

Tailings Management Plan for Sierra Rutile Limited, Sierra Leone

Sierra Rutile Limited



Sierra Rutile Limited

March 2018

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List of abbreviations

AG	Acid Generating
CEO	Chief Executive Officer
CET	Coarse Electrostatic Tailings
COO	Chief Operating Officer
CRL	Consolidated Rutile Limited
DM1	Lanti Plant (land based Wet Concentrator Plant) – also referred to as “Lanti Dry Mining Plant”.
DM2	Gangama Plant (land based Wet Concentrator Plant) – also referred to as “Gangama Dry Mining Plant”.
EAP	Environmental Assessment Practitioner
EHA	Environmental Health Area (as per the IFC)
EHS	Environment Health and Safety
EHS Guideline	World Bank Group International Finance Corporation 2007. Environmental Health and Safety Guidelines
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EP	Equator Principles
EP III	Equator Principles III (of June 2013)
EPA Act	<i>Environmental Protection Act</i> (Act No. 11 of 2008)
EPA-SL	Environmental Protection Agency of Sierra Leone
EPFIs	Equator Principles Financial Institutions
ESAP	Environmental and Social Action Plan
ESHIA	Environmental, Social and Health Impact Assessment
ESHMP	Environmental, Social and Health Management Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
FET	Fine Electrostatic Tailings
GIIP	Good International Industry Practice
GOSL	Government of Sierra Leone
HMC	Heavy Mineral Concentrate
HSEC	Health, Safety, Environment and Community
HTT	High Tension Tailings
IT	Ilmenite Tailings
IFC	International Finance Corporation
IFC 2012	IFC Performance Standards and Guideline Notes
MCP	Mine Closure Plan
MLCPE	Ministry of Lands, Country Planning and the Environment
MSP	Mineral Separation Plant
NP	Neutralisation Potential
NAF	Non-Acid Forming

OECD	Organisation for Economic Co-operation and Development
PAG	Potentially Acid Generating
PM	Particulate Matter
PS	Performance Standards (IFC)
ROM	Run of Mine
SLEP (MM) Reg. 2013	<i>Sierra Leone's Environmental Protection (Mines and Minerals) Regulations 2013</i>
SRK	SRK Consulting (South Africa) (Pty) Limited
SR Area 1	Sierra Rutile Mine Lease Area 1
SRL	Sierra Rutile Limited
SFT	Sulfide Flotation Tailings
TMP	Tailings Management Plan
TT	Total Tailings
WCP	Wet Concentrator Plant

1 Introduction and background

Sierra Rutile Limited (SRL) is an existing mining operation located in the Bonthe and Moyamba Districts of the Southern Province of Sierra Leone (Figure 1-1). The mine has been in operation for over 50 years and produces rutile, ilmenite and zircon rich concentrate.

In 2015, the Environmental Protection Agency of Sierra Leone (EPA-SL) issued a notification to SRL (reference number EPA-SUHA.96/214/a/HNRM), instructing them to undertake an Environmental, Social and Health Impact Assessment (ESHIA) and develop an Environmental, Social and Health Management Plan (ESHMP) for their current and proposed mining activities including the proposed expansion areas within Area 1. This included the Gangama and Lanti deposits and other deposits within SRL's current operations in Sierra Rutile Area 1 (SR Area 1).

SRK Consulting (South Africa) (Pty) Ltd (SRK) was appointed by SRL to undertake the ESHIA / ESHMP process to meet Sierra Leonean legal requirements as well as SRL's corporate policies, which are aligned with Good International Industry Practice (GIIP). The Draft ESHIA / ESHMP Report was submitted to the EPA-SL in March 2018.

This document presents the Tailings Management Plan (TMP), which is an appendix to the above ESHIA / ESHMP Report and presents the environmental management actions specific to the facilities where process residues are stored within the SR Area 1.

