BIODIVERSITY ASSESSMENT

Mozal SA

FINAL REPORT

GT1233

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GroundTruth

Water, Wetlands and Environmental Engineering

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INDEMNITY

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LIST OF ACRONYMS

ASI	Aluminium Stewardship Initiative
CBD	Convention on Biological Diversity
IAP	Invasive Alien Plant
IAS	Invasive Alien Species
IBA	Important Bird Area
IBAT	Integrated Biodiversity Assessment Tool
IUCN	International Union for the Conservation of Nature
MITADER	Ministério da Terra, Ambiente e Desenvolvimento Rural
SCC	Species of Conservation Concern
WWTW	Wastewater Treatment Works

1. INTRODUCTION

GroundTruth were appointed by SE Solutions to undertake a Biodiversity Assessment for Mozal SA in Boane, Mozambique. The primary objective of this study was to characterise and define the biodiversity features within the company's Area of Influence (including the estuarine and marine environment) that may potentially be affected by its activities, with a particular focus on natural and/or sensitive communities and the Red Listed species identified in the Integrated Biodiversity Assessment Tool (IBAT) Proximity Report for the site.

1.1 Background and Objectives

Mozal SA is an aluminium smelter located in Beluluane Industrial Park, Boane, approximately 20km west of Mozambique's capital city Maputo (**Figure 1-1**)**.** Mozal's area of operation includes not only the aluminium smelter site in Boane, which occupies approximately 140 hectares of land, but also transport infrastructure, namely a harbour terminal at the Port of Matola, access roads and a bridge. Additionally, Mozal's operational infrastructure includes a pump station located in Boane on the Umbeluzi River for abstraction of freshwater, a pump station on the Matola River for abstraction of saline water, a Wastewater Treatment Works (WWTW) on a tributary of the Matola River east of the smelter and a desalination plant at the bulk terminal within the Port of Matola (**Figure 1-2**).

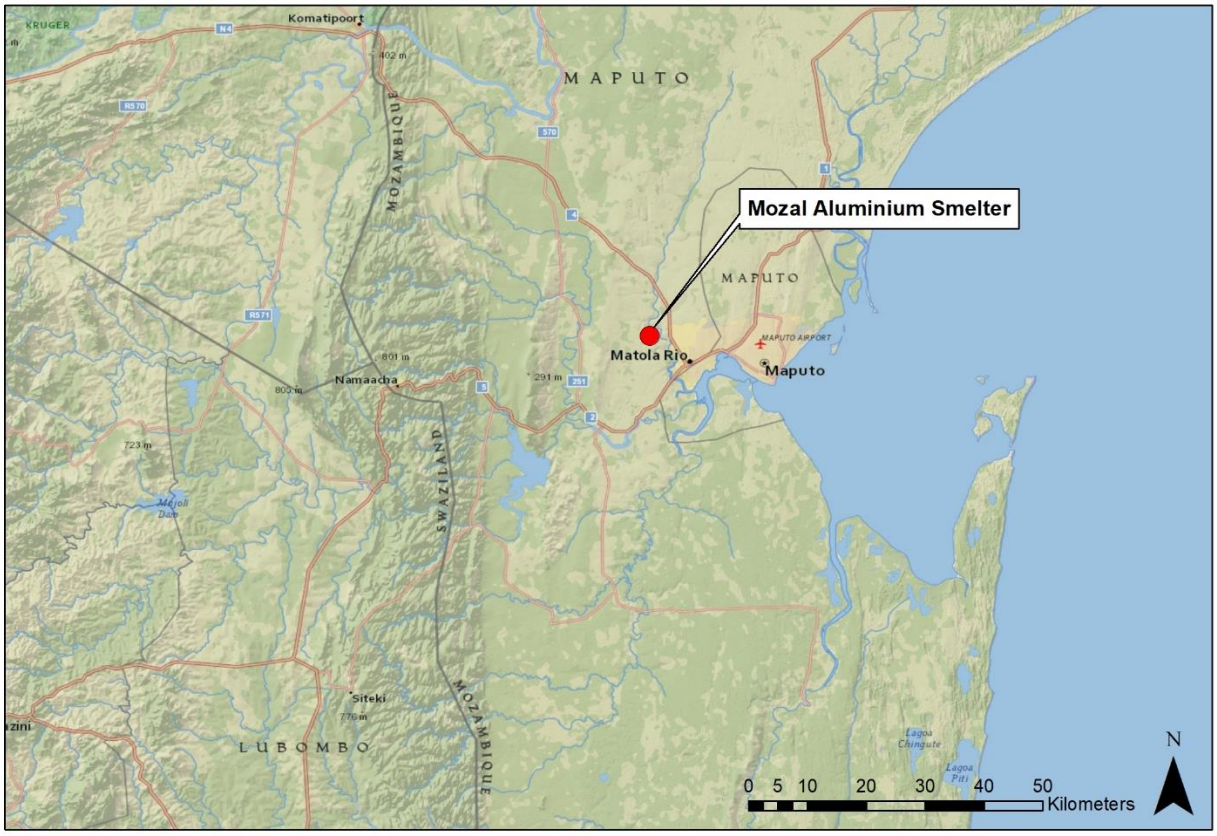

Figure 1-1 Locality of the Mozal Aluminium Smelter in relation to Maputo, Mozambique

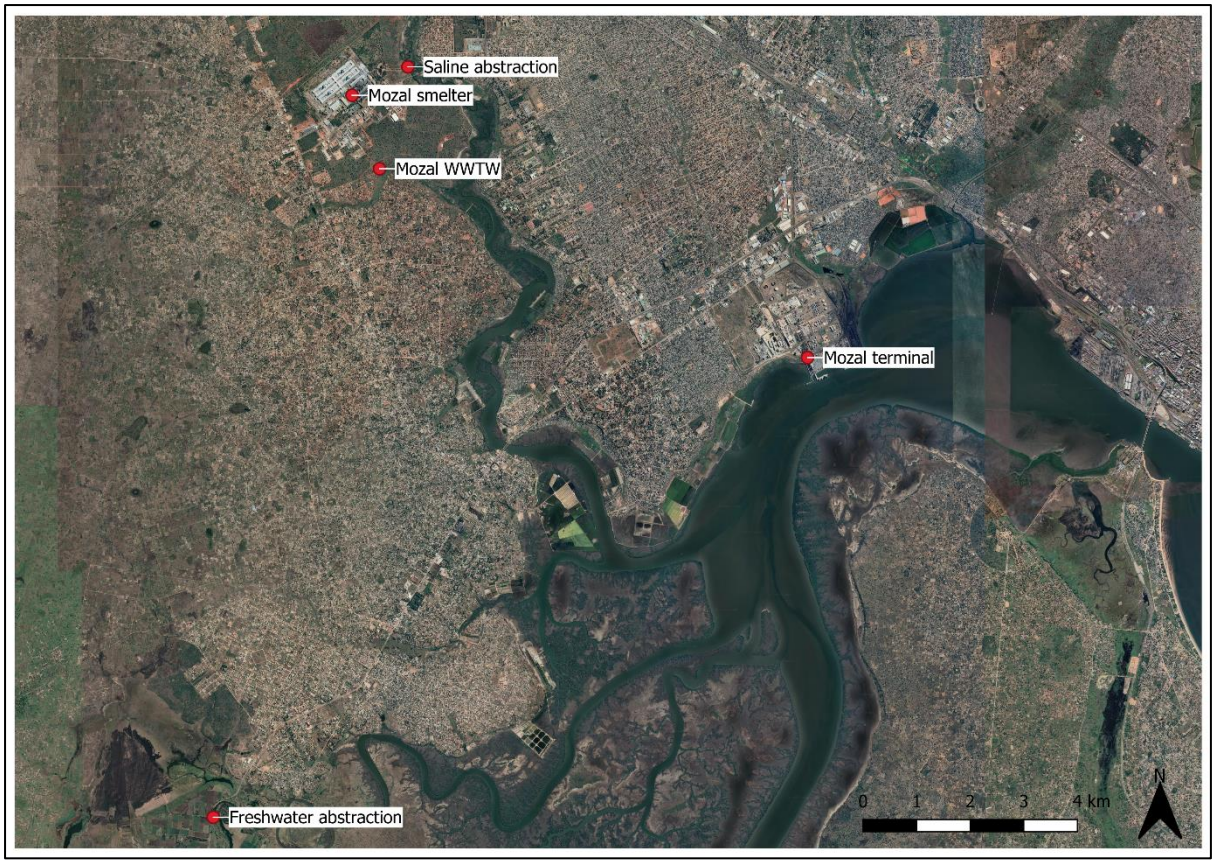

Figure 1-2 Locations of Mozal's key operational infrastructure

Mozal is Africa's second largest aluminium smelter, producing more than half a million tonnes of aluminium a year. The smelter produces aluminium ingots, primarily for export to Europe by sea, although some of the products are sold to Midal in Mozambique for the production of aluminium cables (Tchamo, 2021). Mozal has the capacity to handle approximately 600 tonnes of raw material, which includes alumina, petroleum coke and pitch (Zacarias, pers. Comm, 2021). Raw materials are imported by ship from the USA, China, India, Australia, South Korea, Belgium and occasionally Europe (Zacarias, pers. Comm, 2021).

