to the Central Zone pit void where it is intended for sub-aqueous disposal below the final pit water level. The combination of surface and groundwater inflows to the mine void will form the aqueous cover that will act to prohibit oxygen introduction to the PAF waste rock and by this action, eliminate the initiation of acid rock drainage.

Operational procedures will be developed which outline the appropriate transport, segregation, storage and management of waste rock for the Gatsuurt Project. These procedures will apply to the designated waste rock disposal and temporary storage locations. The Surface Water Management Plan provides the framework for how water is to be managed in the Project area to ensure impacts from waste rock management and ARD are minimized.

Surface and groundwater monitoring locations will be identified and appropriate monitoring bores installed in order to monitor the impacts to water resources in the Project area and to confirm that ARD management measures are being effective.

5.2 Plan Goals and Objectives

The overarching goals of the Gatsuurt approach to management of ARD are to:

- Minimise and mitigate ARD impacts that are directly and indirectly caused by Gatsuurt's operations;
- Design and construct waste rock features and ore stockpiles to best practice industry standards;
- Manage water flows within the Project footprint to ensure they are not impacted by waste rock disposal practices or from ore stockpiles; and

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- Ensure that the performance of waste rock disposal features and ore stockpiles are measured and monitored during the life of the Project and into closure to ensure no ARD issues are identified.

These objectives will be pursued through implementation of this Management Plan, and will be measured and evaluated through the key performance indicators.

5.3 Management Controls

The following control measures will be put in place during the construction, operational and closure phase of the Gatsuurt Mine to avoid and reduce impacts associated with ARD. These control measures will be implemented through the operational mine plan run by the Mining Department.

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Table 2 Key Management Controls

ID	Topic/ Aspect	Control Description	Responsible Parties	Means of verification
ARD01	Characterisation of waste rock	Develop and maintain geological block model of the ore and waste rock before and during operations to assist in identification of potential PAF material	Geology Department	Geological block model developed prior to commencement of mining and maintained throughout operations.
ARD02	Characterisation of waste rock	Conduct an in pit testing program of waste rock to verify block model information and direct waste rock to appropriate storage location	Mine Planning	Laboratory results
ARD03	ARD Planning	Review the occurrence of each rock type and when each is scheduled to be mined, and plan for workers, costs, transportation of samples etc. to coincide with the mining of each block.	Mine Planning	ARD management integrated with mine plans.
ARD04	Construction of waste rock formations	Waste Rock Formations will be designed and constructed according to best practice industry standards	Operations	Waste Rock Feature design and construction verified by appropriate professional
ARD05	Ore Stockpiles	Ore stockpiles at the Gatsuurt mine or at the Boroo Gold Mine will be designed to ensure ore is isolated from surface drainage and managed such that run-off water is collected for treatment. Ore stockpiles will be placed in compacted clay substrate that will prevent leachate to subsoil.	Operations	Surface and Groundwater monitoring data. Site inspections and internal audits.
ARD06	Temporary storage location	The temporary storage location for PAF waste rock shall be clearly designated and signed	Operations	Internal Audit Visual Inspections
ARD07	Transport	Operators shall be made aware of the waste rock transport requirements and end disposal location	Operations Environment Department	Suitable awareness material and

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ID	Topic/ Aspect	Control Description	Responsible Parties	Means of verification
				training presented
ARD08	Placement of waste rock	Specific studies related to the sub-aqueous storage of the PAF material in the Central Zone Pit void shall be undertaken to ensure environmental acceptability prior to Project commencement	Specialist Consultant	Study results including trials.
ARD09	Surface water management	Surface and groundwater flows from outside the operational mine area shall be diverted around mining infrastructure to prevent contamination	Operations	Surface water diversion infrastructure in place Internal Audit Visual Inspections
ARD10	Surface water management	All water contacting mine features including the open pits, stockpiles and waste rock features shall be captured and diverted to the Project water treatment ponds.	Operations	Internal Audit Visual Inspections

6 IMPLEMENTATION SCHEDULE

6.1 Review and Revision of this Management Plan

This Management Plan will be reviewed on an annual basis and any necessary revisions made to reflect the changing circumstances or operational needs of the Gatsuurt Mine. Revision of this Management Plan will be the responsibility of the Director Environment, who is custodian of this Plan.

If material changes to operating procedures are required (as identified through management of change procedures contained within the BGC health, safety and environment (HSE) and community relations (CR) Management System), this Management Plan may be updated on an "as required" basis.