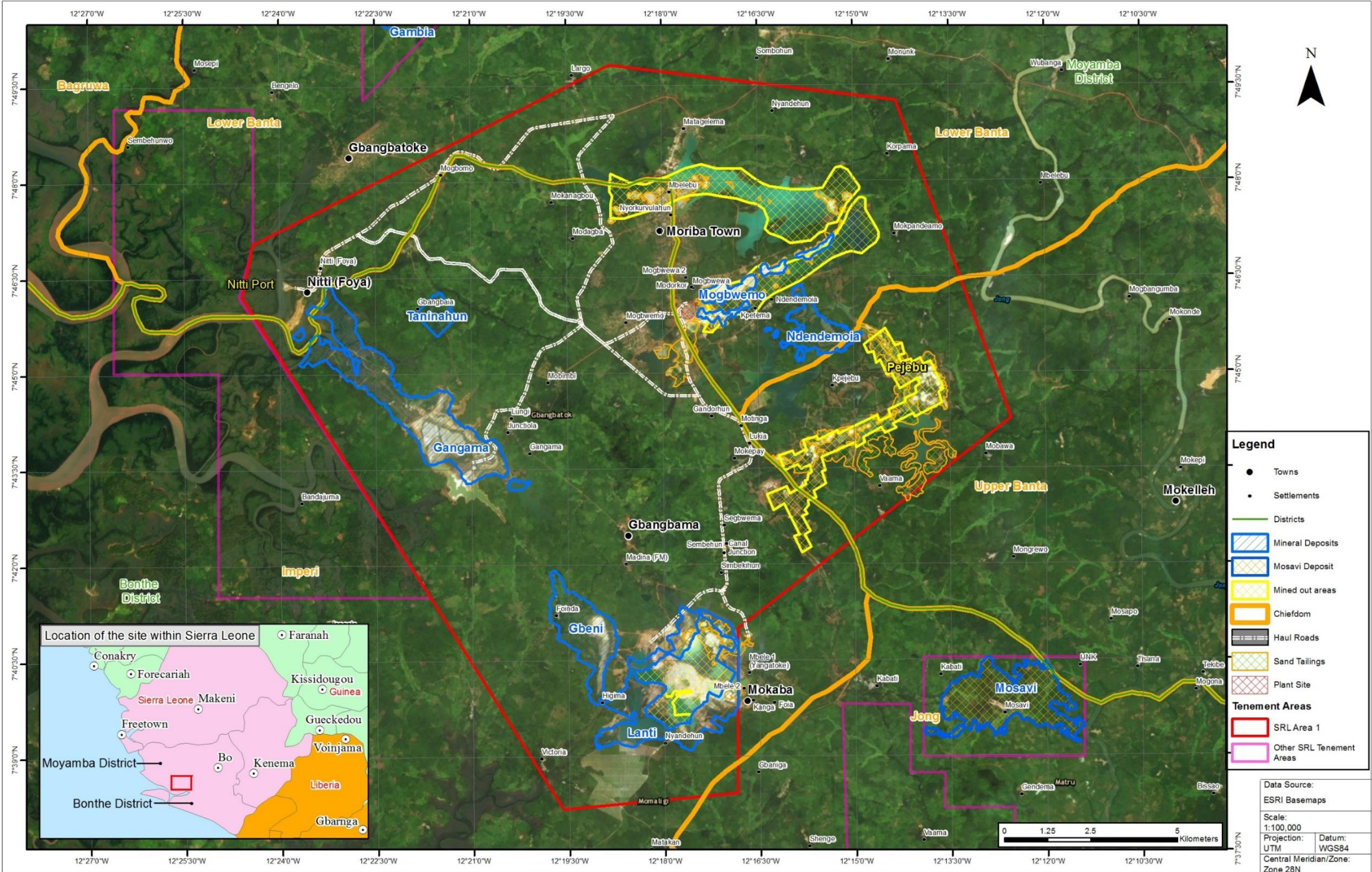
1.1 Purpose of this plan

The primary objective of the TMP is to limit potential environmental impacts associated with the various mining residues, which include sand tailings, slimes and the residues generated during secondary processing. The TMP is a component of the integrated environmental and social management system and is a specific management plan that forms a component of the management activities described in the ESHIA / ESHMP. Specific objectives of the TMP are to:

- To ensure that tailings management is performed in accordance with Sierra Leone legal requirements and Good International Industry Practice (GIIP); and
- To operate infrastructure in a manner which will allow for progressive decommissioning of infrastructure at capacity, thereby minimizing the closure liability at the end of life of mine.

While geotechnical considerations may potentially affect the environmental impact of the various tailings storage facilities, the purpose of this plan is not to describe the management of geotechnical aspects, rather the intent is to describe the various activities required to manage potential environmental impacts.

This TMP will be implemented as part of the SRL's Health Safety Environmental and Community (HSEC) management system.



Legend

- Towns
- Settlements
- Districts
- Mineral Deposits
- Mosavi Deposit
- Mined out areas
- Chiefdom
- Haul Roads
- Sand Tailings
- Plant Site

Tenement Areas

- SRL Area 1
- Other SRL Tenement Areas



Data Source:	
ESRI Basemaps	
Scale:	
1:100,000	
Projection:	Datum:
UTM	WGS84
Central Meridian/Zone:	
Zone 28N	
Date:	Compiled by:



**SR AREA 1 ESHIA & ESHMP
SITE LOCALITY**

****Note**
The Mosavi Deposit is not included in the SRL Area 1 Study, but is shown on the locality due to its proximity to Area 1.

Date: 30/10/2017
Compiled by: ALLK
Project No: 515234
Fig No: 1-1

2 Description of mining residues

2.1 Tailings sources

Currently, SRL's primary operations at Area 1 consist of: Lanti mining operations (both wet and dry mining); processing operations (floating and land-based concentrators); Gangama dry mining operation (dry mining and land-based concentrator); Mineral Separation Plant (MSP); and the transport and export of product through the Nitti Port facilities (Figure 1-1).

Tailings are generated from both the wet and dry primary processes as well as from MSP, as described below.

Wet mining (Lanti):

- Excavated material is processed in the floating Wet Concentrator Plant (WCP);
- De-sliming removes clay from the ore and then gravity separates the heavier minerals from the lighter minerals;
- The resultant Heavy Mineral Concentrate (HMC) is processed further at the MCP, while the residues from the floating WCP are deposited behind mining activities; and
- The slimes (clay material) is pumped to a containment pond and the sand is pumped to a sand stacking area.