The Aluminium Stewardship Initiative (ASI) aims to work "together with producers, users and stakeholders in the aluminium value chain to collaboratively foster responsible production, sourcing and stewardship of aluminium" (ASI, 2017). The ASI lays out a Performance Standard which defines environmental, social and governance principles and criteria, with the aim to address sustainability issues in the aluminium value chain. Mozal is a member of ASI and thus aims to conform with this ASI Performance Standard, which is structured around three core pillars, namely 1) Governance, 2) Environment, and 3) Social. Each of these pillars consist of a number of criteria which are required to be met, one of which pertains to biodiversity and its management. Within this exists Performance Standard 8.1: Biodiversity assessment. This Standard states that "the Entity shall assess the risk and materiality of the impacts on biodiversity from the land use and activities in the Entity's Area of Influence". Listed as a point of consideration under this criterion is the need to "undertake a risk assessment to identify the material impacts on biodiversity from activities conducted by or within the Area of Influence of the Entity".

In order to effectively manage and prevent unfavourable impacts on biodiversity, it is important to 1) understand the risk and materiality of the impacts associated with the company's activities in its Area of Influence, and 2) possess an understanding of the biodiversity present that may be affected by these impacts, with a particular focus on sensitive species, namely Critically Endangered (CR), Endangered (EN), Vulnerable (VU), or Near Threatened (NT) Red Listed species. For the purposes of this study, the company's Area of Influence encompasses the areas likely to be affected by the 1) company's activities/facilities, and 2) the company's associated facilities.

In order to gain insights into the biodiversity associated with Mozal's Area of Influence and the impacts the company's activities may have on this biodiversity, this study had the following objectives:

1. Identify the risks and materiality of the impacts on biodiversity from the company's activities;
2. Confirm the type and condition of vegetation on site, with consideration of areas adjacent to the site;
3. Define floral and faunal elements present in terms of species diversity, highlighting dominant/indicator species associated with the site, as well as movement patterns and supporting habitat;
4. Record and map sensitive/ecologically important areas and habitats, as well as areas that are already transformed and/or degraded;
5. Identify any conservation important/protected biodiversity, including Red Listed, regionally and nationally protected, and rare species, and record their respective locations; and
6. Assess the condition of the habitat in terms of its ability to support species of conservation concern.

An Integrated Biodiversity Assessment Tool (IBAT) Proximity Report had been produced by South32 for the Mozal site in March 2021. This report identified 124 IUCN Red Listed Species that may occur on or within the vicinity of the site. The presence of such Species of Conservation Concern (SCC) has numerous implications for the site's activities and management. As such, the broad approach adopted for this study was to review this list of species and assess the actual likelihood of their occurrence based on available habitat.

2. BACKGROUND AND CONTEXT

2.1 Mozambican Biodiversity

Biodiversity, or biological diversity, refers to the variety of life on Earth, or within particular habitats or ecosystems. It encompasses all living things, from bacteria to plants and animals. Biodiversity is of critical importance as it underpins the provision of ecosystem goods and services on which society is dependent for survival.

Mozambique is a highly biodiverse country, possessing three key groups of important natural ecosystems, namely 1) terrestrial ecosystems, 2) coastal and marine ecosystems and 3) interior water systems (MITADER, 2015). The country is one of the five main phytogeographical zones of southern Africa. These are:

1. Regional Mosaic Maputaland-Tongoland

2. Afromontane Endemism Centre
3. Zambezian Regional Centre of Endemism
4. Swahilian Regional Centre of Endemism
5. Regional Swahilian-Maputaland Transition Zone (MITADER, 2015).

These zones contain important biodiversity hotspots and endemism areas (MITADER, 2015). The main diversity hotspots and areas of plant endemism in Mozambique include Maputaland, Chimanimani, coastal forests and the mountains-island "inselbergs" in northern Mozambique.

Mozambique is home to an estimated 6 000 species of plants, 3 075 insects, 726 birds, 214 mammals, 171 reptiles and 85 amphibians (MITADER, 2015). Of the 6 000 plant species present, 300 are Red Listed and 22% are endemics (MITADER, 2015). The country contains 16 Important Bird Areas (IBAs) (i.e. areas that possess high bird diversity and endemism), two of which are marine and the remaining 14 terrestrial.

Mozambique's biodiversity faces a number of threats, the main ones being loss of habitat due to conversion, loss and fragmentation, overexploitation of species, invasion by alien species, pollution, and climate change (MITADER, 2015). Given Mozambique's biodiversity value, and the threats it faces, it is critical that efforts are made to protect and conserve this biodiversity.

2.2 Applicable Legislation, Guidelines and Standards

Mozambique has a legal framework in place to guide and enforce the conservation of biodiversity. Additionally, the country is a signatory to several international conventions related to biodiversity. Some of the relevant applicable legislation and conventions are discussed in greater detail below.

2.2.1 *Mozambican legislation*

2.2.1.1 *Land Law (Law 19/97)*

The Land Law covers the key aspects of land occupation and use, regulating various practices. This Law defines Nature Protection Zones as those intended for the conservation of certain animal or plant species, biodiversity, historical, scenic or natural monuments, within a system of management that preferably involves local community participation and is the subject of specific legislation. Article 7 of this Law defines Total Protection Zones as those intended for nature conservation or preservation activities and areas for State security and defence.

2.2.1.2 *Environmental Law (Law 20/97)*

This Law lays out the protective requirements to be satisfied in order to exploit the environmental sector and impact assessment conditions in order to avoid adverse environmental impacts. Article 4 of this Law lays out the fundamental principles of environmental management whilst Article 12 addresses the protection of biodiversity.

2.2.1.3 *Law of Forestry and Wildlife (Law 10/99)*

The Law of Forestry and Wildlife deals with the protection, conservation and sustainable exploitation of forest and wildlife resources under an integrated management framework for the economic and

social development of the country. This Law also defines the different types of protected areas for Mozambique.

2.2.1.4 *Conservation Law (Law 16/2014)*

The Conservation Law establishes the basic principles and rules on the protection, conservation and sustainable use of biological diversity within conservation areas. It also addresses integrated management for sustainable development of the country. The Conservation Law applies to all values and natural resources existing in the national territory and in waters under national jurisdiction, including all public and private entities that directly or indirectly impact upon biodiversity.

2.2.2 *International Guidelines and Standards*

2.2.2.1 *Convention on Biological Diversity (CBD)*

Mozambique is a signatory of the UN Convention on Biological Diversity (CBD), the objectives of which include biodiversity conservation, sustainable use of biological resources, and the fair and equitable use of biological and genetic resources. The CBD encourages individual countries to develop or adapt national strategies, plans or programmes to address the provisions of the Convention.

2.2.2.2 *African Convention on the Conservation of Nature and Natural Resources*

Mozambique is a signatory of the African Convention on the Conservation of Nature and Natural Resources. This Convention has a number of objectives, namely, to enhance environmental protection, foster the conservation and sustainable use of natural resources and harmonize and coordinate policies in these fields with a view to achieving ecologically sound and socially acceptable development policies and programmes.

2.2.2.3 *International Union for Conservation of Nature (IUCN)*

The IUCN system is designed to determine the relative risk of extinction of species, with the main purpose of the IUCN Red List to catalogue and highlight those taxa that are facing a higher risk of global extinction, with those listed as Critically Endangered, Endangered and Vulnerable collectively considered as Threatened. The IUCN Red List also includes information on taxa that cannot be evaluated because of insufficient information (i.e. Data Deficient), as well as taxa that are close to meeting the threatened thresholds (i.e. Near Threatened). The IBAT draws upon IUCN data to produce Proximity Reports such as the one produced for Mozal. The IUCN categories are summarised **Table 2-1**.

Table 2-1 IUCN categories used to assess the conservation status of species

IUCN Category	Description
Extinct	Where there is no reasonable doubt that the last individual of a species has died.
Extinct in the Wild	A species that no longer occurs in the wild and is only found in cultivation or in captivity.
Critically Endangered	A species that is considered to be facing an extremely high risk of extinction in the wild, based on IUCN criteria.
Endangered	A species that is considered to be facing a very high risk of extinction in the wild, based on IUCN criteria.
Vulnerable	A species that is considered to be facing a high risk of extinction in the wild, based on IUCN criteria.
Near Threatened	A species that does not qualify for a Threatened category but is close to qualifying for or is likely to qualify in one of those categories in the near future when evaluated against IUCN criteria.
Least Concern	A species that does not qualify for any category as Threatened or Near Threatened when evaluated against IUCN criteria. This includes widespread and abundant species.
Data Deficient	Where there is inadequate information regarding a species' population size, distribution or threats for an assessment to be made.

