Sierra Rutile Limited

Mining Area 1

IFC PS6 compliant Biodiversity Action Plan

28 December 2020

SRL would like to acknowledge the work and contribution of Biotope (www.biotope.fr) in the preparation and development of this document.

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LIST OF ABBREVIATIONS

BAP: Biodiversity Action Plan

BMEP: Biodiversity Monitoring and Evaluation Plan

BMF: Biodiversity Management Framework

CH: Critical habitat

CHA: Critical Habitat Assessment

CR: Critically Endangered (conservation status in the IUCN red list of threatened species)

DD: Data Deficient (conservation status in the IUCN red list of threatened species)

EHS MS: Environmental, Health and Safety Management System

EN: Endangered (conservation status in the IUCN red list of threatened species)

EPA-SL: Environmental Protection Agency of Sierra Leone

ESHIA: Environmental and Social Health Impact Assessment

ESHMP: Environmental, Social and Health Management Plan

GoSL: Government of Sierra Leone

IAS: Invasive and Alien Species of flora

IFC PS6: International Finance Corporation Performance Standard n°6 (related to biodiversity conservation and sustainable management of living natural resources)

IUCN: International Union for Conservation of Nature

KPI: Key Performance Indicator

LC: Least concern (conservation status in the IUCN red list of threatened species)

NG: Net Gain

NH: Natural habitat

NNL: No Net Loss

NT: Near Threatened (conservation status in the IUCN red list of threatened species)

MH: Modified habitat

MPA: Marine Protected Area

MSP: Mineral Separation Plant

PDA: Project Development Area

QHa: Quality-hectare

SCC: Species of Conservation Concern

TSF: Tailing Storage Facility

VU: Vulnerable (conservation status in the IUCN red list of threatened species)

Executive Summary

Sierra Rutile Limited (SRL) is an existing mining operation located in the Bonthe and Moyamba districts in the southern province of Sierra Leone. The mine produces rutile, ilmenite and zircon concentrate. Exploration began in 1950 and SRL has been intermittently mined under various ownerships since 1967. Iluka Resources (Iluka) acquired SRL as a wholly-owned subsidiary at the end of 2016. In 2019, the International Finance Corporation (IFC) invested in SRL through a partnership agreement with Iluka. SRL holds seven mining leases covering almost 560 km^2 (Figure 1). To date, all mining has occurred within the "Area 1" mining lease, although planning is underway for potential future mining in Area 5. Given uncertainties in the design of activities in Area 5 and the haul road, the scope of this Biodiversity Action Plan (BAP) is limited to the Area 1 mining lease, where operations are foreseen to end in 2024.

This BAP presents SRL's approach to applying the mitigation hierarchy. As a matter of priority, SRL will avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimize impacts and restore biodiversity and ecosystem services will be implemented.

This document provides the context in which SRL's BAP Actions were developed and will be applied. A summary of the specific BAP actions are provided in the table below with details noted in Appendix III.

Table E1. Summary of BAP Actions

BAP Action	Objective summary	Action description summary
BAP1 – Improve understanding of species composition, density and habitat use	Given the gaps in biodiversity baseline information, SRL will undertake routine biodiversity surveys to better understand the presence and distribution of critical habitat (CH) qualifying species, species of conservation concern (SCC), and habitat conditions. This BAP action coincides with, and is described in more detail in, the Biodiversity Monitoring and Evaluation Plan (BMEP).	Additional surveys include : • Annual forest mapping. • Annual wet and dry season Chimpanzee, monkey and duiker, birds, marine and Ichthyologic surveys.
BAP2 - Reduce operational deforestation and maintain terrestrial forest corridors	Reduce operational deforestation to maintain ecological connectivity for wildlife populations (especially Western Chimpanzees).	Reduce operational clearing within priority avoidance areas : • Enforce land disturbance permit (LDP) process. • Avoid land disturbances within 50 meters of natural habitats (excepting those impact areas authorised under the BAP. • Include a “natural habitats” shapefile in a conservation layer that will be provided to short and long term mine planning teams for inclusion on plans. • Update the “natural habitats” shapefile annually.
BAP3 – Protect and improve water quality	Protect and improve water quality.	Develop a water quality protection plan (including sediment and erosion control) including: • Minimise erosion risk. • Stormwater management and treatment. • Verification that all offsite discharge locations are monitored.
BAP4 - Progressive pond lowering to minimise fauna mortality when closing dams	Lower pond levels progressively, relying on seasonal water fluctuations, to minimise impacts on pond and downstream fauna and habitats.	SRL’s Mine Closure Plan (2020) involves full or partial removal of all 35 existing earthen dams and closure of the associated ponds. Actions have been identified to prevent adverse impacts to aquatic fauna related to fam removal and pond closure.
BAP5 - Adopt controls over vegetation clearance practices to minimize the impacts on Critical	Develop good practices related to the necessary vegetation clearance to minimize the impacts on CH species, SSC and critical habitats.	• Where possible apply a 50m buffer around natural habitat.

BAP Action	Objective summary	Action description summary
Habitat species, species of conservation concern and critical habitats		• When possible, avoid clearing during breeding season (Jan – May, Lopes *et al*. 2018 for nesting birds. If not possible, flush mobile species before land clearing commence. • Train equipment operators and contractors to recognise CH and SSC. If encountered during land clearing, work should stop until species are flushed from work area by staff of SRL ER&R Operations department. • When possible, clearing and topsoil stripping should be conducted during the dry season to limit erosion and sediment loads flowing into the mangrove ecosystem. • Remove and store topsoil stockpiles in such a way so that it is not washed into the mangrove ecosystem during the wet season.
BAP6 - Community, workforce and stakeholder education on good environmental practices	• Develop education and sensitization programs on good environmental practices for local communities, and biodiversity practices for SRL workers and contractors. • Reduce traffic speeds in areas of anticipated Western Chimpanzees crossing (see BAP12). • Use training, education and engagement to combat illegal wildlife trade and hunting in the mining lease.	• Develop an environmental awareness raising, communication, ownership program that targets schools, villages and employees. Program will consider initiatives to encourage and support the community to participate in conservation activities. • Incorporate conservation and biodiversity principles in closure and rehabilitation planning. • Reduce speed limits in anticipated chimpanzee crossing locations and erect signage accordingly to reduce collision risks, particularly on the road between Simbekihun and Mokepay.
BAP7 – Explore initiatives to reduce hunting pressures	Explore initiatives to reduce hunting pressure, focusing on community-led programs.	• Investigate opportunities to reduce hunting pressure in collaboration with local communities. • Institute a zero tolerance policy on the possession, purchase, trade, or collection of wildlife or forest resources protected under Sierra Leone law, are CITES listed, or classed as Threatened by IUCN Red List for all SRL staff and contractors.

BAP Action	Objective summary	Action description summary
		• Support local communities in developing animal farming as an alternative to hunting (see BAP 8). • Train SRL security guards to patrol and monitor Mobimbi Hill (ecoguard program). • Contingent on the success of the SRL Ecoguard program, and results of the social surveys (BAP 6), investigate the possibility of expanding the Ecoguard program into communities.
BAP8 - Enhance the ecological quality of the agricultural mosaic by promoting suitable agricultural practices and agroforestry	Incorporate conservation and biodiversity considerations when designing community development programmes to limit impacts on natural forested habitats and improve agricultural efficiency, while still promoting and respecting traditional knowledge and dynamics.	SRL will integrate biodiversity and conservation objectives into community agricultural / livelihood programmes and closure / rehabilitation planning work scheduled for 2021.
BAP9 - Train existing spotters on ships to monitor marine and estuarine animal species of concern	Observe marine and estuarine animal SCC to mitigate the impacts of vessels travelling to and from Nitti Port.	• Establish a species monitoring systems by developing a data collection sheet for spotters to record information such as: date and time of observation, GPS location, animal species observed, number observed, and distance from spotting ship. • Train current ship spotters on how to recognize animal species concerned and how to enter information onto data sheet. • Operators on mobile vessels (such as the security boat) will be trained on avoidance of marine and estuarine species of concern
BAP10 – Minimise and control the introduction and spread of invasive alien species	Actively manage and control infestation and spreading of terrestrial invasive alien floral species communities within active mining areas and land under rehabilitation to decrease pressure on natural habitats.	Develop and implement an Invasive Alien Species (IAS) Plan.

BAP Action	Objective summary	Action description summary
BAP11 – Restore natural habitats impacted after 2017	Achieve No Net Loss on terrestrial and aquatic habitats to mitigate the impacts of the project on the biodiversity features on the mining lease.	Develop a detailed rehabilitation design for forests, gallery forests, mangroves, and IVS impacted after 2017.
BAP12 – Promote forest protection in core Chimpanzee territories	Promote the protection of CH and Chimpanzee's core habitats in the mining lease and improve/restore ecological corridors to favour species dispersion and movements on the mining lease.	Undertake a community conservation feasibility study including investigation of the following: • Potential initiatives to promote conservation of targeted areas by providing materials or tools to improve community farms, in exchange for delivering on specific conservation commitments. • Potential ecoguard program to track and discourage logging and hunting in identified conservation areas. • Potential incentives to promote conservation by crops or woodlots in areas that are not targeted for conservation.
BAP13 – Restore select natural habitats impacted by mining before 2017	Achieve Net Gain on CH in order to mitigate the impacts of the project on the biodiversity features	SRL prepared a conceptual pond closure plan, which is included as an appendix to the BAP. Develop a detailed restoration design for Pejebu and Motinga Ponds.

1. CONTEXT

1.1. The Project

Sierra Rutile Limited (SRL) is an existing mining operation located in the Bonthe and Moyamba districts in the southern province of Sierra Leone. The mine produces rutile, ilmenite and zircon concentrate. Exploration began in 1950 and SRL has been intermittently mined under various ownerships since 1967. Iluka Resources (Iluka) acquired SRL as a wholly-owned subsidiary at the end of 2016.

In 2019, International Finance Corporation (IFC) invested in SRL through a partnership agreement with Iluka. SRL holds one mining lease in seven parts covering almost 560 km^2 (Figure 1). To date, all mining has occurred within the "Area 1" mining lease, although planning is underway for potential future mining in Area 5.

Given uncertainties in the design of activities in Area 5 and the haul road, the scope of this BAP is limited to the Area 1 mining lease, where operations are foreseen to end in 2024.

Historic dredge ponds, processing ponds and tailings areas remain un-rehabilitated in the northeast portion of Area 1. These "legacy" areas were mined-out by the early 1990's, pre-dating Sierra Leonean regulations and modern industry best practice. Mining of the Gangama, Lanti, and Gbeni deposits, located in the southern and western portions of Area 1, began in the 1990s and is ongoing. Current operations include dry mining (truck and shovel) and two land-based plants, where the heavier mineral sands are separated from waste using gravitational and centrifugal forces (no chemicals are used). Tailings are returned to the mining pit, allowing the landform to be restored to surface contours resembling the original landform. The mineral concentrate (<3% of the soil profile) is hauled to the Mineral Separation Plant (MSP) at the Plant Site for final processing via gravity, electromagnetic and electrostatic separation. Final products are hauled from the MSP to the Nitti port before being barged about 40 km to sea vessels awaiting in the Sherbro River Estuary and exported.

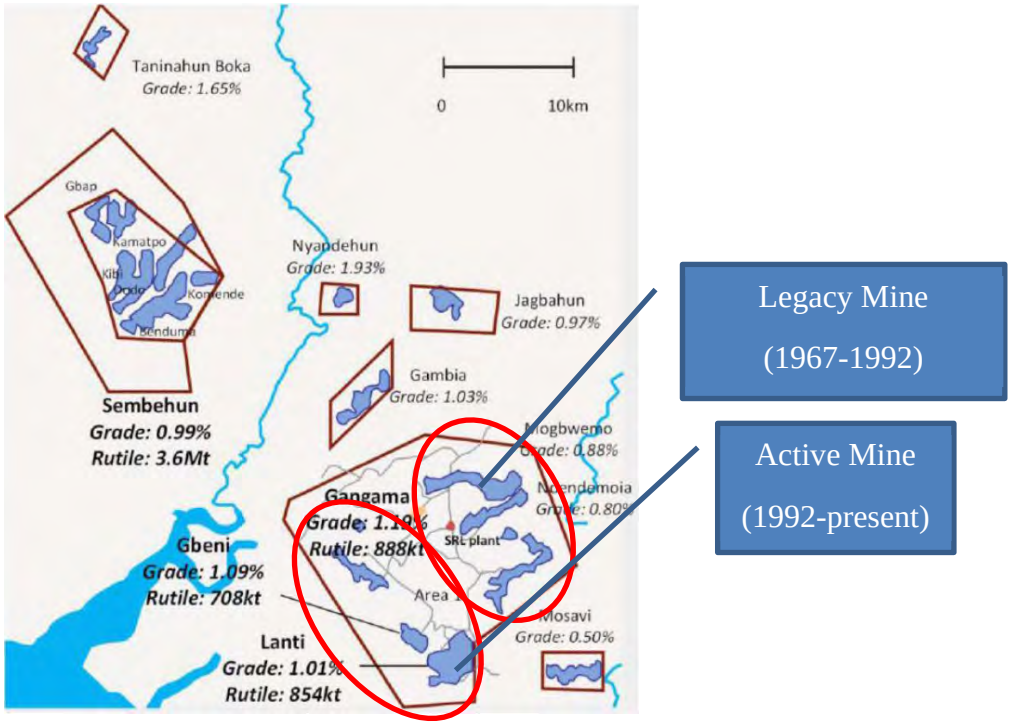


Figure 1: SRL Mining Leases and Deposits

1.2. Habitats and biodiversity

The Project lies within the Western Guinean Lowland Forests and the Guinean Mangroves ecoregions:

- The Western Guinean Lowland Forests ecoregion covers *circa* 200 000 km^2 and is associated with several charismatic large mammal species, including the Critically Endangered (CR) Western Chimpanzee (*Pan troglodytes verus*);
- The Guinean Mangroves ecoregion covers 23 000 km^2 and provides important habitats for migratory birds and Vulnerable species such as the African Manatee (WWF 2017b).

The Project Area is located in a cropland-forest mosaic dominated by modified habitats used for subsistence agriculture (approximately 62.5%): actively farmed fields and lands that are lying fallow, as part of the shifting agriculture system ('farmbush') practiced throughout Sierra Leone.

Natural habitats include remnant lowland and gallery forests that are largely degraded and fragmented due to 50 years of shifting cultivation, mining and related in-migration. Mangroves and some uncultivated wetlands are still relatively well-preserved in some valley-bottoms (TBC 2019). See Figure 2 and Section 5 for more detail.

Most of coastal Sierra Leone can be characterized as degraded. Past mining activity and induced in-migration to Area 1 likely contributed to the prevalence of modified habitats in the project area. Existing threats to biodiversity in the area are similar across Sierra Leone and West Africa as a whole and include degradation and conversion of forested habitats into agricultural lands, timber extraction for charcoal production, bushmeat hunting, Chimpanzee poaching and trafficking, and unsustainable fishing in freshwater and marine areas (Brashares *et al*. 2004; Brncic *et al*. 2010; Molotoks *et al.* 2017).

1.3. Scope of the Biodiversity Action Plan

This BAP presents SRL's approach to applying the mitigation hierarchy. As a matter of priority, SRL will avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimize impacts and restore biodiversity and ecosystem services will be implemented.

Avoid Impacts → Minimize Impacts → Restore Impacted Land → Offset residual impacts

In areas of **'natural habitat'**, mitigation measures will achieve 'no net loss' (NNL) of biodiversity.

For **'critical habitat' values**, mitigation measures will achieve a 'net gain' (NG) of biodiversity

Natural and critical habitats are identified in the sections that follow.

Specific actions that will be taken by SRL are detailed in Appendix III. This document provides the context in which SRL's BAP Actions were developed and will be applied.

January 2017 is the baseline date for this BAP. This coincides with Iluka's investment in SRL. IFC's investment in the project, however, only began in June 2019. SRL is required to comply with PS6 for all impacts which occurred after the baseline date.

Approximately 6,027 hectares will be disturbed by the end of the Area 1 mine life. Of this, 710 hectares (11%) of impact will have occurred after the baseline date.

1.4. Expert Consultation

Given the presence of Chimpanzees in Area 1, SRL hired recognized Chimpanzee specialists[1] to carry out baseline Chimpanzee surveys during the 2019 wet and dry seasons. One of these specialists, Jessica Swaray, PhD, was subsequently hired as SRL's Principal Environmental Scientist. Dr. Swaray is responsible for developing and executing the BAP with support from specialist consultants as required.

The following external experts and organizations were additionally consulted in the preparation of the BAP:

- Chimpanzee specialist Rosa Garriga, who has been working for more than three decades on Chimpanzee research and conservation in Sierra Leone, including in the Moyamba District. She led part of the Moyamba District field surveys in partnership with the Tacugama Sanctuary.
- Chimpanzee specialists at The Biodiversity Consultancy (Genevieve Campbell and Adeline Serckx) who were involved in the 2019 critical habitat screening and wet- and dry-season primate surveys at SRL.
- The IUCN Primate Specialist Group Section on Great Apes task force reviewed an early version of the BAP in June 2020. The BAP and BMEP were refined based on their input. The IUCN specialist group will continue to be consulted subsequent updates.
- Timneh Parrot experts Drs. Stuart Marsden and Simon Valle have provided initial input into best practices for surveying and monitoring Timneh Parrots. They will continue to be engaged as field work develops.
- Ichthyologist and estuarine expert Dr. Barry Clark was consulted on best survey practices for freshwater and marine fish.
- COVID-19 limited SRL's ability to consult local communities as part of the development of this BAP. However, stakeholders were consulted during 2019 primate surveys and in 2017-2018 as part of the ESHIA process.

[1] Geneviève Campbell, Adeline Serckx, Jessica Swaray & Rosa Garriga

2. NATURAL, MODIFIED AND CRITICAL HABITATS

2.1 Natural and modified habitats

As per PS6, **Natural Habitat (NH) and Modified Habitat (MH)** are differentiated based on the level of human modification they have undergone. Only substantially disturbed areas are classified as MH - like slash and burn agriculture, urban or industrial areas - whereas selectively logged forests which had retained most of their ecological functions are classified as NH.

Different habitat categories appeared in numerous impact studies conducted for SRL dating back to 2001. In 2020, habitat categories were updated based on field observations from 2019 surveys (Table 1).

Table 1 : Habitat categories

Habitat category	Definition	Illustration
Natural habitats (Total: Area 1 = 3,544.8 ha)		
Forest (1187.3 ha, 33.5% of natural habitats)	**Lowland forests** with generally low tree density and relatively low species diversity per hectare. Many canopy trees are above 30m tall, with some emergent individuals reaching a height of 50-60m (WWF 2017). **Old secondary growth forests** are naturally regenerating forests after significant removal or disturbance of the original forest vegetation. They usually have lower canopy cover and tree species composition than lowland and gallery forests. Logging and agriculture have reduced the area of primary forest in Sierra Leone from more than 70% to less than 6% (Davies 1987). In the Project Area forest is present in very small and degraded patches due to agriculture, charcoal production, artisanal logging and mining.	
Gallery / Riparian forest (348 ha, 9.8% of natural habitats)	Approximately 50m wide strips of closed-canopy rainforest with trees to 25m high, along rivers and streams. Widespread in Sierra Leone; present in very small patches in the Project Area and already degraded because of agriculture, charcoal production, artisanal logging and mining.	
Inland Valley Swamp (IVS) (851.9 ha, 24% of natural habitats)	**IVS** are flat-bottomed and relatively shallow valleys. They are seasonally or annually inundated depending on their hydrological setting. Most IVS in the Project Area have been converted into rice plantations (TBC 2019). Only undisturbed IVS are included in this category.	
Wetland	**Wetland** refers to an area where plants and animals have become adapted to temporary or permanent flooding by saline, brackish or freshwater. It consists of pond, marshes and swamps other than IVS.	

Habitat category	Definition	Illustration
Mangrove (910.8 ha, 25.7% of natural habitats)	**Mangroves** are a complex ecosystem consisting of a range of functional forms adapted to survive a harsh intertidal region. They include trees (up to 5 mangrove species), shrubs, palms and ferns, all generally greater than half a meter in height, with low species richness (SRK 2018; WWF 2017b). The Sherbro River Estuary is the largest mangrove area in Sierra Leone (998 km^2 with an estimate of 1,721 km^2 in the country).	
Open water (246 ha, 6.9% of natural habitats)	In the project area, open water includes estuarine ecosystems: streams in Mangroves and Sherbro River Estuary. Mining ponds are considered as modified habitats.	
Modified habitats (total: Area 1 = 25,545 ha)		
Building, settlement, road, infrastructure, industrial area, mining ponds and sand tailings (5536.2 ha, 21.7% of modified habitats)	Includes all buildings, settlements and roads belonging to local communities, Sierra Leonian government (GoSL) or to the Project. Infrastructures and industrial area along with mining ponds and sand tailings refer only to the ones related to the Project development.	
Shifting cultivated area ('farmbush') (18,588.2 ha, 72.8% of modified habitats)	The dominant shifting cultivation system ('slash-and-burn' agriculture) consists of cultivating a piece of land for a few years before switching to another piece of land. Abandoned lands become fallows for the next years and slowly evolve into young secondary forests before being cultivated again. The rotation cycle was traditionally around 10 years, but growing pressure on farmland has now shortened it. . Anecdotally this period is now as short as four years (SRK 2018) This category includes land at various steps in the slash-and-burn cycle such as crop fields, fallows and young secondary forests, cultivated IVS and farm bush in unmaintained oil palm plantations (cropland and fallow with oil palm trees).	
Oil palm plantation (14.21.6 ha, 5.5% of modified habitats)	Consist of the currently exploited oil palm plantations.	

A land use map showing the distribution habitats categorized above is shown in Figure 2. Modified habitats are shown on Figure 3. Land use designations are based on interpretation of aerial photographic imagery and will be refined over time as the BAP is implemented and field data are collected.

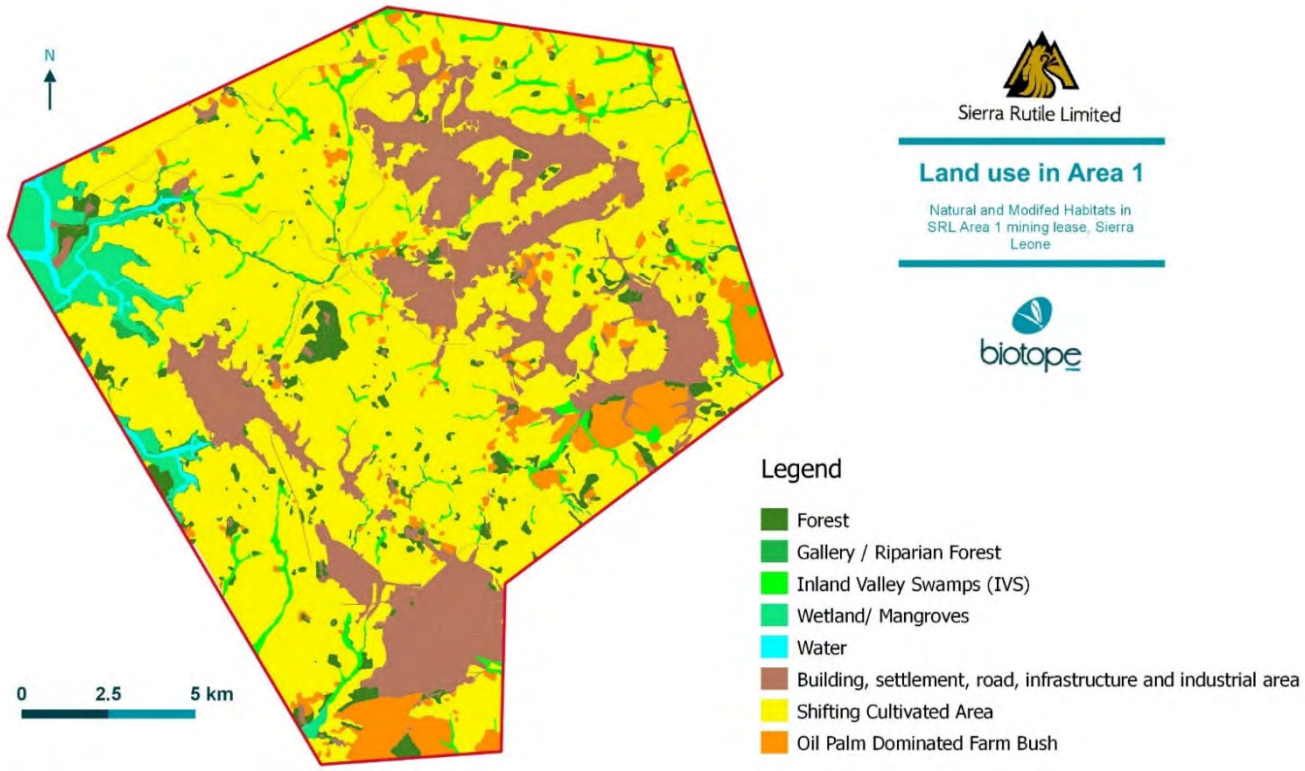


Figure 2 : Habitats in Area 1

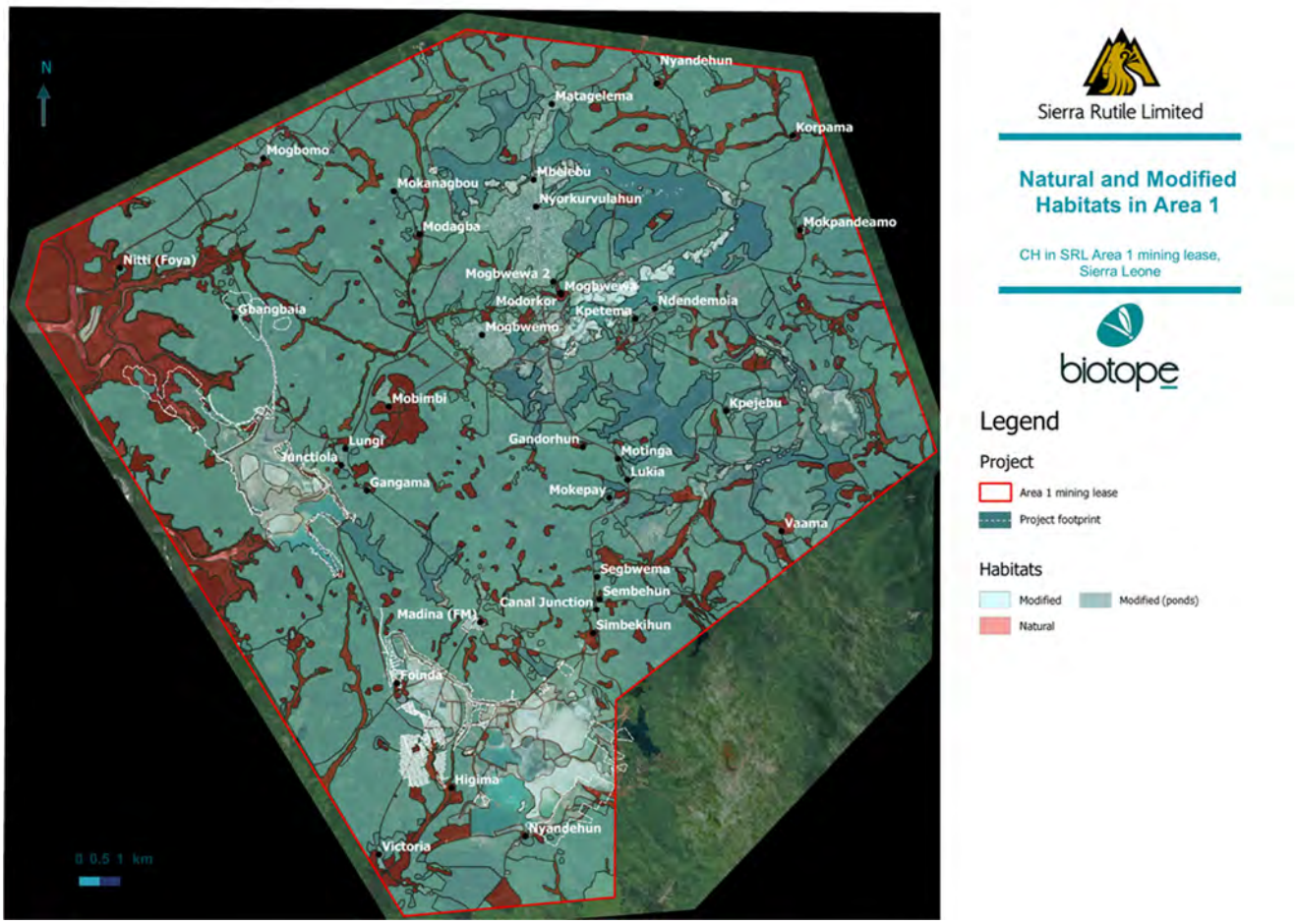


Figure 3 : Natural and modified habitat

2.2 Critical Habitats

Critical Habitats (CH) are areas with high biodiversity value[2], including (i) habitat of significant importance to Critically Endangered and/or Endangered species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and/or congregatory species; (iv) highly threatened and/or unique ecosystems; and/or (v) areas associated with key evolutionary process.

IFC PS6 thresholds for critical habitat designation are applied to an 'ecologically appropriate area of analysis' for the species, ecosystems or processes that could potentially trigger a critical habitat designation. This area of analysis is defined independently of the project's impacts and both NH and MH can be designated as CH.