Any revisions to this Management Plan will be uploaded to the BGC to ensure that all staff have access to the latest version of this Management Plan.

7 MONITORING

7.1 Overview of Monitoring Requirements

Monitoring measures are implemented during the operations phase to assess compliance with Project Standards and compliance obligations. Monitoring will include operational sampling and analysis of rock types to verify the ARD model developed from pre-mining testwork. In addition, the monitoring of surface water and groundwater will allow verification of the effectiveness of ARD management and mitigation plans and design.

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In the event that monitoring identifies non-conformance with established standards, these will be investigated and appropriate corrective actions identified.

7.2 Key Performance Indicators

The table below summarises the key performance indicators and associated key monitoring actions that can be used to assess the progress and effectiveness of proposed mitigation strategies.

Table 3: Key Performance Indicators and monitoring actions – ARD

ID	KPI	Target
ARD-KPI 01	Number of reported ARD incidents from on-site activities	<5% non-compliances
ARD -KPI 02	Number of instances of waste rock being disposed of to the incorrect storage location	<5% instances of waste rock disposed to incorrect disposal location
ARD -KPI 03	Number of recorded ARD impacts on water resources in Project area	<5% instances of monitoring results indicating ARD impacts to water resources

7.3 Key Monitoring Activities

Pre-mining ARD Testwork

A program of ARD testwork will be completed prior to commencement of mine operations. The testwork program will include the following key tasks:

- Add to the existing waste rock data work and collect rock samples based on rock types, conduct ARD test work on discrete samples of the most prominent waste rock types to establish low, average and maximum sulphide levels in each rock type (ARD chemistry); and
- Add to the existing data and list details of the physical appearance of each major waste rock type and combine with the ARD chemical characteristics.

Operational Pre-Placement Sulphide Analysis

Key operational monitoring activities will focus on mined rock total sulphide concentration to enable assessment and verification of acid generating potential. The operational sampling program will provide adequate intensity of sampling (number of samples, size of samples, compositing instructions etc.). The sampling and analysis regime will be developed based on identified risk from pre-mining ARD test work and documented within specific operational ARD monitoring plans for each mine zone/phase.

Post-Placement Verification

The rock material will be sampled following placement to verify effectiveness of mine plan and validate the design of waste features/ ARD mitigation strategies.

Key monitoring measures are set out below.

Table 4: Key Monitoring Measures

ID	Topic/Aspects	Methods	Periodicity	Location
ARD001	Surface Water Runoff	Analysis of grab water samples from waste rock facilities for elevated sulphate levels, acidity, nitrate. Use field instruments for	Monthly	Consistent locations at the base of waste

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ID	Topic/Aspects	Methods	Periodicity	Location
		parameter analysis and verify with analytical test results with periodic laboratory analysis.		rock facilities and at surface water pool locations on the waste rock facility
ARD002	Groundwater	Analysis of groundwater quality for sulphates, acidity and nitrates in monitoring wells located around the perimeter of the mine.	Monthly	Groundwater bore locations immediately external to mine area
ARD003	Operational rock analysis pre placement	Rock sampling and total sulphur analysis during mining to verify predictive ARD model	Continuous (in accordance with mine block sampling plan)	Active mine areas.
ARD004	Operational rock analysis post-placement	Sampling and total sulphur analysis of rock from waste features to verify accuracy of placement controls and design effectiveness.	At least monthly (in accordance with mine block sampling plan)	Mine Waste Formations

8 TRAINING

All employees of BGC and Contractors working on the Gatsuurt Project are provided with basic training on the management of ARD. Additional specialist training is to be provided to mobile plant operators transporting waste rock within the Gatsuurt Project area.

9 AUDIT AND REPORTING

9.1 Internal Auditing

Regular inspections will be carried out by operational area supervisors covering a broad range of operational aspects, including management of waste rock and water issues as appropriate to activities within the Project area.

Any incidents identified during these inspections will be reported in accordance with eth BGC HSEMS.

Conformance will be monitored via an annual internal audit program undertaken to assess broad compliance with requirements of the HSEMS.

All incidents and non-conformances identified during these inspections are reported as per the requirements of the BGC HSEMS.

9.2 External Auditing

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Conformance with this plan will be subject to periodic assessment as part of the Centerra audit programme and by Project Lenders.

9.3 Record Keeping

Records of audits, inspections and incidents will be managed in accordance with Gatsuurt procedures.