3. METHODS

The study comprised an assessment of the terrestrial, freshwater, marine and estuarine ecosystems associated with Mozal's operational areas and involved two key components of work, namely a desktop assessment and a site visit. Each of these components is discussed in detail below.

It must be noted that the terrestrial assessment primarily targeted the aluminium smelter site, including the adjacent saline abstraction site and discharge canal, as this was the only site with assessable terrestrial habitat. The aquatic assessment included the sites not targeted in the terrestrial assessment, namely the abstraction points, WWTW, and bulk terminal at the Port of Matola.

3.1 Desktop Assessment

An initial scoping/screening of the site was undertaken at the desktop level. Data and literature relating to terrestrial, freshwater, marine and estuarine biodiversity (i.e. vegetation types, vegetation cover, ecosystem types, flora and fauna, etc.) within the study area were sourced and reviewed to characterise the area and provide insights into the species assemblages that occur in the region.

The desktop assessment process utilised available information, such as aerial imagery, maps and spatial datasets to stratify and map vegetation/ecological units. It must be noted that limited spatial data was available for the area, and, as such, this process largely relied on the utilisation of Google Earth imagery. Once characterised, vegetation/habitat units provided a template to establish areas to focus in-field validations and surveys and provide insights into what species were likely to be present in the area.

Conservation important fauna and flora, including terrestrial, freshwater, estuarine and marine species, that may potentially occur within Mozal's operational areas were identified using the IBAT Proximity Report produced for the site in March 2021. This report was supplied to GroundTruth by the client. This list of species was reviewed using available datasets, such as the IUCN database, in order to assess species distributions, habitat preferences etc. and thus provide insights into whether these species have a reasonable likelihood of occurring within Mozal's Area of Influence.

The desktop assessment also included a brief review of Mozal's activities in order to identify the potential risks that these activities may pose to biodiversity.

3.2 Site Visit

A site visit was conducted over two days from the 15th-17th of March 2022. This fieldwork was undertaken in conjunction with the fieldwork for a separate component of work, namely a baseline alien species assessment for Mozal SA. The primary purpose of the site visit was to assess the actual biodiversity present on site and identify the activities being undertaken that may adversely impact this biodiversity. This included an assessment of the habitat present on site to ascertain its ability to potentially support Red Listed species (i.e., evaluating the potential likelihood of Red Listed species occurring on site based on the available habitat).

The terrestrial assessment primarily focused on the smelter site, as well as the area around the adjacent holding dam, discharge canal and discharge abstraction point (**Figure 3-1**). This is largely due to the fact that Mozal's additional operational areas (i.e., the bulk terminal at the Port of Matola,

WWTW and freshwater abstraction point) possess limited assessable terrestrial habitat within their boundary. In order to undertake the terrestrial assessment of the smelter site, the boundary of the property was driven in a vehicle escorted by Mozal personnel. Stops were made at key points and the habitat assessed. To note, the electrical transmission corridor servicing Mozal was not assessed. This corridor runs a short distance and traverses through highly transformed area. Additionally, the land under the overhead powerlines associated within this transmission corridor is regularly cleared. As such, it is highly unlikely that any notably important biodiversity is associated with this corridor. Risk associated with this corridor are, however, included.

For the aquatic assessment, key sampling points employed in Mozal's water quality monitoring programme were visited, as well as sites where various known activities take place, e.g. freshwater abstraction, stormwater discharge, etc. Three of these sites were on the Matola River and were used to investigate the extent of saline influence and thus characterise the nature of the aquatic environment. *In-situ* water quality measurements collected from these sites are included in the Appendix. To note, the mangrove area immediately adjacent to the bulk terminal within the Matola Port could not be investigated due to access restrictions.

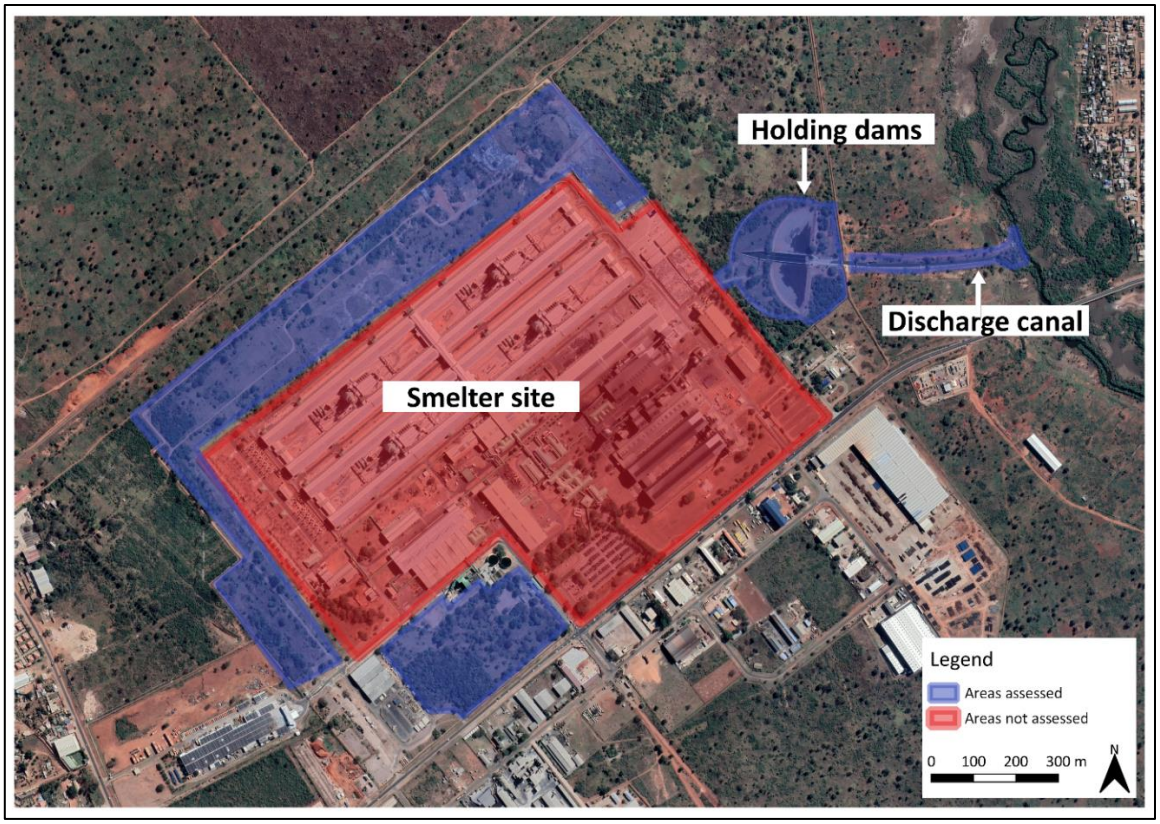

Figure 3-1 Areas associated with the Mozal Aluminium Smelter assessed as part of the terrestrial and aquatic biodiversity assessments

4. TERRESTRIAL BIODIVERSITY ASSESSMENT

4.1 Overview of Mozal's Activities

A review of Mozal's operations revealed that the site's activities may potentially have some adverse impacts for terrestrial biodiversity. However, it is anticipated that the most significant impacts to terrestrial biodiversity would likely have occurred during the construction phase of the smelter, rather than the current operational phase. Additionally, a review of the Biodiversity Risk and Opportunity Analysis undertaken for Mozal indicated that the site's operations do not pose a significant material risk to biodiversity.

Some of the site's activities and infrastructure that could potentially pose a risk to biodiversity are presented in **Table 4-1** below. Mitigation measures that could potentially be employed to reduce these risks are also presented.

Table 4-1 Summary of Mozal's operations and infrastructure that could potentially have adverse impacts on terrestrial biodiversity

Activity/infrastructure	Purpose/description	Potential Environmental Impacts	Mitigation measures
Powerlines	Supply electricity to support the operation of the smelter. Powerlines traverse the western boundary of the smelter site and run approximately 3km north to nearby Maputo substation.	• Powerlines pose a collision and electrocution risk to a number of bird species • As is best practice, vegetation is cleared under the powerlines. This, however, alters the habitat and creates an available niche for the establishment of alien plant species, which reduces native biodiversity	• Bird diverting devices, such as Bird Flight Diverters, bird flappers and bird deflectors, could be installed on powerlines to increase the visibility of these lines for birds and reduce collisions. Such installations should only take place with the appropriate permissions and be undertaken by appropriately qualified contractors/personnel. • Alien plant clearing should take place under powerlines to prevent the proliferation of these alien species.
Stockpiling of basement and carbonaceous material	Basement and carbonaceous material from the smelter were observed to be stockpiled along the northern boundary of the smelter site (**Figure 4-1**)	• Potential soil contamination, which in turn will negatively impact floral and faunal communities. • Disturbance around the area leading to areas denuded of vegetation and thus creating an available niche for invasion by alien plant species.	• Soil sampling and analyses should be undertaken in the area surrounding the stockpile to assess whether this stockpiled material is resulting in any soil contamination. The results of this sampling could more effectively inform mitigation measures, which may potentially include efforts to line the area to prevent stockpiled material from coming into direct contact with soils. • A number of the bags in which basement material were stored were found to be torn and spilling their contents. This should be avoided where possible, or bags more effectively covered to prevent damage.