Designation of 'critical habitat' does not necessarily mean the area is subject to high impacts. The designation simply reflects the extent of mitigation required (Net Gain).

An initial critical habitat assessment (TBC 2019) identified a number of potential and confirmed critical habitat (CH) triggers. The CHA was updated in 2019 (Biotope 2019). Natural and modified critical habitats were identified in Area 1 (Table 2).

Applying the precautionary principle led to identification of **34 CH likely qualifying species** (Table 3).

Table 2 : Habitats that qualify as Critical Habitat and associated priority species

Habitats	Priority species (present and potentially present)
Natural habitats	
Mangroves	West African Nile Crocodile, Slender-snouted Crocodile, Timneh Parrot, *Scriptaphyosemion chaytori*, Atlantic Humpback Dolphin
Natural critical habitats	
Sherbro Estuary	Atlantic Humpback Dolphin, African Wedgefish, African Manatee
Rivers	Likely CH qualifying freshwater fish species, Slender-snouted Crocodile, West African Nile Crocodile
Gallery / Riparian Forest	Slender-snouted Crocodile, West African Nile Crocodile
Forest	Western Chimpanzees, Western Red colobus, King Colobus, Diana Monkey, Jentink's Duiker, Timneh Parrot, Freetown Long-fingered Frog
Inland Valley Swamps (IVS)	Western Chimpanzees
Modified critical habitats	
Shifting cultivated areas (« farmbush ») used by Western Chimpanzees	

Table 3 : Summary table of the confirmed and potential CH qualifying species in SRL Area 1 mining lease

Taxa	Scientific name	Common name	IUCN cat.	Criteria	Habitat category used in the BAP analysis
Confirmed CH Qualifying species					
Terrestrial mammal	*Pan troglodytes verus*	Western Chimpanzee	CR	1	Forest - Gallery / Riparian Forest – IVS (Wetland / Mangroves were excluded)

2 Legally Protected and Internationally Recognized Areas are also generally considered to be critical habitats.

Taxa	Scientific name	Common name	IUCN cat.	Criteria	Habitat category used in the BAP analysis
Marine mammal	*Sousa teuszii*	Atlantic Humpback Dolphin	CR	1	Sherbro River Estuary
Likely CH Qualifying species					
Birds	*Psittacus timneh*	Timneh Parrot	EN	1	Forest - Gallery / Riparian Forest - Wetland / Mangroves - Cultivated Area - Oil Palm Dominated Farm Bush and plantation
Freshwater Fishes	*Epiplatys njalaensis*		EN	1, 2	River
	Notoglanidium maculatum		EN	1, 2	River
	Notoglanidium thomasi		EN	1, 2	River
	Scriptaphyosemion bertholdi		EN	1, 2	River
	Enteromius bagbwensis		VU	2	River
Possibly CH Qualifying species					
Terrestrial mammal	*Cephalophus jentinki*	Jentink's Duiker	EN	1	Forest - Gallery / Riparian Forest
	Piliocolobus badius	Western Red Colobus	EN	1	Forest - Gallery / Riparian Forest - IVS - Wetland / Mangroves
	Colobus polykomos	Black-and-white Colobus	VU	1	Forest - Gallery / Riparian Forest
	Cercopithecus diana	Diana Monkey	EN	1	Forest - Gallery / Riparian Forest
Reptile	*Crocodylus suchus*	West African Nile Crocodile	NE	1	Gallery / Riparian Forest - IVS - Wetland / Mangroves – Water
	Mecistops cataphractus	Slender-snouted Crocodile	CR	1	Forest - Gallery / Riparian Forest - IVS - Wetland / Mangroves – Water
Amphibians	*Conraua alleni*	Allen's Slippery Frog	LC	1	Forest - Gallery / Riparian Forest - Wetland / Mangroves - Water
	Arthroleptis aureoli	Freetown Long-fingered Frog	NT	1	Forest - Gallery / Riparian Forest - Wetland / Mangroves - Cultivated Area
Freshwater fish	*Chrysichthys johnelsi*		LC	3	River
	Coelotilapia joka		VU	2	River
	Enteromius liberiensis		EN	1, 2, 3	River
	Epiplatys fasciolatus ssp. josianae		CR	1, 2	River
	Epiplatys fasciolatus ssp. zimiensis		EN	1, 2	River
	Ladigesia roloffi		EN	1, 2	River
	Leptocypris taiaensis		VU	2	River
	Marcusenius meronai		EN	2	River
	Mochokiella paynei		LC	2	River
	Ophichthus leonensis		DD	2, 3	River & Marine Water
	Scriptaphyosemion chaytori		DD	2	Wetland / Mangroves - River
	Scriptaphyosemion roloffi		NT	2	River
Marine fish	*Rhynchobatus luebberti*	African Wedgefish	CR	1, 2	Sherbro River Estuary
Insect	*Pseudagrion mascagnii*		CR	1, 2	Forest - Gallery / Riparian Forest - IVS - River

Taxa	Scientific name	Common name	IUCN cat.	Criteria	Habitat category used in the BAP analysis
	Elattoneura dorsalis	Yellow-fronted Threadtail	VU	2	Forest - Gallery / Riparian Forest- IVS - River
Decapod	*Afrithelphusa leonensis*		DD	2	Forest - Gallery / Riparian Forest- IVS - River
	Afrithelphusa afzelii		DD	2	Forest - Gallery / Riparian Forest- IVS - River

CR=Critically endangered; EN=Endangered; LC= Least Concern; NE=Not Evaluated; VU=Vulnerable

2.3 Chimpanzees

The Critically Endangered Western Chimpanzee has been documented in the Area 1 mining lease and surrounding areas. SRL's 2019 Chimpanzee baseline survey estimated a total population size of 30 – 98 individuals from three groups (A, B, C) in and around Area 1 (Figure 4). Group A is located within the Area 1 mining lease boundary, in the "Mobimbi Hills". Groups B and C are located just outside the Area 1 mining lease boundary, to the south and east respectively. Chimpanzees were documented in an additional area located just outside the northeast corner of Area 1. Due to distance and location, these individuals are unlikely to be part of Groups A, B, or C. More data on Chimpanzee population dynamics and habitat use is needed to improve these group boundaries and to inform Chimpanzee conservation efforts (see BAP Actions 1, 11-13 in Appendix III).

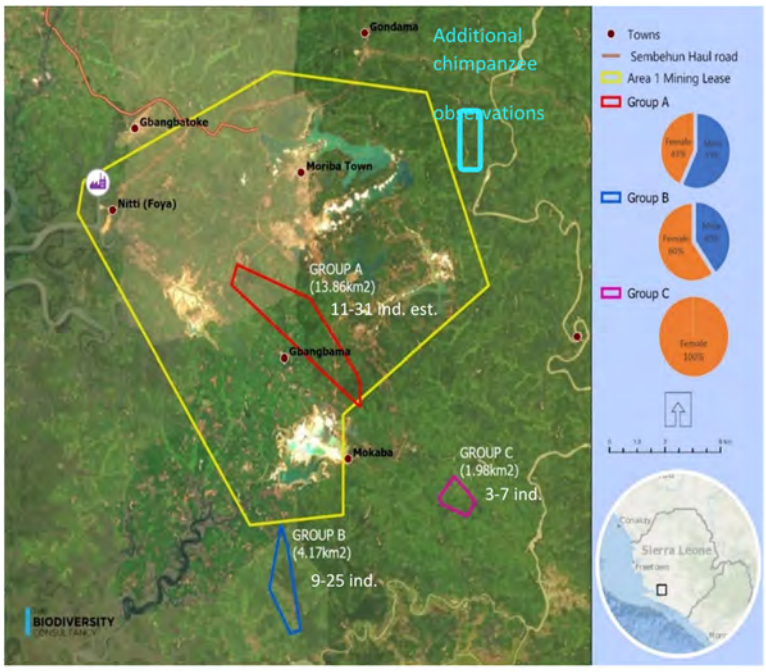


Figure 4 : Chimpanzee communities identified in Area 1

2.4 Timneh parrots

The Endangered Timneh Parrot (*Psittacus timneh*) is a likely qualifying Critical Habitat species. While this species has been informally reported in Area 1, there are no systematic population data on this species. While the Timneh parrot is thought to typically inhabit dense forest, individuals are commonly observed at forest edges, clearings, gallery forest, mangroves, wooded savannah, cultivated areas, and even gardens (Juniper and Parr 1998).

2.5 Other Priority Species

Other likely and possibly qualifying Critical Habitat species that are likely to occur within Area 1 but have not been formally documented through surveys include 3 monkey species (Red Colobus, King Colobus, Diana Monkey),

Jentink's duiker, West African Nile Crocodile, Slender-snouted Crocodile, Freetown Long-fingered Frog, Allen's Slippery Frog, Atlantic Western Humpback Dolphin, African Wedgefish, African Manatee, and 14 freshwater fish species).

3. AVOIDANCE AND MINIMIZATION

SRL will implement the mitigation hierarchy to firstly avoid, minimize and then restore impacts on natural and critical habitats.

3.1 Summary of avoidance and minimization actions

Below is a summary the BAP actions aimed at avoiding and minimizing impacts. These actions are described in more detail in Appendix III.

Action	Objective
BAP 1	Improve understanding of species composition, density and habitat use
BAP 2	Reduce operational deforestation and maintain terrestrial forest corridors
BAP 3	Protect and improve water quality
BAP 4	Progressive pond lowering to minimise fauna mortality when closing dams
BAP 5	Adopt controls over vegetation clearance and other good practices to minimize the impacts on species of conservation concern and critical habitats
BAP 6	Community, workforce and stakeholder education on good environmental practices
BAP 7	Explore initiatives to reduce hunting pressure
BAP 8	Enhance the ecological quality of the agricultural mosaic by promoting suitable agricultural practices and agroforestry
BAP 9	Train existing spotters on ships to monitor marine and estuarine species of concern
BAP 10	Minimise and control the introduction and spread of invasive alien species

4. RESIDUAL IMPACTS

4.1 Direct and Indirect Impacts

Residual impacts are environmental effects that will remain after application of avoidance and minimisation. Vegetation clearance for mining and associated infrastructure will cause direct habitat loss (**direct impacts**) from the construction phase until completion of rehabilitation. Indirect impacts are also expected to adjacent areas due to noise, dust, smells, human activity, habitat fragmentation, change in water levels, change in vegetative composition, etc.

Indirect impacts to forests, gallery forests, and IVS were calculated based on distance from the direct impact (Table 4). This approach (the assumption that impacts lessen as distance increases) is subjective (i.e. not specific to SRL or habitat type) and will be updated in the next version of the BAP following completion of a comprehensive literature review.

Table 4 : Estimated % loss of habitat quality based on distance from direct impacts

	Direct impact	Indirect impact (% loss of habitat quality based on distance from direct impact)			
		0 to 50m	50 to 100m	100 to 150m	More than 150m
Loss of habitat quality relative to baseline condition	100%	75%	50%	25%	0%

Indirect impacts for mangroves were calculated based on the anticipated area that will be subject to drawdown due to dewatering and do not necessarily correspond to the above distances. Indirect impacts were not calculated for modified habitats (shifting cultivation).

4.2 Direct and indirect impacts to forest habitats

Based on the current life-of-mine plan, 16 ha of forests (1% of total in Area 1) and 21 ha of gallery forests (6% of total) will be directly impacted by SRL between 2017 and the end of mining in Area 1. Indirect impacts are anticipated for 38 ha of forest and 24 ha of gallery forests. Figures 5a and b illustrate direct impact locations.

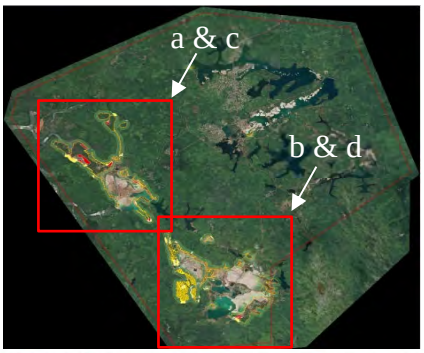
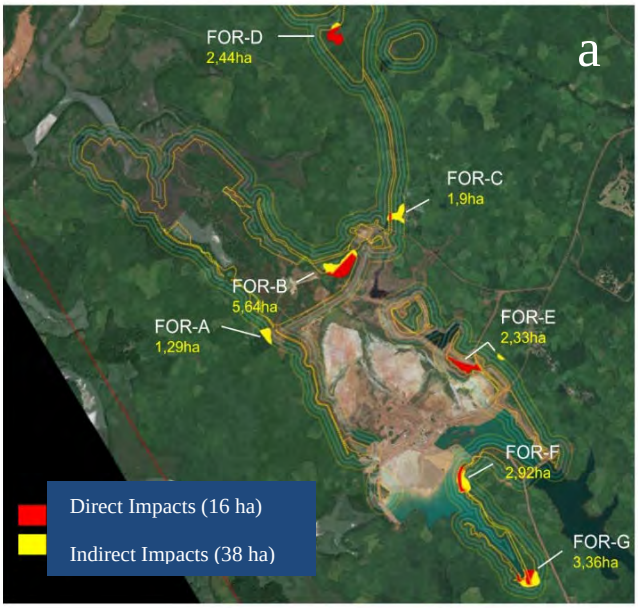
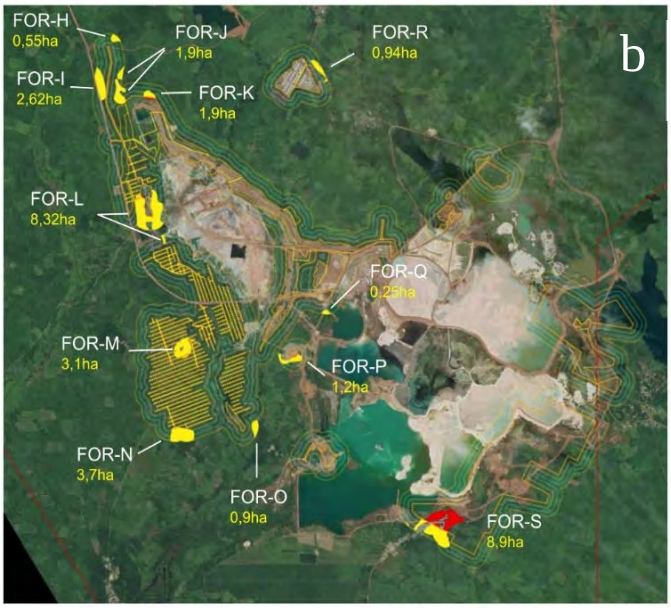
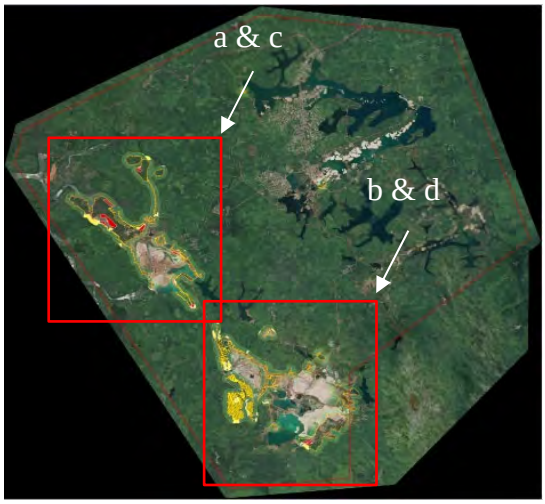


Figure 5a : Direct and indirect forest impacts







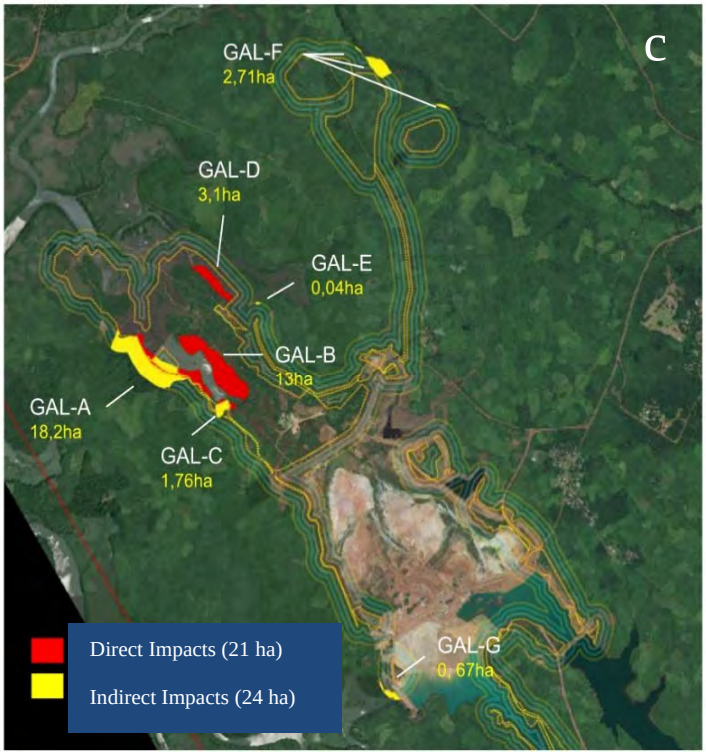


Figure 5b : Direct and indirect gallery forest impacts

4.3 Direct and indirect impacts to mangroves

Based on the current life-of-mine plan, the Project will directly impact 72 ha of mangrove (7% of total in Area 1). Indirect impacts are anticipated in 40 ha. Figures 6 illustrates direct impact locations.

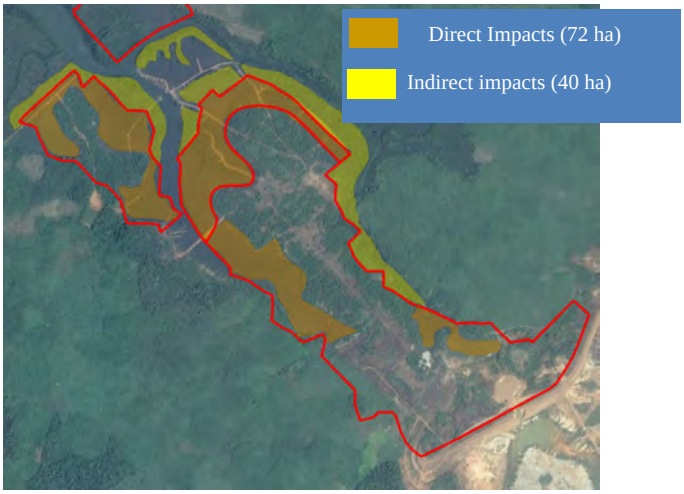


Figure 6 : Direct and Indirect Mangrove Impacts

4.4 Direct and indirect impacts to inland valley swamps (IVS)

Based on the current life-of-mine plan, 6 ha of Inland Valley Swamp (IVS) (>1% of total in Area 1) will be directly impacted. Indirect impacts are anticipated to occur within 30 ha. Figures 7 illustrates impact locations.

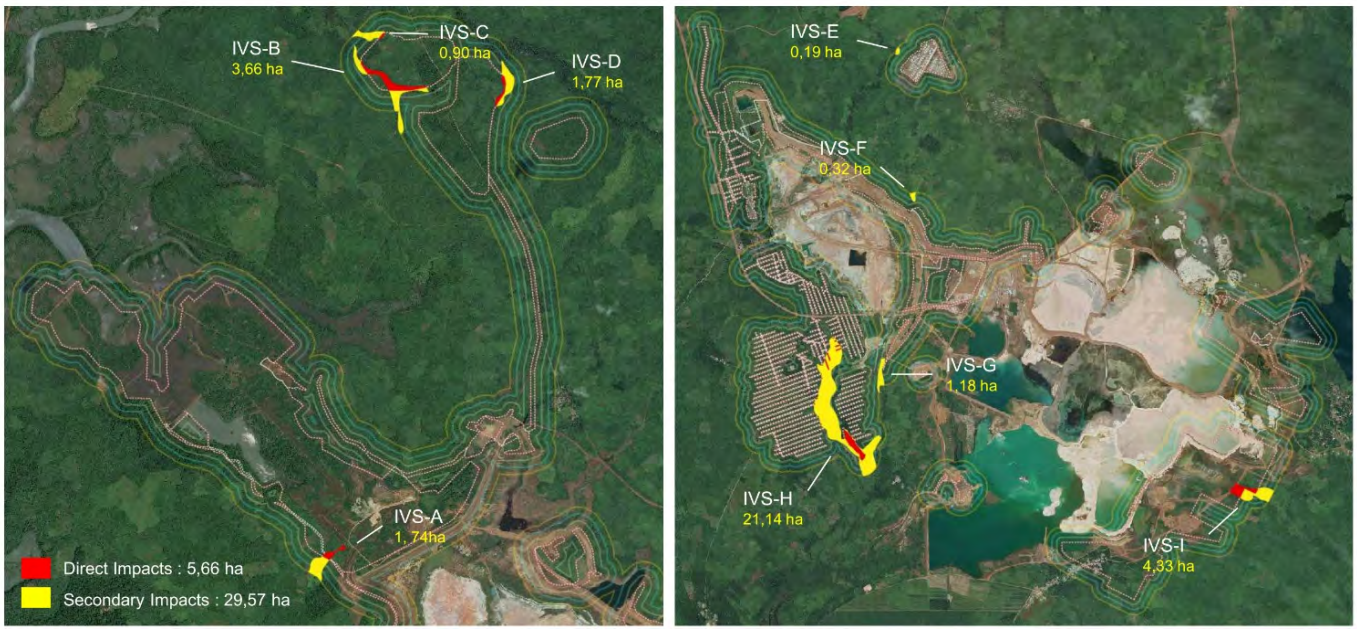


Figure 7 : Direct and Indirect IVS Impacts

4.5 Impacts to Western Chimpanzee habitats

Insufficient survey data exist to quantify Chimpanzee population loss due to post-2017 project activities. Therefore, impact quantification focuses on Chimpanzee habitat. No mining related activities are planned in the core Chimpanzee habitat areas. However, in applying the precautionary principle, all forested habitats and inland valley swamps in Area 1 were considered as critical habitat based on potential use by Chimpanzees. Impacts to

these habitats were quantified and habitat will be restored as described in the “no net loss net gain approach” section below.

The 2019 surveys demonstrate that Chimpanzees also use shifting cultivation in Area 1. The project will impact 99 ha of shifting cultivation within Area 1 between 2017 and the end of mining. Indirect impacts were not quantified because this is a modified habitat type. Because these indirect impacts are not quantified, additional surveys of Chimpanzees (as outlined in BAP Action 1) and consequent monitoring (BMEP 4) aim to calculate Chimpanzee population numbers to ensure a net gain of this species by the end of the life of the project.

4.6 Summary of impacts

Based on the current life-of-mine plan, the following impacts are foreseen in Area 1 from the baseline date of this BAP (2017) until the end of mining.

Table 5 : Summary of hectares impacted (direct and indirect) by habitat type

Habitat Type	**Type of habitat**	**Total in mining lease**	**Direct Impact**		**Indirect Impact**		**Total area affected**
		Ha	**Ha**	**%**	**Ha**	**%**	**Ha**
Habitats							
IVS	NH	843	6	1%	30	4%	35
Wetland/ Mangroves	NH	911	72	8%	40	4%	112
Forest	NH-CH	1,187	16	1%	38	3%	54
Gallery / Riparian Forest	NH-CH	349	21	6%	24	7%	45
Shifting cultivated area	MH-CH	18,064	99	1%	0	0%	99
Total		**21,354**	**213**	**17%**	**132**	**18%**	**345**

5. NO NET LOSS AND NET GAIN APPROACH

As per IFC PS 6, project activities must result in a "net gain" (NG) to critical habitats (forests, gallery forests, IVS) and "no net loss" (NNL) to natural habitats (mangroves). Due to the substantial legacy impact (dating back to the 1960s), SRL has an opportunity to achieve NNL/NG by restoring natural habitat impacts that could otherwise remain un-rehabilitated or could be rehabilitated to target a subsistence agricultural post-mining land use as per regulatory obligations. SRL's locally significant NNL/NG approach is intended to restore biodiversity value to the landscape and communities that were directly affected by mining. No significant residual impacts occur and restoration plans are sufficient to mitigate project impacts. The approach is multi-faceted and includes the following actions (**detailed in Appendix III**):

Action	Objective
BAP 4	Progressive pond lowering to minimise fauna mortality when closing dams
BAP 7	Explore initiatives to reduce hunting pressure
BAP 8	Enhance the ecological quality of the agricultural mosaic by promoting suitable agricultural practices and agroforestry
BAP 11	Restore natural habitats impacted by mining after 2017
BAP 12	Promote forest protection in core Chimpanzee territories
BAP 13	Restore select natural habitats impacted by mining before 2017

5.1 Uniform Mitigation Assessment Method

The Uniform Mitigation Assessment Method (UMAM[3]) was used to estimate how much natural habitat must be restored under BAP Actions 11 and 13 to achieve NNL/NG. In brief, UMAM is a standardized method to quantify the functional losses associated with natural habitat impacts and the functional gains associated with natural habitat restoration. This quantitative approach enables establishment of specific, measurable targets to demonstrate habitat NNL/NG.

UMAM quantifies functional losses and gains by scoring "current", "with impact", and "with restoration" conditions based on "functional indicators" in the following categories:

1. Location and Landscape Support,
2. Water Environment (for aquatic systems only), and
3. Community Structure.

UMAM datasheets and calculations are provided in Appendix I.

In the context of this BAP, UMAM assumes habitat functional value as a proxy for biodiversity. It is understood that habitat restoration does not guarantee NNL / NG for individual species or biodiversity in general. Rather,

[3] UMAM was developed by the State of Florida Department of Environmental Protection as a standard tool to estimate the functional loss associated with habitat impacts and the functional gain associated with mitigation (CH 62-340, F.A.C.). This method is accepted by the US Army Corps of Engineers to evaluate mitigation proposals for projects involving impacts to federally jurisdictional wetlands and waterways across the United States. UMAM was selected because SRL's parent company (Iluka) has experience using this tool at its former US operations and in the absence of any formal tool used by the Sierra Leonean regulators.

biodiversity gain depends on successful planning, implementation, and management of restored habitat. NNL/NG for species will be demonstrated by monitoring biodiversity indicators as discussed in the BMEP (Appendix IV).

5.2 Natural Habitat Functional Loss and Gain

5.2.1 Functional Loss

The functional value of each impact area in its "current" and "with impact" condition was quantified using the UMAM method. An "impact delta" was then calculated as the difference between the "current" and "with impact" scores. For direct impacts, Functional Loss (FL) is calculated as the product of the "impact delta" and the hectares of impact. For indirect impacts, the "impact delta" is subjected to a multiplier ranging from 0.75 to 0.25 depending on distance from the direct impact (Table 5). Equations are provided below.

*Direct Impacts: Functional Loss (FL) = Impact Delta * Hectares of Impact = Credits required*

*Indirect Impacts: FL = Impact Delta * Hectares of Impact * Distance Multiplier = Credits required*

Where:
Impact Delta = "after impact" score – "current" score

For each habitat type, Functional Loss (FL) represents the number of restoration "credits" that must be generated to achieve NNL/NG.

Tables 6 and 7 summarise the anticipated FL due to post-2017 impacts.

Table 6 : Summary of functional loss for mangroves as calculated using the UMAM approach.

Impact Type	Impact Area	Direct Impact (ha)	*	Impact Delta (per UMAM)	=	Functional Loss/Credits Needed
Direct	Mang-A	5		0.5		2.5
	Mang-B	17		0.5		8.5
	Mang-C	22		0.5		11
	Mang-D	28		0.5		14
		72				**36**
Indirect	Mang-C	10		0.23		2.3
	Mang-D	25		0.23		5.75
	Mang-E	5		0.23		1.15
	TOTAL	**40**				**9.2**
TOTAL		**112**				**45.2**

Table 7 : Summary of functional loss for forests, gallery forest, and IVS as calculated using the UMAM approach

Impact Area	Direct Impact (ha)	Indirect impacts			FL / Credits Needed
		Area within 50m (ha)	Area within 100m (ha)	Area within 150m (ha)	
Forest	16	16	11	11	16
Gallery forests	21	10	7	7	15
IVS	6	14	11	4	17

5.2.2 Functional Gain

BAP Actions 11 and 13 requires SRL to finalise and execute a plan to restore natural habitats (Appendix III). SRL's conceptual habitat restoration plan aims to restore all natural habitats impacted after 2017, and selected natural habitats impacted before 2017 (Appendix II). Pre-2017 restoration focuses on closure of artificial dams and ponds that were constructed in the 1960's.

The number of restoration "credits" to be generated under the conceptual restoration plan was estimated using UMAM. The anticipated functional value of each restoration area in its "current" and "with restoration" condition was quantified using the UMAM method (see datasheets Attachment I). A "mitigation delta" was then calculated as the difference between the "current" and "with restoration" scores. For each restoration area, "Relative Functional Gain" (RFG) was calculated by dividing the "mitigation delta" by a coefficient to account for temporal lag (t-factor). Functional Gain (FG) was then calculated as the sum of the product of RFG and hectares of restoration the product of RFG and hectares of impact.

Functional Gain (FG) equates to the number of "credits" that will be generated through habitat restoration.