Dry mining (Lanti (Gbeni) and Gangama):

- A conventional load and haul method delivers ore from Lanti (Gbeni) and Gangama deposits into two beneficiation and land-based WCPs, known as the Lanti Plant (DM1) and the Gangama Plant (DM2);
- The Run of Mine (ROM) feed is stockpiled at the land-based WCP's where a grader tips the ROM feed into a 150 tonne hopper, and the material is then passed onto an apron feeder, which discharges onto a vibrating grizzly feeder;
- The grizzly feeder separates the undersize material which discharges into a primary scrubber;
- Material leaving the primary scrubber is discharged onto a double deck screen;
- The oversize material from both decks is combined and conveyed to tailings disposal:
 - The undersize material is pumped to the de-sliming and effluent disposal section, where it is fed to cluster cyclones. The overflow from the primary and secondary cyclones flow to the final effluent sump together with sand tailings from the spiral modules. From the effluent sump, the tailings are pumped to stacker cyclones, which stack the underflow. The overflow gravitates to the water dam. The underflow from the de-sliming cyclones collects in the spirals feed sump where it is diluted before being pumped to the spirals module. Sand tailings and slimes tailings are co-disposed, while HMC is dewatered and stockpiled for transportation to the MSP for further processing;
 - The sand tailings are classified into coarse and fine material and dealt with separately. The <1.6 mm material is produced from the land-based WCP's tailings, while the coarse material comprises of screen oversize +1.6 mm – 200 mm. Fine material is pumped to a cyclone stacker, where it is stacked; and
 - The cyclones separate finer fractions from the coarse fractions to build sand beaches. The material is spread and moved with dozers. Oversize (+200 mm) material originating from the grizzly is discharged into an oversize bunker for removal by front end loader. Coarse material is transported by conveyors and dispersed by a spreader conveyor.

MSP:

- The coarse and fine materials is separated, and the fine fraction is sent to a flotation plant where sulfur is removed and the resultant rutile rich feed then goes to the dry plant;
- The sulfur tailings are deposited in the Sulfide Flotation Tailings (SFT) pond;

- The main processes at the dry plant are drying, sizing and electrostatic separation. The electrostatic process deflects non-conductors (zircon and silica) and separates them from conductors (rutile, hematite and ilmenite) in the product stream;
- The fine and coarse tailings from the electrostatic separation process discharges separately to the Fine Electrostatic Tailings (FET) and Coarse Electrostatic Tailings (CET) ponds;
- The conductors (rutile, hematite and ilmenite) undergo electromagnetic separation where the non-magnetic rutile separates from the magnetic hematite and ilmenite;
- Ilmenite Tailings (IT) discharges to the IT pond. The rest of the tailings consisting of a mixture of various streams (slimes, ilmenite etc.), discharge to the Total Tailings (TT) pond. FET and CET are dry stacked in the containment facilities; and
- SFT is deposited sub-aqueously and is stored under a water cover to limit sulfide oxidation in the tailings. The TT is also deposited in a facility containing water, however, there are areas of TT that are above the pond water level and are never submerged.

In summary SRL expects the following material types to be associated with the residues generated from mineral processing within the SR Area 1:

- Sand from both wet mining as well as sand from the dry mining primary concentrating process that segregated during gravitational classification following deposition;
- Slimes typically from wet mining and disposed of in dedicated slimes paddocks. There may however, also be slimes that segregate from the dry mining tailings by gravitational classification, with these concentrated near the centre of the sub aqueously disposed tailings;
- Sand/Slimes mix typically from dry mining disposal where incomplete classification has occurred; and
- Specific residues generated from the various beneficiation steps at the MSP.

The current estimated area under the different residues is presented in Table 2-1 and represented in Figure 2-1.