			• Specific access points to the stockpile should be selected to minimize disturbance in the surrounding area.
Smelting activities	The smelting of aluminium produces emissions, which likely include fluoride	• A number of plants are sensitive to fluoride and exposure to this pollutant may have negative impacts, such as a reduction in chlorophyll, in some sensitive species.	• The condition of plants on site should be monitored to assess whether any impacts from smelting activities materialize.
Smelter site operation, including transport	The operation of the smelter likely results in noise pollution, from the smelting activities, the operation of machinery and vehicles. Additionally, the facility is assumed to be lit at night, resulting in light pollution. The smelting activities may also potentially result in water pollution. This is discussed in greater detail the aquatic biodiversity assessment.	• Noise pollution can adversely impact biodiversity, particularly fauna, in a number of ways. For example, loud noises can hinder the ability of animals to find food and/or communicate with one another. For example, bats rely on echolocation to find their prey. Loud noises may reduce their ability to hunt and ultimately impact their health. • Light pollution can affect wildlife in a number of ways. Light pollution ultimately alters the nighttime behavioral patterns of fauna. For example, nocturnal animals that hunt/forage at night may be negatively affected by the presence of bright light during their active period. Additionally, the presence of light at night can disorientate animals.	• Try limit operational activities to during daylight hours, if not already in practice. • Where possible, use LED lightbulbs. • Ensure lights are only used in the operational area and not in the surrounding open natural space. • Ensure lights are angled downwards and bulbs covered to reduce light pollution into the sky.


Figure 4-1 Basement and carbonaceous material stockpiled on the Mozal smelter site

4.2 Protected Areas

Only one protected area, namely Malhazine Municipal Park, occurs within 20km of the Mozal site. This park lies approximately 17km northeast of the Mozal smelter site, on the opposite side of the Matola River. This park is located within Maputo and is entirely surrounded by urban development. There are no evident ecological linkages between Mozal and Malhazine, with the sites separated by a river and large amounts of urbanization. It is therefore highly unlikely that Mozal's activities would have any influence on the biodiversity associated with Malhazine Municipal Park.

4.3 Terrestrial Vegetation and Habitat Description

As part of the Maputo Bay Ecosystem study, undertaken by WIOMSA in 2014, the terrestrial environment adjacent to Maputo Bay was studied and the vegetation communities defined. This study encompassed the area in which the Mozal smelter site is located. Based on this study of terrestrial communities, the Mozal smelter site was found to fall within Woodland vegetation type (**Figure 4-2**). This vegetation type largely includes areas that have been transformed by anthropogenic activities, such as agriculture and cattle grazing, and is characterized by legume species, such as *Acacias, Albizia adianthifolia, Albizia versicolor,* and grass species such as *Hyperthelia dissoluta* (WIOMSA, 2014). Additionally, succulent species, such as *Aloe marlothii,* and climbers, such as *Abrus precatorius* and *Cissampelos hirta*, are also commonly found in Woodland vegetation (WIOMSA, 2014).

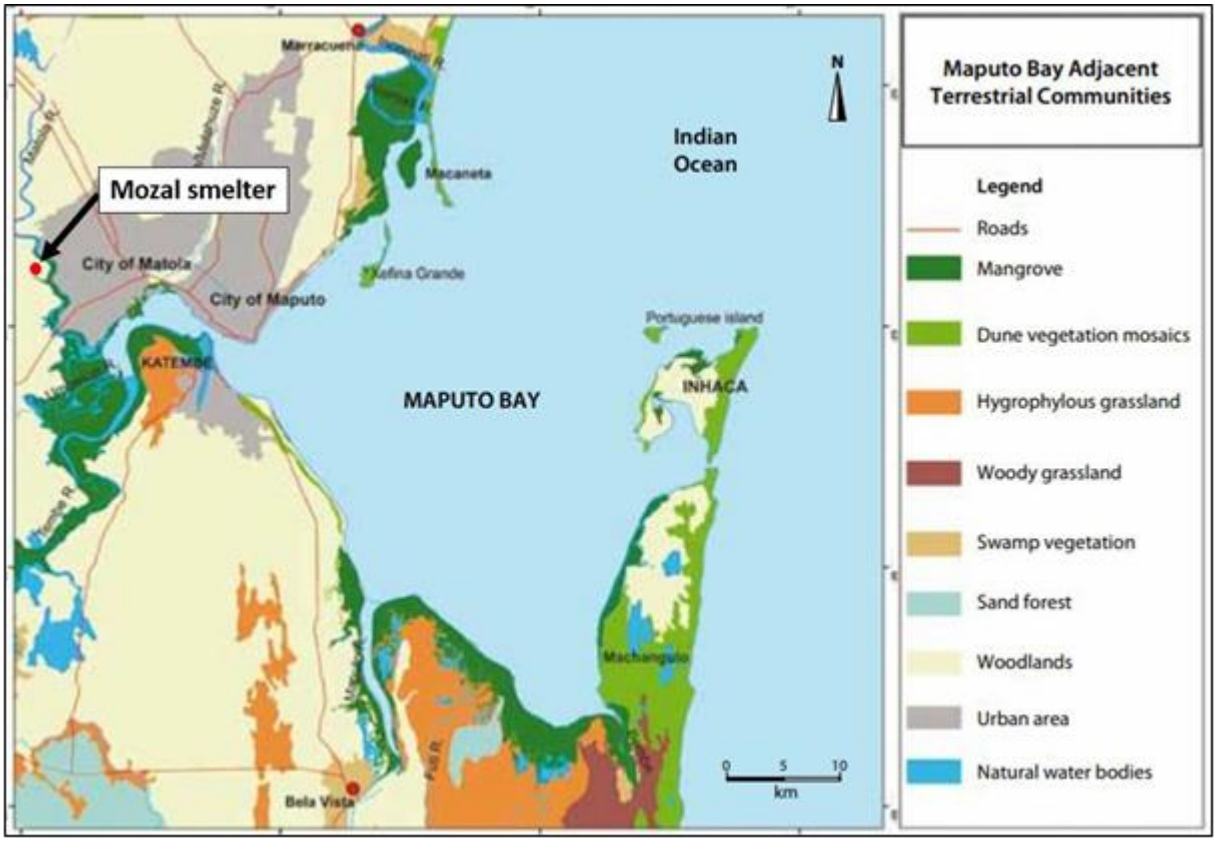

Figure 4-2 Terrestrial vegetation communities in the area adjacent to Maputo Bay (adapted from WIOMSA, 2014)

Google Earth imagery and the site visit were used to assess the actual terrestrial vegetation types present within the Mozal smelter area (including in the adjacent area around the holding dams, saline abstraction/discharge point and discharge canal). The site is highly transformed, with the majority of the area consisting of artificial surfaces. The site does, however, possess approximately 36ha of terrestrial vegetation which can be divided into four key vegetation types. These can be defined based on their prevailing plant communities and are presented in **Figure 4-3** and described below.