Calculations are provided on the following page:

Relative Functional Gain (RFG) is the "mitigation delta" adjusted for time lag:

RFG = Mitigation Delta / (t-factor)

Where:

Mitigation Delta = "with impact" score – "after restoration" score

And:

Years until "after restoration" condition is acheived	T-factor
< or = 1	1
2	1.03
3	1.07
4	1.10
5	1.14
6-10	1.25
11-15	1.46
16-20	1.68
21-25	1.92
26-30	2.18
31-35	2.45
36-40	2.73
41-45	3.03
46-50	3.34
51-55	3.65
>55	3.91

Functional Gain (FG) is the sum of the product of RFG and hectares of restoration.

FG = ∑ (RFG * Hectares Restored)

UMAM datasheets calculations are provided in Appendix I. Results are summarised in Table 8.

Table 8 : Summary of anticipated total functional gain (i.e. number of "credits" to be generated) under BAP 11

Restoration Area	Hectares Restored	TFG / Credits Generated
Forest	16	6
Gallery Forest	21	8
Mangrove	143	80

Table 9 : Anticipated total functional gain (i.e. number of "credits" to be generated) under BAP 13

AREA	Hectares Restored	Time-lag	RFG	TFG / Credits Generated
Forest	**75**			**13**
Motinga	36	2.18	0.37	6
Pejebu	40	2.18	0.37	7
Gallery Forest	**75**			**13**
Motinga	36	2.18	0.37	6
Pejebu	40	2.18	0.37	7
IVS	**75**			**44**
Motinga	36	1.1	0.64	21
Pejebu	40	1.1	0.64	23

Detailed restoration design for Motinga and Pejebu is pending further technical studies and community input (scheduled for 2021). Restoration hectares are therefore assumptions based on conceptual designs. Actual restoration hectares will be updated when detailed designs are complete.

5.2.3 Summary of Functional Loss and Gain

Based on the UMAM assessment, the project is expected to generate a surplus of restoration credits in all natural habitat categories. While this analysis indicates that SRL's approach is reasonably expected to achieve NNL / NG targets, success will depend on achievement of biodiversity targets identified in the BMEP. The surplus of credits may retained for future mining expansion at Area 5, or applied to demonstrate NNL / NG if biodiversity targets are not achieved in other areas.

Table 10 : Number of surplus credits by habitat type.

Habitat Type	FL / Credits Needed	TFG / Credits Generated - BAP 11	TFG / Credits Generated - BAP 13	Surplus
Mangrove	>45	80	0	**35**
Forest	>16	6	13	**3**
Gallery Forest	>15	8	13	**6**
IVS	>17	0	44	**27**

5.3 Loss and Gain to Priority Species

5.3.1 Loss and gain to freshwater species

Preliminary data from aquatic studies as part of the ESHIA (2018) found a lower diversity of fish species at two monitoring sites downstream of post-2017 mining locations, however data are limited. Surveys to be completed under BAP Action 1 will serve as a baseline to evaluate population trends across a suite of locations moving forward. The following actions are specifically targeted to improve habitat for freshwater species.

In addition to the restoration of riverine forests (gallery forests) and streams within existing ponds, pond closure and restoration will provide opportunities to restore aquatic habitats downstream of the dams, to the benefit of threatened or restricted range freshwater fish and other aquatic species (some of which may be critical habitat triggers pending results from additional surveys under BAP 1).

Restoration actions will include:

- Restoring severed hydrology to downstream waterways that were impacted decades ago when the dams which impound historic (northern) ponds were constructed;
- Reshaping riverbed morphology (bed level raising may be necessary to counteract historic dredging);
- Re-meander straightened channels by installing berms and woody debris. The channels should be narrowed, and woody debris can be installed within the narrowing berms to provide fish habitat;
- Where necessary reconnect riverbeds to floodplains;
- Restoring forest vegetation along the new streams.

Pond rehabilitation plans under this BAP will enable approximately 2.6 km of downstream waterways (between the dam outlet and/or spillway and the first unaffected stream) to be restored to a natural flow regime. In addition, approximately 12.6 km of 'new' streams will be recreated within the currently flooded area of the ponds as they are restored.

5.3.2 Loss and gain to Chimpanzees

It is not possible to quantify Chimpanzee population decline related to post-2017 project activities. The 2019 primate surveys will serve as a baseline to evaluate population trends (based on genetic analysis) moving forward.

The preceding sections quantify SRL's quantitative approach to demonstrating losses and gains to natural habitats used by the Chimpanzee (forest, gallery forest, IVS). SRL acknowledges that Chimpanzees also use modified habitat (farm bush / shifting agriculture) in Area 1. It is impractical to attempt net gain for Chimpanzees by increasing the area of farmbush. Rather, SRL's approach to achieving net gain for Chimpanzee includes the following:

- Restore forest, gallery forest, and IVS as described above (see BAP 11 and 13 in Appendix III for details)
- Influence community and other stakeholders to adopt practices that reduce pressures of hunting and agriculture on Chimpanzees (see BAP 7, 8, and 12 in Appendix III for details)
- Promote forest protection in Chimpanzee core habitat areas in Mobimbi hills and "Simbekihun hills" (see BAP12 in Appendix III for detail)

5.3.3 Loss and gain to estuarine species

The Sherbro River Estuary is designated as a Marine Protected Area, covering 284 km^2. According to the Regional network on West African Marine Protected Areas (RAMPAO 2017), the MPA has no recognized IUCN management category, no formal management plan and no official boundaries. A USAID-funded programme[4] is however, addressing this limitation (which also applies to the other MPAs in Sierra Leone). Despite the absence of recent field data, and following the precautionary principle, Sherbro Bay is considered a likely critical habitat for the Atlantic Humpback Dolphin and African Wedgefish.

To contribute to the conservation of the Atlantic Humpback Dolphin, African Manatee, and African Wedgefish, SRL will carry out targeted surveys in 2021 to determine the if these species are present in the Sherbro Bay. These

[4] https://www.wabicc.org/mdocs-posts/literature-review-in-preparation-of-the-co-management-plan-for-the-sherbro-river-estuary/

surveys are described in BAP action 1 and 9 (Appendix III). If these species are not recorded during the 2021 surveys, then this action will no longer be required in 2022 and the BAP will be updated accordingly. However, ad hoc monitoring and fish market surveys will continue to monitor for these species. If any of these species are recorded during these surveys, subsequent population monitoring would be included in the Biodiversity Monitoring and Evaluation Plan (BMEP). Further, a stakeholder engagement plan would be developed as a new BAP Action for 2022.

6. MONITORING AND EVALUATION

A standalone Biodiversity Monitoring and Evaluation Plan (BMEP) is included in Appendix IV of the BAP. The purpose of the BMEP is to outline the requirements to measure the success (or margins of improvement) of the implementation of the BAP and enable adaptive management where margins of improvement is identified. It allows to assess the net gains for priority biodiversity features and the effectiveness of the mitigation actions (rehabilitation and restoration) implemented in the long-term. The BMEP will be updated annually.

The BAP is an evolving document which will be revised by SRL at least every 2 years under the principle of continuous improvement and adaptive management. SRL's environmental planning function will be responsible for reviewing and updated the BAP every 2 years, at a minimum. Updates can be completed by internal staff or external consultants as required based on staff capacity and capability.

7. REFERENCES

Arcus Foundation. 2015. State of the Apes: Industrial agriculture and ape conservation. Cambridge University Press, Cambridge.

Brashares, J.S., Arcese, P., Sam, M.K., Coppolillo, P.B., Sinclair, A.R.E., Balmford, A., 2004. Bushmeat hunting, wildlife declines, and Fish Supply in West Africa. Science. Vol. 306, Issue 5699.

Brncic, T.M., Amarasekaran, B. McKenna, A. 2010. Sierra Leone National Chimpanzee Census. FreetownSierra Leone: Tacugama Chimpanzee Sanctuary.

Brncic T, Amarasekaran B, McKenna A, Mundry R, Kuehl HS. 2015. Large mammal diversity and their conservation in the human-dominated land-use mosaic of Sierra Leone. Biodiversity Conservation 24:2417-2438.

Campbell, G., Ganas-Swaray, J. & Starkey, M. 2019. Rapid Primate Survey in Sierra Rutile Limited Areas 1&5 mining leases, and along the Sembehun Haul Road. The Biodiversity Consultancy. Cambridge, UK.

Davies G. 1987. The Gola Forest Reserve, Sierra Leone. IUCN, Gland, Switzerland and Cambridge, UK.

FAO 2019. Restoring landscape through Natural Assisted Revegetation (ANR) – A practical manual. Bangkok, 52 p. Licence: CC BY-NC-SA 3.0 IGO.

IFC 2019. Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. International Finance Corporation, Washington DC, USA.

IUCN 2020. The IUCN Red List of Threatened Species. Online Ressource, https://www.iucnredlist.org/

Lopes, D.C., Martin, R.O., Henriques, M., Monteiro, H., Regalla, A., Tchantchalum, Q., 2018. Nest-site characteristics and aspects of the breeding biology of the endangered Timneh Parrot *Psittacus timneh* in Guinea-Bissau. Ostrich. 89:1. 33-40.

Molotoks, A., Kuhnert, M., Dawson, T.P., Smith, P. 2017. Land. 6:67.

RAMPAO. 2017. Sierra Leone: These coastal estuaries that do not yet have formal Marine Protected Area status despite their importance. Réseau Régional d'Aires Marines Protégées en Afrique de l'Ouest. http://www.rampao.org/Sierra-Leone-Ces-ecosystemes.html?lang=en

SRK Consulting 2018. Sierra Rutile Project Area 1 - Environmental, Social and Health Impact Assessment: Mine Closure Plan, Report Number: 515234 / Mine Closure Plan (draft), prepared for Sierra Rutile Limited, Freetown, Sierra Leone.

TBC 2019. Critical Habitat Assessment; Iluka Resources Areas 1 and 5 Mining Lease, Sembehun Haul Road, Sierra Leone. The Biodiversity Consultancy Ltd, Cambridge, U.K.

WWF 2017. Western Africa: coastal areas of Guinea, Côte d'Ivoire, Liberia and Sierra Leone, https://www.worldwildlife.org/ecoregions/at0130

WWF 2017b. Africa: Senegal, The Gambia, Guinea-Bissau, Guinea, Sierra Leone, Liberia, and Ivory Coast, https://www.worldwildlife.org/ecoregions/at1403



Sierra Rutile Limited

Mining Area 1

Biodiversity Action Plan:

Appendix I – Uniform Mitigation Assessment Method (UMAM) datasheets

28 December 2020

SRL would like to acknowledge the work and contribution of Biotope (www.biotope.fr) in the preparation and development of this document.

Impact Quantification (Functional Loss)
Mangroves

Site	Assessment conducted by:	Assessment Area Name or Number
SRL Area 1	Laura Vedral	Direct Impacts - Mangroves

Description of Impact:
Mangroves will be *directly* impacted by dewatering, vegetation clearing and mass earthworks associated with mining. These mangroves have been subjected to decades of historic impact and provide a lower "current" value than the Sherbro system. Duration of impact < 1 year.

Assessment date: 12-Aug-20

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	Current Condition	With Impact (No Mitigation)
Location and Landscape Support current: 6 / with impact: 0	The adacent landscape benefits fish and wildlife within the assessment area (e.g. nesting, foraging, cover) at 60% of the optimal capacity. Reduction in value is mostly due to proximity to existing mine[1]. Other factors include land clearing for subsistence agriculture, forestry, and mining exploration, and pressures related to hunting and subsistence fisheries. The assessment area provides 60% functional benefit to adjacent areas based on altered water and vegetative conditions.	During mining, the there will be negligible or no opportunity for the assessment area to provide benefits to downstream or other hydrologically connected areas.
Water Environment (n/a for uplands) current: 4 / with impact: 0	Water levels are higher than optimal due to historic access roads and water impoundments (built 10+ years ago) which are restricting flow and impounding water. These features constitute a barrier to upstream migration of biota, especially during the dry season, reduce freshwater flow, and create a source for erosion and sedimentation[2]. Water quality and sediment analyses documented evidence of such impacts[2].	Mining will involve complete vegetation removal and mass earthworks. Improved environmental controls will protect downstream water quality but the shallow inter-tidal zone will be excavated. The post-mining water environment will be insufficient (too deep) to support mangrove habitat characteristics unless restoration activities are undertaken.
Vegetative Structure 1. Vegetation and/or 2. Benthic Community current: 5 / with impact: 0	The impact altered water environment on vegetative structure is evident in the aerial imagery1. Areas of dense mangrove cover in the 2003 imagery appear as open water in the 2010 image, when access roads are present. Inappropriate species composition and minimal regeneration were noted in 2018 estuarine surveys[2].	Mining will involve complete vegetation removal and mass earthworks. Improved environmental controls will protect downstream water quality but the shallow inter-tidal zone will excavated. The post-mining water environment will be insufficient (too deep) to support mangrove habitat characteristics. Mangroves could naturally recruit in incidental shallow zones but with potential competition from exotic and/or invasive species.

Score = sum of above scores/30 (if uplands, divide by 20)	
current	with impact
0.50	0.00

Delta = (current - impact)
0.50

Sources:
[1] Aerial Imagery, 2003-2020, Google Earth.
[2] *Sierra Rutile Project Area 1, ESHIA: Specialist Estuarine Study, Anchor Environmental* , 2018.

Impact Quantification (Functional Loss)
Mangroves

Site	Assessment conducted by:	Assessment Area Name or Number
SRL Area 1	Laura Vedral	Indirect Impacts - Mangroves

Description of Impact:	Assessment date:
Indirect impacts due to adjacent mining. These mangroves have been subjected to decades of historic impact and provide a lower "current" value than the Sherbro system. Duration of impact < 1 year.	12-Aug-20

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	Current Condition	With Impact (No Mitigation)
Location and Landscape Support current: 6 with impact: 3	The adacent landscape benefits fish and wildlife within the assessment area (e.g. nesting, foraging, cover) at 60% of the optimal capacity. Reduction in value is mostly due to proximity to existing mine[1]. Other factors include land clearing for subsistence agriculture, forestry, and mining exploration, and pressures related to hunting and subsistence fisheries. The assessment area provides 60% functional benefit to adjacent areas based on altered water and vegetative conditions.	During mining, secondary impact areas will continue to provide landscape support value to adjacent areas although to a reduced functional value, primarily related to increased noise.
Water Environment (n/a for uplands) current: 4 with impact: 2	Water levels are higher than optimal due to historic access roads and water impoundments (built 10+ years ago) which are restricting flow and impounding water. These features constitute a barrier to upstream migration of biota, especially during the dry season, reduce freshwater flow, and create a source for erosion and sedimentation[2]. Water quality and sediment analyses documented evidence of such impacts[2].	Enviromnmental controls will be in place to protect water quality degradation. The most signiticant impacts will be related to drawdown associated with temporary dewatering of adjacent areas for mining. Some biodiversity function will remain, albeit reduced.
Vegetative Structure 1. Vegetation and/or 2. Benthic Community current: 5 with impact: 3	Water levels are higher than optimal due to historic access roads and water impoundments (built 10+ years ago) which are restricting flow and impounding water. These features constitute a barrier to upstream migration of biota, especially during the dry season, reduce freshwater flow, and create a source for erosion and sedimentation[2]. Water quality and sediment analyses documented evidence of such impacts[2].	Vegetation will not be directly removed but is expected to become stressed as a result of changed hydrology. Given the short duration of impact (<1 yr), most trees are expected to survive. Importantly, soil structure and seed sources will remain intact.

Score = sum of above scores/30 (if uplands, divide by 20)	
current	with impact
0.50	0.27

Delta = (current - impact)
0.23

Sources:

[1] Aerial Imagery, 2003-2020, Google Earth.

[2] *Sierra Rutile Project Area 1, ESHIA: Specialist Estuarine Study, Anchor Environmental*, 2018.

Mitigation Quantification (Functional Gain)
Mangrove Restoration

Site	Assessment conducted by:	Assessment Area Name or Number
SRL Area 1	Laura Vedral	Restoration of direct impacts - mangroves
Description of Mitigation Mangroves directly impacted by mining activities will be restored through landform reconstitution, hydrology restoration, revegetation, and invasive species management.		**Assessment date:** 12-Aug-20

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	With Impact	With Restoration
Location and Landscape Support with impact: 0 with restoration: 8	During and after mining, the there will be negligible or no opportunity for the assessment area to provide benefits to downstream or other hydrologically connected areas.	All areas directly and indirectly impacted by mining (historic and legacy) will be rehabilitated, improving the availability of adjacent landscape support. Pressures related to subsistence agriculture, forestry, fisheries, and hunting will remain to some extent but will be less severe due to community education and incentive programs to be implemented by SRL.
Water Environment (n/a for uplands) with impact: 0 with restoration: 8	Mining will involve complete vegetation removal and mass earthworks. Improved environmental controls will protect downstream water quality but the shallow inter-tidal zone will excavated. The post-mining water environment will be insufficient (too deep) to support mangrove habitat characteristics.	While dewatering continues, post-mining earthworks will be undertaken to restore a shallow inter-tidal zone after mining is complete. Topsoil and mulched vegetation that was stripped and stockpiled prior to mining will be spread across the recontoured landform to restore nutrient quality. Water impoundments will be removed and the historic downstream (freshwater) hydrologic connection will be restored. After revegetation, the estuarine connection will be slowly restored through cessation of dewatering (pumping) and spillway modifications. Landform restoration will be complete less than one year after impact.
Vegetative Structure 1. Vegetation and/or 2. Benthic Community with impact: 0 with restoration: 8	Mining will involve complete vegetation removal and mass earthworks. Improved environmental controls will protect downstream water quality but the shallow inter-tidal zone will excavated. The post-mining water environment will be insufficient (too deep) to support mangrove habitat characteristics. Mangroves could naturally recruit in incidental shallow zones but with potential competition from exotic and/or invasive species.	Mangrove species consistent with upstream environments will be nursery grown onsite during mining. Trees will be planted after landform reconstitution. Dewatering will cease during planting, allowing slow filling of the dewatered area, initially through soil infiltration then later through spillway lowering. Vegetation will be monitored and maintained until success criteria are met. Invasive species inspections and maintenance will occur monthly initially and then quartely when native vegetation is established.

Score = sum of above scores/30 (if uplands, divide by 20)		Delta = [with-current]	Time lag coefficient	Risk factor
current: 0.00	with: 0.80	0.80	1.25	1

Relative Functional Gain

RFG = delta/(t-factor x risk)
0.64

Sources:
[1] Aerial Imagery, 2003-2020, Google Earth.
[2] *Sierra Rutile Project Area 1, ESHIA: Specialist Estuarine Study, Anchor Environmental*, 2018.

Mitigation Quantification (Functional Gain)
Mangrove Restoration

Site/Project Name	Assessment conducted by:	Assessment Area Name or Number
SRL Area 1 - Mangrove Restoration	Laura Vedral	Restoration of Indirect and Historic Impacts - Mangroves
Description of Mitigation Mangroves indirectly impacted mining will be restored by hydrology restoration, revegetation, and invasive species management.		**Assessment date:** 12-Aug-20

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	*Insufficient* to support biodiversity characteristics expected for this habitat type

	With Impact	With Restoration
Location and Landscape Support with impact: 3 / with restoration: 8	During and after mining, these areas will continue to provide landscape support value to adjacent areas although to a reduced functional value, primarily related to increased noise.	All areas directly and indirectly impacted by mining (historic and legacy) will be rehabilitated, improving the availability of adjacent landscape support. Pressures related to subsistence agriculture, forestry, fisheries, and hunting will remain to some extent but will be less severe due to community education and incentive programs to be implemented by SRL.
Water Environment (n/a for uplands) with impact: 2 / with restoration: 8	Secondary mangrove impacts are evident in the vicinity of the Gangama mine, primarily due to hydrological alterations. In some areas, impacts are caused by a severed hydrologic connection and in other areas impacts are related to flooding from impounded waters. Water quality implications include elevated dry season salinity due to severed freshwater inputs and increased TSS due to erosion[2].	Water impoundments will be removed to restore hydrologic flow and salinity. Riparian and shoreline reforestation will target landform stabilisation and erosion reduction.
Vegetative Structure 1. Vegetation and/or 2. Benthic Community with impact: 3 / with restoration: 8	These areas exhibit lower canopy cover and/or vegetation stress to inapprorpiate hydrological conditions.	Supplemental revegetation will be undertaken where necessary to backfill voids. Vegetation will be monitored and maintained until success criteria are met. Invasive species inspections and maintenance will occur monthly initially and then quartely when native vegetation is established.

Score = sum of above scores/30 (if uplands, divide by 20)		Delta = [with-current]	Time lag coefficient	Risk factor
current: 0.27	with: 0.80	0.53	1.1	1

Relative Functional Gain

RFG = delta/(t-factor x risk)
0.48

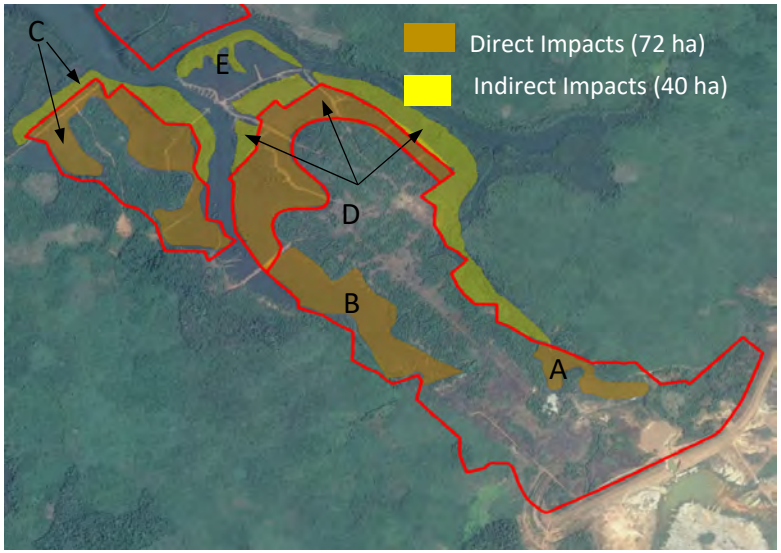
Sources:

[1] Aerial Imagery, 2003-2020, Google Earth.

[2] *Sierra Rutile Project Area 1, ESHIA: Specialist Estuarine Study, Anchor Environmental*, 2018.

Mangrove Impact & Restoration Summary

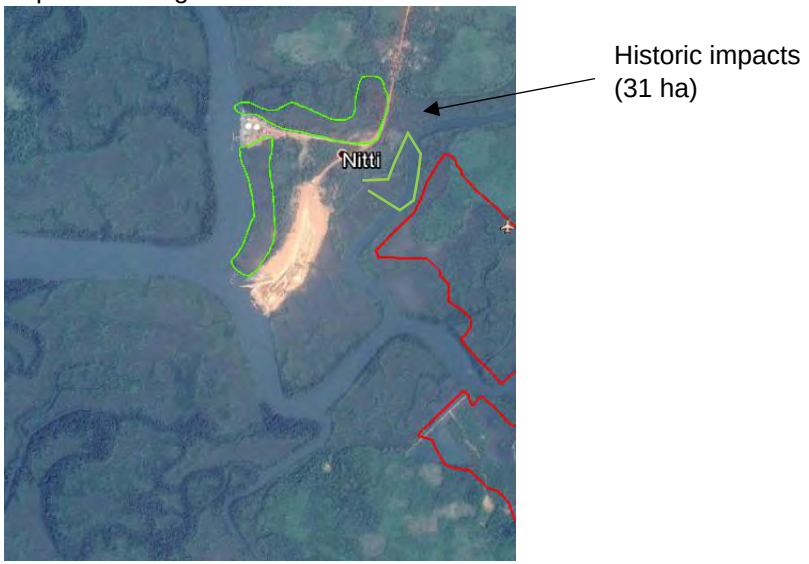
Mangroves will be directly and indirectly impacted by project activities.



The number of restoration "credits" needed to offset impacts equals the summation of the calculated functional value for each impact area * the hectares of impact

Impact Type	ID	Ha	*	Functional Value	=	Credits Needed
Direct	Mang-A	5		0.5		2.5
	Mang-B	17		0.5		8.5
	Mang-C	22		0.5		11
	Mang-D	28		0.5		14
		72				**36**
Indirect	Mang-C	10		0.23		2.3
	Mang-D	25		0.23		5.75
	Mang-E	5		0.23		1.15
		40				**9.2**
TOTAL		**112**				**45.2**

All impacted mangroves will be restored. Additonally 31 ha of historically impacted mangroves will be restored.



The total generated restoration "credits" is the sum of credits for all mitigation areas, where credits equal the relative functional gain (RFG) times the hectares of mitigation.

Restoration Type	RFG	*	Hectares	=	Credits Generated
Direct	0.64		72		46
Indirect	0.48		40		19
Historic	0.48		31		15
TOTAL			**143**		**80**

Surplus restoration credits generated : **35**

Impact Quantification (Functional Loss)
Forests and gallery forests

Site	Assessment conducted by:	Assessment Area Name or Number
SRL Area 1		Direct Impacts - Forests and gallery forests
Description of Impact:		**Assessment date:**
Forests will be *directly* impacted by vegetation clearing and mass earthworks associated with mining. Duration of impact < 1 year.		

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	Current Condition	With Impact (No Mitigation)
Location and Landscape Support	Forests directly and indirectly impact by mining have been subjected to decades of historic impact and include mostly small and disconnected patches of old fallows (secondary forests). Functional quality scores range between 2 and 8, depending on criteria such as forest patch size and connectedness with neighbouring patches, as assessed using aerial imagery.	Above ground vegetation will be cleared and soils compacted, moved or removed through earthworks and resoure extraction.
current: between 2 and 8 / with impact: 0		

	Current Condition	With Impact (No Mitigation)
Water Environment (n/a for uplands)	Not applicable, although flow regimes and water quality in gallery forests contribute to their value for wildlife.	Not applicable, although vegetation and earthworks will affect hydrologic flows in gallery forests downstream. Improved environmental controls will protect downstream water quality, e.g. from excess sediment loads.
current: N/A / with impact: N/A		

	Current Condition	With Impact (No Mitigation)
Vegetative Structure 1. Vegetation and/or 2. Benthic Community	Forests directly and indirectly impact by mining have been subjected to decades of historic impact and include mostly old fallows (secondary forests), with varying levels of degradation relative to optimal pristine conditions. No old growth forests are found in Area 1. Functional quality scores range between 2 and 8, depending on criteria such as forest patch size and connectedness with neighbouring patches, tree cover and canopy height (indicators of forest age), assessed using aerial imagery. Field data would include the presence, diversity and abundance of resource trees used by wildlife species of concern, signs of anthropogenic pressure (e.g. snares, cut trees, etc.), signs of soil erosion or compaction, and the presence of exotic invasive species.	Above ground vegetation will be cleared and soils compacted, moved or removed through earthworks and resoure extraction.
current: between 2 and 6 / with impact: 0		

Score = sum of above scores/30 (if uplands, divide by 20)	
current	with impact
0.2 to 0.8	0.00

Delta = (current - impact)
between 0.8 and 0.2

Impact Quantification (Functional Loss)
Forests and gallery forest

Site	**Assessment conducted by:**	**Assessment Area Name or Number**
SRL Area 1		Indirect Impacts - Forests and gallery forests

Description of Impact:	**Assessment date:**
Indirect impacts due to adjacent mining. Wildlife in forests will be impacted by disturbance (noise, dust, presence of humans), and forests will be fragmented and suffer impacts from edge effects and easier access by third parties leading to increased resource extraction (hunting, timber and firewood collection, etc.). Duration of disturbance impact < 1 year, but effects of adjacent clearing will last until forest cover is recovered in the cleared areas.	