Table 2-1. Areas under different mine residues with SR Area 1

Material form	Area (ha)
Sand	1,300
Slimes	552
Sand/slimes	1,015
MSP	30

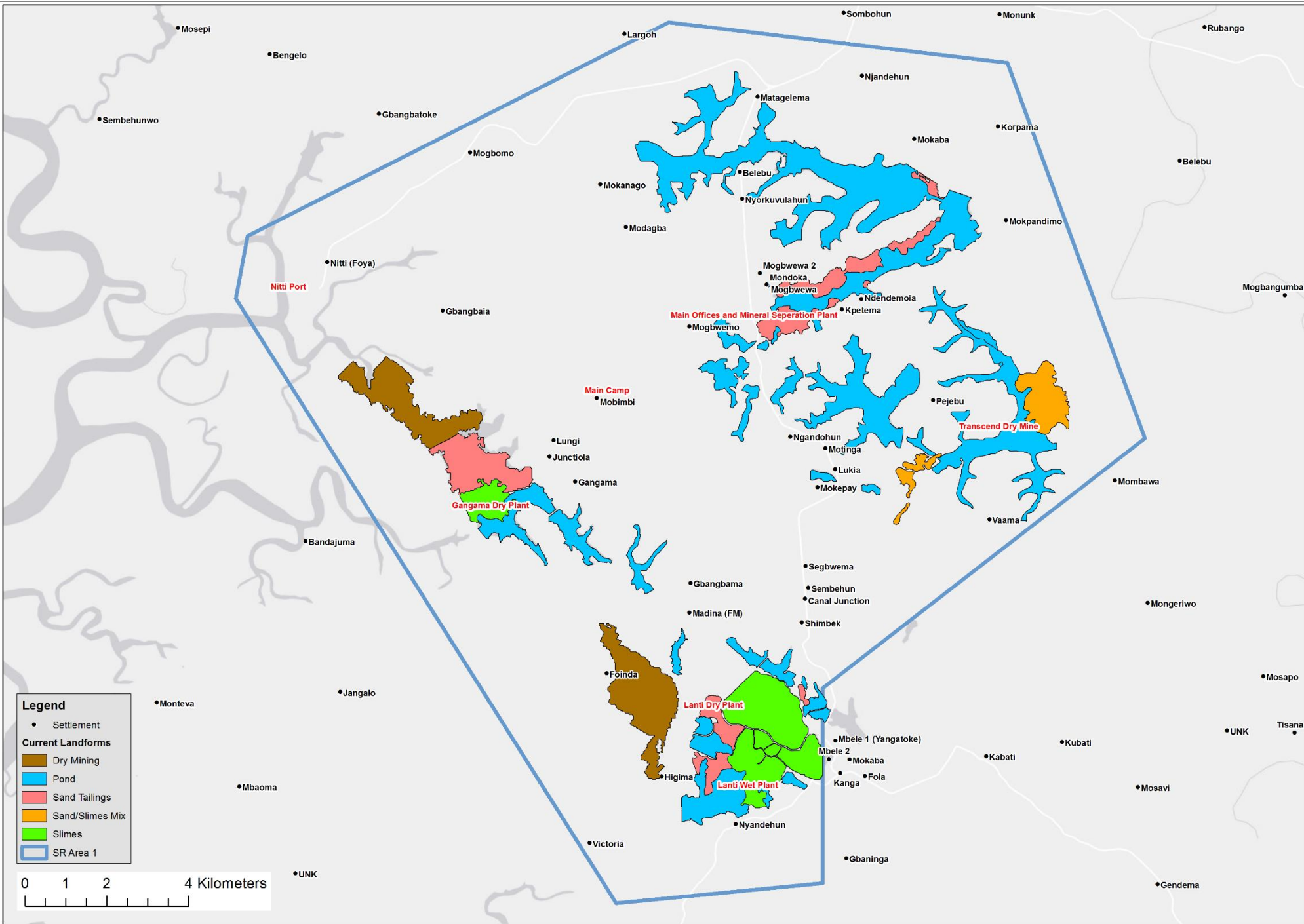
2.2 Tailings characteristics

2.2.1 Geochemistry

The primary process tailings are Non-Acid Forming (NAF). This is consistent with the mineralogy results that showed that there are no detectable sulfide minerals that could potentially generate acidity in the primary process tailings.

SFT are Acid Generating (AG) and have the potential to stay acidic in the long term if exposed to oxidizing conditions. TT and IT also contain sulfides and are Potentially Acid Generating (PAG). FET and CET are NAF for the following reasons:

- As the primary process tailings are currently slightly acidic, but inherently NAF and non-saline, the bulk of this material is considered to be geochemically unreactive. However, elevated concentrations of Al, Ca, Cu, Mn, Ni, NO₃ as N and SO₄ in the leachate from the primary process tailings relative to background surface water levels have been detected; and
- The secondary process tailings, specifically SFT, TT and IT, are PAG, acidic and non-saline and are likely to present a risk of increased acidity when exposed to oxidising conditions. The low pH of the tailings supernatant and seepage is likely to present a risk to the already slightly acidic environment and add to the overall acidity of the surface and groundwater system. Although no significant salt generation is expected, secondary process tailings leach elevated concentrations of Al, Ca, Cu, Mn, Ni and SO₄ relative to background surface water levels.



Legend

- Settlement

Current Landforms

- Dry Mining
- Pond
- Sand Tailings
- Sand/Slimes Mix
- Slimes
- SR Area 1



Data Source:	
Scale:	A3
1:85 000	
Projection:	Datum:
UTM	WGS
Central Meridian/Zone:	
28 N	
Date:	Compiled by:
02/03/2018	VERJ
Project No:	Fig No:
515234	2-1



SR AREA 1 ESHIA & ESHMP
DISTRIBUTION OF TAILINGS ACROSS SR AREA 1

2.2.2 Water holding properties

Sand tailings consist of relatively uniform material of large particle size, which results in a poor capacity to retain water and nutrients. As a result, these materials are not suitable to sustain vegetation in the dry periods in their current form. This is exacerbated by the climatic conditions where there is a distinct wet and dry season, with the soils required to store water for plant utilisation during the dry season, potentially to a depth in excess of 2 meters.

The above-water sand tailings have an undulating morphology with steep slopes in some areas. SRL expects that this similar morphology will be reflected in the subaqueous sand tailings, given that the sand tailings have a relatively high angle of repose, even underwater.

Slimes deposited in the slimes paddocks exhibit localised cracking during the dry season, potentially indicating a surface instability associated with the slimes surface. There is currently no data to indicate the extent of the cracking or the depth to which drying occurs. Visual evidence suggests that the fine fraction associated with the slimes provides sufficient water holding capacity for vegetation to survive through the dry season.

The transitional material between sand and slimes in the sand/slimes is likely to have a higher water holding potential than the coarse material, but less than the fine material.

3 Governance framework

The TMP has been developed in accordance with national and international regulations and guidelines as they relate to the environmental aspects of tailings management.

3.1 National standards and guidelines

The EPA-SL is the custodian of environmental law within Sierra Leone. The EPA-SL is housed within the President's Office and is the main government agency in charge of all issues concerning the environment. The EPA-SL was established in 2009 with the goal of creating and enforcing a strict regulatory framework for environmental Regulation in Sierra Leone. It has the mandate to coordinate, monitor and evaluate the implementation of national environmental policies, programmes and projects, including issuing environmental licences. The following Acts and Regulations form the basis of the environmental regulatory framework in Sierra Leone that is applicable to this project:

- *Sierra Rutile Agreement (Ratification) Act, 2002;*
- *Mines and Minerals Act, 2009;*
- *Environment Protection Agency Act, 2008 (EPA Act); and*
- *Environmental and Social Regulations for Mining, 2013 (SLEP (MM) Reg. 2013).*

The legislation applicable to mining activities is documented in the ESHIA, with the section below referencing clauses that have implications for tailings management.