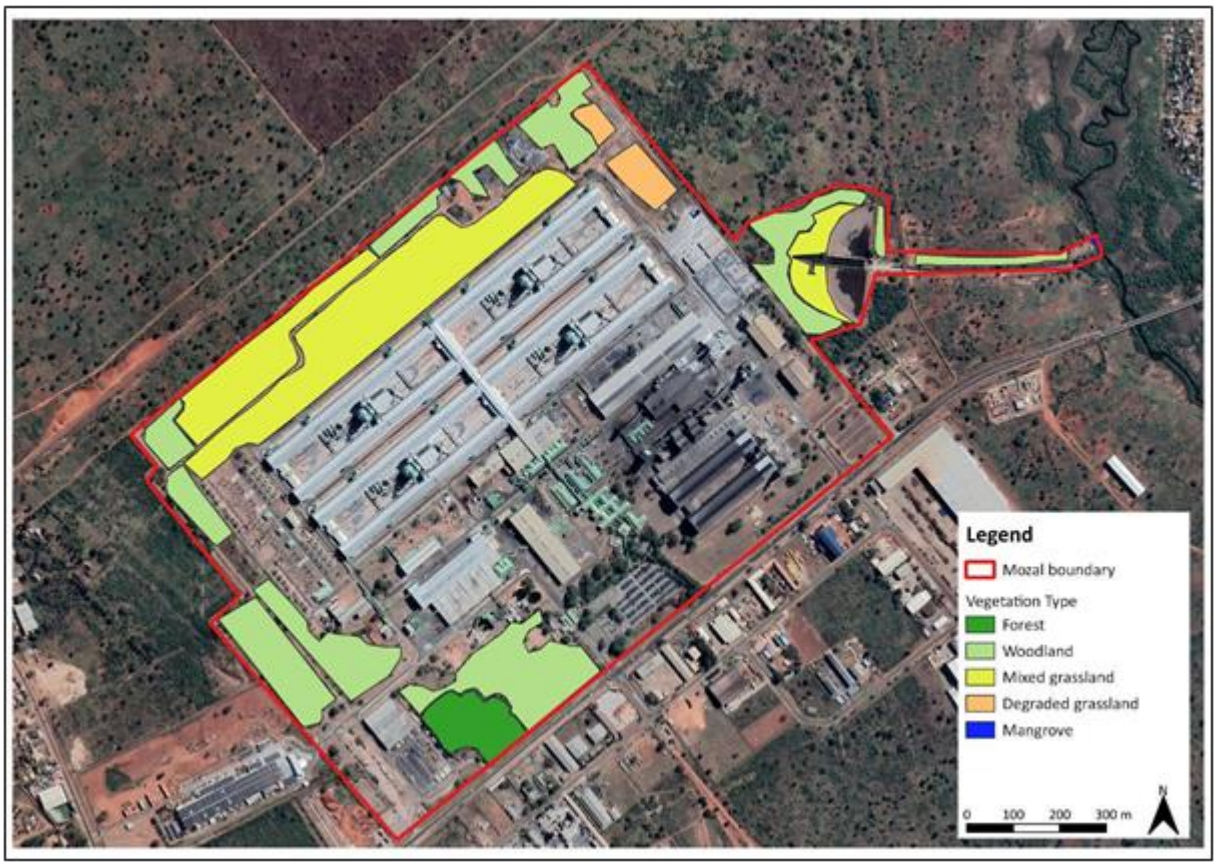

Figure 4-3 Terrestrial vegetation types identified within the Mozal smelter site

1. **Woodland**: This was the most abundant vegetation type identified on site, occupying approximately 17ha and occurring throughout the site. For the purpose of this study woodland was defined as areas consisting of woody plants, herbs and grass cover. This vegetation type has a relatively high density of trees and shrubs but retains an open canopy.
2. **Mixed grassland**: This was the second most abundant vegetation type. It occupied approximately 15ha and was largely confined to the northern boundary of the site and the area around the holding dams. This vegetation type was dominated by grasses and herbs, but trees and shrubs are interspersed individually or in small stands throughout the grassland.
3. **Forest**: A small patch of forest covering approximately 2 ha was identified in the corner of the open habitat on the southern boundary of the property. This vegetation type was dominated by relatively large trees, with an understory of small trees and shrubs, and possessed a closed canopy.
4. **Degraded grassland**: Degraded grassland was observed in areas of disturbance, namely in areas around the stockpiling of basement and carbonaceous material and where old machinery and equipment had been dumped (**Figure 4-4**). This grassland occupies approximately 1.5ha and was defined by a grass layer, often in poor condition and containing patches denuded of vegetation. Additionally, a number of small herbaceous alien plant species were found to occur within this area.

5. **Mangroves**: Mangroves grow along the river's edge at the point where the discharge canal discharges into the river. This is covered in greater detail in the aquatic assessment section of this report.

Figure 4-4 Dumping of old machinery and equipment observed along the western boundary of Mozal

The area surrounding the Mozal smelter site is highly urbanised, with open areas often in poor condition and dominated by Invasive Alien Plant (IAP) species such as *Lantana camara.* Additionally, in a number of areas adjacent to Mozal, land was found to be used for informal agricultural, namely the growing of *Zea mays* (Milho) (**Figure 4-5**). Given the highly transformed nature of the land surrounding Mozal, as well as the relatively limited available habitat within the property's boundaries, it is unlikely that the property will act as an important corridor for species. Additionally, the property possesses fences that are likely to inhibit the movement of many terrestrial faunal species, with the exception of birds (**Figure 4-6**). Given the relatively "isolated" nature of the Mozal smelter site and the extensive impacts in the surrounding landscape, the area surrounding the site was not considered to fall within the company's Area of Influence.

Figure 4-5 Informal *Zea mays* subsistence agriculture on the eastern boundary of the Mozal smetler site

Figure 4-6 Example of the type of fencing employed at Mozal

4.4 Floral Composition

The site was found to possess a moderately diverse floral community. Some of the common and key species identified, as well as the vegetation units in which they were most commonly found, are presented in **Table 4-2** below.

Table 4-2 Plant species identified within the Mozal smelter site and associated vegetation units

Species name	Common name	Notes	Vegetation unit
Acacia spp	Acacia	**Tree.** A number of *Acacia* species were observed within the site	Woodland
Agave sisalana	Sisal	**Succulent**	Few individuals observed near the saline water abstraction point.
Albizia versicolor	Poison-pod Albizia	**Tree.** Abundant in woodland	Woodland Mixed grassland
Celtis africana	White stinkwood	**Tree.** Common in woodland near holding dam	Forest Woodland Mixed woodland
Chloris virgata	Feather finger grass	**Grass**	Disturbed areas, such as roadsides
Cymbopogon caesius	Turpentine grass	**Grass**	Woodland Mixed woodland
Delonix regia	Flamboyant	**Tree**	Forest
Dichrostachys cinerea	Sickle bush	**Shrub or tree**. Abundant in woodland and mixed grassland	Woodland Mixed grassland
Erythrina lysistemon	Coral tree	**Tree**	Woodland
Ficus burkei/natalensis (**Figure 4-7**)	Common wild fig/coastal strangler fig	**Tree**	Woodland Forest
Garcinia livingstonei	African mangosteen	**Tree.** Not common on site	Forest Woodland
Grewia caffra	Climbing raisin	**Scrambling shrub.** Common in understory of forest	Woodland Forest
Gymnosporia buxifolia	Common spike-thorn	**Shrub or tree**	Forest Woodland

Hibiscus cannabinus	Decan hemp	**Herb**	Woodland Grassland
Hyperthelia dissoluta	Yellow thatching grass	**Grass**	Woodland Grassland
Ipomea obscura	Obscure morning glory	**Climber**	Forest Woodland
Kigelia africana	Sausage tree	**Tree**	Forest Woodland
Lannea schweinfurthii	False marula	**Tree**	Forest Woodland
Lantana camara	Lantana	Alien invasive **shrub** found in high densities	Forest Woodland Mixed woodland
Panicum maximum	Buffalo grass	**Grass.** Abundant in woodland	Forest Woodland
Parthenium hysterophorus	Parthenium	Highly invasive alien **herb**. Found in disturbed areas, mostly along roadsides	Degraded grassland Along roadsides and fence lines
Peltophorum africanum (**Figure** 4-8)	African wattle	**Tree**	Woodland
Phyllanthus reticulatus	Potato bush	**Shrub or small tree**. Common in understory of forest	Forest Woodland
Ricinus communis	Castor-oil	Alien **shrub** common in disturbed areas	Degraded grassland
Sclerocarya birrea	Marula	**Tree**	Forest Woodland
Sesamum triphyllum	Wild sesame	**Herb**	Woodland Mixed grassland
Sesbania bispinosa	Spiny sesbania	**Small tree** abundant in disturbed areas	Degraded grassland
Senna occidentalis	Coffee senna	**Alien Herb**	Woodland

			Mixed grassland
Senna petersiana	Monkey pod	**Shrub or small tree**	Woodland Mixed grassland
Solanum campylacanthum		Herb	Woodland Grassland Mixed grassland
Strychnos spinosa	Spiny monkey orange	Shrub or small tree	Woodland Mixed grassland
Terminalia sericea (**Figure 4-9**)	Silver cluster-leaf	Large tree dominating forest	Forest Woodland
Thespesia acutiloba	Small-leaf tulip tree	Shrub or small tree	Forest Woodland
Trichelia emetica	Natal Mahogany	**Tree.** Seeds observed to be harvested in the area surrounding the discharge canal	Woodland Forest
Vachellia xanthophloea	Fever tree	Tree	Woodland

Figure 4-7 *Ficus* seedling as an epiphyte on *Acacia* tree in the Mozal smelter site

Figure 4-8 ***Peltophorum africanum*** **specimen observed in the Mozal smelter site**

Figure 4-9 ***Terminalia sericea*** **speciman observed in the Mozal smelter site**

4.5 Faunal composition

Few faunal species were observed on site, with the majority of species observed being birds. One species of reptile was observed, namely *Acanthocercus atricollis* (**Figure 4-10**).