Scoring Guidance	**Optimal (10)**	**Moderate(7)**	**Minimal (4)**	**Not Present (0)**
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	Current Condition	With Impact (No Mitigation)
Location and Landscape Support current: between 8 and 2 with impact: between 6 and 0.5	Forests directly and indirectly impact by mining have been subjected to decades of historic impact and include mostly small and disconnected patches of old fallows (secondary forests). Functional quality scores range between 2 and 8, depending on criteria such as forest patch size and connectedness with neighbouring patches, as assessed using aerial imagery.	The clearing of adjacent forests will fragment forest patches and induce negative edge effects on forest species, and enable easier access by third parties leading to increased resource extraction (hunting, timber and firewood collection, etc.).
Water Environment (n/a for uplands) current: N/A with impact: N/A	Water levels are higher than optimal due to historic access roads and water impoundments (built 10+ years ago) which are restricting flow and impounding water. These features constitute a barrier to upstream migration of biota, especially during the dry season, reduce freshwater flow, and create a source for erosion and sedimentation[2]. Water quality and sediment analyses documented evidence of such impacts[2].	Enviromnmental controls will be in place to protect water quality degradation. The most signiticant impacts will be related to drawdown associated with temporary dewatering of adjacent areas for mining. Some biodiversity function will remain, albeit reduced.
Vegetative Structure 1. Vegetation and/or 2. Benthic Community current: between 8 and 2 with impact: between 6 and 0.5	Forests directly and indirectly impact by mining have been subjected to decades of historic impact and include mostly old fallows (secondary forests), with varying levels of degradation relative to optimal pristine conditions. No old growth forests are found in Area 1. Functional quality scores range between 2 and 8, depending on criteria such as tree cover and canopy height (indicators of forest age), assessed using aerial imagery. Field data would include the presence, diversity and abundance of resource trees used by wildlife species of concern, signs of anthropogenic pressure (e.g. snares, cut trees, etc.), signs of soil erosion or compaction, and the presence of exotic invasive species.	Vegetation will not be directly affected, but edge effects and easier access by third parties will lead to increased resource extraction (hunting, timber and firewood collection, etc.) affecting vegetation structure and habitat quality for wildlife

Score = sum of above scores/30 (if uplands, divide by 20)	
current	with impact
0.2 to 0.8	0.05 to 0.6

Delta = (current - impact)
between 0.2 and 0.75

Mitigation Quantification (Functional Gain)
Forest Restoration

Site	Assessment conducted by:	Assessment Area Name or Number
SRL Area 1		Restoration of direct impacts - forests
Description of Mitigation		**Assessment date:**
Forests directly impacted by mining activities will be restored through landform reconstitution, revegetation, invasive species management, fire suppression, and protection from other pressures (clearing by third parties)		12-Aug-20

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	With Impact	With Restoration
Location and Landscape Support	During and after mining, the there will be negligible or no opportunity for the assessment area to provide benefits to adjacent forest patches.	All areas directly and indirectly impacted by mining (historic and legacy) will be rehabilitated, improving the availability of adjacent landscape support. Pressures related to subsistence agriculture, forestry, fisheries, and hunting will remain to some extent but will be less severe due to community education and incentive programs to be implemented by SRL.
with impact: 0		with restoration: 8

	With Impact	With Restoration
Water Environment (n/a for uplands)	Not applicable, although complete vegetation removal and mass earthworks will impact waterways in gallery forests. Improved environmental controls will protect downstream water quality (e.g. sediment loading).	Not applicable, although forest restoration will also benefit hydrologic flows and address sediment loading in gallery forest streams.
with impact: N/A		with restoration: N/A

	With Impact	With Restoration
Vegetative Structure 1. Vegetation and/or 2. Benthic Community	Mining will involve complete vegetation removal and mass earthworks.	All areas directly and indirectly impacted by mining (historic and legacy) will be rehabilitated and forests restored through landform reconstitution, revegetation using native species and resource trues used by wildlife species of concern, and invasive species management. Pressures related to subsistence agriculture (clearing, bush fires), forestry (logging), and hunting will remain to some extent but will be less severe due to community education and incentive programs to be implemented by SRL.
with impact: 0		with restoration: 8

Score = sum of above scores/30 (if uplands, divide by 20)		Delta = [with-current]	Time lag coefficient	Risk factor
current	with	0.80	2.18	1
0.00	0.80			

Relative Functional Gain

RFG = delta/(t-factor x risk)
0.37

Mitigation Quantification (Functional Gain)
Forest restoration

Site/Project Name	**Assessment conducted by:**	**Assessment Area Name or Number**
SRL Area 1 - Forest conservation and restoration		Restoration of Indirect and Historic Impacts - Forests
Description of Mitigation Forests that are indirectly impacted by mining will be restored by active (planting, invasive species management) and passive (fire, grazing and clearing exclusions) restoration techniques.		**Assessment date:**

Scoring Guidance	**Optimal (10)**	**Moderate(7)**	**Minimal (4)**	**Not Present (0)**
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	*Insufficient* to support biodiversity characteristics expected for this habitat type

	With Impact	With Restoration
Location and Landscape Support with impact: X with restoration: 8	During and after mining, these areas will continue to provide landscape support value to adjacent areas although to a reduced functional value, primarily related to increased noise.	All areas directly and indirectly impacted by mining (historic and legacy) will be rehabilitated, improving the availability of adjacent landscape support. Pressures related to subsistence agriculture, forestry, fisheries, and hunting will remain to some extent but will be less severe due to community education and incentive programs to be implemented by SRL.
Water Environment (n/a for uplands) with impact: N/A with restoration: N/A	Not appicable, although gallery forests may be affected by changes in hydrology (altered flow regimes) and water quality (sediment loads) caused by activities upstream.	Not applicable, although water impoundments will be removed to restore hydrologic flows and revegetation of bare soils (and forest restoration) will address sediment loading.
Vegetative Structure 1. Vegetation and/or 2. Benthic Community with impact: X with restoration: 8	These areas exhibit higher fragmentation and increased pressure on larger trees and resource trees, and a higher risk of exotic invasive species.	Revegatation and forest restoration in adjoining areas will reverse fragmentation. Any exotic invasive species will be removed as part of the dedicated plan. Passive restoration will be favoured for vegetation structure, although some resource trees may be planted to enhance habitat quality for chimpanzees and other species of concern.

Score = sum of above scores/30 (if uplands, divide by 20)	
current	with
varies between 0.2 and 0.8	0.80

Delta = [with-current]
varies between 0.05 and 0.6

Time lag coefficient
1.92

Risk factor
1

Relative Functional Gain

RFG = delta/(t-factor x risk)
RFG varies between 0.63 and 1.25

Sources:

[1] Aerial Imagery, 2003-2020, Google Earth.

[2] *Sierra Rutile Project Area 1, ESHIA: Specialist Estuarine Study, Anchor Environmental* , 2018.

Impact Quantification (Functional Loss)
Inland Valley Swamps

Site	Assessment conducted by:	Assessment Area Name or Number
SRL Area 1		Direct Impacts - Inland valley swamps

Description of Impact:

Inland valley swamps (IVS) will be *directly* impacted by vegetation clearing and mass earthworks associated with mining. Duration of impact < 1 year.

Assessment date:

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	Current Condition	With Impact (No Mitigation)
Location and Landscape Support	IVS directly and indirectly impacted by mining are located in landscapes that have been subjected to decades of historic impact for agriculture, including bottomland cultivation of inland valley swamps, with mostly small and disconnected patches of secondary habitat (fallows).	Above ground vegetation will be cleared and soils compacted, moved or removed through earthworks and resoure extraction.
current: 5		with impact: 0
Water Environment (n/a for uplands)	Water levels are higher than optimal due to historic access roads and water impoundments (built 10+ years ago) which are restricting flow and impounding water. These features constitute a barrier to the movement of biota, especially during the dry season, where freshwater flows are reduced.	Mining will involve complete vegetation removal and mass earthworks. Improved environmental controls will protect downstream water quality. The post-mining water environment will be insufficient (too deep) to support IVS unless targeted restoration activities are undertaken.
current: 4		with impact: 0
Vegetative Structure 1. Vegetation and/or 2. Benthic Community	IVS directly and indirectly impacted by mining have been subjected to decades of historic impact from bottomland cultivation. However, given the relatively rapid recovery rate of IVS vegetation following cultivation, functional quality scores were estimated at 6 on average.	Above ground vegetation will be cleared and soils compacted, moved or removed through earthworks and resoure extraction.
current: 6		with impact: 0

Score = sum of above scores/30 (if uplands, divide by 20)	
current	with impact
0.50	0.00

Delta = (current - impact)
0.50

Impact Quantification (Functional Loss)
Inland Valley Swamps

Site	Assessment conducted by:	Assessment Area Name or Number
SRL Area 1		Indirect Impacts - Inland Valley Swamps

Description of Impact:

Inland valley swamps (IVS) will be *directly* impacted by vegetation clearing and mass earthworks associated with mining. Duration of impact < 1 year.

Assessment date:

Scoring Guidance	Optimal (10)	Moderate(7)	Minimal (4)	Not Present (0)
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	Current Condition	With Impact (No Mitigation)
Location and Landscape Support	IVS directly and indirectly impacted by mining are located in landscapes that have been subjected to decades of historic impact for agriculture, including bottomland cultivation of inland valley swamps, with mostly small and disconnected patches of secondary habitat (fallows).	The clearing of adjacent vegetation will fragment IVS patches and induce negative edge effects and enable easier access by third parties leading to increased resource extraction. The loss of functional quality is a function of the distance from the direct impacts.

current	with impact
5	between 3.75 and 0.9375

	Current Condition	With Impact (No Mitigation)
Water Environment (n/a for uplands)	Water levels are higher than optimal due to historic access roads and water impoundments (built 10+ years ago) which are restricting flow and impounding water. These features constitute a barrier to the movement of biota, especially during the dry season, where freshwater flows are reduced.	Enviromnmental controls will be in place to protect IVS from water quality degradation caused by adjacent works. The most signiticant impacts will be related to drawdown associated with temporary dewatering of adjacent areas for mining. Some biodiversity function will remain, albeit reduced. The loss of functional quality is a function of the distance from the direct impacts.

current	with impact
4	between 3 and 0.75

	Current Condition	With Impact (No Mitigation)
Vegetative Structure 1. Vegetation and/or 2. Benthic Community	IVS directly and indirectly impacted by mining have been subjected to decades of historic impact from bottomland cultivation. However, given the relatively rapid recovery rate of IVS vegetation following cultivation, functional quality scores were estimated at 6 on average.	Vegetation will not be directly affected, but edge effects and easier access by third parties will lead to increased resource extraction affecting vegetation structure and habitat quality for wildlife but some biodiversity function will remain, albeit reduced. The loss of functional quality is a function of the distance from the direct impacts.

current	with impact
6	between 4.5 and 1.125

Score = sum of above scores/30 (if uplands, divide by 20)	
current	with impact
0.50	between 0.375 and 0.1

Delta = (current - impact)
between 0.125 and 0.4

Mitigation Quantification (Functional Gain)
Inland Valley Swamp restoration

Site	**Assessment conducted by:**	**Assessment Area Name or Number**
SRL Area 1		Restoration of direct impacts - IVS
Description of Mitigation Inland valley swamps directly impacted by mining activities will be restored through landform reconstitution, revegetation, invasive species management, fire suppression, and protection from other pressures (clearing by third parties)		**Assessment date:**

Scoring Guidance	**Optimal (10)**	**Moderate(7)**	**Minimal (4)**	**Not Present (0)**
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	Insufficient to support biodiversity characteristics expected for this habitat type

	With Impact	With Restoration
Location and Landscape Support with impact: 0 / with restoration: 6	During and after mining, the there will be negligible or no opportunity for the assessment area to provide benefits to adjacent habitats	All areas directly and indirectly impacted by mining (historic and legacy) will be rehabilitated, improving the availability of adjacent landscape support. Pressures related to subsistence agriculture, forestry, fisheries, and hunting will remain to some extent but will be less severe due to community education and incentive programs to be implemented by SRL.
Water Environment (n/a for uplands) with impact: 0 / with restoration: 4	During and after mining, the there will be negligible or no opportunity for the assessment area to provide benefits to adjacent habitats	Post-mining earthworks will be undertaken to restore valley bottoms. Topsoil and mulched vegetation that was stripped and stockpiled prior to mining will be spread across the recontoured landform to restore water residence times. Water impoundments will be removed, however, and the historic downstream (freshwater) hydrologic connection will be restored, which may reduce some inland valley swamp area. Landform restoration will be complete less than one year after impact.
Vegetative Structure 1. Vegetation and/or 2. Benthic Community with impact: 0 / with restoration: 6	Mining will involve complete vegetation removal and mass earthworks.	Given the relatively rapid recovery rate of IVS vegetation following the rehabilitation of landforms and water flows, a return to the initial vegetation structure is expected in 1 year

Score = sum of above scores/30 (if uplands, divide by 20)	
current	with
0.00	0.50

Delta = [with-current]	**Time lag coefficient**	**Risk factor**
0.50	1	1

Relative Functional Gain

RFG = delta/(t-factor x risk)
0.50

Mitigation Quantification (Functional Gain)
Inland valley swamp restoration

Site/Project Name	**Assessment conducted by:**	**Assessment Area Name or Number**
SRL Area 1 - Forest conservation and restoration		Restoration of Indirect and Historic Impacts - IVS
Description of Mitigation Inland valley swamps that are indirectly impacted by mining will be restored by active (planting, invasive species management) and passive (fire, grazing and clearing exclusions) restoration techniques.		**Assessment date:**

Scoring Guidance	**Optimal (10)**	**Moderate(7)**	**Minimal (4)**	**Not Present (0)**
Scoring represents functional quality of the assessment area and is specific to the habitat type being assessed	Supports *all* biodiversity characteristics expected for this habitat type	Supports *most* biodiversity characteristics expected for this habitat type	Supports *minimal* biodiversity characteristics expected for this habitat type	*Insufficient* to support biodiversity characteristics expected for this habitat type

	With Impact	With Restoration
Location and Landscape Support with impact: between 3.75 and 0.9375 with restoration: 5	During and after mining, these areas will continue to provide landscape support value to adjacent areas although to a reduced functional value, primarily related to increased noise.	All areas directly and indirectly impacted by mining (historic and legacy) will be rehabilitated, improving the availability of adjacent landscape support. Pressures related to subsistence agriculture, forestry, fisheries, and hunting will remain to some extent but will be less severe due to community education and incentive programs to be implemented by SRL.
Water Environment (n/a for uplands) with impact: between 3 and 0.75 with restoration: 4	During and after mining, the there will be negligible or no opportunity for the assessment area to provide benefits to downstream or other hydrologically connected areas.	Water impoundments will be removed to restore hydrologic flows and revegetation of bare soils (and forest restoration) will address sediment loading.
Vegetative Structure 1. Vegetation and/or 2. Benthic Community with impact: between 4.5 and 1.125 with restoration: 6	IVS directly and indirectly impacted by mining have been subjected to decades of historic impact from bottomland cultivation. They subsist as isolated patches of habitat.	Revegatation and forest restoration in adjoining areas will reverse fragmentation. Any exotic invasive species will be removed as part of the dedicated plan. Passive restoration will be favoured for vegetation structure, although some resource trees may be planted to enhance habitat quality for chimpanzees and other species of concern. Given the topography, areas of inland valley swamps will be restored wherever hydrological conditions allow, in a mosaic with gallery forest vegetation.

Score = sum of above scores/30 (if uplands, divide by 20)	**Delta = [with-current]**	**Time lag coefficient**	**Risk factor**
current: between 0.375 and 0.1 with: 0.50	between 0.125 and 0.4	1	1

Relative Functional Gain

RFG = delta/(t-factor x risk)
RFG varies between 0.125 and 0.4

Sources:

[1] Aerial Imagery, 2003-2020, Google Earth.

[2] *Sierra Rutile Project Area 1, ESHIA: Specialist Estuarine Study, Anchor Environmental* , 2018.

Sierra Rutile Limited

Mining Area 1

Biodiversity Action Plan:

Appendix II – Conceptual Habitat Restoration Plan

28 December 2020

SRL would like to acknowledge the work and contribution of Biotope (www.biotope.fr) in the preparation and development of this document.

TABLE OF CONTENTS

LIST OF FIGURES

1. CONTEXT

A key feature of this BAP is the progressive rehabilitation and ecological restoration of disturbed areas that are no longer required by SRL, with the involvement of local communities in this rehabilitation / restoration; and changes in agricultural practices to enable forest landscape restoration at the landscape scale.

Iluka maintains a financial provision for rehabilitation of all lands disturbed by mining to Sierra Leonean regulatory standards. Sierra Leonean regulations require restoration of pre-mining surface contours and agricultural land uses, with little mention of biodiversity restoration. SRL therefore has an opportunity to comply with the mitigation requirements of IFC PS6 by additionally pursuing biodiversity restoration when rehabilitating historically impacted streams, IVS, gallery forest, and mangrove habitats.

This section describes SRL's strategy to restore biodiversity value directly to the landscape that has been impacted by mining. The strategy is informed by technical studies completed since Iluka acquired SRL in 2017. While some data gaps will be filled as detailed landform designs are developed, sufficient work has been undertaken to demonstrate high confidence in the intended biodiversity outcome.

2. POND CLOSURE AND BIODIVERSITY RESTORATION

Ponds comprise 2,900 ha of the Area 1 disturbance footprint. SRL's ponds were constructed by raising an earthen dam within natural waterways to artificially impound water, resulting in the biodiversity loss of the streams, inland valley swamps, and gallery forests that became submerged. At least one spillway was constructed in each pond to prevent water overtopping and damaging the dam wall during extreme rainfall events. Tributaries downstream of the spillways continued to receive water flow albeit for a shorter duration and lower flood stage elevation (Jones & Wagener, 2019a). Tributaries downstream of dam walls without spillways were severed from upstream hydrologic flow, and thus experienced additional biodiversity loss due to altered hydrology.

Most of SRL's dams were built to allow mining of the submerged ore body by a floating dredge. A floating concentrator followed the dredge, returning tailings (in the form of oversize, sand and fine, clayey materials) directly into the waterbody. The deposited sand and slime tailings remain submerged, and in some cases emergent, in the ponds today. Other dams were built to provide a year-round water source for land-based processing plants and the domestic water treatment system. These "process water" ponds are simply flooded natural waterways and riparian land with native soils intact beneath the surface (no tailings), although they will have been affected by the continued flooding (anoxic conditions).

Dam removal (complete or partial) provides a readily actionable opportunity for SRL to achieve 'no net loss' and 'net gains' of biodiversity against the 2017 baseline.

SRL's Mine Closure Plan (ESHIA Appendix L-4, SRK 2018) involves partial or complete removal of all 35 existing dams. Dam removal will restore hydrologic flow and landform conditions that resemble pre-mining conditions. Meandering waterways will become restored where artificially impounded waters are currently present. Dam removal will restore biodiversity value to downstream channels that were impacted when the dams were built. Dam removal will also expose an expansive footprint of land that can be restored for biodiversity restoration or subsistence agriculture.

2.1 Prioritisation of ponds for biodiversity restoration

Dam removal will expose up to 2,900 hectares of land (**Error! Reference source not found.**1). It is unreasonable to target the entire footprint for long-term biodiversity gain as local communities depend on the land for livelihood and are expecting most of the footprint to be returned to them. Therefore, the success of

this biodiversity mitigation strategy will largely depend on stakeholder input to and acceptance of biodiversity conservation as a post-mining land use that is compatible with post-mining livelihoods. To that end, SRL has completed a stakeholder map and is finalizing a stakeholder engagement plan with the objective of agreeing on post-mining land uses for each land holding within the disturbance footprint. As discussed in BAP Action 8 (Appendix III), agroforestry and agroecology will be promoted in areas located away from crop fields and villages and/or areas that form part of a forest landscape restoration corridor (within the constraints of land ownership). A socio-economic impact assessment scope of work will be executed in 2021, the outcome of which will inform potential landholdings for pursuing agroforestry initiatives for landowners.

As a necessary first step before initiating stakeholder engagement, ponds were prioritised for biodiversity restoration based on practical factors:

1. **Does the pond contain tailings?** Tailings ponds carry a lower likelihood of success due to uncertainties in landform restoration methods (discussed further below). Confidence will improve as methods are implemented, monitored, and adapted over time. Until methods are proven, biodiversity restoration should focus on process ponds that are underlain by native soils.

2. **Is the pond close to major towns?** Areas that are further from major settlements are expected to experience fewer human pressures in the near term and are therefore prioritised for biodiversity restoration.

3. **Is the pond located within an apparent chimpanzee corridor?** Ponds that presently create barrier between areas of documented chimpanzee use were prioritised.

4. **When can pond lowering begin?** Some ponds currently provide process water for operations and therefore cannot be lowered until mining and processing is complete. Areas that can be lowered sooner were prioritised.

The table below shows the outcome of the prioritization process.

Table 1: Initial prioritization for biodiversity restoration

Area	Hectares	Contains Tailings?	Close to Major Towns?	Apparent Chimp Corridor?	When Pond Lowering Can Begin	Pond prioritized for biodiversity
B5/B6 Pond	275	Partially	Yes	No	In progress	No
Bamba Belebu Pond	600	Partially	Yes	No	In progress	No
Titan	105	Yes	Yes	No	After Closure	No
Mogbwemo Dredge Pond	500	Yes	Yes	No	After Closure	No
Motinga Pond	270	No	No	Yes	2021	Yes
Mosama Pond	25	No	No	Yes	2021	Yes
Pejebu Pond	615	Partially	No	Yes	2021	Yes
Yangatoke Pond	25	No	No	Yes	2025	No
Lanti Dredge Pond	140	Yes	No	Yes	2025	No
GB3 Pond	50	No	No	Yes	2025	No
C3 Pond	70	No	No	Yes	2025	No
G5 Pond	70	No	No	Yes	2025	No
Gondama Pond	10	No	No	Yes	2025	No

Area	Hectares	Contains Tailings?	Close to Major Towns?	Apparent Chimp Corridor?	When Pond Lowering Can Begin	Pond prioritized for biodiversity
SRL 1 Pond	12	No	No	Yes	2025	No
Dredge Canal	100	No	No	Yes	n/a	No

Motinga and Pejebu ponds were prioritized for biodiversity restoration. Additional areas may be targeted in the future.

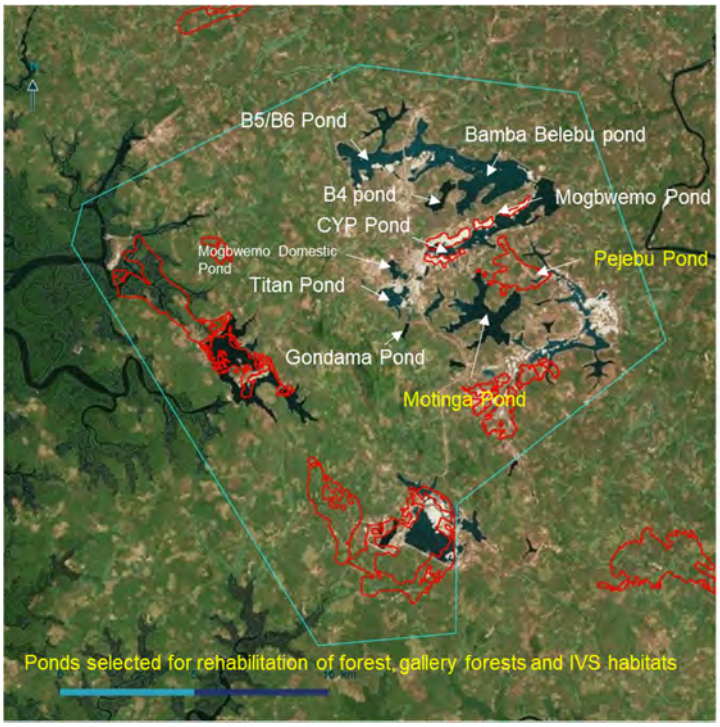


Figure 1: Location of legacy ponds selected for biodiversity restoration in Area 1 mining lease. Areas outlined in red represent known mineral deposits.

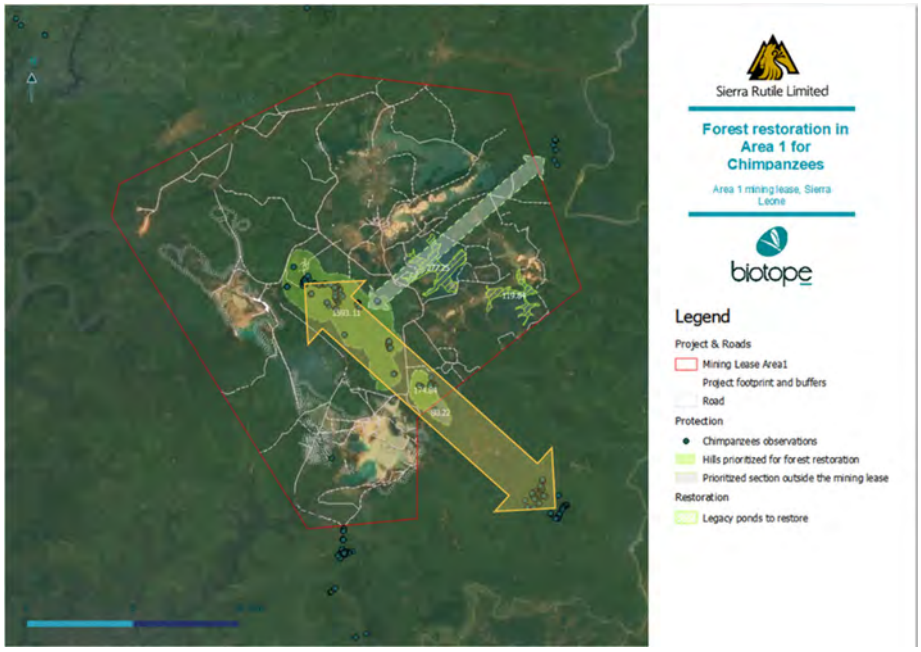


Figure 2: Map of priority areas for biodiversity restoration in the legacy ponds

2.2 Stakeholder Engagement and Detailed Design

Stakeholder engagement has been postponed due to COVID-19 restrictions on travel and social distancing. Due to this delay, the pond restoration design is conceptual in nature. Figure 3 shows the anticipated area of land that can be reasonably restored for biodiversity value based on our understanding of community requirements. A detailed design, including revegetation plan and actual size / footprint will be finalised following stakeholder engagement.

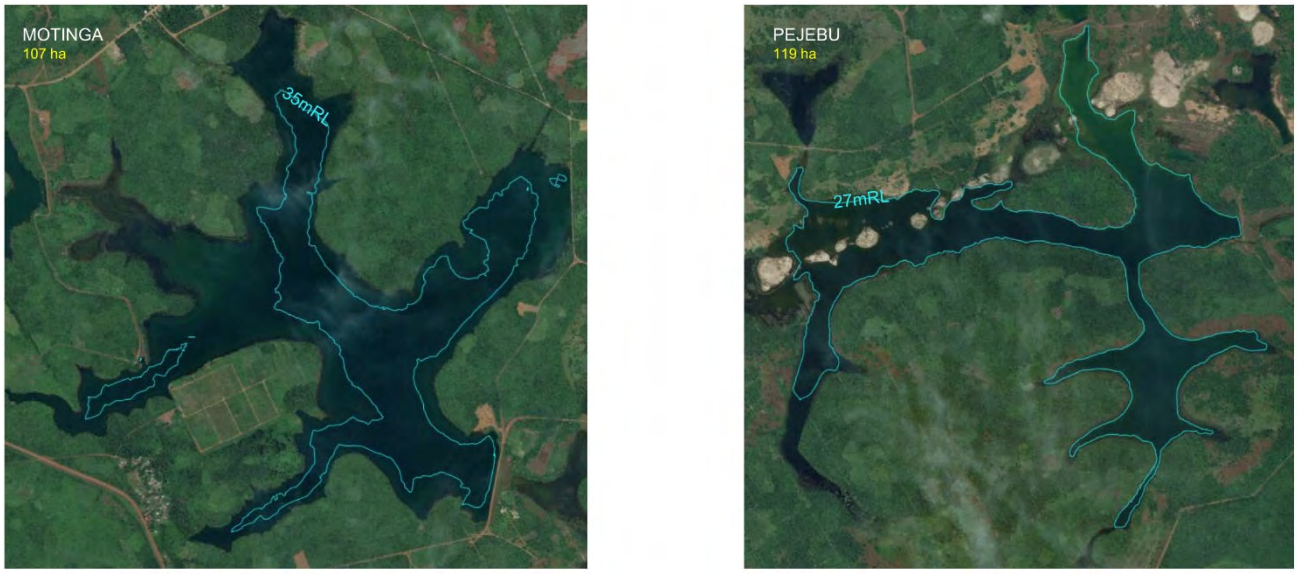


Figure 3: Forest restoration in Motinga and Pejebu – Conceptual plan.

2.3 Restoration of inland valley swamps (IVS)

Because IVS is used by chimpanzees, SRL's restoration efforts will need to generate functional gains to mitigate these impacts. To achieve this, a proportion of IVS will be included in the pond restoration program: some of the lower, wetter parts of the rehabilitated ponds will be a mosaic of IVS and gallery/riparian forest.

2.4 Controlled pond lowering through spillway modification

In order to remove the dams, the water level in the ponds must be reduced. This will be undertaken in a controlled manner to limit the impact of released water on downstream communities and biodiversity. Recognising that pond levels fluctuate significantly between the wet and the dry season, current planning is to reduce water levels by annual progressive lowering or widening of spillways in the dry season, to the dry season pond water level. The new spillway level created each year will release water entering the ponds in the subsequent wet season in a controlled manner. Spillway lowering will continue in this manner until the desired final landform elevation is achieved (this varies for each pond). Thereafter, the earthen walls can be left in situ or excavated and the material blended into the exposed sediments to improve nutrient and/or water holding properties (discussed in the section below).

Technical studies were completed in 2019 to understand the impact of pond lowering strategy on downstream communities and biodiversity, with specific attention to water flows, flood lines, and water quality (Jones & Wagener, 2019a).

2.4.1 Downstream Streamflow

A change to downstream streamflow will be evident during the transition between wet and dry seasons, with increased downstream flow at the start of the wet season and reduced flow at the end of the wet season (i.e. start of the dry season). This will be most noticeable in the first year after the spillway has been lowered to the dry season low water elevation. This is because the downstream channel will receive water earlier in the wet season, whereas previously overflow did not occur until later in the wet season, when water levels had risen to the spillway crest. In subsequent years, greater overflow can be expected early in the wet season, with slightly reduced overflow during the course of the wet season and significantly reduced overflow at the end of the wet season and start of the dry season. It follows that the flow in the downstream watercourse will be affected in the same manner, though the impact will reduce as one moves downstream, as the total contributing catchment increases.

In summary, the primary impact is earlier onset of flows at the start of the wet season, but each year the spillway is lowered, downstream flow conditions will more closely mimic the historic (pre-mining) hydroperiod, to the benefit of native wildlife. This will be complemented by ecological restoration of riparian vegetation downstream of the ponds. As specified in the BMEP, these effects will be monitored.