3.1.1 *Mines and Minerals Act, 2009*

The key provisions of the *Mines and Minerals Act* relate to mineral rights and access to surface rights (including compensation for land owners), radioactive materials, protection of the environment, community development, health and safety, and transparency in the extractives industry. An EIA must fulfil the requirements of this Act and the EPA Act. The Minister for Mineral Resources and the National Minerals Agency (NMA) are the current relevant authorities for enforcing the Act.

General provisions for environmental protection

General and specific provisions for varying mining activities are provided in Part XV – Protection of the Environment of the Act (§131 – 137). The majority of this part in the Act is applicable for mining

licence holders seeking a small or large-scale mining licence. There are however certain sections that apply to all mining licence holders. The relevant sections are as follows:

- §132 (1), which requires the mining licence holder to exercise duty of care to protect the environment and minimise pollution, and states “a holder of a mineral right is subject to all laws of Sierra Leone concerning the protection of the environment”; and
- §136 (1)-(6), provides a potential need for rehabilitation of damaged areas and the associated financial provision requirements.

Large-scale mining licence

The Act sets out the following environmental requirements for granting of a large-scale mining licence in Part XII:

- §105 (2)(i)(v) provides the mechanism for the application to include “proposals for the progressive reclamation and rehabilitation of land disturbed by mining and for the minimisation of the effects of mining on surface water and ground water and on adjoining or neighbouring lands” Additionally, a statement of the “effects of the mining operations on the environment and on the local population and proposals for mitigation, compensation and resettlement measures” (§105 (2)(i)(vi)). Additionally, the provision of details and results of stakeholder consultation (§105 (2)(l)); and
- §115, sets out the obligations of holders of a large-scale mining licences. Specifically, §115 (1)(a) “develop and mine the mineral deposits covered by the licence in accordance with the approved programme of mining operations and the environmental management programme”.

3.1.2 Environment Protection Agency Act, 2008 and EIA Regulations

The *Environment Protection Agency Act, 2008*, which repeals the EPA Act of 2000, outlines the functions of the EPA-SL and the EIA and management requirements. The Act specifies in §24 (1) the requirement for an environmental licence (valid for 12 months and eligible for renewal on application) for specific listed activities in the First Schedule, through an EIA process. In the Second Schedule the Act sets out the criteria for determining whether an EIA is necessary. Schedule Three specifies the required contents of an EIA. The Act also outlines fines for offences, inspections by the EPA-SL, the prohibition of the import, storage, disposal and release of hazardous and toxic substances. A clause covering financing requirements for rehabilitation is included.

Guidelines on EIA procedures were published by the Ministry of Lands, Country Planning and the Environment (MLCPE) in July 1999. They were then re-issued by the MLCPE in July 2002. The original intent of the guidelines was to facilitate implementation of the EIA provisions in the repealed *Environment Protection Act, 2000*. To date, they are still considered by the MLCPE to be valid for the EIA provisions in the new EPA Act, 2008.

3.1.3 The Environmental and Social (Mines and Mining) Regulations, 2013

The SLEP (MM) Reg. 2013 were drafted under the EPA Act and apply to corporates or individuals applying for, or having been issued exploration or mineral rights under the *Mining and Minerals Act, 2009*. All persons or industries who undertake or have cause to undertake any extractive industries project will likely be subject to its provisions.

The Regulations raise the standard of environmental management required by mining operations and align favourably with the principles of GIIP. Key international environmental management principles form the basis of the Regulations, including sustainability, access to information, public participation and consultation, the precautionary principle, protection of affected communities, corporate social responsibility, adoption of environmental best practice and the polluter pays principle.

Historically in Sierra Leone, mining companies would operate under a specific Act that would be comprised of varying environmental and social commitments relevant for that operation. This was necessitated due to an absence of legislation dealing with environmental and social protection and management. The Government of Sierra Leone (GOSL), through the EPA-SL, is now in a position to

implement these Regulations as the primary means of environmental and social governance for the mining sector within the country, superseding company specific Acts.

Of particular relevance for a mining licence holder are the following:

- §3 (2)(a) – (m) Application of principles and accountability to be applied by the EPA-SL or other authorities;
- Monitoring, auditing and reporting - annual reporting on social and environmental performance to the Authority (§25 and §26), including an annual update of the Environmental and Social Management Plan (ESMP) based on project changes (§24); quarterly reporting on emissions and effluents in relation to specific environmental quality standards. Environmental quality standards specified thus far are generic and few are provided at this stage.

The *Mines and Minerals Act*, 2009, requires any person or organisation that is in possession of a mining right licence (or seeks to renew their licence) to provide details on environmental impacts. While the Act does not provide information on the required details, the mining authority might refer the applicant to the project screening requirements outlined in these Regulations.

Part VII (§42 - §54) of the Regulations provide the obligations that an environmental licence holder must meet with regards to environmental standards. These obligations are as follows:

- §42 (1), gives effect to the establishment and §42 (2) the enforcement of environmental quality standards and parameters;
- §43 (1), provides the obligation for the mining licence holder to ensure that they meet the prescribed effluent and emission quality standards;
- §45, prevents the discharge of any toxic and hazardous substance into the air or waters of Sierra Leone as imposed by §58 (5) of the EPA Act;
- §46, states that if the natural quality of water used in mining activities already exceeds the minimum effluent standards, the effluent discharged from such operations shall not have a lower quality than the water taken from its natural source; and
- §47, sets out the “effluent international quality standards for mining and metallurgic operations”.