Figure 4-10 *Acanthocercus atricollis* speciman observed in the smelter site

Bird species observed during the site visit included:

- *Apus caffer* (White-rumped swift)
- *Ardea melanocephala* (Yellow-billed stork; **Figure 4-11**)
- *Bubulcus ibis* (Cattle egret)
- *Coracias caudatus (*Lilac-breasted roller)
- *Mycteria ibis* (Black-headed heron)
- Nightjar (insufficient observation to determine species)
- *Pandion haliaetus (*Osprey, observed at Mozal's freshwater abstraction point)
- *Pyconotus barbatus* (Common bulbul)
- *Streptopelia senegalensis* (Laughing dove)
- *Treron calvus* (African green pigeon, dead specimen)

Figure 4-11 Yellow-billed stork (*Ardea melanocephala*) observed on the dam wall of the holding dam at the Mozal smelter site

Although few faunal species were observed on site, it is acknowledged that many species may be inconspicuous, cryptic and/or nocturnal and thus may be present on site but have been missed during the field inspection. Due to limited habitat availability, it is not anticipated that large mammal species will occur on site. Additionally, given the small area, it is likely that were large mammals present, these would have been observed.

Although no Red Listed species were observed on site, it must be acknowledged that the field work was not exhaustive and Red Listed species may potentially be present. To assess whether Red Listed species may potentially occur on the site, despite not being observed, the site inspection included a review of the smelter's available habitat. This was done to ascertain whether the site possesses habitat suitable to harbour any of the Red Listed species identified in the IBAT report for the site. A review of the Red Listed terrestrial species' likelihood of occurrence at the Mozal site based on available habitat is presented below.

4.6 Red Listed Species Screening

Each of the terrestrial Red Listed Species identified in the IBAT report was assessed using various databases, such as IUCN and GBIF, in order to assess their habitat requirements and whether they have been ever recorded in the vicinity, and thus ultimately assess their likelihood of occurring in the Mozal smelter site. The findings of this assessment are presented below. Colour - coding is applied to the table in the following manner:

Mammals
Plants
Birds
Reptiles
Insects

The following abbreviations are applied in the table below:

CR – Critically Endangered

EN – Endangered

VU – Vulnerable

Species Name	Common name	IUCN ranking	Habitat	Likelihood of occurrence
Diceros bicornis/Diceros bicornis ssp.minor	Black Rhino/south-eastern black rhino	CR	Black rhino are found in a variety of habitats, favouring savanna and bushveld.	Mozambique has a very small population of black rhino, with the species thought to have become extinct in the country before 2 specimens were recorded in 2015. Given the extremely small population, which is likely confined to protected areas, and the highly urbanised nature of the area surrounding Mozal it is **highly unlikely** the species occurs on, or within the site's Area of Influence. Additionally, the species is a charismatic species of high conservation importance and had it been observed within the area there would be record of this. Moreover, the Mozal site does not offer sufficient habitat to support the species.
Necrosyrtes monachus	Hooded Vulture	CR	Hooded vultures occur in a range of habitats, including open grassland, forest edge, wooded savanna, desert and along coasts (BirdLife International, 2017). The species feeds primarily on carrion.	The Mozal site does possess suitable habitat for Hooded vultures and it thus **possible** that the species may occur on site. However, the lack of large fauna observed does indicate that food would potentially be a limiting factor for the species. Large powerlines service the site, and these would likely pose a threat to the species due to the risk of collisions. The installation of bird diverters on powerlines would help mitigate this risk.

Gyps africanus	White-backed Vulture	**CR**	White-backed vultures primarily inhabit open wooded savanna, particularly areas of *Acacia* (BirdLife International, 2021a). They require tall trees for nesting and primarily feed on carrion	The site possesses relatively limited suitable habitat for the species and, as with Hooded vultures, food on site would likely be a limiting factor for the species. It is **possible** that the species may be present on site. It is, however, anticipated that they would only utilise the area for brief periods of time and would not be resident on site. As with Hooded vultures, the large powerlines present on site are likely to pose a threat to the species. The installation of bird diverters on powerlines would help mitigate this threat.
Trigonoceps occipitalis	White-headed Vulture	**CR**	White-headed vultures prefer mixed, dry woodland at low altitudes and tend to avoid human settlements (BirdLife International, 2021b).	Mozambique contains a very small population of white-headed vultures, with an estimated 150 pairs remaining. No records on the GBIF database indicate that the species has been recorded in the vicinity of the Mozal site. The site does possess some suitable habitat for the species. This, however, is limited. As such, whilst it is **possible** that the species may be present on site, given the nature of the species, this is not anticipated. As with other vultures, the powerlines on site may pose a risk to the species. The installation of bird diverters on powerlines would help mitigate this threat.
Emicocarpus fissifolius	-	**CR**	The species is a prostrate herb that grows on sandy soils (Matimele *et al*; 2016). The species has not been observed since 1966.	Insufficient information on the species is available to accurately comment on the likelihood of occurrence

Indigofera gobensis	-	**CR**	The species has only been recorded in one locality, between rocks in rocky open woodland (Llewllyn and Rokni, 2019).	Insufficient information on the species is available to accurately comment on the likelihood of occurrence
Redunca fulvorufula	Mountain Reedbuck	**EN**	Mountain Reedbuck live on ridges and hillsides in broken rocky country and high-altitude grasslands (IUCN SSC Antelope Specialist Group, 2017)	The site and its associated infrastructure do not possess suitable habitat for Mountain reedbuck. Additionally, in Mozambique the species is only known from the Lubombo Mountains. It is thus **unlikely** that the species will occur on site.
Gyps coprotheres	Cape Vulture	**VU**	Cape vultures are usually found near steep terrain where they breed and roost on cliffs (BirdLife International, 2021c). They have been found to show a preference for protected areas and woody species for foraging (BirdLife International, 2021c).	The site possesses limited suitable habitat for the species. However, it is **possible** that the species may traverse the site occasionally. It must be noted that Mozambique possesses a small population of Cape Vultures (10-15 pairs) which occurs near Eswatini and as such occurrence at the site is not anticipated. As with other vultures, the powerlines on site may pose a risk to the species. The installation of bird diverters on powerlines would help mitigate this threat.
Torgos tracheliotos	Lappet-faced Vulture	**EN**	Lappet-faced vultures inhabit dry savanna, arid plains, deserts and open mountain slopes (BirdLife International, 2021d). They are predominantly carrion eaters that range widely when foraging.	The habitat at the Mozal site is not ideal for the species. However, Lappet-faced vultures may **possibly** traverse the site when foraging. As with other vultures, the powerlines on site may pose a risk to the species. The installation of bird diverters on powerlines would help mitigate this threat.

Terathopius ecaudatus	Bateleur	**EN**	Bateleurs inhabit a range of habitats, including grasslands, savanna and subdesert thornbush (BirdLife International, 2020)	The Mozal smelter site does possess suitable habitat for the species. Additionally, according to the GBIF database, the species has been recorded in the region. As such, it is **possible** that the species may be found on site. The species may be at risk of collision with overhead powerlines. The installation of bird diverters on powerlines would help mitigate this risk.
Aquila nipalensis	Steppe Eagle	**EN**	Steppe eagles inhabit areas of steppe and semi-desert (BirdLife International, 2021e).	The Mozal site and associated infrastructure do not possess suitable habitat for Steppe eagles. Additionally, a review of available databases (i.e. SABAP2 and GBIF) did not reveal any records of the species in the region. Although it is **possible** that the species may utilise the site briefly, most likely during migration, it is not anticipated that the species will be found on site. It must be noted that Steppe Eagles are affected by powerlines, and should the species occur on site these would pose a risk to them. The installation of bird diverters on powerlines would help mitigate this risk.
Polemaetus bellicosus	Martial Eagle	**EN**	The species inhabits open woodland, wooded savanna, bushy grassland, thornbush, open country and subdesert (BirdLife International, 2020b). Studies indicate that pairs require large territories (approximately 175km^2) and avoid breeding in human-disturbed habitats.	The Mozal Smelter site and associated infrastructure possess suitable habitat for Martial Eagles. Additionally, the GBIF database indicates that the species has been recorded in the region. It thus is **possible** that the species may occur on site. Pairs are unlikely to breed on site but may utilise the area for foraging purposes. Martial eagles are known to be susceptible to powerline fatalities, and this is thus a risk for any individuals that do traverse the site. The installation of bird flight diverters would help

				mitigate this risk.
Sagittarius serpentarius	Secretarybird	**EN**	Secretarybirds inhabit open landscapes, including open plains, grassland and lightly wooded savanna (BirdLife International, 2020c).	Limited habitat is available on site for the species. However, it is **possible** that the species may utilise parts of the site from time to time. As with other large bird species discussed, Secretarybirds are susceptible to collisions with overhead powerlines, and as such may be at risk should they fly over the site. The installation of bird diverters on powerlines would help mitigate this risk.
Morus capensis	Cape Gannet	**EN**	Cape Gannets are strictly marine (BirdLife International, 2018).	The species is **unlikely** to occur on the Mozal smelter site. However, it is **highly likely** that the species will occur in the vicinity of the Mozal harbour terminal with GBIF records indicating that the species has been recorded in Maputo Bay. Mozal's activities at the terminal are not anticipated to have a notable impact on the species.
Phalacrocorax capensis	Cape Cormorant	**EN**	Cape cormorants are usually found in the Benguela Current within 10km of the coastline (BirdLife International, 2018b). They also inhabit cliffs and ledges on the mainland and offshore islands. They occasionally occur in brackish water of lagoons, estuaries and harbours	The species is **unlikely** to occur on the Mozal smelter site. However, it is **likely** that the species will occasionally occur in the vicinity of the Mozal harbour terminal. It is not anticipated that Mozal's activities at the harbour will have significant adverse impacts on the species.