2.4.2 Water quality

Geochemical studies completed as part of the Area 1 ESHIA identified naturally occurring conditions that have the potential to create acidic pH conditions when submerged lands are exposed to air (SRK, 2018d). This is due to a chemical reaction that occurs when naturally occurring sulphide minerals (pyrite and marcasite) oxidise and yield sulphuric acid. Conversely, the sand and fine tailings submerged at the bottom of SRL's historic dredge ponds were found to be non-acid forming as mineralogy yielded no detectable sulfide minerals that could potentially generate acidity. A pilot benthic sampling and geochemical modelling study at the B5/B6 pond confirmed that low pH conditions are correlated to natural sediments at the pond periphery and not the dredge mined areas where tailings are submerged (Jones & Wagener, 2019b).

Low pH conditions can have biodiversity implications if released metal ions from clay minerals cause bioaccumulation or toxicity. Acidification is therefore a risk that must be managed as ponds are lowered. Geochemical modelling completed as part of 2019 pilot study found that pH can be buffered to background conditions by applying limestone powder along the exposed shoreline at the end of each dry season,

concurrent with spillway lowering (Jones & Wagener, 2019b). This carries risks to water quality which will be managed by:

- Determining the quantity of limestone to be applied based on pond-specific geochemical characteristics, spillway elevations, and flow.
- Applying limestone powder along the exposed shoreline at the end of the dry season, such that the exposed sediments are buffered and mixed with rainwater before water discharges through the spillway.

As specified in the BMEP, water quality will be monitored monthly, in the ponds and downstream of the ponds, throughout.

2.5 Landform Reconsitution

Bathymetric surveys completed in 2018 confirmed that pre-mining topography, and therefore native soils, are intact beneath the surface of the process water ponds . Landform reconstitution is therefore expected to be relatively straight-forward for these areas. Major earthworks are not anticipated to restore land capability, beyond the acid sulphide management actions discussed above.

In contrast, bathymetric surveys found that dredge pond lowering will expose high-walls in some areas where ore was removed by the dredge. High-walls will be near vertical and will require reshaping to restore natural contours. In other areas, sand and fine tailings that were returned to the pit by the floating concentrator will be exposed. Sand tailings are visible in the aerial imagery in areas where deposition continued above the water surface. 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, in their current form, these materials may not be suitable to sustain vegetation in the dry periods. This is exacerbated by the distinct wet and dry seasons at SRL, where soils are required to store water for plant utilisation during the dry season. Although the sand tailings have poor physical properties for plant growth, there are a variety of materials that could be added to improve their texture, particularly increasing the fines content to a level at which there is sufficient water retention to support plant growth during the dry season. Given that a large quantity of fine materials were deposited as tailings in the dredge ponds this material can be mixed with the sand to improve soil texture and water retention capacity. In addition to slimes, the material removed from the dams could be used to improve texture, if the removed material is not used to stabilise the remaining wall. Technical studies undertaken in 2018 and 2019 found that a proportion of 20% fine tailings should be mixed into sand tailings (*i.e.* 1 part fines to 4 parts sand tailings by volume), ideally to a depth of 2 metres in order to restore adequate soil-water retention (Dobrowolski 2020).

3. MANGROVE RESTORATION

Mangrove habitats within the mining lease are degraded due to decades of direct and secondary impacts related to exploration, mining and human activities. SRL therefore has an opportunity to mitigate mangrove impacts through restoration of recent direct impacts and historic secondary impacts.

Mining within mangroves will require complete vegetation removal and mass earthworks. However, less than 3% of the substrate will be extracted, the remainder of which are returned as tailings to the location of disturbance. Therefore, all mangrove impacts (direct and secondary) can be restored after mining. SRL's mangrove restoration strategy draws from decades of in-house experience restoring wetlands in the footprint of mineral sand mining at Iluka's US Operations[1].

[1] https://www.iluka.com/iluka/media/website/sustainability%20report/environment_wetland-restoration-in-green-cove-springs.pdf

Dewatering will be required in order to mine the mangrove areas. Topsoil and vegetation will then be stripped and stockpiled for later use in rehabilitation. Once topsoil and vegetation are cleared, mining will commence via excavators and haul trucks and ore taken to the wet concentrator plants (WCP). Tailings will be pumped and piped back to the mining void. After mining and tailing are complete, rehabilitation earthworks will re-shape the landform to restore a shallow inter-tidal zone (elevation 0.5-2mRL) that will support mangrove growth.

Stockpiled topsoil and mulched vegetation will be spread across the recontoured landform to restore nutrient quality and seed source. Revegetation will then occur as dewatering is ongoing. After revegetation, the estuarine connection will be slowly restored through cessation of dewatering (pumping) and spillway modifications. Water impoundments will be removed, using the same approach as described above for the legacy dams, and the historic hydrologic connection will be restored. Landform restoration will be complete less than one year after impact.

The conceptual mitigation strategy is depicted in Figure 4, below. Next steps include designing mangrove restoration contours and restoration strategies.

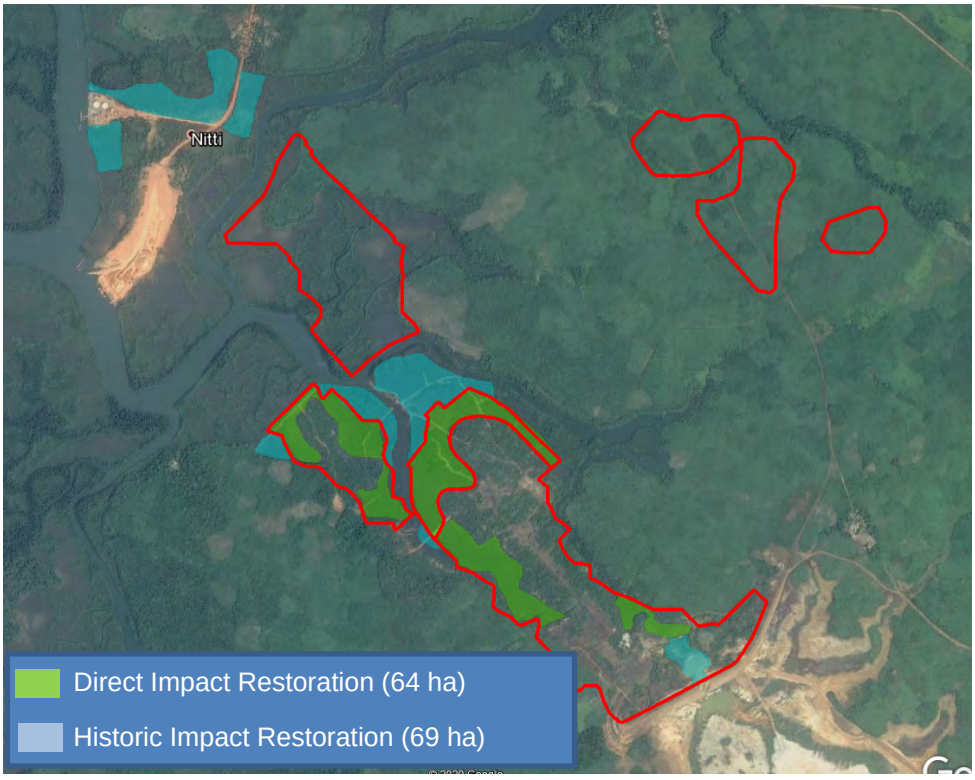


Figure 4: Mangrove Restoration – Conceptual Plan. Red lines indicate known mineral deposits.

By restoring both direct and indirect impacts on mangroves, SRL will achieve no net loss for this natural habitat.

4. REFERENCES

Jones and Wagener. (2019). *Dam Failure Consequence Study.*

Jones and Wagener. (2019). *Sierra Rutile Benthic Sediment Sampling and Geochemistry.*

Dobrowolski, M. (2020). Report on soil sampling, analysis and modelling of sand tailings and slimes mixes to inform a suitable soil profile prescription for rehabilitation of SRL sand tailings. *Iluka Resources Technical Report*.



Sierra Rutile Limited

Mining Area 1

Biodiversity Action Plan:

Appendix III – BAP Actions

28 December 2020

SRL would like to acknowledge the work and contribution of Biotope (www.biotope.fr) in the preparation and development of this document.

1. BAP 1 - Improve understanding of species composition, density, and habitat use

BAP 1 - Improve understanding of species composition, density, and habitat use	
SCOPE OF THE ACTION	
Objective:	Given the gaps in biodiversity baseline information, SRL will undertake routine biodiversity surveys to better understand the presence and distribution of critical habitat (CH) qualifying species, species of conservation concern (SCC), and habitat conditions. This BAP action coincides with, and is described in more detail in, the Biodiversity Monitoring and Evaluation Plan (BMEP). Aim of surveys: • Document baseline habitat conditions, and CH species population baseline estimate and status and habitat use patterns, and changes over time. • Have the faunal population estimates serve as the baseline number to measure subsequent monitoring against. • Inform adaptative management and land rehabilitation strategies. • Formalise monitoring protocols for CH and SCC, following international standards and guidelines.
Critical habitat concerned:	All
Species concerned:	All terrestrial and aquatic CH qualifying species and natural habitats.
Impacts addressed:	All impacts of the project on biodiversity and ecosystems.
ACTION IMPLEMENTATION	
Action description:	Additional surveys • Annual (Mar-May) Forest mapping: use remote sensing and plot-based field surveys to locate and characterize forest patches, revise and improve condition scoring for UMAM, and inform forest landscape restoration plans (which Forest and Gallery Forest patches to preserve, connect, and/or restore). SRL ER&R Operations team will take the lead on data collection and analysis with support from external technical experts. • Annual Dry (Mar/Apr) and Wet (Sept/Oct) Season Chimpanzee surveys: To inform the design of a Chimpanzee forest corridor from outside the northeast corner of Area 1 to the proposed pond restoration nearby (e.g. Motinga, Pejebu ponds), further details on chimpanzee presence and habitat use in this area are required. To investigate, conduct interviews in nearby villages and recces in nearby forest patches. DNA sampling will be collected on an ad hoc basis if dung is encountered. The SRL ER&R Operations team will take the lead on data collection and analysis with support from external technical experts. • Annual Dry (Mar/Apr) and Wet (Sept/Oct) Season monkey and duiker surveys: In locations not surveyed during the 2019 primate survey, conduct community interviews as a first step to understanding presence/absence. Additionally conduct camera trap (terrestrial and arboreal) surveys in the wet and dry season in forest patches to document the presence and habitat use of Western Red Colobus (*Piliocolobus badius*), King Colobus (*Colobus polykomos*), Diana monkey (C*ercothecus diana*) and Jentink's duiker (*Cephalophus jentinki*). Given potential issues with theft, the feasibility on the use of camera traps will first be investigated. The SRL ER&R Operations team will take the lead on data collection and analysis with support from external technical experts. • Annual Dry(Mar/Apr) and Wet (Sept/Oct) Season Herpetological surveys

	- Amphibians (Allen's Slippery Frog [*Conraua alleni]* and Freetown Long-fingered Frog [*Arthroleptis aureoli]*): Conduct visual and acoustic surveys in select forest patches[1] in the rainy season to determine the presence and habitat use. The use of eDNA should also be considered. Mining ponds that are in the process of being lowered (BAP 4) should be included in the area of study. - Crocodiles (Slender-snouted Crocodile [*Mecistops cataphractus]*, West African Nile Crocodile [*Crocodylus suchus],* Dwarf crocodile *[Osteolaemus tetraspis])*: Engage with experts and local communities to understand the likelihood of presence of these species, and conduct targeted surveys aimed at confirming their presence through river navigation with light boats. Mining ponds that are in the process of being lowered (BAP 4) should to be included in the area of study. For both Amphibians and Crocodiles, external technical experts will lead on data collection and analysis for surveys, but will train the SRL ER&R Operations team on survey methods for subsequent monitoring • Annual Dry (Mar/Apr) and Wet (Sept/Oct) Season birds surveys: Conduct annual wet and dry season surveys to assess the presence of Timneh Parrot (*Psittacus timneh*) and Hooded Vulture (*Necrosyrtes monachus*). A baseline population estimate is required, and Distance sampling methods are recommended. When possible collect information on roosting and breeding locations and corresponding tree characteristics. (e.g. tree species, tree height and tree DBH). External technical experts will lead on data collection and analysis for surveys, but will train the SRL ER&R Operations team on survey methods for subsequent monitoring • Annual Dry (Mar/Apr) and Wet (Sept/Oct) Season marine species surveys: Conduct community interviews and surveys to understand the potential presence, the habitat use and distribution of the Atlantic Humpback Dolphin, African Wedgefish and the African Manatee in the Sherbro River Estuary. Second, targeted data collection of the Atlantic Humpback Dolphin should be conducted. Field surveys should also include the African Manatee and African Wedgefish. The use of eDNA will be investigated. External technical experts will lead on data collection and analysis for surveys, but will train the SRL ER&R Operations team on survey methods for subsequent monitoring • Annual Wet (Sept/Oct) and Dry (Marc/Apr) Season Ichthyologic surveys: Conduct field surveys to further investigate the potential presence and to qualify the state of conservation of the 16 species of fish qualifying for CH, particularly focusing on the watershed heads. In addition to traditional methods, the use of eDNA will be investigated. Mining ponds that are in the process of being lowered (BAP 4) should to be included in the area of study. External technical experts will lead on data collection and analysis for surveys, but will train the SRL E &R Operations team on survey methods for subsequent monitoring
Deadline / Milestones	Wet (Mar/Apr) and Dry season (Sept/Oct) surveys to be completed in year 2021.
Who is responsible?	SRL ER&R Operations Manager
Implementation constraints and other remarks:	COVID-19 travel restrictions could prevent expatriate technical experts from accessing the site. This could impede ability to meet most KPIs.
MEASURE MONITORING	
See BMEP for detailed monitoring methods and KPIs	
ESTIMATED BUDGET	
Estimated costs:	$100,000 per year, included in E&R planning budget for 2021.

[1] It is exted that the higher diversity and probability to encounter the species will be in continuous forest patches.(cf. Almeida et al (2016) Patch size matters for amphibians in tropical fragmented landscapes. Biological Conservation 195:89-96)

2. BAP 2 - Reduce operational deforestation and maintain terrestrial forest corridors

BAP 2 - Reduce operational deforestation and maintain terrestrial forest corridors	
SCOPE OF THE ACTION	
Objective :	Reduce operational deforestation to maintain ecological connectivity for wildlife populations (especially Western Chimpanzees).
Critical habitat concerned:	• Forests • Gallery forests • Mangroves
Species concerned:	• Terrestrial mammals: Western Chimpanzee (*Pan troglodytes verus)*, King Colobus (*Colobus polykomos)*, Western Red Colobus (*Piliocolobus badius)*, Diana Monkey (*Cercopithecus diana*), Jentink's Duiker (*Cephalophus jentinki*) • Reptiles: Slender-snouted Crocodile (*Mecistops cataphractus*), West African Nile Crocodile (*Crocodylus suchus*) • Amphibians: Allen's Slippery Frog (*Conraua alleni)* and Freetown Long-fingered Frog (*Arthroleptis aureoli)* • Timneh Parrot (*Psittacus timneh*) and Hooded Vulture (*Necrosyrtes monachus*)
Impacts addressed:	• Loss of habitat, biota and ecosystem services. • Loss of species diversity and SCC. • Fragmentation of habitats and alteration of ecosystem functioning.
ACTION IMPLEMENTATION	
Action description:	Reduce operational clearing within priority avoidance areas. 1. Continue enforcing the land disturbance permit (LDP) procedure to avoid and minimise clearing of natural habitats. 2. Avoid land disturbances within 50 meters of natural habitats (excepting those impact areas authorised under the BAP or LDP). 3. Develop and implement research to study the effectiveness of the 50 m buffer by end of Q2 2021. 4. Include a "natural habitats" shapefile in a conservation layer that will be provided to short and long term mine planning teams by end of Q1 for inclusion on plans. 5. Update the "natural habitats" shapefile annually (by end of Q4, or soonest available) based on biodiversity survey results and distribute to short and long term mine planning teams.
Deadline:	Implement by end of 2021.
Who is responsible?	SRL ER&R Operations Manager
Implementation constraints and other remarks:	None identified at this time.
ACTION MONITORING	

Key Performance Indicators and targets	• No incidents of unauthorized land clearing (i.e. full compliance with LDP procedure). • Natural habitat layer included in annual mine plans prior to finalization of subsequent planning period.
How will we monitor compliance?	• Annual Independent Environmental & Social Consultant (IESC) audit. • Annual internal audit of LDP process and procedure.
ESTIMATED BUDGET	
Estimated costs:	• Cost per IESC Audit: $75,000 • Included in Admin Budget

3. BAP 3 – Protect and Improve Water Quality

BAP 3 – Protect and improve water quality	
SCOPE OF THE ACTION	
Objective :	Protect and improve water quality
Critical habitat concerned:	• Gallery forests • Mangroves
Species concerned:	• Marine mammals: Atlantic humpback dolphin (*Sousa teuszii*) and African Manatee (*Trichechus senegalensis)* • Marine fish: African Wedgefish (*Rhynchobatus luebberti*) • Freshwater fish • Amphibians: Allen's Slippery Frog (*Conraua alleni*) and Freetown Long-fingered Frog (*Arthroleptis aureoli*) • Insects: *Pseudagrion mascagnii* and Yellow-fronted Threadtail (*Elattoneura dorsalis*) • Decapods: *Afrithelphusa leonensis* and *Afrithelphusa afzelli* • Aquatic plants: *Ledermanniella aloides and Stonesia heterospathella*
Impacts addressed:	• Potential erosion, sediment runoff and drainage issues. • Soils washed up and potential release of suspended matter in water. • Degradation of water quality.
ACTION IMPLEMENTATION	
Action description:	Develop a water quality protection plan (including sediment and erosion control) that addresses the following: <u>Minimize erosion risk</u> The plan should aim to minimise erosion due to Project activities. Measures could include: • Minimize the size of deforested and stripped land to what is strictly necessary. • Regular road maintenance. • Ensure water from SRL infrastructure (road, mine, etc.) is collected and treated in sediment traps before releasing in the hydrosystem. • Design earth stockpiles, embankments and excavations with gentle slopes to avoid erosion (temporary earthwork as well as during the more permanent works). • Grow vegetation or otherwise stabilize slopes which pose a risk to critical aquatic habitats. • Implement a drainage network to collect rainwater around operational areas. • Deviate and channel surface water flow to avoid uncontrolled flows which may cause erosion. • Treat drained water before disposing in the natural environment (cf. below). • Consider engineering solutions (e.g. vegetative mats, geotextile, socks filled with organic matter, bunds) to control erosion. <u>Stormwater management and treatment</u> The plan should include appropriate management and treatment to prevent or limit: • Erosion from the newly exposed mining areas. • Transport of sediment into the lower reaches of the mangrove channels and gallery forests. • Creation of suspended particles in water as well as pollutants release. All waters (surface water, drained water, wash water, grey water) should be properly treated (*e.g.* sediment traps, sewage systems) in accordance with applicable Sierra Leonean requirements and GIIP (Good International Industry Practices) standards and guidelines. <u>Monitoring locations and frequencies</u>

	Audit existing surface water monitoring discharge points included in SRL's surface water monitoring procedure (SRL-SOP-EPR-023) to verify all offsite discharge locations are being monitoring for the appropriate parameters.
Deadline	Water quality protection plan to be developed by end of Q2 2021.
Who is responsible?	SRL ER&R Operations Manager
Implementation constraints and other remarks:	None identified at this time.
MEASURE MONITORING	
Water quality monitoring procedures addressed in SRL-SOP-EPR-023. Aquatic biodiversity monitoring addressed in BMEP 4.	
ESTIMATED BUDGET	
Estimated costs:	The water quality protection plan will be developed internally by ER&R Operations Manager (no consulting cost).

4. BAP 4 - Progressive pond lowering to minimise fauna mortality when closing dams

BAP 4 - Progressive pond lowering to minimise fauna mortality when closing dams	
SCOPE OF THE ACTION	
Objective :	Lower pond levels progressively, relying on seasonal water fluctuations, to minimise impacts on pond and downstream fauna and habitats.
Critical habitat concerned:	• Mangroves • Critical streams
Species concerned:	• Freshwater fishes • Reptiles: Slender-snouted Crocodile(*Mecistops cataphractus*), West African Nile Crocodile (*Crocodylus suchus*) • Amphibians: Allen's Slippery Frog (*Conraua alleni*) and Freetown Long-fingered Frog (*Arthroleptis aureoli*) • Insects: *Pseudagrion mascagnii* and Yellow-fronted Threadtail (*Elattoneura dorsalis*)
Impacts addressed:	Fauna mortality upon dam closure.
MEASURE IMPLEMENTATION	
Action description:	SRL's Mine Closure Plan (2020) involves full or partial removal of all 35 existing earthen dams and closure of the associated ponds. The following actions will be taken to prevent adverse impacts to aquatic fauna related to dam removal and pond closure. • Pond water levels will be slowly drawn down by annually lowering or widening of existing spillways at the end of the dry season such that water does not stage as high during the next wet season. • Adequate fish pathways will be maintained when possible to avoid "trapping" aquatic species in residual pools formed when water levels are lowered. • Ponds will be monitored as water levels recede. SCC will be flushed from the area or recovered and released by trained staff if found trapped in residual pools when it is safe to do so. • Construction activities (e.g. spillway lowering) will be avoided when possible during breeding periods of the West African Nile Crocodile and the Slender-snouted Crocodile (approximately Feb – Jul). • Limestone powder will be applied at the end of the dry season to manage the risk of pond acidification as historically submerged natural sulphidic soils are exposed upon pond lowering and oxidise. • Ponds will be included in annual biodiversity studies (BAP 1) to monitor the effects of pond drawdown on reptiles, fish, and macroinvertebrates.
Deadline	Complete first Dry (Mar/Apr) and Wet (Sept/Oct) season surveys in 2021 (BAP 1). Annual spillway lowering as per spillway lowering schedule in the Mine Closure Plan (2020).
Who is responsible?	Pond Closure Design: SRL Rehab & Closure Manager Surveying: SRL ER&R Operations Manager
Implementation constraints and other remarks:	None identified at this time.
MEASURE MONITORING	

Key Performance Indicators and targets	• No documented SCC mortality related to pond lowering. • No water quality standard violations related to pond lowering.	
How will we monitor compliance?	• Weekly dry (Dec-Apr) season surveys to inspect for trapped wildlife conducted by ER&R Operation staff during pond lowering. • Monthly water quality monitoring at spillways by ER&R Operation staff.	
Who is responsible for monitoring?	SRL ER&R Operations Manager	
Non-compliance and response:	**Non-compliance** • Fish and reptiles of conservation concern trapped in pools and harvested by local communities. • Pond water discharge falls below background pH for an analogue physical environment following commencement of lowering.	**Response** • Hire staff to salvage species of conservation concern. • Remedial action to buffer discharge water.
ESTIMATED BUDGET		
Estimated costs:	This work will be completed by ER&R Operations staff.	

5. BAP 5 - Adopt controls over vegetation clearance practices to minimize the impacts on Critical Habitat species, species of conservation concern and critical habitats

BAP 5 – Adopt controls over vegetation clearance practices to minimize the impacts on critical habitat species, species of conservation concern and critical habitats	
SCOPE OF THE ACTION	
Objective :	Develop good practices related to the necessary vegetation clearance to minimize the impacts on CH species, species of conservation concern and critical habitats.
Critical habitat concerned:	• Forests • Gallery forests • Mangroves
Species concerned:	• Terrestrial mammals: Western Chimpanzee (*Pan troglodytes verus*), Western Red Colobus (*Piliocolobus badius*) and King Colobus (*Colobus polykomos*), Diana Monkey (*Cercopithecus diana*), and Jentink's Duiker (*Cephalophus jentinki*) • Reptiles: Slender-snouted Crocodile (*Mecistops cataphractus*), West African Nile Crocodile (*Crocodylus suchus*) • Timneh Parrot (*Psittacus timneh*) • Amphibians: Allen's Slippery Frog (*Conraua alleni*) and the Freetown Long-fingered Frog (*Arthroleptis aureoli*) • Insects: *Pseudagrion mascagnii* and Yellow-fronted Threadtail *(Elattoneura dorsalis*) • Decapods: *Afrithelphusa leonensis* and *Afrithelphusa afzelli* • Species of stakeholder concern (three pangolins and six sea turtles) • Flora: *Terminalia ivorensis* (Bajii / Black Afara) and *Nauclea diderrichii* (Bundui / Opepe)
Impacts addressed:	• Loss and degradation of critical habitats. • Loss of CH species and species of stakeholder concern. • Indirect impacts linked to past in-migration induced by the Project (e.g. agriculture, charcoal, domestic needs).
ACTION IMPLEMENTATION	
Action description:	• Where possible, a buffer of 50 m will be applied around natural habitats to increase the protection of these areas and reduce the edge effects of project infrastructure and human disturbance. • When possible, avoid clearing during breeding season for nesting birds (e.g. Timneh Parrots on the riverbanks (February to May, see Lopes et al. 2018). • When it is not possible to avoid clearing during breeding season, flush mobile species before land clearing begins. • Train equipment operators and contractors to recognise CH and SSC species. If such species are encountered during land clearing, work should stop until the species has been flushed from the work area. • When possible, clearing and topsoil stripping should be conducted during the dry season to limit erosion and sediment loads flowing into the lower reaches of the mangrove ecosystem. • Remove and store topsoil stockpiles in such a way that it is not washed into the mangrove creeks during the wet season.
Who is responsible?	SRL ER&R Operations Manager
Implementation constraints and other remarks:	None identified at this time

ACTION MONITORING		
Key Performance Indicators and targets	• No documented mortality of CH or SSC due to earthworks. • No clearing within agreed buffers and NH. • Five ER&R Operations staff members trained in SCC identification.	
How will we monitor?	Biodiversity representative to conduct inspections during land clearing (at least once during land clearing process).	
Who is responsible?	SRL ER&R Operations Manager	
Non-compliance and response:	**Non-compliance** • No training of equipment operators and contractors to recognise CH and SSC species. • Documented mortality of CH and SSC species.	**Response** • Develop and implement a training program for equipment operators and contractors. • Assign a biodiversity advisor to land clearing inspections.
ESTIMATED BUDGET		
Estimated costs:	This work will be completed by internal staff.	

6. BAP 6 - Community, workforce and stakeholder education on good environmental practices

BAP 6 - Community, workforce and stakeholder education on good environmental practices	
SCOPE OF THE ACTION	
Objective :	• Develop good environmental practices and ensure the sustainability of the BAP actions implemented through: (a) education and sensitization programs for local communities, and (b) training of SRL workers and contractors on biodiversity practices. • Reduce traffic speeds in areas of anticipated Western Chimpanzee crossing (see BAP 12). • Use training, education and engagement to combat illegal wildlife trade and hunting in the mining lease.
Critical habitat concerned:	• Forests • Gallery forests • Mangroves
Species concerned:	All fauna and flora species, in particular Western Chimpanzees.
Impacts addressed:	• Habitat loss and degradation due to unsustainable agricultural practices. • Species disturbance or mortality due to unsustainable agricultural and hunting practices, collisions with vehicular traffic, and conflicts with humans.
ACTION IMPLEMENTATION	
Action description:	**SRL will develop an environmental awareness raising, communication, ownership program that targets schools, villages and employees**. The program will consider the following: • Develop initiatives to encourage and support the community to take ownership of, and participate in, conservation activities. • Work with communities to identify an appropriate mechanism for them to participate in conservation activities, such as conservation committees etc. In an effort to decrease human-wildlife conflicts resulting from SRL activities, **SRL will incorporate conservation and biodiversity principles in closure and rehabilitation planning**, including but not limited to, locating targeted biodiversity restoration areas as far away from farming and populated areas as possible. Therefore, SRL will: • Establish a BAP champion in the Community Affairs Department (CAD) team to deliver the biodiversity education programme. BAP related deliverables will be included in the champion's performance objectives for 2021. Where appropriate, **SRL will reduce speed limits in anticipated chimpanzee crossing locations and erect signage accordingly** to reduce collision risks, particularly on the road between Simbekihun and Mokepay (see BAP 12).
Deadline	BAP champion identified in CAD team by end of Q1 2021. Program development and feasibility study stage complete by end of Q2 2021.
Who is responsible	SRL ER&R Planning Manager (rehabilitation planning aspects). Iluka Manager Communities - International (livelihood restoration aspects).
Implementation constraints and other remarks:	Sanitary measures and constraints linked to COVID-19 could impact the timeline of this action as it is dependent upon community consultation.
ACTION MONITORING	
Key Performance Indicators and targets	**Environmental awareness raising, communication and education** • BAP champion identified in CAD team

	• Environmental education campaigns run **Community ownership** • Community engagement has commenced/is underway	
How will we monitor?	• Audit the internal and external environmental education and communication campaigns. • Undertake social surveys to evaluate the impact on the local communities, SRL staff and contractors behavioural change towards biodiversity conservation. • Monitor SRL vehicle speeds using FROTCOM speed monitors (24/7).	
Monitoring frequency:	• Annual audits of environmental education and communication campaigns. • Daily SRL vehicle speed monitoring via FROTCOM (24/7).	
Who is responsible?	Iluka Manager Communities - International	
Non-compliance and response:	**Non-compliance** • No education programme developed. • No CAD champions identified. • No education programme delivery. • Speed limits within mining lease remain unchanged / no signs erected.	**Response** • Develop and implement an environmental education program. • Analysis of the reasons of the issues in the training (*e.g.* issues due to the trainer, the trainees, lack of financial means to implement the methods learned, etc.), and adapt accordingly (*e.g.* further training of driver, change of trainer, and/or change of trainees, etc.).
ESTIMATED BUDGET		
Estimated costs:	This work will be completed by internal staff and will be informed by a socio-economic impact assessment study (funded under closure planning).	