Part VIII (§55- §60) sets out the monitoring and inspection requirements undertaken by the authorities, including Regulations on auditing. Part IX (§61- §66) provides Regulations to ensure enforcement (in part these Regulations are in accordance to §53 - §56 of the EPA Act).

Additionally, the mining licence holder must allow the authorised authorities to enter the project premises and provide assistance where relevant (§65 (1)). §65 (2) requires the mine’s environmental officer to report any major incident that could, or is giving rise to adverse environmental impact or social impact to the authorities within 24 hours and submit a detailed report within 10 working days from which the incident took place.

3.2 International standards and guidelines

The Equator Principles Financial Institutions (EPFIs) have adopted a set of guidelines, known as the EP, published in 2003 and revised in 2006 and update in 2012. EP III was adopted in 2013.

The principles provide a framework for an accepted international approach to the management of social and environmental issues. They were developed by a number of leading financial institutions, including the International Performance Standards (IFC), to provide an approach to determine, assess and manage environmental and social risk in project financing. The intention is to ensure that projects are developed in a site-specific manner that is socially responsible and reflects sound environmental management practices. The principles apply to all new projects seeking project finance from EPFIs with total project costs of US\$10 million or more. While SRL is not currently seeking funding from EPFI’s, the principles, sentiments and approaches included in the EPs and IFC 2012 Performance Standards are still relevant to the operation. To provide guidance on how the broad-based EPs can be made specific to this project, reference is made to IFC 2012 Performance Standards and Guideline

Notes, which are generally considered to represent GIIP.

3.2.1 IFC Performance Standards

The IFC 2012 Performance Standards (PS) are an international benchmark for identifying and managing environmental and social risk, and has been adopted by many organizations as a key component of their environmental and social risk management.

There are eight IFC PS's in total, seven of which are relevant to the SR Area 1 operations, namely:

- PS 1: Assessment and Management of Environmental and Social Risks and Impacts;
- PS 2: Labour and Working Conditions;
- PS 3: Resource Efficiency and Pollution Prevention;
- PS 4: Community Health, Safety and Security;
- PS 5: Land Acquisition and Involuntary Resettlement;
- PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources; and
- PS 8: Cultural Heritage.

The IFC PS, and the Equator Principles, which generally follow the requirements of the IFC, have been adopted for this project. The PS that relates to waste management is PS 3, Resource Efficiency and Pollution Prevention. This document aims to address the waste management requirements of PS 3.

PS 3: Resource Efficiency and Pollution Prevention

PS 3 outlines a project-level approach to resource efficiency and pollution prevention and promotes application of technologies and practices where feasible based on commercially available skills and resources to achieve this.

3.2.2 Environmental Health and Safety Guidelines

The World Bank Group Environmental, Health and Safety Guidelines (EHS Guideline) are technical reference documents with general and industry-specific examples of GIIP, as defined in IFC's PS 3: Resource Efficiency and Pollution Prevention. The IFC uses the EHS Guideline as a technical source of information during project appraisal.

The EHS Guidelines contain the performance levels and measures that are normally acceptable to IFC, and that are generally considered to be achievable in new facilities at reasonable costs by existing technology.

Industry sector EHS guidelines are designed to be used together with the General EHS Guidelines document. Of relevance, here are the Mining EHS guidelines.

EHS Guidelines for Mining

The EHS Guidelines for Mining are applicable to underground and open-pit mining, alluvial mining, solution mining, and marine dredging. They contain recommendations for waste management including strategies for tailings management. This document aims to address the tailings management strategies for this guideline.

3.3 Sierra Rutile Limited Policies

3.3.1 Environmental Policy

SRL believes that environmental excellence is an integral part of any efficient, successful and sustainable business. To achieve this, Sierra Rutile and all employees will:

Promote open and honest communication on environmental issues by:

- Integrating environmental issues into the decision-making process of all aspects of our operations;

- Liaising with the community and other stakeholders throughout the life of the Mine with the aim of continuing to operate and develop activities to the benefit of all;
- Complying with all relevant laws, regulations and standards of the country; and
- Strengthening relationship with the community and respecting the heritage and cultural values of the mining community.

Protect the environment by:

- Minimizing impacts to land, air and water; and systematic environmental programs;
- Reducing emissions, effluents and generation of waste; and
- Progressively rehabilitating areas that are no longer required to support our operations using sound practical methods.

Promote sound and responsible practices by:

- Developing management systems to ensure that environmental impacts are managed appropriately;
- The use of environmentally acceptable materials, products and services;
- Measuring and managing the environmental impact of our activities;
- Re-cycling and re-using waste materials generated in our operations to ensure effective use of available resources; and
- Ensuring management commitment, accountability and allocation of resources.

Foster continual improvement by:

- Training and motivating all employees and contractors to regard environmental considerations as an integral and vital element of their day-to-day activities; and
- Conducting environmental audits at regular intervals to measure and improve on our performance.

3.3.2 Sustainability Policy

To ensure sustainable development we will implement management systems that make health, safety, environment and community responsibilities an integral part of all our business decisions and activities.

We will:

- Identify, assess and manage risks to employees, business partners, the environment and the community;
- Meet applicable legal requirements;
- Set and review targets and provide the resources and training to our people to achieve continuous improvement in the areas of health, safety and environment; and
- Strive to form partnerships with our host communities and stakeholders, sharing and participating in the preservation of their environment, traditions and values.