Spheniscus demersus	African Penguin	**EN**	The species is marine, occurring within 40km of the coastline. African penguins come ashore on islands or non-contiguous areas of coast to breed, moult and rest (BirdLife International, 2020d). However, the species does not breed in Mozambique.	African penguins are not often found off of Mozambique. The species is **highly unlikely** to be found at the Mozal smelter site and, given the lack of coastline and suitable habitat, **unlikely** to be found in the vicinity of the Mozal harbour terminal.
Thalassarche carteri	Indian Yellow-nosed Albatross	**EN**	The species is marine and breeds on slopes or cliffs, typically in bare, rocky areas but occasionally in tussock-grass and ferns (BirdLife International, 2018c).	The species is **unlikely** to occur on the Mozal smelter site. However, it is **possible** that the species may occasionally occur in the vicinity of the Mozal harbour terminal. It is not anticipated that Mozal's activities at the harbour will have significant adverse impacts on the species
Empogona maputensis	Maputo Jackal-coffee	**EN**	Maputo-Jackal coffee is restricted to the thicket or short Sand Forest on ancient sand dunes (Matimele et al; 2016b).	There was little evidence on site to suggest that the area possesses Sand Forest. However, the field inspection was not exhaustive and it is **possible** that the species, as well as other Sand Forest species, may occur on site. Should the decision be made to clear the vegetation on site for development, it is suggested that a protected plant search and rescue operation be undertaken, whereby a plant specialist undertakes an extensive assessment of the site, identifies TOPS and relocates these to an area not planned for immediate development.

Warneckea parvifolia	-	**EN**	The species is restricted to short sand forest in Northern KwaZulu-Natal, South Africa, and Licuati thicket (Sand Forest) in southern Mozambique (Matimele et al., 2020).	There was little evidence on site to suggest that the area possesses Sand Forest. However, the field inspection was not exhaustive and it is **possible** that the species, as well as other Sand Forest species, may occur on site. Should the decision be made to clear the vegetation on site for development, it is suggested that a protected plant search and rescue operation be undertaken, whereby a plant specialist undertakes an extensive assessment of the site, identifies TOPS and relocates these to an area not planned for immediate development.
Xylopia torrei	-	**EN**	The species has been recorded from dry forests and forest margins, particularly in thicket-type forest on sand (Matimele *et al*., 2019).	The Mozal smelter site possesses suitable habitat for *Xylopia torrei* and it is thus **possible** that the species may occur on site. Should the decision be made to clear the vegetation on site for development, it is suggested that a protected plant search and rescue operation be undertaken, whereby a plant specialist undertakes an extensive assessment of the site, identifies TOPS and relocates these to an area not planned for immediate development. Should alien plant clearing be undertaken on site it is suggested that clearing teams be educated on which species to target and which to avoid, and on correct application of herbicides to prevent any damage to indigenous vegetation, particularly CR, EN, or VU Red Species.

Caretta caretta	Loggerhead Turtle	VU	Loggerhead turtles are highly migratory and utilise a wide range of habitats during their lifetimes (Casale and Tucker, 2017). They nest on sandy beaches throughout temperate and subtropical regions, including Mozambique.	The species is **highly unlikely** to occur on the Mozal smelter site as it is confined to the marine environment. A review of the GBIF database revealed that the species has frequently been recorded in Maputo Bay. It is thus **possible** that the species may occur in the vicinity of the Mozal harbour terminal. Given the relatively low shipping traffic associated with the Mozal terminal, and the presence of surrounding terminals, it is unlikely that activities associated with the terminal will have a significant impact on Loggerhead turtles.
Dermochelys coriacea	Leatherback Turtle	VU	The species is an oceanic, deep-diving marine turtle that inhabits tropical, subtropical and subpolar seas (Wallace et al., 2013).	The species is **highly unlikely** to occur on the Mozal smelter site as it is confined to the marine environment. A review of the GBIF database revealed that the species has been recorded in Maputo Bay. The species predominantly occurs in the open ocean, but does occasionally visit bays and estuaries. It is thus **possible** that the species may occasionally occur in the vicinity of the Mozal terminal. Given the relatively low shipping traffic associated with the Mozal terminal, and the presence of surrounding terminals, it is unlikely that activities associated with the terminal will have a significant impact on Loggerhead turtles.
Giraffa camelopardalis	Giraffe	VU	Giraffes are found in a range of habitats, most commonly occurring in savanna/woodland habitats (Muller et al., 2018)	Giraffes in Mozambique are confined to protected areas and it is thus **highly unlikely** that the species will occur on the Mozal site. Moreover, the species is conspicuous and were it present on site, this would be known.

Hippopotamus amphibius	Hippopotamus	VU	Hippopotamuses are amphibious, spending their days in water and emerging at night to graze (Lewison and Pluháček, 2017).	It is **unlikely** that the species will occupy any of Mozal's operational areas
Kinixys natalensis	KwaZulu-Natal Hinged-back Tortoise	VU	The species prefers dry, rocky habitats in thornveld, valley bushveld, dry thicket or bushveld savanna and is generally absent from coastal regions and forest (Hofmeyr and Boycott, 2018).	The location of the Mozal smelter and its associated infrastructure falls outside of the IUCN's listed range for the species. Additionally, the site does not possess ideal habitat for the species. It is thus **unlikely** that the species will occur on site.
Smutsia temminckii	Temminck's Pangolin	VU	The species occurs in a range of habitats, predominantly savannas and woodlands in low lying regions with moderate to dense scrub where average annual rainfall is between 250mm and 1400mm, but also floodplain grassland, rocky slopes and sandveld (Pietersen et al., 2019). It does not, however, inhabit forest or true desert.	Although the Mozal site does possess some suitable habitat for the species the property is smaller than the home range for the species (600- 1400 Ha) and fenced in such a manner that individuals would not easily be able to traverse the property. Additionally, the land surrounding the site is highly transformed, thus further limiting available habitat for the species. The species is illegally trafficked, making them highly vulnerable in populated areas. As such, if the species had been observed on site, it is likely that this would have been a notable occurrence. It is thus **unlikely** that the species will occur on site.
Panthera leo	Lion	VU	Lions occur in a broad range of habitats, absent only from tropical rainforest and the interior of the Sahara desert (Bauer et al., 2016)	The Mozal smelter site and associated infrastructure fall outside of the species' range in Mozambique. It is thus **highly unlikely** that the species will occur on site. Additionally, if the species occurred in the vicinity, this would be notable and would have been reported.

Panthera pardus	Leopard	VU	Leopards occur in a wide range of habitats.	According to the IUCN's distribution range for the species, leopard are believed to be extinct in the region in which the smelter site and associated infrastructure are located. It is thus **highly unlikely** that the species will occur on site.
Raphia australis	Rafia	VU	The species occurs in swamps, peatlands and seasonally inundated dunes (Matimele et al., 2016c)	The smelter sites does not offer suitable habitat for the species and it is thus **highly unlikely** that the species will occur on site.
Cercopithecus mitis ssp. labiatus	Samango monkey	VU	The species lives in many forest types (Butynski and de Jong, 2019)	The site possesses only a small fragment of forest that is unlikely to be large enough to support a substantial population of the species. Thus, whilst it is **possible** that the species may occur on site, it is **unlikely**.
Pseudagrion newtoni	Harlequin Sprite	VU	The species is endemic to South Africa	
Bucorvus leadbeateri	Southern Ground-hornbill	VU	The species inhabits woodland and savanna, also frequenting grassland adjoining patches of forest, having a preference for short grass habitat (BirdLife International, 2016)	The site possesses suitable habitat for the species and it is thus **possible** that the species may occur at the Mozal smelter site. The species is, however, mobile and would likely only occur on the site for brief periods of time. Ground - hornbills may be at risk of collisions with powerlines. The installation of bird flight diverters would help mitigate this risk.