7. BAP 7 – Explore initiatives to reduce hunting pressure

BAP 7 - Explore initiatives to reduce hunting pressure	
SCOPE OF THE ACTION	
Objective :	Explore initiatives to reduce hunting pressure, focusing on community-led programs. A key first step in developing conservation initiatives to reduce hunting pressure is to better understand current hunting practices, including illegal hunting and trafficking and opportunistic snaring around cultivated plots by communities. Understanding how local people are organized and what pressures they exert on wildlife is a particular challenge that will require trustful relations with communities to be successful, but should be documented to aid in the development of the plan. To capture this information, as part of the social surveys in BAP 6, questions on hunting practices and pressures should be integrated in the surveys.
Species concerned:	• Terrestrial mammals: Western Chimpanzee (*Pan troglodytes verus*), Western Red Colobus (*Piliocolobus badius*), King Colobus (*Colobus polykomos*), Diana Monkey (*Cercopithecus diana*), and Jentink's Duiker (*Cephalophus jentinki*). • Reptiles: Slender-snouted Crocodile (*Mecistops cataphractus*), West African Nile Crocodile (*Crocodylus suchus*). • Pangolin species of stakeholder concern: Black-bellied Pangolin (*Phataginus tetradactyla*), White-bellied Pangolin (*Phataginus tricuspus*), Giant Ground Pangolin (*Smutsia gigantea*).
Impacts addressed:	Previous in-migration increased the hunting pressure in Area 1.
ACTION IMPLEMENTATION	
Action description:	Hunting in the mining lease consists mainly of poaching and trapping (SRK, 2018). In parallel to development of local communities and alternative resources measure (BAP 8), **SRL will investigate opportunities to reduce hunting pressure** in collaboration with local communities. This measure aims to reduce hunting pressure in Area 1 during the whole project lifespan. It will aim to: • Understand current hunting practices through social surveys. • Investigate community-based initiatives to reduce hunting and to prevent illegal wildlife trade on the mining lease. • Develop programs within SRL to reduce hunting pressure and wildlife trade. • Complete an assessment of potential opportunities to reduce hunting pressure. • If any favorable opportunities are identified, develop subsequent plan(s) in 2022. Potential actions to be considered: • Institute a zero tolerance policy on the possession, purchase, trade, or collection of wildlife or forest resources protected under Sierra Leone law, are CITES listed, or classed as threatened by IUCN Red List for all SRL staff and contractors. • Support local communities in developing animal farming as an alternative to hunting (see BAP 8). Different alternatives will be considered, and their feasibility evaluated in relation to local communities' practices and expectations. • Implement an Ecoguard program at Mobimbi Hill. Train SRL security guards to patrol and monitor Mobimbi Hill (using tools such as SMART) to monitor for evidence of hunting and poaching in an effort to track and discourage these activities. • Contingent on the success of the SRL Ecoguard program, and results of the social surveys (BAP 6), investigate the possibility of expanding the Ecoguard program into communities, in particular within the Mobimbi Hills – Simbikihun Hills corridor.
Deadline	• SRL Ecoguard program developed by end of 2021. • Zero Tolerance policy instituted at SRL on the possession, purchase, trade, or collection of wildlife or forest resources by end of Q1 2021.
Who is responsible?	Iluka Manager Communities - International

Implementation constraints and other remarks:	Sanitary measures and constraints linked to COVID-19 could impact the timeline of this action as it is dependent upon community consultation.
ACTION MONITORING	
Key Performance Indicators and targets	• HSEC management system is updated to reflect a zero-tolerance policy on hunting by SRL staff and contractors (of 2021). • SRL Ecoguard program developed at Mobimbi Hill. • Community led programs to reduce hunting are investigated.
ESTIMATED BUDGET	
Estimated costs:	This work will be completed by internal staff and will be informed by a socio-economic impact assessment study (funded under closure planning).

8. BAP 8 - Enhance the ecological quality of the agricultural mosaic by promoting suitable agricultural practices and agroforestry

BAP 8 - Enhance the ecological quality of the agricultural mosaic by promoting suitable agricultural practices and agroforestry	
SCOPE OF THE ACTION	
Objective:	The consequences of slash and burn agriculture for the environment are almost always destructive, especially when the density of human population increases (which isn't limited to in-migration effects) and as a result, land is left fallow for shorter and shorter periods, which decreases the amount of second growth / older fallows in the landscape. Community education and initiatives to promote sustainable agricultural practices (e.g. agroecology, agroforestry, woodlots) could increase yields and decrease the area of land cleared for cultivation every year. This will contribute to mitigating impacts to natural and critical habitats. Aim: Incorporate conservation and biodiversity considerations when designing community development programmes to limit impacts on natural forested habitats and improve agricultural efficiency, while still promoting and respecting traditional knowledge and dynamics. Long term objective: The ecological quality of the agricultural mosaic is improved through co-development with local communities and capacity building.
Critical habitat concerned:	• Forests • Gallery forests • Mangroves
Species concerned:	• Terrestrial mammals: Western Chimpanzee (*Pan troglodytes verus*), Western Red Colobus (*Piliocolobus badius*), King Colobus (*Colobus polykomos*), Diana Monkey (*Cercopithecus diana*), Jentink's Duiker (*Cephalophus jentinki*). • Reptiles: Slender-snouted Crocodile (*Mecistops cataphractus*), West African Nile Crocodile (*Crocodylus suchus*). • Timneh Parrot (*Psittacus timneh*). • Amphibians: Allen's Slippery Frog (*Conraua alleni*) and Freetown Long-fingered Frog (*Arthroleptis aureoli*). • Insects: *Pseudagrion mascagnii* and Yellow-fronted Threadtail (*Elattoneura dorsalis*). • Decapods (Freshwater crabs): *Afrithelphusa leonensis* and *Afrithelphusa afzelli* • Pangolin species of stakeholder concern: Black-bellied Pangolin (*Phataginus tetradactyla*), White-bellied Pangolin (*Phataginus tricuspus*), Giant Ground Pangolin (*Smutsia gigantea*).
Impacts addressed:	• Habitat loss and degradation due to 'slash-and-burn' agriculture, use of wood fuel and charcoal production. • Hunting, poaching and pet-trade pressure.
ACTION IMPLEMENTATION	
Action description:	**In consultation and agreement with local communities, SRL will integrate biodiversity and conservation objectives into community agricultural / livelihood programmes and closure / rehabilitation planning work scheduled for 2021.** Opportunities to investigate include: • Creating wood lots to provide timber and fuelwood to communities. This could be done on land not desired for cultivation such as old quarry sites, borrow pits, and ponds that SRL will rehabilitate to benefit communities. • Establishing "community forests" as in Uganda (*e.g.* FAO, 2019). • Using organic manure and pesticides in land rehabilitation practices to prevent adverse impacts to water quality and Chimpanzee populations. • Promoting fuel-efficient stoves as an alternative to traditional wood stoves, to direct smoke away from the users, cook faster than traditional stoves or even use a different fuel source. • Promote mixing of annual and perennial plantations with woodlots on low biodiversity value modified habitat that is easily accessible from existing roads, to decrease pressure on forested patches in Mobimbi hills and along the corridors for Western Chimpanzees. • Promote environmental friendly agricultural practices by community.

	• Animal farming as an alternative source of proteins / income to substitute for wild threatened species targeted by bushmeat hunting (see BAP 7).
Deadline	Demonstrate inclusion of biodiversity and conservation objectives in community agricultural / livelihood programmes and closure / rehabilitation planning work that is scheduled for 2021, by end of Q1 2021.
Who is Responsible?	• SRL ER&R Planning Manager (rehabilitation planning aspects). • Iluka Manager Communities – International (livelihood restoration aspects).
Implementation constraints and other remarks:	Because SRL doesn't have authority over the land use of communities, the success of these activities will depend on the participation of local communities. The intent of the conservation education programme (BAP6) is to encourage community buy-in and participation. Sanitary measures and constraints linked to COVID-19 could impact the timeline of this action as it is dependent upon community consultation.
MEASURE MONITORING	
KPIs and targets	Demonstrate inclusion of biodiversity and conservation objectives in community agricultural / livelihood programmes and rehabilitation planning work (such as Annual Land Rehabilitation Implementation Plan, 2020) by end of 2021.
ESTIMATED BUDGET	
Estimated costs:	This work will be completed by internal staff and will be informed by a socio-economic impact assessment study (funded under closure planning).

9. BAP 9 – Train existing spotters on ships to monitor marine and estuarine animal species of concern

BAP 9 – Train existing spotters on ships to monitor marine and estuarine animal species of concern	
SCOPE OF THE ACTION	
Objective:	Given the possible presence of critically endangered Atlantic Humpback Dolphin, as well as vulnerable African Manatees, several sea turtle species (and local fishermen in dugout canoes), in 2021, SRL will monitor marine and estuarine animal species of conservation concern to mitigate the impacts of vessels travelling to and from Nitti Port on these species (12 round trips per month) with the aim to decrease and/or eliminate any collision risk. Ad hoc fish market surveys will also be conducted. If these species are not recorded during these surveys, then this action will no longer be required in 2022 and the BAP will be updated accordingly. If any of these species are recorded during these surveys (and/or population surveys in BAP 1), subsequent population monitoring would be included in the Biodiversity Monitoring and Evaluation Plan in 2022. Further, a stakeholder engagement plan would be developed as a new BAP Action for 2022.
Critical habitat concerned:	Mangroves surrounding Nitti Port and within the shipping channel and Sherbro River Estuary.
Species concerned:	Marine and estuarine animal species: • Atlantic Humpback Dolphin (*Sousa teuszii*) • African Manatee (*Trichechus senegalensis*) • West African Nile Crocodile (*Crocodylus suchus*) • Hawksbill Turtle (*Eretmochelys imbricata*) • Green Turtle (*Chelonia mydas*) • Leatherback Sea Turtle (*Dermochelys coriacea)* • Loggerhead Turtle (*Caretta caretta*) • Olive Ridley Turtle (*Lepidochelys olivacea*)
Impacts addressed:	Potential species disturbance.
ACTION IMPLEMENTATION	
Action description:	Given the likely presence of threatened marine mammals and reptiles in the Sherbro River Estuary and river channels, SRL will: • Establish a species monitoring systems by: - Developing a data collection sheet for spotters to record information such as: date and time of observation, GPS location, animal species observed, number observed, and distance from spotting ship. - Train current ship spotters on how to recognize animal species concerned and how to enter information onto data sheet. - Train operators on mobile vessels (such as the security boat) on avoidance of marine and estuarine species of concern.
Deadline	Implement training program by end of Q2 2021.
Who is responsible?	• SRL ER&R Operations Manager • SRL E&R Planning Department
Implementation constraints and other remarks:	None at this time.

MEASURE MONITORING	
Key Performance Indicators and targets	• Complete monitoring on every boat trip. • Develop a database of species observations and locations. • Prepare monthly reports of animal observations. • Analyse results to inform any modifications to boat paths and speeds.
ESTIMATED BUDGET	
Estimated costs:	This work will be completed by internal staff.

10. BAP 10 - Control the introduction and spread of invasive alien species

BAP 10 - Control the introduction and spread of invasive alien species	
SCOPE OF THE ACTION	
Objective:	Actively manage and control infestation and spreading of terrestrial invasive alien floral species communities within Area 1 where SRL has control (especially *Chromolaena odorata*, *Lantana camara* and *Imperata cylindrica*) to decrease pressure on natural habitats. A specific attention has to be paid to all vehicles, equipment and materials imported and stored on the mining lease.
Critical habitat concerned:	• Forests • Gallery forests • Mangroves
Species concerned:	Flora: *Terminalia ivorensis* (Bajii / Black Afara,) and *Nauclea diderrichii* (Bundui / Opepe,)
Impacts addressed:	Introduction of alien invasive species during the whole project cycle (*e.g.* building access roads and other infrastructures, transportation of equipment and materials in the area to Nitti port, vehicles / machinery movements, etc.).
ACTION IMPLEMENTATION	
Action description:	Due to extensive, long term, slash-and-burn subsistence agriculture a high abundance of alien floral species mostly associated with agriculture are encountered in the mining lease (*e.g. Manihot esculenta* (Cassava)*, Psidium guajava* (Guava) and *Mangifera indica* (Mango) . Furthermore, various exotic timber species, including *Acacia mangium* (Forest Mangrove)*, Acacia auriculiformis* (Earleaf Acacia) and *Eucalyptus globulus* (Southern Blue Gum)*,* which have been cultivated as part of rehabilitation efforts, have potential to invade natural habitats. Finally, *Chromolaena odorata* (Famine Weed) is also abundant and seems to pose a significant threat to floral habitat. Preventing the introduction of invasive plant species is typically the most efficient and cost- effective approach to invasive plant management. Averting the movement of propagules into unaffected areas and creating or maintaining environments that do not favour the establishment of invasive plants are basic, effective approaches to minimize potential introduction. In addition, treatment and control measures are necessary to decrease the infested areas, and monitoring will allow to follow-up the efficiency of the measures implemented and adaptive management needed. **SRL will develop and implement an Invasive Alien Species (IAS) Plan that <u>could include</u> the following**: • Invasive plant species survey to establish baseline information on the status, distribution and density of invasive species (*e.g.* potentially complete the existing list of IAS present in the mining lease, map the infested areas to control, manage and monitor and to propose eradication and/or control methodologies, etc.) and to propose monitoring modalities for detecting and predicting change, including range changes and emerging impacts on critical habitats. • Biosecurity and prevention procedures to prevent introduction of IAS via project activities. • Equipment cleaning procedures such as: - remove target species (if present) and dispose properly, - vehicle wash stations at designated project checkpoints if deemed necessary. • Communication and training material to help identify and remove IAS in the Project Area by both Company and Contractors. • Management procedure for sourcing of seed mixes from reputable dealers, complete with certificates of analysis for all species that are in the mix. • IAS containment and adapted removal procedures (*e.g.* detailing the mechanical, biological, etc. modalities for the different IAS identified – frequency, period of intervention, location, etc.). • Monitoring of IAS controlled sites and rehabilitation areas in the mining lease to evaluate efficacy of treatment and requirements for follow-up treatment.

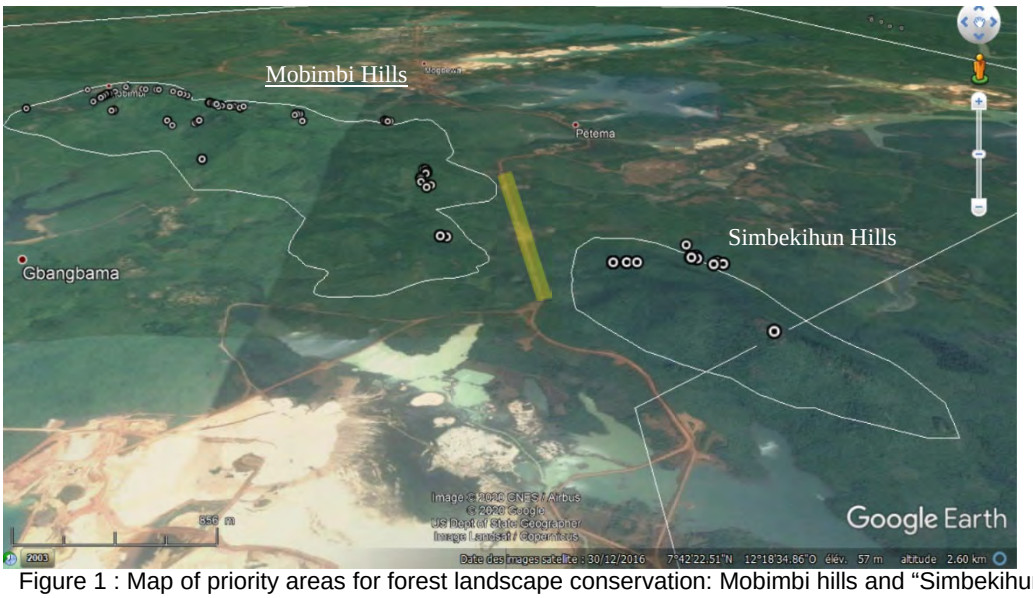
	• Develop and annually update an IAS geodatabase for the Project Area, including a register of existing (or potentially present) IAS , related risks and management. • Cease introduction of exotic fish species to ponds as part of aquaculture.
Deadline	IAS plan finalized by the end of Q3 2021.
Who is responsible?	SRL ER&R Operations Manager
Implementation constraints and other remarks:	Identify high-priority species and site-specific best treatment options for invasive plant occurrences in priority areas that present a higher ecological stake.
MEASURE MONITORING	
Key Performance Indicators and targets	IAS plan prepared by end of 2021.
ESTIMATED BUDGET	
Estimated costs:	This plan will be completed by internal staff. Cost of implementation to be determined when IAS plan is completed.

11. BAP 11 – Restore natural habitats impacted after 2017

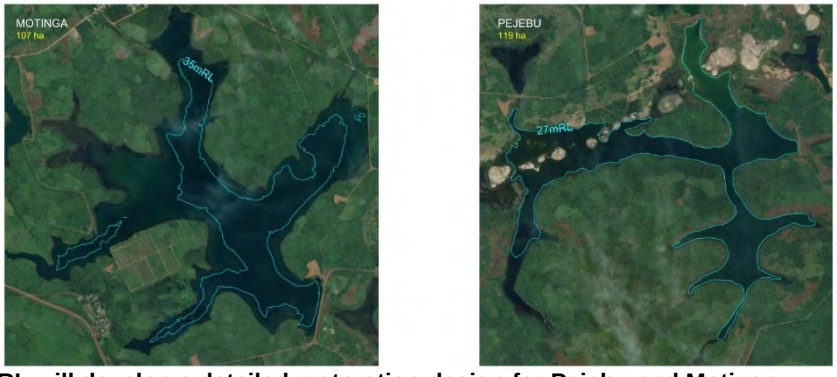
BAP 11 – Restore natural habitats impacted after 2017	
SCOPE OF THE ACTION	
Objective :	Achieve NNL on terrestrial and aquatic habitats to mitigate the impacts of the project on the biodiversity features on the mining lease.
Critical habitat concerned:	• Forests • Gallery forests • IVS • Streams • Mangroves
Species concerned:	All terrestrial and aquatic species.
Impacts addressed:	• Loss of habitat, biota and ecosystem services. • Loss of species diversity and SCC. • Fragmentation of habitats and alteration of ecosystem function.
ACTION IMPLEMENTATION	
Action description:	**SRL will develop a detailed rehabilitation design for forests, gallery forests, mangroves, and IVS impacted after 2017.** Key components will include: • Restoration of soil capability in accordance with SRL's Mine Closure Plan. • Revegetate with native species (seeds and seedlings) appropriate for the landform and targeted community. • Monitoring and maintenance as per SRL's Mine Closure Plan (2020). • Timeline, methods, costs.
Deadline:	Detailed design: end of 2021
Who is responsible?	E&R Planning Manager
Implementation constraints and other remarks:	None identified at this time.
MEASURE MONITORING	
Key Performance Indicators and targets	Detailed restoration plan developed by end of 2021.
ESTIMATED BUDGET	
Estimated costs:	Mangrove restoration design - $75,000 (included in 2021 E&R Planning Department budget).

12. BAP 12 – Promote forest protection in core Chimpanzee territories

BAP 12 – Promote forest protection in core Chimpanzee territories	
SCOPE OF THE ACTION	
Objective :	Promote the protection of CH and Chimpanzee's core habitats in the mining lease and improve/restore ecological corridors to favour species dispersion and movements on the mining lease.
Critical habitat concerned:	• Forests • Gallery forests
Species concerned:	• Terrestrial mammals: Western Chimpanzee (*Pan troglodytes verus*), King Black and White Colobus (*Colobus polykomos*), Western Red Ccolobus (*Piliocolobus badius*), Diana monkey *Cercopithecus diana*, and Jentink's Duiker (*Cephalophus jentinki).* • Birds: Timneh Parrot (*Psittacus timneh*). • Reptiles: Slender-snouted Crocodile (*Mecistops cataphractus*), West African Nile crocodile (*Crocodylus suchus*). • Amphibians: Allen's Slippery Frog (*Conraua alleni*) and Freetown Long-fingered Frog (*Arthroleptis aureoli*). • Pangolin species of stakeholder concern: Black-bellied Pangolin (*Phataginus tetradactyla*), White-bellied Pangolin (*Phataginus tricuspus*), Giant Ground Pangolin (*Smutsia gigantea*).
Impacts addressed:	• Loss of habitat, biota and ecosystem services. • Loss of species diversity and SCC. • Fragmentation of habitats and alteration of ecosystem functioning.
ACTION IMPLEMENTATION	
Action description:	The measure aims to: • Increase the proportion of forest cover in Mobimbi hills and "Simbekihun hills" (within the mining lease). • Select with local communities where forest and gallery forest areas can be restored for Chimpanzees and other terrestrial and aquatic fauna in Mobimbi hills and "Simbekihun hills". Community consultation, involvement and support is essential to achieve these goals. As a matter of first priority, **SRL will undertake a community conservation feasibility study** including investigation of the following: • Potential initiatives to promote conservation of targeted areas by providing materials or tools to improve community farms, in exchange for delivering on specific conservation commitments. • Potential ecoguard program to track and discourage logging and hunting in identified conservation areas. • Potential incentives to promote conservation by crops or woodlots in areas that are not targeted for conservation. The exact locations of the forested patches or gallery forests to target will be decided in consultation with local communities as part of mine closure and end land use planning. The guiding principle will be to discourage clearing of remnant and restored forest patches, expand the forested area (by letting fallow grow into secondary forests through fire and grazing controls) and reconnect (stepping stones) forest patches, especially along watercourses (gallery forests), to allow easier movement by wildlife. Two potential areas have been identified: • Mobimbi hills: core habitat of Chimpanzees on the mining lease. • Simbekihun hills (south-east of Mobimbi hills): on the other side of the road between Simbekihun and Mokepay, where chimpanzee signs were observed.

	 Figure 1 : Map of priority areas for forest landscape conservation: Mobimbi hills and “Simbekihun hills” in the south-west
Deadline	Complete feasibility study by end of 2021.
Who is responsible?	SRL E&R Planning Manager
Implementation constraints and other remarks:	Involvement of local population in the selection of areas to restore and the species to use is a prerequisite for the implementation. *Sanitary measures and constraints linked to COVID-19 could impact the timeline of this action as it is dependent upon community consultation.*
MEASURE MONITORING	
Key Performance Indicators and targets	Feasibility study complete by end of 2021.
ESTIMATED BUDGET	
Estimated costs:	This work will be completed by internal staff.

13. BAP 13 - Restore select natural habitats impacted by mining before 2017

BAP 13 – Restore select natural habitats impacted by mining before 2017	
SCOPE OF THE ACTION	
Objective :	Achieve NG on CH in order to mitigate the impacts of the project on the biodiversity features.
Critical habitat concerned:	• Forests • Gallery forests • IVS
Species concerned:	• Terrestrial mammals: Western chimpanzee (*Pan troglodytes verus)*, King Colobus (*Colobus polykomos*), Western Red Colobus (*Piliocolobus badius*), Diana Monkey (*Cercopithecus diana*), and Jentink's Duiker (*Cephalophus jentinki*). • Reptiles: Slender-snouted Crocodile *Mecistops cataphractus*, West African Nile crocodile (*Crocodylus suchus*). • Amphibians: Allen's Slippery Frog (*Conraua alleni)* and Freetown Long-fingered Frog (*Arthroleptis aureoli*). • Pangolin species of stakeholder concern: Black-bellied Pangolin (*Phataginus tetradactyla*), White-bellied Pangolin (*Phataginus tricuspus*), Giant Ground Pangolin (*Smutsia gigantea*).
Impacts addressed:	• Loss of habitat, biota and ecosystem services. • Loss of species diversity and SCC. • Fragmentation of habitats and alteration of ecosystem functioning.
ACTION IMPLEMENTATION	
Action description:	SRL's Mine Closure Plan (ESHIA Appendix L-4, SRK 2018) requires full or partial removal of all 35 existing dams. Dam removal will restore historic hydrology patterns and biodiversity value to downstream channels that were impacted when the dams were built. Dam removal will also expose an expansive footprint of land that can be restored for biodiversity restoration or subsistence agriculture. SRL prepared a conceptual pond closure plan, which is included as an appendix to the BAP. Based on a panel of factors, 2 ponds were prioritised for biodiversity restoration: Motinga and Pejebu. These ponds comprise a total area of 226 ha (respectively 107ha and 119ha) and a potential of 95 restoration credits (Figure 3). Figure 3 : Biodiversity restoration for Motinga and Pejebu legacy ponds (respectively areas <35 mRL and < 27mRL in the ponds)  As the next step, **SRL will develop a detailed restoration design for Pejebu and Motinga Ponds**. The plan will reflect: • Outcome of stakeholder engagement on post-mining land uses. • Restoration of soil capability in accordance with SRL's Mine Closure Plan (2020). • Revegetation with native species (seeds and seedlings) appropriate for the landform and targeted community.

	• Monitoring and maintenance as per SRL's Mine Closure Plan (2020).
Deadline	Develop detailed designs by end of 2021.
Who is responsible?	SRL E&R Planning Manager
Implementation constraints and other remarks:	COVID-19 travel restrictions could prevent expatriate technical experts from accessing the site to execute or support biodiversity monitoring.
ACTION MONITORING	
Key Performance Indicators and targets	Develop detailed designs by end of 2021.
ESTIMATED BUDGET	
Estimated costs:	Engineering design (spillway lowering): $75,000

Sierra Rutile Limited

Mining Area 1

Biodiversity Action Plan:

Appendix IV – Biodiversity Monitoring & Evaluation Plan (BMEP)

28 December 2020

SRL would like to acknowledge the work and contribution of Biotope (www.biotope.fr) in the preparation and development of this document.

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1. OBJECTIVES

1.1. Objectives of the BMEP

Monitoring and evaluation of biodiversity is the gathering of data to enable the detection of changes in population status and documentation of threats to improve the effectiveness of management of that biodiversity. They are the primary mechanisms to evaluate whether a project is meeting its targets and objectives or not.

The purpose of the BMEP is to outline the requirements to measure the success (or margins of improvement) of the implementation of the BAP and enable adaptive management where margins of improvement is identified. It allows to assess the net gains for priority biodiversity features and the effectiveness of the mitigation actions (rehabilitation and restoration) implemented in the long-term.

1.2. Scope of the BMEP

1.2.1 Priority biodiversity features

The priority biodiversity features were determined in the Critical Habitat Assessment (TBC 2019). They correspond to the critical habitats and their qualifying species present and likely present such as:

- **Forests and gallery forests**: Chimpanzees, other primates and Jentink's Duiker, Crocodiles (*i.e.* West African Nile Crocodile & Slender-snouted Crocodile), Timneh Parrot, fish species[1], Frog species (*i.e.* Allen's Slippery Frog & Freetown Long-fingered Frog)
- **Mangroves**: Western Red Colobus; West African Nile Crocodile
- **Inland Valley Swamp**: Chimpanzees and other primates
- **Rivers**: Crocodiles, Fish species
- **Sherbro River Estuary**: Atlantic Humpback Dolphin, African Manatee and African Wedgefish

Table 1 : Summary table of the confirmed and potential CH qualifying species in SRL Area 1 mining lease

Taxa	Scientific name	Common name	IUCN cat.	Criteria	Habitat category used in the BAP analysis
Confirmed CH Qualifying species					
Terrestrial mammal	*Pan troglodytes verus*	Western Chimpanzee	CR	1	Forest - Gallery / Riparian Forest – IVS (Wetland / Mangroves were excluded)
Marine mammal	*Sousa teuszii*	Atlantic Humpback Dolphin	CR	1	Sherbro River Estuary
Likely CH Qualifying species					
Birds	*Psittacus timneh*	Timneh Parrot	EN	1	Forest - Gallery / Riparian Forest - Wetland / Mangroves - Cultivated Area - Oil Palm Dominated Farm Bush and plantation
Freshwater Fishes	*Epiplatys njalaensis*		EN	1, 2	River
	Notoglanidium maculatum		EN	1, 2	River
	Notoglanidium thomasi		EN	1, 2	River

[1] Scientific names in the table hereafter ; the exact list of species of concern will be established following BAP 1 surveys.