4 Tailings management

As stated in Section 1.1, the purpose of the TMP is to manage potential environmental impacts associated with the deposited tailings. Geotechnical risks, which may result in environmental impacts, will be considered by SRL in a separate, engineering focused, management plan. Potential environmental risks associated with the various tailings facilities have been adapted from the Air Quality (SRK, 2018a), Surface Water (SRK, 2018b), Groundwater (Graell, 2018), Geochemistry (SRK, 2018c) and Terrestrial Ecology (Scientific Terrestrial Services, 2018) specialist reports. These are as follows:

- Dust generation and potential community health and nuisance impacts, particularly associated with wet and dry mining tailings deposited on land behind the advancing mining face;
- Generation of leachate which impacts on SRL ability to achieve water quality objectives for both surface and groundwater resources, particularly at the MSP; and
- Communities not being able to utilise historical areas where tailings are deposited, due to limited potential of sand tailings to sustain vegetation during the dry season, leading to an increase in pressure on land availability for community requirements.

As there are significant areas that have been utilised historically for the placement of tailings, retrospective impact management is difficult to achieve through operational activities, particularly for tailings that have not been disposed of subaqueously. However, SRL will implement the closure actions documented in the Mine Closure Plan (MCP) (SRK, 2018d) in a progressive manner, concurrently with mining activities to achieve a post-closure land capability and to mitigate the risks stated above. A rehabilitation schedule will be developed to address areas where tailings deposition has ceased, with the schedule developed to address all disturbed areas by the end of SR Area 1 life cycle.

4.1 Management action

Table 4-1 documents the management activities that are required to limit the potential environmental risks associated with the tailings management within SR Area 1.

Table 4-1: Management actions associated with management of environmental impacts.

Aspect	Impact	Management objective	Mitigation measures	Performance criteria	Responsible party
Wet and dry mining tailings deposited on land behind the advancing mining face	Dust emissions during the operational phase	Reduce PM ₁₀ and PM _{2.5} concentrations and dust fall below the EHS Guideline values	<ul style="list-style-type: none"> With respect to sand tailings deposition, where practical and / or necessary: <ul style="list-style-type: none"> Grass will be planted along the boundary of the TSFs¹ to lower the possibility of wind erosion; Long side walls of the TSFs will be re-vegetated / grassed to stabilise surfaces where required; and Grass types will be endemic to the area; Current management measures of rock cladding with laterite will be maintained. As the TSFs increase in height, the current management measures will continue as needed; Where practical, a surface binder will be applied on the TSFs, if monitoring indicates that dust is an issue from this source; A routine emissions and ambient air quality monitoring program will be developed and implemented to determine whether there are any significant increases in emissions and impacts at sensitive receptors; and Actions described in the MCP will be implemented to establish vegetation on residues where no further deposition is envisaged. The actions will be scheduled to target areas where dust represents a health risk or nuisance to communities. Remaining areas to be scheduled so that all areas vegetated at the end of the closure period. 	Continuation of dust monitoring Compliance with EHS Guideline values Monitor against the MCP	Environmental, Health and Safety (EHS) Manager Environment and Radiation Superintendent Community and Rehabilitation Manager
	Loss of land available to community to undertake livelihood activities	Restore land capability through the implementation of closure actions to support a succession of post closure land uses	<ul style="list-style-type: none"> Replacement of soils and concurrent rehabilitation will be undertaken timeously where possible as per the Soil Management Plan, Section 6 of the specialist Soils and Land Capability Study (ESS, 2018); Actions described in the MCP will be implemented to establish vegetation on residues where no further deposition is envisaged; As per the MCP, SRL will rehabilitate the different post-mining land forms to a land capability capable of supporting a range of post closure land uses as far as practical, and within are limitations, to include: Forestry, subsistence agriculture, settlements, conservation and aquaculture. 	Monitor against the Soil Management Plan Monitor against the MCP	EHS Manager Environment and Radiation Superintendent Community and Rehabilitation Manager

¹ Note for clarity: The Air Quality Impact Assessment (SRK, 2018a) report defines TSF as “TSFs are located at the mining areas and at the SRL MSP. Windblown dust will be evident from the sand tailings portions of the TSF”.

Aspect	Impact	Management objective	Mitigation measures	Performance criteria	Responsible party
MSP tailings facilities	Generation of leachate which impacts on SRL ability to achieve water quality objectives for both surface and groundwater resources	Minimise impacts on water quality	<ul style="list-style-type: none"> • Water cover will be maintained on the PAG tailings; • Manpower and equipment will be provided to inspect and maintain tailings facilities in good working order; • Clear instructions will be given to personnel employed at the MSP regarding: <ul style="list-style-type: none"> - How and why tailings must be managed according to the engineering designs; - What is and is not acceptable for disposal into tailings facilities; • Disciplinary procedures will be enforced for employees who disregard waste disposal instructions; • Public access to the TT and Chemical Tailings Facilities will be prevented; • Records will be maintained of: <ul style="list-style-type: none"> - The volume of material being placed in the disposal area; - Any special handling or treatment processes that are required for the placement of the waste; - Observation of the physical condition of the tailings facilities and tailings embankments, including evidence of seepage, movement or unusual conditions; - Identification of any other materials, debris, or chemicals placed into the tailings facilities; • A waste characterization and monitoring program will be implemented to confirm that current waste management practices are appropriate to contain the waste being generated; • A dam safety inspection program will be implemented as applicable to the Total Tailings and Chemical Tailings Facilities; • The results of monitoring programs will be communicated to the EHS Manager and the MSP Manger so that both are aware of any changes that may needed due to the characteristics of the waste being generated; • Recorded information will be reviewed by competent persons for interpreting purposes; • The collected data will be stored in a sensible and retrievable manner; and • Emergency preparedness and response planning and containment / mitigation procedures will be prepared and implemented in the event of release of tailings or supernatant waters. 	<p>Water cover maintained and water quality comparable with background quality</p> <p>Design, operation, and maintenance of structures according to specifications of ICOLD3 and ANCOLD4, or other internationally recognized standards based on a risk assessment strategy</p> <p>Ongoing monitoring of both the physical structures and water quality, during operation and decommissioning</p>	<p>MSP Manager EHS Manager Environment and Radiation Superintendent</p>