Taxa	Scientific name	Common name	IUCN cat.	Criteria	Habitat category used in the BAP analysis
	Scriptaphyosemion bertholdi		EN	1, 2	River
	Enteromius bagbwensis		VU	2	River
Possibly CH Qualifying species					
Terrestrial mammal	*Cephalophus jentinki*	Jentink's Duiker	EN	1	Forest - Gallery / Riparian Forest
	Piliocolobus badius	Western Red Colobus	EN	1	Forest - Gallery / Riparian Forest - IVS - Wetland / Mangroves
	Colobus polykomos	Black-and-white Colobus	VU	1	Forest - Gallery / Riparian Forest
	Cercopithecus diana	Diana Monkey	EN	1	Forest - Gallery / Riparian Forest
Reptile	*Crocodylus suchus*	West African Nile Crocodile	NE	1	Gallery / Riparian Forest - IVS - Wetland / Mangroves – Water
	Mecistops cataphractus	Slender-snouted Crocodile	CR	1	Forest - Gallery / Riparian Forest - IVS - Wetland / Mangroves – Water
Amphibians	*Conraua alleni*	Allen's Slippery Frog	LC	1	Forest - Gallery / Riparian Forest - Wetland / Mangroves - Water
	Arthroleptis aureoli	Freetown Long-fingered Frog	NT	1	Forest - Gallery / Riparian Forest - Wetland / Mangroves - Cultivated Area
Freshwater fish	*Chrysichthys johnelsi*		LC	3	River
	Coelotilapia joka		VU	2	River
	Enteromius liberiensis		EN	1, 2, 3	River
	Epiplatys fasciolatus ssp. josianae		CR	1, 2	River
	Epiplatys fasciolatus ssp. zimiensis		EN	1, 2	River
	Ladigesia roloffi		EN	1, 2	River
	Leptocypris taiaensis		VU	2	River
	Marcusenius meronai		EN	2	River
	Mochokiella paynei		LC	2	River
	Ophichthus leonensis		DD	2, 3	River & Marine Water
	Scriptaphyosemion chaytori		DD	2	Wetland / Mangroves - River
	Scriptaphyosemion roloffi		NT	2	River
Marine fish	*Rhynchobatus luebberti*	African Wedgefish	CR	1, 2	Sherbro River Estuary
Insect	*Pseudagrion mascagnii*		CR	1, 2	Forest - Gallery / Riparian Forest - IVS - River
	Elattoneura dorsalis	Yellow-fronted Threadtail	VU	2	Forest - Gallery / Riparian Forest- IVS - River
Decapod	*Afrithelphusa leonensis*		DD	2	Forest - Gallery / Riparian Forest- IVS - River
	Afrithelphusa afzelii		DD	2	Forest - Gallery / Riparian Forest- IVS - River

CR=Critically endangered; EN=Endangered; LC= Least Concern; NE=Not Evaluated; VU=Vulnerable

1.2.2 Monitoring Schedule

The monitoring should be implemented through the whole project duration, depending on the relevant frequency respectively adapted to the indicators monitored. Regarding critical habitat (CH) qualifying species and species of stakeholder concern (SSC), a typical yearly monitoring schedule is provided in the Section 5 of this document.

1.2.3 Articulation/Integration with other plans

This BMEP presents the details of the monitoring protocols for Critical Habitats and target qualifying species (Table 1). It completes the existing Environmental, Social and Health Monitoring Plan (ESHMP) that includes actions oriented on water quality monitoring and some related to rehabilitation monitoring.

1.3. Conceptual Framework

This BMEP builds on the "PSR" conceptual framework whereby the **pressures** of human activities on environmental **states** is assessed to provide **responses** in order to come back to a "desirable state" (OECD, 1993). Indicators allow the monitoring of the progress of the project relative to biodiversity conservation and restoration objectives and outcomes, which are the achievement of a Net Gain for Critical Habitats (Forests, Gallery forests, Mangroves, Inland Valley Swamps) and their qualifying species (e.g. Chimpanzees, Atlantic Humpback Dolphin, etc.).

The BMEP isn't limited to the KPIs of the BAP actions but will enable SRL to monitor changes in biodiversity across Area 1 and demonstrate the achievement of its No Net Loss and Net Gain objectives.

The three types of indicators used are:

1) **State (S)** - State indicators generally correspond to the size of populations / habitats and / or distribution of species. State indicators are particularly important as they directly reflect the achievement or not of biodiversity objectives and outcomes. However, some changes in the state of biodiversity can take a long time to be detected and measured in the field, and they are often linked to phenomena independent of the project itself (*e.g.* climate change, anthropic activities, etc.). It is therefore necessary to also rely on pressure and response indicators because they are often easier to observe and measure.

2) **Pressure (P)** - pressure indicators measure the main threats to biodiversity: water quality, water flows, fishing and hunting rates, etc. Pressure indicators are particularly important because they are generally easier to measure and are generally more sensitive to change than condition indicators. Pressure monitoring can often be done more precisely and can therefore provide more relevant information to justify adaptive management.

3) **Response (R)** - response indicators measure the effect of management actions, such as the restoration of critical habitats or the protection of an area. Response indicators are also easier to measure, as they make it possible to monitor the management actions undertaken by the project. However, their success is not always linked to the achievement of objectives (see state indicators).

An effective monitoring and evaluation program therefore relieson a pragmatic selection of status, pressure and response indicators.

1.4. Limits of the BMEP

Due to the lack of baseline data and/or uncertainty on the population estimates and distribution on the mining lease, it is not always applicable to propose relevant and evidence-based targets and relative thresholds for quantitative indicators.

An updated baseline will be prepared through BAP 1 which will inform a revision of the BAP and the BMEP by end Q1 2022.

This BMEP is an evolving document that will be modified to reflect new information on the states, pressures and responses concerning biodiversity and changes to the BAP actions and objectives. BAP 1 will enable SRL to:

- Finalize the consolidated list of confirmed CH qualifying species and SCC and better understand their distribution, habitat use and population estimates on the mining lease;
- Prepare maps of Natural and Critical Habitats;
- Fine-tune the monitoring protocols regarding the methods, indicators targets and thresholds, and sampling sites selection;
- Edit the BMEP accordingly.

2. MONITORING OF NATURAL HABITATS

BMEP 1 to 4 are focused on monitoring natural habitats: forested habitats, mangroves, inland valley swamps and aquatic (freshwater) habitats. This is essentially a continuation of baseline monitoring required under BAP Action 1.

BMEP 1: Forests and Gallery forests monitoring

BMEP 1 – Forests and Gallery forests monitoring	
SCOPE OF THE MONITORING	
Objective:	Monitor changes in the area and condition of Forest and Gallery forest in the mining lease
Critical habitat concerned:	• Forests • Gallery forests
Species concerned:	• Flora: *Terminalia ivorensis* (Bajii / Black Afara, VU) and *Nauclea diderrichii* (Bundui / Opepe, VU). • Terrestrial mammals: Western Chimpanzee (*Pan troglodytes verus)*, King Colobus (*Colobus polykomos)*, Western Red Colobus (*Piliocolobus badius)*, Diana monkey (*Cercopithecus diana)*, Jentink's duiker (*Cephalophus jentinki*). • Birds: Timneh Parrot (*Psittacus timneh).* • Reptiles: Slender-snouted Crocodile (*Mecistops cataphractus).* • Amphibians: Allen's Slippery Frog (*Conraua alleni)* and Freetown Long-fingered Frog (*Arthroleptis aureole).* • Pangolin species of stakeholder concern: Black-bellied Pangolin (*Phataginus tetradactyla*), White-bellied Pangolin (*Phataginus tricuspus*), Giant Ground Pangolin (*Smutsia gigantea*).
Impacts addressed:	• Loss, degradation and fragmentation of natural and/or critical habitat. • Alteration of ecosystem functioning and ecosystem services.
MONITORING IMPLEMENTATION	
Location:	Area 1 mining lease
Data collection method:	**1/ Forest and Gallery forests mapping using remote sensing data** Forest and Gallery forests being the main CH linked to the mining activity, an updated map of forest area and condition will be established using remote sensing data combined with ground truthing (see BAP 1). Maps will be produced every year, to quantify changes in the area and condition of forests, including habitats under restoration. Key pressures will be monitored in parallel: agricultural clearing, logging, and bushfires.

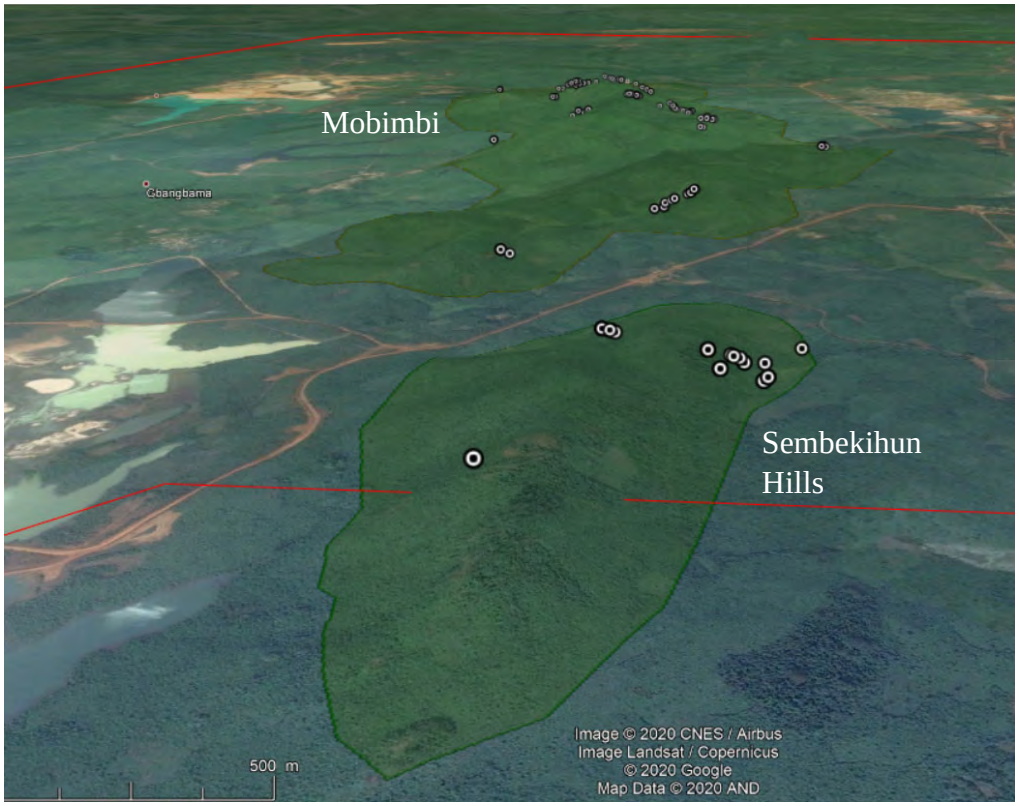


Figure 1 : Forested hills to conserve and restore for chimpanzees (2018 & 2019 observations in white) and other forest CH qualifying species with Mobimbi hills in the background (Source: Google earth)

2/ Monitoring of forest condition and adapting UMAM criteria

A mix of imagery and ground data (BAP 1 surveys, 2021) will be used to determine forest habitat condition using different parameters such as:

- Size and extent of forested patches
- Shape of forested patches (edge effects)
- Vegetation cover (trees, shrubs, herbs)
- Tree height
- Herbaceous cover and composition
- Tree size (DBH)

Monitoring will be based on sampling representative patches of forests, with a particular focus on areas in and around operations (BAP 11), restored ponds (see below, BAP 13) and the Mobimbi hills and Simbekihun hills (see BAP 12). Additionally, monitoring will be conducted in subset of areas that are part of a 50 m buffer given to land disturbance projects.

The data will be used to prepare an adapted set of criteria and thresholds to determine 'Functional Gains' and restoration time-lags for SRL's use of the UMAM approach in demonstrating biodiversity losses and gains.

3/ Monitoring of restored forests on project footprint and former mining ponds

Particular attention will be given to monitoring the performance of Forest and Gallery Forest (and IVS) restoration to be carried out under BAP 11 and BAP 13. Starting in 2021, this will include mapping the extent of different classes of habitat quality, scored using the UMAM approach (as revised), as well as standard indicators of restoration success (e.g. soil physical and biological characteristics, use of inputs, seedling survival, among others), biannually. Invasive alien species (IAS) will also be monitored attentively (see BMEP 12).

Frequency:	1/ Forest and Gallery forests mapping using remote sensing data: Yearly updates 2/ Monitoring of forest condition and adapting UMAM criteria: Bi-annual (Mar/Apr and Sept/Oct) monitoring every year until mitigation is complete; revised UMAM method following BAP 1 surveys, and subsequently after 5 years. 3/ Monitoring of restored forests on project footprint and former mining ponds: Once at the beginning and end of the restoration works, and biannually (during the dry (Mar/Apr) and rainy (Sept/Oct) season) thereafter.
Data analysis:	• Changes in the coverage and condition of forested habitats in the mining lease. • Changes in the connectivity of forested habitats. • Changes in the areas of IAS infestation in or near forested areas. • Variations in forest restoration rate and success and its determinants. • Revised UMAM method.
Data Reporting:	Yearly report (end of Q4 annually) presenting the results of the forested habitats monitoring including: • Updated map and analysis of forested habitats and restored habitats, and their condition. • Updated maps and analysis of the pressures on forest area and condition.
Responsible for monitoring:	SRL ER & R Operations Manager
KPI[2]	**Targets**
KPI 1 : Maps of forested habitats, including post-cultivation fallows and oil palm plantations (R)	• Revised maps by end of 2021, using data from surveys under BAP 1. • Updated map ground-truthed (yearly the first 5 years, every 3 years after).
KPI 2 : Revise UMAM approach for forest and IVS habitats	• Use data from field surveys (BAP1; 2020-2021) to prepare an adapted set of criteria and thresholds to determine 'Functional Gains' and restoration time-lags for SRL's use of the UMAM approach in demonstrating biodiversity losses and gains. Deadline: end of 2021. • Field data will also be used to modify size of avoidance of buffers (50 m) if necessary and to inform the categorization of indirect impacts.
KPI 3 : Area and condition of forested habitat in the mining lease assessed using UMAM approach (S)	Achieve > 16 forest restoration credits and > 15 gallery forest habitat restoration credits by the end of closure monitoring period as per the Mine Closure Plan (2020). Interim targets will be set and included in the next revision of the BAP.
KPI 4 : Incidents of unauthorized land clearing (i.e. full compliance with LDP procedure) (P)	• No unauthorized operational land clearing in Area 1.
KPI 5 : Area and condition of forest	• Restoration of Pejebu and Motinga ponds to be initiated during 2021.

[2] S = State indicator ; P = Pressure indicator ; R = Response indicator

habitat restored in legacy ponds (R)	
Implementation constraints and other remarks:	COVID-19 travel restrictions could prevent expatriate technical experts from accessing the site to execute or support biodiversity monitoring.
ESTIMATED BUDGET	
Estimated costs:	Monitoring to be completed as part of wet and dry season biodiversity surveys (included in budget for BAP 1). Mapping requirements to be completed by in-house GIS staff.

BMEP 2: Mangrove monitoring

<table>
<tr><th colspan="2">BMEP 2 – Mangrove monitoring</th></tr>
<tr><td colspan="2">SCOPE OF THE MONITORING</td></tr>
<tr><td>Objective:</td><td>Monitor changes in the area and condition of mangroves in the mining lease</td></tr>
<tr><td>Natural habitat concerned:</td><td>• Mangroves</td></tr>
<tr><td>Species concerned:</td><td>• Freshwater and estuarine fish species
• West African Nile Crocodile (Crocodylus suchus)</td></tr>
<tr><td>Impacts addressed:</td><td>• Loss and degradation of natural habitat
• Alteration of ecosystem functioning and ecosystem services</td></tr>
<tr><td colspan="2">MONITORING IMPLEMENTATION</td></tr>
<tr><td>Location:</td><td>Restored mangroves and mangroves on the mining lease and channels around and downstream of Nitti port to Sherbro Bay.</td></tr>
<tr><td>Data collection method:</td><td>
1/ Mangrove mapping using remote sensing data:
Mangroves will be included in the analysis of remotely sensed data to map forested habitats across the mining lease (BMEP 1), but the focus on mangroves will extend beyond the mining lease to channels downstream of Nitti port to Sherbro Bay.

2/ Field surveys of mangrove condition
To complement remote-sensing data, surveys will be undertaken on a selection of several transects set at 90° to the coastline (especially around Nitti port and downstream of Gangama pond and Higima), where mangrove condition will be assessed using data on e.g. species present, tree size, %-canopy cover, sedimentation/erosion (accretion/low degree of sedimentation; degree of erosion), etc. Condition scores are illustrated in the table below.

Table 2 : Codes used to record the impact of pressure on mangrove ecosystems
<table>
<tr><th>Code</th><th>Impact</th><th>% Cover Canopy</th><th>Example</th></tr>
<tr><td>0</td><td>No Impact</td><td>96-100</td><td>Even canopy of trees. No gaps. No evidence of human interference.</td></tr>
<tr><td>1</td><td>Slight Impact</td><td>76-95</td><td>Canopy of trees fairly continuous but some gaps. Some regrowth. Isolated cutting/stripping of trees or some evidence of pigs digging up saplings.</td></tr>
<tr><td>2</td><td>Moderate Impact</td><td>51-75</td><td>Broken canopy of trees with lower regrowth and recruitment areas. Some trees cut and stripped.</td></tr>
<tr><td>3</td><td>Rather High Impact</td><td>31-50</td><td>Tree canopy is uneven, the majority of the area is not showing regrowth and there is bare mud.</td></tr>
<tr><td>4</td><td>High Impact</td><td>11-30</td><td>Only a few trees remain at canopy height. Extensive clearance and some recruitment, large areas of bare mud</td></tr>
<tr><td>5</td><td>Severe Impact</td><td>0-10</td><td>Extensive clearance to bare mud, little recruitment, few trees remain alive</td></tr>
</table>
3/ Monitoring of restored mangroves through permanent plots
Small permanent plots of 10m x 10m (or 5x5 if high tree density) will be set-up in the restored area on the project footprint and in other (control) locations in order to monitor restoration progress and
</td></tr>
</table>

	performance. Plot location will be determined during mangrove restoration design (BAP 11). Data collected will include species name, diameter at breast height (DBH, circumference around 1,3 m above the mud level), tree height and diameter (determined later through circumference measurement, physicochemical characteristics of sediments and the water column, among others).
Frequency:	1/ Mangrove mapping using remote sensing data: annually (dry season) 2/ Field surveys of mangrove condition: annually 3/ Monitoring of restored mangroves through permanent plots: monthly for the first year, bi-annually the next years
Data analysis:	• Maps of mangrove area and condition • Drivers of mangrove condition • Mangrove restoration pathways • Factors determining mangrove restoration success
Data Reporting:	Annual report by end of Q4 on mangrove area and condition with a focus on restored mangroves and mangrove degradation outside the mining lease.
Who is responsible?	SRL ER & R Operations Manager
KPI[3]	**Targets**
KPI 6 : Map of the Mangrove habitats in the mining lease (R)	• Yearly updated map available.
KPI 7 : Area and condition of Mangroves in the mining lease assessed using UMAM approach	• Achieve 45 mangrove restoration credits by end of closure monitoring period. • Field data will also be used to modify size of avoidance of buffers (50 m) if necessary and to inform the categorization of indirect impacts.
Implementation constraints and other remarks:	• Access to areas outside the mining lease for mangrove condition surveys and long-term plots. • Design of mangrove restoration to be implemented by an Aquatic Specialist. • COVID-19 travel restrictions could prevent expatriate technical experts from accessing the site to execute or support biodiversity monitoring.
ESTIMATED BUDGET	
Estimated costs :	Mapping requirements to be completed by in-house GIS staff Monitoring to be completed as part of wet and dry season biodiversity surveys (included in budget for BAP 1).

[3] S = State indicator; P = Pressure indicator; R = Response indicator

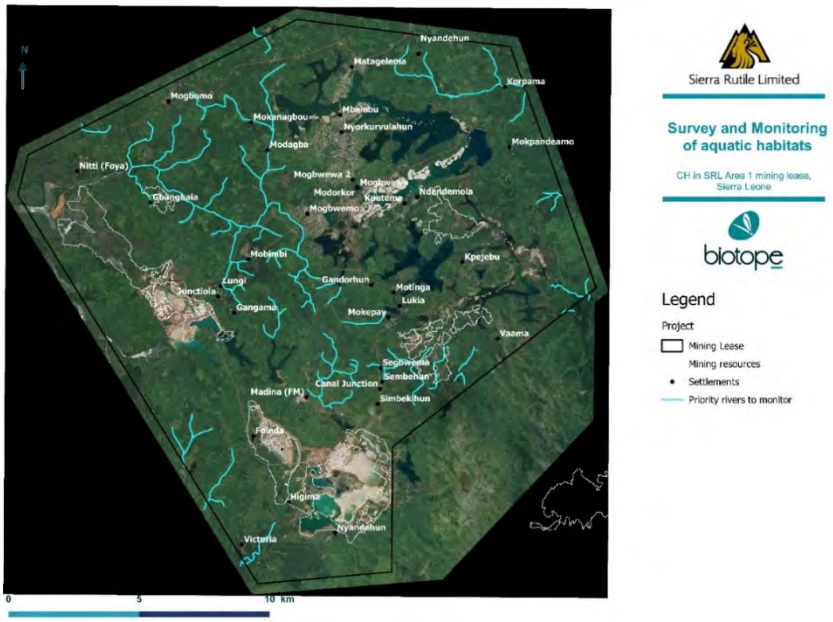
BMEP 3: Inland Valley Swamp monitoring

BMEP 3 – Inland Valley Swamp monitoring	
SCOPE OF THE MONITORING	
Objective:	Monitor changes in the area and condition of inland valley swamps in the mining lease.
Critical habitat concerned:	IVS
Species concerned:	• Western Chimpanzees (*Pan troglodytes verus*)
Impacts addressed:	• Loss and degradation of natural/critical habitat. • Alteration of ecosystem functioning and ecosystem services.
MONITORING IMPLEMENTATION	
Location:	IVS across the mining lease, with a focus on those restored in former mining ponds (BAP 13)
Data collection method:	**1/ IVS mapping using remote sensing data:** IVS will be included in the analysis of remotely sensed data to map forested habitats across the mining lease (BMEP 1). **2/ Field surveys of IVS condition and functioning in former mining ponds** To complement remote-sensing data, twice yearly plot based surveys will be undertaken in IVS to collect data on their physical and hydrological characteristics, vegetation, wildlife presence and human activities. Surveys will be conducted in restored former mining ponds and appropriate control sites in the mining lease. The following factors could be investigated: Physical and hydrological characteristics of IVS • Water regime: period and extent & depth of flooding • Water quality (e.g. chemical composition, pollutants); see BMEP 4 • Soil nature and physicochemical characteristics • Size and declivity of the upland area contributing to runoff, the size of the valley bottom that receives the runoff, and the general topography of the catchment • Vegetation cover and land-uses in the IVS catchment area • Evidence of soil runoff and erosion in the IVS catchment area Vegetation and wildlife • Dominant species of flora and their coverage • IAS and their coverage (see BMEP 12) • All evidence of animal presence; data on Chimpanzees will be particularly sought (see BMEP 5) Human activity and surroundings • Human uses of the IVS (agriculture, aquaculture, fishing, hunting & trapping, etc.) and their timing (seasonality), duration (permanent vs. temporary) and intensity Based on the data collected, a revised set of criteria and thresholds will be identified to determine 'Functional Gains' and restoration time-lags for IVS to inform SRL's use of the UMAM approach in demonstrating biodiversity losses and gains.

Frequency:	1/ IVS mapping using remote sensing data: annually (dry season) 2/ Field surveys of IVS condition in former mining ponds: bi-annually
Data analysis:	• Maps of IVS area and condition • Revised criteria for assessing IVS condition under the UMAM approach • IVS restoration pathways and factors determining IVS restoration success • IVS use by Chimpanzees (see BMEP 5)
Data Reporting:	Annual report (by end of Q4) on IVS condition, use by Chimpanzees and which factors can be used to better predict the favourability of the IVS habitat for Chimpanzees
Who is responsible?:	SRL ER & R Operations Manager
KPI[4]	**Targets**
KPI 8 : Maps of Inland Valley Swamps on the mining lease, including those frequented by chimpanzees on the mining lease (R)	• Surveys (BAP 1) will provide a better understanding of the use of IVS by Chimpanzees. • Data on Chimpanzee use of IVS to be included in bi-annual Chimpanzee survey reports and analyzed yearly to provide information on use of IVS by Chimpanzees.
KPI 9 : Area and condition of IVS in the mining lease assessed using UMAM approach (S)	• Achieve > 17 IVS restoration credits by end of closure monitoring period. • Field data will also be used to modify size of avoidance of buffers (50 m) if necessary and to inform the categorization of indirect impacts.
ESTIMATED BUDGET	
Estimated costs:	Monitoring to be completed as part of dry (Mar/Apr) and wet (Sept/Oct) season biodiversity surveys (included in budget for BAP 1). Mapping requirements to be completed by in-house GIS staff Detailed cost estimate for surveys and permanent plots to be included in pond restoration design (BAP 13).

[4] S = State indicator ; P = Pressure indicator ; R = Response indicator

BMEP 4: Aquatic habitats monitoring

BMEP 4 – Aquatic habitats monitoring	
SCOPE OF THE MONITORING	
Objective:	Monitor changes in the condition of aquatic habitats in the mining lease, including restored habitats
Critical habitat concerned:	• Rivers and streams are potential critical habitats for freshwater fish species
Species concerned:	• Freshwater fish species • Reptiles: Slender-snouted Crocodile (*Mecistops cataphractus)*, West African Nile crocodile (*Crocodylus suchus*) • Amphibians: Allen's Slippery Frog (*Conraua alleni)* and Freetown Long-fingered Frog (*Arthroleptis aureoli)* • Insects: *Pseudagrion mascagnii* and Yellow-fronted Threadtail (*Elattoneura dorsalis)* • Decapods (Freshwater crabs): *Afrithelphusa leonensis* and *Afrithelphusa afzelli*
Impacts addressed:	• Loss and degradation of natural and/or critical habitat • Alteration of ecosystem functioning and ecosystem services
MONITORING IMPLEMENTATION	
Location:	Streams and other aquatic habitats in Area 1 mining lease.
Data collection method:	Changes in the condition of aquatic habitats will be monitored in streams, rivers and riverine habitats directly or indirectly impacted by the project, and the aquatic habitats benefiting from restoration action (BAP 11, 12 & 13). Focal streams and rivers will be identified through BAP 1 surveys and analyses in BAP 3. The map below provides an overview of current information.  Figure 2 : Main areas anticipated to perform the aquatic monitoring in Area 1

	Data will be collected on the following • Water regime • Substrate, including evidence of fine sediment and sand loading (see BAP 3) • Vegetation composition and structure of aquatic and riverine habitats, including IAS • Aquatic fauna, including potential critical habitat triggers (see BMEP 8 to 10 and 12) • Human uses of aquatic habitats (fishing, hunting & trapping, etc.) and their timing (seasonality), duration (permanent vs. temporary) and intensity • Water quality, including indicators based on benthic diatoms and macro-invertebrates (see below) • Land-cover and land-use in the watersheds of aquatic habitats (see BMEP 1, 2 and 3) Macro-invertebrate communities monitoring: Benthic macroinvertebrates are valuable for bioassessments, due largely to their visibility to the naked eye, ease of identification, rapid life cycle often based on the seasons and their largely sedentary habits. Carry out Macro-invertebrates sampling following the South African Scoring System (SASS5) method designed to comply with international accreditation protocols (Dickens & Graham, 2002). The values of the indexes and the proportions of the different types of macro-invertebrates will glean information on habitat and water quality over time.
Frequency:	• Restoration sites: Once before restoration and once at the end of the restoration works and then twice a year (during the dry and wet season). • Other CH aquatic sites: biannually (during the dry and wet season).
Data analysis:	• Map of critical aquatic habitats, their area and length, and condition • Progress in aquatic habitat restoration • Changes in water quality in CH streams and its drivers • Change in IAS in aquatic habitats
Data Reporting:	Yearly report (end of Q4) presenting the results of the aquatic habitats monitoring, including: • Habitat area and condition, including AIS (see BMEP 12) • Water quality monitoring results, including diatoms and macro-invertebrate communities • Aquatic habitat use by CH qualifying species populations: fish, crocodiles, etc. (see BMEP 7 to 10) • Data collected on harvesting of CH qualifying species during pond lowering process (see BAP 4; BMEP 8 & 10)
Who is responsible?:	SRL ER & R Operations Manager
KPI[5]	**Targets**
KPI 10 : Map of critical freshwater habitats, including the number of endemic fish species and population estimates (R)	• Surveys (BAP 1) will provide a better understanding of aquatic critical habitat triggers and habitats across the mining lease. • Data on fish and other species shared on GBIF.

[5] S = State indicator; P = Pressure indicator; R = Response indicator

KPI 11 : Condition of aquatic habitats (S)	• The condition of streams, rivers, wetlands and gallery forests (ecological continuity, species diversity, water quality, invasive alien species) is monitored annually and improves in the mining lease. • Indicators specific to confirmed critical habitat triggers will be determined following BAP 1.
KPI 12 : Pre-treatment of process water released in natural environment (R)	• Development of a water quality protection plan by end of 2021. • Water quality discharge complies with Sierra Leonean regulations and industry best practice.
Implementation constraints and other remarks:	COVID-19 travel restrictions could prevent expatriate technical experts from accessing the site to execute or support biodiversity monitoring.
ESTIMATED BUDGET	
Estimated costs :	Monitoring to be completed as part of wet and dry season biodiversity surveys (included in budget for BAP 1. Mapping requirements to be completed by in-house GIS staff Detailed cost estimate for surveys of stream restoration success to be included in pond restoration design (BAP 13). Costs for design of expanded water quality monitoring included in SRL ER & R Operational budget.

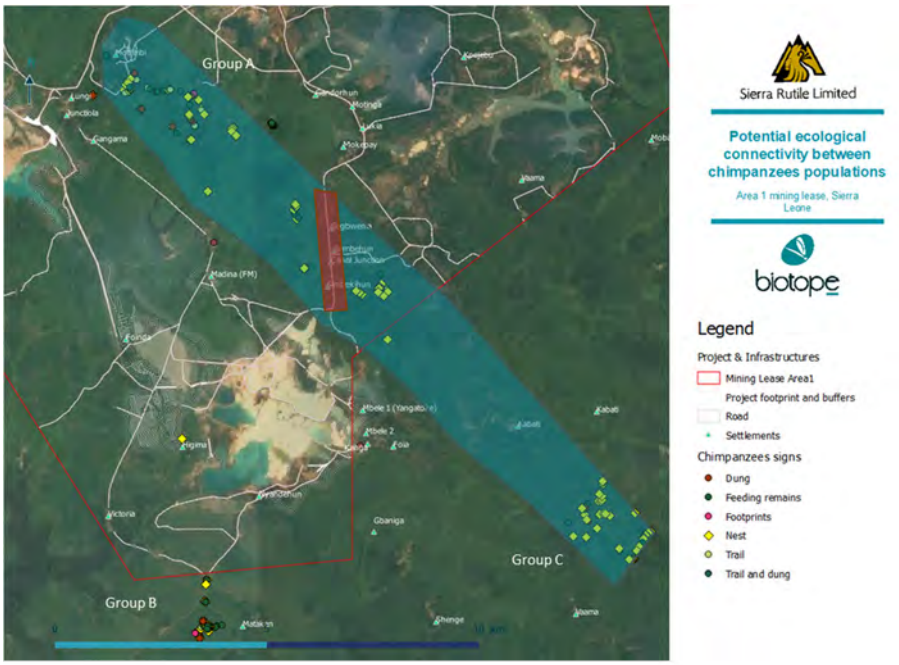
3. MONITORING OF CH QUALIFYING SPECIES

BMEP 5 to 12 are focused on critical habitat qualifying species, across the mining lease. SRL will share data with GBIF (as recommended under the 2020 version of the Equator Principles[6]) and relevant IUCN specialist groups.

BMEP 5: Monitoring of Chimpanzees

BMEP 5 – Chimpanzee monitoring	
SCOPE OF THE MONITORING	
Objective:	Estimate chimpanzee numbers and the status of the local community in the mining lease.
Critical habitat concerned:	• Forest • Gallery Forest • IVS • Shifting cultivation
Species concerned:	• Western Chimpanzee *(Pan troglodytes verus)*
Impacts addressed:	• Habitat loss and fragmentation • Zoonotic disease transmission • Hunting
MONITORING IMPLEMENTATION	
Location:	Across the mining lease, with a focus on habitat types favoured by the SCC, especially Mobimbi hills and Simbekihun hills.
Data collection method:	**1/ Genetic capture - mark-recapture** Chimpanzees present in the mining lease are part of the Moyamba chimpanzee population, estimated to 600 individuals in 2011 (Carlsen et al, 2012).  Figure 3 : Eleven core areas for chimpanzee populations based on chimpanzee density, regional threats and protected area status, estimated to facilitate viability studies about chimpanzees in Sierra Leone (Source: Carlsen et al, 2012) In the mining lease, the 2019 Chimpanzee genetic baseline survey estimated a total population size of 30 – 98 individuals from three groups in Area 1 (including two groups just outside the Area 1 boundary). Genetic sampling of all three groups will be continued to refine the precision of this population estimate. Genetic monitoring can also help to elucidate whether there are 1 or 2 groups within Area 1 (it is possible that chimpanzees that cross the road to the east of Gbangbama, near the village of Canal, are a separate group, Campbell *et al.* 2019). Genetic monitoring can also track the movement of individuals among groups, which will help to plan and assess forest restoration efforts. Samples should be collected monthly (can be done while conducting recces, see below) and sent to a lab for analysis twice per year. It is recommended to use the same laboratory as the baseline population

[6] https://equator-principles.com/wp-content/uploads/2020/09/Biodiversity_Data_Sharing_Guidance_Ext_Sept_2020.pdf

	estimate (Max Planck Institute for Evolutionary Anthropology). For dung collection methods, see Campbell *et al.* 2019. **2/ Camera trapping** Camera trapping is ideal for monitoring chimpanzee demography (as an indicator of population growth and intergroup transfers) and health (*e.g.* snared and/or sick individuals). However, challenges associated with theft must be managed before SRL commits to this monitoring method. SRL will investigate feasibly of a camera trapping program.  Figure 4 : Recommendations for first priority sampling areas to potentially position camera-trapping (In Blue: Mobimbi Hills and the potential connections of the community A to the communities B in the south-east of the mining lease, in red : along the haul road between Segbwema and Simbekihun). **3/ Recces** To gain an understanding of the seasonal use of habitats by Chimpanzees, foot surveys (reconnaissance surveys or 'recces') should be conducted monthly in areas known and thought to be used by Chimpanzees (which can be facilitated by developing a community phone network, see below). To ensure equal coverage of all areas, a grid square should be overlaid (*e.g.* 1 km x 1 km) onto a map of Area 1 and recces walked within each grid. The number of squares monitored should increase as knowledge of Chimpanzee habitat use also increases. Along the recce trails, data should be collected on Chimpanzee direct and indirect sign (vocalizations, feeding remains, trails and nests, etc) with nests classified by age on a 1 -4 scale following Tutin & Fernandez (1984). Data should also be collected on any threats (*e.g.* snares, gunshells, logging). For each sign recorded, a corresponding land use land cover (LULC) type should also be recorded. During the recces, the research team should carry sample tubes for opportunistic dung collection for the ongoing genetic survey. The use of Spatial Monitoring and Reporting Tool ("SMART") technology to collect data as part of adaptive management could be assessed for feasibility. This tool allows for data collection on mobile devices and makes it possible to collect, store, communicate and analyze data collected on chimpanzee presence and human disturbance activities. **4/ Community reporting network** Chimpanzee community reporting networks have been successful in West Africa (Campbell *et al*. 2019). Here, community members can be contacted (or vice-versa) to report on current Chimpanzee evidence seen or heard, a successful method employed during the 2019 Chimpanzee surveys. Feasibility of this monitoring method will be evaluated.
Frequency:	• Continuous data collection, to be adjusted via adaptive management

Data analysis:	• Estimates of chimpanzee numbers and other relevant demographic data • Maps of chimpanzee habitat use
Data Reporting:	• Bi-annual reports (end of Q2 and Q4) of chimpanzee survey data • Annual estimates (end of Q4) of chimpanzee numbers and demographic data • Data contributed to the IUCN SSC A.P.E.S. database
Who is responsible?	SRL ER & R Operations Manager
KPI[7]	**Targets**
KPI 13 : Chimpanzee Population surveys (S)	• Bi-annual chimpanzee survey reports available including records of sightings, data collected and results analyzed, and maps of habitat use by chimpanzees produced. • Chimpanzees documented in areas targeted for forest conservation and restoration (Mobimbi hills and Simbekihun hills). • Increase in population by end of closure period as determined by genetics analysis (compared to 2019 baseline). • Data shared with IUCN SGA.
KPI 14 : Number of collisions and/or accidents between chimpanzees and vehicles in the mining lease (P)	• Opportunistic sightings of chimpanzees crossing roads or near roads included in chimpanzee survey reports. • No collisions and/or accidents between chimpanzees and SRL vehicles.
ESTIMATED BUDGET	
Estimated costs :	• $66,700 for yearly genetic analysis and community monitoring • $3,000 for 10 Camera traps (if this method is deemed feasible). After the successful implementation and sustained use of 10 cameras, more cameras will be added to the studieS • Included in E&R Planning Department budget

[7] S = State indicator ; P = Pressure indicator ; R = Response indicator

BMEP 6: Monitoring of other primates and terrestrial mammals

BMEP 6 –Monitoring of other primates and terrestrial mammals	
SCOPE OF THE MONITORING	
Objective:	Document presence, habitat use and distribution of CH qualifying mammals other than Chimpanzees
Critical habitat concerned:	• Forest • Gallery Forest
Species concerned:	Western Red Colobus (*Piliocolubs badius*), King Colobus (*Colobus polykomos*), Diana Monkey (*Cercopithecus diana*), Jentink's duiker (*Cephalophus jentinki*)
Impacts addressed:	• Habitat loss • Habitat degradation and fragmentation • Zoonotic disease transmission • Hunting
MONITORING IMPLEMENTATION	
Location:	Across the mining lease, with a focus on habitat types favoured by the SCC.
Data collection method:	This obligation is contingent on confirming the presence of all four species, which are all currently unverified (however during community interviews during the 2019 primate survey, respondents did report the presence of both Colobus monkeys). BAP 1 discusses the additional surveys needed to confirm presence of these taxa. Due to the very secretive nature and likely low density of these species (if they are documented at all), standard transects/recces would likely not yield enough, or any information about their presence and habitat use. Therefore, the use of remote camera traps is recommended. The use of camera traps at SRL is contingent on an accepted/successful incentive program to discourage camera theft. If any of these species are verified to be present at SRL, ground and arboreal camera traps should be used to continue to document their presence and habitat use in the exact area and surrounding areas where each species was located. Camera should be placed in these areas and set to continuously collect data 24 hrs/day throughout the year (using methods explained in BMEP5, Chimpanzees monitoring). The use of eDNA, in particular in rivers within Gallery forests, will also be explored. Community interviews to determine species presence can be employed while the camera trapping program is being vetted, targeting those communities not included in the 2019 primate survey.
Frequency:	• Bi-annual until all villages in SRL have been interviewed • Continuous data collection, to be adjusted via adaptive management
Data analysis:	• Consolidated list of primates (other than chimpanzees) and terrestrial mammal CH qualifying species present on the mining lease • Map of habitat use of present species
Data Reporting:	• Bi-annual (end of Q2 and Q4) mammal survey reports
Who is responsible:	SRL ER & R Operations Manager

KPI[8]	Targets
KPI 15 CH Terrestrial mammal population surveys	• Wet and dry season CH terrestrial mammal survey reports available including records of animal signs, their distribution, maps of habitat use and recommendations for future monitoring. • Map of critical habitats for terrestrial mammals available in 2021.
ESTIMATED BUDGET	
Estimated costs:	Monitoring to be completed as part of Dry (Mar/Apr) and Wet (Sept/Oct) season biodiversity surveys (included in budget for BAP 1). Cost of camera trapping included in the cost of BMEP 5.

[8] S = State indicator ; P = Pressure indicator ; R = Response indicator

BMEP 7: Monitoring of birds

BMEP 7 – Monitoring of birds	
SCOPE OF THE MONITORING	
Objective:	Document population dynamics, habitat use and distribution of CH qualifying bird species on the mining lease
Critical/natural habitat concerned:	• Forests • Mangroves • Shifting cultivation
Species concerned:	Timneh Parrot (*Psittacus timneh*), Hooded Vulture (*Necrosyrtes monachus*)
Impacts addressed:	Habitat loss, degradation and fragmentation, potential electrocution (if cases documented)
MONITORING IMPLEMENTATION	
Location:	Across the mining lease, with a focus on habitat types favoured by the SCC
Data collection method:	*Hooded vulture* If this species is identified in the baseline surveys (BAP1), surveys will be undertaken in and around those locations where Hooded Vultures were documented. These may include road surveys across the mining lease, focused on large soaring birds, and villages and locations where rubbish / garbage attracts vultures. Potential nesting sites (large trees) will also be investigated. If Hooded vultures are documented to range around villages, community monitors could be employed to record the species. Data should be collected on location, number of individuals, habitat type, and behaviour (soaring, scavenging, etc.). *Timneh Parrot* BAP Action 1 will use Distance methods to estimate a population count. Using these data, recce surveys will then be utilized to monitor this population over time. The accuracy of comparing recce surveys to Distance-based surveys have been validated (Marsden *et al.* 2016)*Data on recces will include locations of sightings*, number of individuals, and whether individuals were perching or flying. When roosting locations are observed, information on tree characteristics should be recorded (tree species, diameter at breast height [DBH] of tree, and height of roosting location from the ground). Areas targeted for forest conservation and restoration (e.g. Mobimbi hills and Simbekihun hills) should also be prioritized for parrot surveys.
Frequency:	• Biannually or monthly, depending on results of BAP 1 surveys
Data analysis:	• Presence, distribution, and habitat use of Hooded vulture and Timneh Parrot in the mining lease • Maps of habitat use in the mining lease
Data Reporting:	Bi-annual (Jun/Dec) report
Responsible for monitoring :	SRL ER & R Operations Manager
KPI[9]	**Targets**

[9] S = State indicator ; P = Pressure indicator ; R = Response indicator

KPI 16 : Population survey of Hooded Vultures, Timneh Parrot and other bird species of concern in the mining lease	• Twice annual bird survey reports available including records of animal signs, their distribution, maps of habitat use and recommendations for future monitoring. • Data shared on GBIF.
Implementation constraints and other remarks:	/
ESTIMATED BUDGET	
Estimated costs :	Monitoring to be completed as part of dry (Mar/Apr) and wet (Sept/Oct) season biodiversity surveys (included in budget for BAP 1).

BMEP 8: Monitoring of crocodiles

BMEP 8 – Monitoring of crocodiles	
SCOPE OF THE MONITORING	
Objective:	Document population dynamics, habitat use and distribution of crocodiles on the mining lease
Critical/natural habitat concerned:	• Gallery forests • Mangroves • Streams and rivers
Species concerned:	West African Nile Crocodile (*Crocodylus suchus*), the Slender-snouted Crocodile (*Mecistops cataphractus*) and the African Dwarf Crocodile (*Osteolaemus tetraspis*).
Impacts addressed:	• Habitat loss, degradation and fragmentation • Hunting and trafficking
MONITORING IMPLEMENTATION	
Location:	Mining lease, with a focus on aquatic habitats downstream of new dams and in restored streams.
Data collection method:	Results from BAP 1 and BAP 4 will guide monitoring locations for crocodiles. Both diurnal and nocturnal surveys should be conducted, by boat, or on foot if watercourses are narrow and small. Diurnal surveys should be utilized to detect basking crocodiles and roosting sites, and plan nocturnal survey routes (Shirley *et. al* 2009). When spotted, crocodiles should (safely) be approached to determine species and estimate total length and record any behaviour. Surveys should be conducted during the wet and the dry season, planning on particular time periods depending on the species biology (e.g. egg laying by the Slender-snouted crocodile mostly begins at the start of the rainy season). The use of eDNA and camera traps will also be investigated for feasibility.
Frequency:	Bi-annually, to be modified depending on threat level
Data analysis:	• Consolidated list of CH qualifying reptile species present on the mining lease. • If presence verified, present habitat use and expected and/or confirmed distribution of the species on the mining lease.
Data Reporting :	• Bi-annual reports (Jun/Dec)
Who is responsible?:	SRL ER & R Operations Manager
KPI[10]	**Targets**
KPI 17 Population surveys of CH crocodiles and frogs on the mining lease	• Twice annual crocodile survey reports available (Jun/Dec) including records of animal signs, their distribution, maps of habitat use and recommendations for future monitoring. • Data shared on GBIF.

[10] S = State indicator ; P = Pressure indicator ; R = Response indicator

KPI 15 : Direct or indirect mortality of CH qualifying species in the context of pond lowering (P)	• No CH qualifying species and/or species of stakeholder concern mortality related to pond lowering.
Implementation constraints and other remarks:	Reptile and Amphibian Program (RAP) of Sierra Leone may be approached for technical assistance.
ESTIMATED BUDGET	
Estimated costs :	Monitoring to be completed as part of wet and dry season biodiversity surveys (included in budget for BAP 1)

BMEP 9: Monitoring of amphibians

BMEP 9 – Monitoring of amphibians	
SCOPE OF THE MONITORING	
Objective:	Document population dynamics, habitat use and distribution of CH-qualifying amphibians on the mining lease, if their presence is confirmed
Critical habitat concerned:	• Aquatic habitats • Gallery forests
Species concerned:	• Allen's Slippery Frog (*Conraua alleni*) • Freetown Long-fingered Frog (*Arthroleptis aureoli*)
Impacts addressed:	Habitat loss, degradation and fragmentation of streams, rivers, wetlands and gallery forests
MONITORING IMPLEMENTATION	
Location:	Continuous forest patches close to rivers in a good state of conservation.
Data collection method:	Results from BAP 1, BAP 4 and BAP 5 will guide monitoring locations. Conduct visual and acoustic surveys in a selection of forest patches[11], in the rainy season (preferably between June and August), to determine the presence of the species in Area 1 and Area 5. Surveys will need to take place in the evening, using sound identification to detect individuals and if necessary, record the sound, then capture and/or photograph specimens. If possible, breeding sites for the two species could be identified in suitable forest patches and forest galleries. Investigate slow-flowing or nearly stagnant sections of streams close to fast-flowing permanent streams in gallery forests to find tadpoles. Concerning *Arthroleptis aureole*, its documented habitats are forests and rural gardens in their vicinity. These habitat mosaics should as well be considered and be part of the sampling sites. Sample along a gradient of forest patch sizes and distance from a river, with 3 samples/replicates in each habitat category, choosing representative locations both upstream and downstream of mining ponds (12 sample sites in total, covering notably : selected forest patches in Mobimbi hills ; streams around Victoria village – SW of Foinda ; and the main gallery forest at the north of Mobimbi to Nitti). This protocol and the exact locations of the sampling sites will have to be adapted to specific local conditions, especially following BAP 1 surveys. The use of eDNA will also be investigated for feasibility.
Frequency:	• Bi-annual (Dry: Mar/Apr; Wet: Sept/Oct) surveys
Data analysis :	• Consolidated list of amphibian CH qualifying species present on the mining lease. • Map of habitat use of present species.

[11] It is expected that the higher diversity and probability to encounter the species will be in continuous forest patches.(cf. Almeida et al (2016) Patch size matters for amphibians in tropical fragmented landscapes. Biological Conservation 195:89-96)

Data Reporting :	• Annual reports (end Q4)
Who is responsible? :	SRL ER & R Operations Manager
KPI[12]	**Targets**
KPI 17 : Population surveys of CH crocodiles and frogs on the mining lease *Presence and abundance of CH qualifying frog species and population thresholds to be determined based on additional surveys results (BAP 1)* (R)	• Bi-annual herpetological survey reports available including records animal signs, their distribution, maps of habitat use and recommendations for future monitoring. • Data shared on GBIF.
Implementation constraints and other remarks:	Reptile and Amphibian Program (RAP) of Sierra Leone may be approached for technical assistance.
ESTIMATED BUDGET	
Estimated costs :	Monitoring to be completed as part of wet and dry season biodiversity surveys (included in budget for BAP 1

[12] S = State indicator; P = Pressure indicator; R = Response indicator

BMEP 10: Monitoring of freshwater and estuarine fish

BMEP 10 –Monitoring of freshwater and estuarine fish	
SCOPE OF THE MONITORING	
Objective:	Document population dynamics, habitat use and distribution of CH-qualifying freshwater on the mining lease and estuarine fish in Sherbro Bay, if their presence is confirmed
Critical habitat concerned:	• Streams and rivers • Gallery Forests • Sherbro River Estuary
Species concerned:	Those fish species recorded during the additional BAP 1 surveys, which may include: • African wedgefish (*Rhynchobatus luebberti*, estuarine species) • Candidate freshwater species listed below: *Chiloglanis polyodon* *Chrysichthys johnelsi* *Coelotilapia joka* *Enteromius bagbwensis* *Enteromius liberiensis* *Epiplatys fasciolatus ssp. Josianae* *Epiplatys fasciolatus ssp. Zimiensis* *Epiplatys njalaensis* *Ladigesia roloffi* *Leptocypris taiaensis* *Marcusenius meronai* *Mastacembelus taiaensis* *Mochokiella paynei* *Notoglanidium maculatum* *Notoglanidium thomasi* *Ophichthus leonensis* *Scriptaphyosemion bertholdi* *Scriptaphyosemion chaytori* *Scriptaphyosemion roloffi*
Impacts addressed:	• Habitat loss and degradation • Fishing
MONITORING IMPLEMENTATION	
Location:	Waters where CH-qualifying fish species presence was verified in BAP 1 surveys, including streams and rivers in Area 1 and Sherbro River Estuary.
Data collection method:	Freshwater fish monitoring is also described as part of aquatic habitat monitoring under BMEP 4. Results from BAP 1, BAP 3 and BAP 4 will guide monitoring locations.

	With direction from a fish expert, survey methods for freshwater fish should use a suite of the following methods, depending on species: sparrow or seine nets, fyke nets, fish traps, etc. Habitat quality indicators (*e.g.* water quality, habitat type), number of specimens, and age/sex class will also be recorded. The use of eDNA will also be investigated for feasibility. Additionally, any relevant threats should also be recorded (fish trapping, artisanal mining, etc.). Monitoring of estuarine species, and the African Wedge fish in particular, could take place through fisher interviews and surveys at landings and fish markets around Sherbro Bay.
Frequency:	Biannually, once each during the dry (Mar/Apr) season and wet (Sept/Oct) season
Data analysis:	• Distribution of the CH qualifying fish species on the mining lease, highlighting their respective spawning areas. • Presence and trends for the African Wedgefish, if present in Sherbro River Estuary.
Data Reporting:	Biannual (Jun, Dec) reports
Who is responsible?:	SRL ER & R Operations Manager
KPI[13]	**Targets**
KPI 18: Populations surveys of CH fish in the mining lease KPI 19: Direct or indirect mortality of CH qualifying species in the context of pond lowering KPI 20: Presence and population estimate of African Wedgefish in Sherbro Bay *Presence of this African Wedgefish and population thresholds to be determined based on additional surveys results (BAP 1)*	• Biannual survey reports of fresh water fish, their distribution, maps of habitat use and recommendations for future monitoring. • No documented mortality of CH qualifying species or species of stakeholder concern related to pond lowering. • Additional surveys (BAP 1) will also provide a better understanding of marine critical habitats in Sherbro Bay and associated estuarine habitats • Data shared annually with IUCN Shark Specialist Group.
Implementation constraints and other remarks:	Potential engagement with the Sherbro Bay MPA managers as part of BAP 12.
ESTIMATED BUDGET	
Estimated costs:	Monitoring to be completed as part of wet and dry season biodiversity surveys (included in budget for BAP 1. eDNA laboratory analysis $10,000/yr

[13] S = State indicator ; P = Pressure indicator ; R = Response indicator

BMEP 11: Monitoring of marine mammals

BMEP 11 – Monitoring of marine mammals	
SCOPE OF THE MONITORING	
Objective:	Monitor population dynamics, habitat use and distribution around the itinerary of SRL's fleet in and out of Nitti port
Critical habitat concerned:	Sherbro River Estuary
Species concerned:	• Atlantic Humpback Dolphin (*Sousa teuszii*) • African Manatee (*Trichechus senegalensis*)
Impacts addressed:	• Mortality by collision • Habitat disturbance • Hunting
MONITORING IMPLEMENTATION	
Location:	Nitti Port and Sherbro River Estuary
Data collection method:	Once each species is verified to range within SRL environs, SRL will organize: • Surveys by trained spotters on the shipping barges should watch for, and record when all highlight marine mammal species are observed. At least 2 spotters should be present on every barge and other boats going through Sherbro River Estuary. • Bi-annual population surveys of the two species of concern in Sherbro River Estuary to be conducted by an expert marine mammologist, who should train SRL staff in survey and monitoring methods. Information to be collected by spotters includes: i) date and time observation, ii) the GPS location of the observation, iii) the number and age class of each individual, iv) any distinguishing characteristics on the dorsal fin or part of body seen of each individual, v) and other specific behaviors observed (feeding, breaching, etc.). Turtle species that are of stakeholder concern should also be recorded. The use of eDNA will also be investigated for feasibility.
Frequency:	• Population surveys to be performed bi-annually (dry season: Mar/Apr; wet season: Sept/Oct) • Spotters' monitoring on every shipping barge passage
Data analysis:	• Population estimates and maps of habitat use in Sherbro River Estuary. • Analysis of the marine mammal observations gathered on the SRL fleet boats to estimate risk of encounter depending on different factors, and identify areas with higher risk of collision along the barge itineraries. • In case of collision, analysis of the conditions and other factors influencing collisions (time of the day, season, weather, speed of the boat, presence of the spotter, etc.).
Data Reporting:	Monthly and annual (Dec) reports

Who is responsible?:	SRL ER & R Operations Manager
KPI[14]	**Targets**
KPI 16 : Population surveys of marine mammals, with a focus on Atlantic humpbacked dolphin and African manatee (R)	• Additional surveys (BAP 1) will provide a better understanding of marine critical habitats in Sherbro Bay and associated estuarine habitats. • Biannual marine mammal survey reports available including records of animal signs, their distribution, maps of habitat use, and recommendations for future monitoring. • No collisions and/or accidents between marine mammals and SRL vessels. • Data on marine mammals and other species shared on GBIF.
Implementation constraints and other remarks:	Potential engagement with the Sherbro Bay MPA managers as part of BAP 12.
ESTIMATED BUDGET	
Estimated costs :	Monitoring to be completed as part of wet and dry season biodiversity surveys (included in budget for BAP 1). Spotters already a component of Nitti Port staff, no added costs.

[14] S = State indicator ; P = Pressure indicator ; R = Response indicator

BMEP 12: Monitoring of Invasive Alien species

BMEP 12 – Monitoring of IAS	
SCOPE OF THE MONITORING	
Objective:	Successful adaptive management of invasive alien species as specified in BAP 6
Critical/natural habitat concerned:	• Forests • Gallery forests • Mangroves
Species concerned:	• Flora: *Terminalia ivorensis* and *Nauclea diderrichii*
Impacts addressed:	Introduction of IAS during the whole project cycle (*e.g.* building access roads and other infrastructures, transportation of equipment and materials in the area to Nitti port, vehicles / machinery movements, restoration construction works, etc.).
MONITORING IMPLEMENTATION	
Location:	The whole mining lease, with a focus on the project footprint (BAP 2 & BAP 5), restoration sites (BAP 11 & 13) and the Mobimbi hills and Simbekihun hills (BAP 12).
Data collection method:	• Map IAS areas as part of BAP 1, BAP 2, BAP 5 and BAP 6. • Implement a follow-up monitoring of IAS controlled sites in the mining lease to evaluate efficacy of treatment and requirements for follow-up treatment. • Track IAS when monitoring restoration progress and performance (BMEP 1 to 4).
Frequency:	Bi-annually
Data analysis:	Develop and annually update (finalise by end of Q4, but also on an ad-hoc basis) an IAS geodatabase, including a register of existing (or potentially present) IAS in the Project Area, distribution, related risks and management options.
Data Reporting:	Annual reporting (end of Q4) on the spread or containment of IAS in terms of diversity, coverage and distribution on the mining lease.
Who is responsible?:	• SRL ER & R Operations Manager • Expert botanist
KPI[15]	**Targets**
KPI 17 : Area of CH covered by IAS in natural habitats on the mining lease *Presence and coverage of IAS to be determined based on additional surveys results (BAP 1) to determine monitoring thresholds*	• Develop IAS monitoring and management plan by end of 2021. • Beginning 2022, annual report on IAS progression on the mining lease available (by end of Q4); including updates to a geodatabase of IAS concentrations and at risk areas. • IAS (plant) coverage in the natural habitats on the mining lease (forests, gallery forests, mangroves) is limited and decreasing.

[15] S = State indicator; P = Pressure indicator; R = Response indicator

KPI 18 : Area covered by IAS on rehabilitated area (P)	• Within 6 years of rehabilitation IAS (plant) coverage is below 5%
Implementation constraints and other remarks:	/
ESTIMATED BUDGET	
Estimated costs:	Monitoring costs to be included in the IAS management plan (BAP 10).

4. REFERENCES

Carlsen,F., Leus, K., Traylor-Holzer, K., McKenna, A.(Editors). 2012. Western Chimpanzee Population and Habitat Viability Assessment for Sierra Leone: Final Report. IUCN/SSC Conservation Breeding Specialist Group – Europe (CBSG Europe), Copenhagen, Denmark

Dickens, C. W. S. & Graham, P. M. 2002. The South African Scoring System (SASS) Version 5 Rapid Bioassessment Method for Rivers. *African Journal of Aquatic Science*; 27: 1-10

Heinicke S. et al, 2019. Advancing conservation planning for western chimpanzees using IUCN SSC A.P.E.S.—the case of a taxon-specific database. Environ. Res. Lett.14 064001

Lindon, A., Tatum-Hume, E., Katariya, V., Starkey, M. (2019). Biodiversity Management Framework for the Sembehun Mineral Sands Project, Sierra Rutile Limited, Sierra Leone. The Biodiversity Consultancy Ltd, Cambridge, UK.

Marsden, S.J., Loqueh, E., Takuo, J., Hart, J.A., Abani, R., Ahon, D., Annohrbah, N., Johnson, R., Valle, S. 2016. Using encounter rates as surrogates for density estimates makes monitoring of heavily traded gray parrots achievable across Africa. Oryx. 50(4). 617-625.

Shirley, M.H., Oduro, W., Beibro, H. 2009. Conservation status of crocodiles in Ghana and Cote d'Ivorie, West Africa. Oryx. 43(1). 136-145.