Aspect	Impact	Management objective	Mitigation measures	Performance criteria	Responsible party
	Dust emissions during the operational phase	Reduce PM ₁₀ and PM _{2.5} concentrations and dust fall below the EHS Guideline values	<ul style="list-style-type: none"> Refer to the mitigation measures presented above for “<i>Wet and dry mining tailings deposited on land behind the advancing mining face</i>”; Actions described in the CMP will be implemented to establish vegetation on residues where no further deposition is envisaged. 	Continuation of dust monitoring Compliance with EHS Guideline values Monitor against the MCP	MSP Manager EHS Manager Environment and Radiation Superintendent
General maintenance and monitoring of ponds and impoundments that receive tailings (i.e. at Lanti and Gangama mining operations (DM1 and DM2) and at the MSP)	Maintenance and upkeep	Minimise impacts on water quality and embankment stability	<ul style="list-style-type: none"> Current tailings and water management plans will be reevaluated including long-term design of facilities. This should include monitoring, site investigation, material characterization, and modelling; General maintenance activities will be ongoing, including construction of safety berms on all embankments, repair of roads, repair of erosion damage, etc.; To evaluate on-going performance of embankments, a monitoring programme will be implemented, including: <ul style="list-style-type: none"> Collect survey data on existing embankments, beaches and bathymetry; Review of design and as-built reports; Installation of piezometers to evaluate pore pressure conditions through embankment; The conducting of a slope stability analyses (low risk, high consequence structure); Monitoring the effects of wave actions on upstream crests and if erosion potentially impacting on stability is identified, crests will be stabilised through the placement of additional wall construction materials; Monitoring of downstream slopes and crests for longitudinal and perpendicular cracking as well as deformation of the structures. Where this is observed, remedial measures specific to the facility will be designed; Consideration of removal of trees growing on slopes; Monitoring of burrowing animal activity to determine whether the animals are potentially impacting on stability, particularly effecting the sand blanket drains. Where necessary, these animals will be trapped and relocated or otherwise removed from the walls. The burrows will be sealed will laterite. Spillways will be monitored for blockages, erosion or damage. If detected, remedial measures will be implemented; Seepage quality and quantity will be monitored, with increased monitoring frequency during rainy season; 	Ongoing evaluation of management plans Ongoing monitoring of both the physical structures and water quality, during operation and decommissioning	MSP Manager EHS Manager Environment and Radiation Superintendent

Aspect	Impact	Management objective	Mitigation measures	Performance criteria	Responsible party
			<ul style="list-style-type: none">Adequate freeboard will be confirmed and maintained through appropriate pond control procedures which will be developed and implemented.		

5 Responsibility

Responsibility for sustainability management, in particular the implementation of the HSEC management system, will be a responsibility of numerous levels and functions in the organisation. As the TMP is a component of the HSEC management system, responsibility for the TMP will follow the structures outlined in the ESHMP. Ultimate responsibility for the implementation of the TMP and the safe and environmentally sustainable operation of the various tailings facilities is vested in the Chief Executive Officer (CEO) of Sierra Rutile. Operational implementation will be devolved to:

- Chief Operating Officer (COO) of Sierra Rutile;
- Mining and Processing managers;
- Environmental, Health and Safety (EHS) Manager; and
- Environment and Radiation Superintendent.

5.1 Checking and corrective actions

Checking and corrective action are key components of the HSEC management system cycle. They ensure that the required TMP management activities are being implemented; and desired outcomes are being achieved.

5.1.1 Inspections

An ongoing pragmatic inspection regime will be developed that allows for potential environmental transgressions to be identified proactively so that mitigation can be quickly and effectively implemented.

5.1.2 Internal and external audits

Where the monitoring data and the inspection reports highlight problems, an internal audit will be used by SRL to ascertain the source of the problem and to define action to prevent its recurrence.

Tailings audits will be aligned with SRL's auditing procedures and timetable, which will fall under the auspices of the discipline leads and in line with the management system.

5.1.3 Corrective action

There are several mechanisms for implementing corrective action, including:

- Verbal instruction (in the event of minor transgressions from established procedure, usually following a site inspection);
- Written instruction (identifying source/s of problems, usually following an audit); and
- Contract notice (following possible breach of contract).

5.1.4 Reporting

Audit findings will be structured into instructive reporting that provides information to all required parties on tailings management, together with clearly defined corrective action where this is seen to be required. Within the reporting structure a review function will be created that continuously assesses the reporting and prescribes any necessary corrective action.

5.1.5 Management review

SRL will undertake a formal management review of the TMP at defined intervals to review the environmental and social management performance during the preceding period and propose measures for improving that performance in the spirit of continuous improvement.

6 Conclusion

SRL will ensure that measures outlined in this TMP are implemented. An on-site and verification audit program will be put in place to define scheduling, conducting and documenting of internal and external audits. Audit findings will be classified in accordance with the corporate rating procedure. The EHS Manager will review final audit findings and ensure that all non-conformances are dealt with expeditiously.

7 References

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