Aquila rapax	Tawny Eagle	VU	The species occupies dry open habitats and will occupy woodland and wooded savannah (BirdLife International, 2021f).	The site does possess suitable habitat for the species. It is **possible** that the species may occur within the Mozal smelter site. The species may be at risk of collisions with overhead powerlines. The installation of bird diverters would help mitigate this risk.
Procellaria aequinoctialis	White-chinned petrel	VU	The species would occur off the Mozambican coast during its non-breeding season (BirdLife International, 2018d)	Given that the species occurs off the coast it is **unlikely** that it will occur within Mozal's operational area.
Dicliptera quintasii		VU	The species is endemic to the Maputaland Centre of Endemism and is known from 8-10 threat-defined locations (Matimele et al., 2016d). This species is restricted to forests on sandy soils.	The site does possess some suitable habitat for the species and it is thus **possible** that the species may occur on site. However, given the very limited range of the species and the level of conversion on site, this is not anticipated. Should the decision be made to clear the vegetation on site for development, it is suggested that a protected plant search and rescue operation be undertaken, whereby a plant specialist undertakes an extensive assessment of the site, identifies TOPS and relocates these to an area not planned for immediate development. Should alien plant clearing be undertaken on site it is suggested that clearing teams be educated on which species to target and which to avoid, and on correct application of herbicides to prevent any damage to indigenous vegetation, particularly CR, EN, or VU Red Listed Species.

Sclerochiton apiculatus		VU	The species is endemic to the Maputaland Centre of Endemism and is known from 8 threat-defined locations (Matimele et al., 2016e). The species occurs in dry semi-deciduous forest, as well as in thicket and riverine forest.	The site does possess some suitable habitat for the species and it is thus **possible** that the species may occur on site. However, given the very limited range of the species and level of conversion on site, this is not anticipated. Should the decision be made to clear the vegetation on site for development, it is suggested that a protected plant search and rescue operation be undertaken, whereby a plant specialist undertakes an extensive assessment of the site, identifies TOPS and relocates these to an area not planned for immediate development. Should alien plant clearing be undertaken on site it is suggested that clearing teams be educated on which species to target and which to avoid, and on correct application of herbicides to prevent any damage to indigenous vegetation, particularly CR, EN, or VU Red Listed Species.
Dioscorea sylvatica		VU	The species inhabits wooded and relatively mesic places, such as moist bushveld area, coastal bush and wooded mountain kloofs (Hills and Wilkin, 2017).	Given the habitat requirements of the species, it is **possible** that it may occur within Mozal's operational areas. Should the decision be made to clear the vegetation on site for development, it is suggested that a protected plant search and rescue operation be undertaken, whereby a plant specialist undertakes an extensive assessment of the site, identifies TOPS and relocates these to an area not planned for immediate development. Should alien plant clearing be undertaken on site it is suggested that clearing teams be educated on which species to target and which to avoid, and on correct application of herbicides to prevent any damage to indigenous

				vegetation, particularly CR, EN, or VU Red Listed Species
Barleria oxyphylla		VU	The species has a highly restricted range in Maputaland Centre of Endemism. It occurs in open shrub-grassland on compacted ground (Darbyshire et al., 2018)	Given the highly restricted range and habitat requirements of the species, it is not anticipated that it will occur in Mozal's operational areas.
Euphorbia baylissii		VU	The species is endemic from southern Mozambique and is found in sand dune vegetation in coastal areas and in *Androstachys johnsonii* woodland (Matimele et al., 2018).	The site does not possess suitable habitat for the species and it is thus **unlikely** that the species will occur within Mozal's operational areas
Adenopodia schlechteri		VU	The species is endemic to Mozambique and only known to occur in six locations (Matimele et al., 2019). The species occurs in coastal thickets and woodland in sandy soils.	The site does possess some suitable habitat for the species and it is thus **possible** that the species may occur on site. However, given the very limited range of the species and level of conversion on site, this is not anticipated. Should the decision be made to clear the vegetation on site for development, it is suggested that a protected plant search and rescue operation be undertaken, whereby a plant specialist undertakes an extensive assessment of the site, identifies TOPS and relocates these to an area not planned for immediate development. Should alien plant clearing be undertaken on site it is suggested that clearing teams be educated on which species to target and which to avoid, and on correct application of herbicides to prevent any damage to indigenous

				vegetation, particularly CR, EN, or VU Red Listed Species.
Polygala francisci		VU	Limited information is available for the distribution of this species	
Tephrosia forbesii subsp. forbesii		VU	The species occurs in several habitats on sandy open ground at low elevation, such as disturbed margins of sand forest, open woodlands, grassland and cultivated areas (Datizua et al., 2019)	Given the habitat requirements of the species, it is **possible** that it may occur in Mozal's operational areas. Should the decision be made to clear the vegetation on site for development, it is suggested that a protected plant search and rescue operation be undertaken, whereby a plant specialist undertakes an extensive assessment of the site, identifies TOPS and relocates these to an area not planned for immediate development. Should alien plant clearing be undertaken on site it is suggested that clearing teams be educated on which species to target and which to avoid, and on correct application of herbicides to prevent any damage to indigenous vegetation, particularly CR, EN, or VU Red Listed Species.

Based on a review of the IBAT species list and available habitat on site, it is evident that the majority of Red Listed species identified in the IBAT have a possibility of occurring on site. However, none of these species were recorded on site during the site visit. The limited size of the available habitat and poor condition of much of it reduces the likelihood that a number of species will occur. Additionally, much of Mozal's Area of Interest is already highly transformed. Moreover, Mozal's smelter site, the only area which possesses notable terrestrial habitat, is surrounded by largely urban development, isolating the natural habitat present and further reducing the likelihood of occurrence of a number of species, particularly mammals. It must be noted that a precautionary approach has been adopted in this review. Namely, where it could not be stated for certain that a species is present or absent, its likelihood of occurrence is listed as "possible".

5. AQUATIC BIODIVERSITY ASSESSMENT

5.1 Overview of Mozal's Activities

A review of Mozal's operations revealed that a number of the site's activities could potentially affect biodiversity of several interconnected waterways and aquatic ecosystems, including freshwater, estuarine and marine systems.

The key operations and activities that have the potential to affect aquatic biodiversity are outlined in **Table 5-1** below and their locations are presented in **Figure 5-1.** To note, the desalination plant located at the Mozal Terminal has not been in operation since August 2021, due to adequate water supply provided by the Umbeluzi River (Moonsamy, pers. comm, 2022) and subsequent downtime of the plant for maintenance (Zacarias, pers. comm, 2022).

Given the nature of the activities associated with Mozal Aluminium, there is a risk of impact to biodiversity, including sensitive and/or threatened aquatic species potentially inhabiting the affected ecosystems.

Figure 5-1 Location of Mozal's operational infrastructure that may impact on aquatic biodiversity

Table 5-1 Summary of Mozal's operations and activities within aquatic ecosystems

Activity	Purpose	Location	Specifications*	Dominant Environment	Potential Environmental Impacts
Abstraction of freshwater	Human consumption, Industrial processes	Umbeluzi River, 13.5 km south-west of the smelter	± 1 440m^3/d	Freshwater, Riverine	• Habitat modification • Modification of physio-chemical conditions • Flow modification • Uptake of organisms
Abstraction of saline water	Dilution of fluoride-bearing stormwater emanating from the smelter	Matola River, east of the smelter, via the stormwater retention facility	Ave. 500m^3/d	Saline, Estuarine	• Habitat modification • Flow modification • Modification of physio-chemical conditions • Uptake of organisms
Discharge of stormwater	Disposal of diluted, fluoride-bearing stormwater	Matola River, east of the smelter, via the stormwater retention facility, 75m downstream of abstraction	Ave. 1 000m^3/d Ave. fluoride concentration: 2.2 mg/l wet season 3.2 mg/l dry season	Saline, Estuarine	• Modification of physio-chemical conditions • Flow modification • Fluoride contamination (water)
Discharge of treated domestic effluent	Disposal of waste water from the Mozal treatment works (WWTW)	Tributary of the Matola River, 1.2km south-east of the smelter		Freshwater, Wetland	• Nutrient & organic loading • Faecal / pathogen contamination
	Treated waste water used for irrigation	Gardens/vegetated areas within the Mozal smelter site	Monthly ave. 12.2 – 29.6 m^3	Terrestrial	No aquatic ecosystems affected
Shipping Terminal	Import and export of materials	Bulk terminal within the Port of Maputo	230m long, with a depth of 12.6m (MPDC, 2020)	Saline, Marine	• Contamination (soil, water, air) • Noise disturbance • Introduction of alien species through ballast water
Desalination plant	Human consumption, Industrial processes	Bulk terminal within the Port of Maputo	Plant size 2Ml/d Ave. treatment capacity 1.53Ml/d		• Habitat modification • Modification of physio-chemical conditions

* Information obtained from Mozal, unless otherwise specified

5.2 Regional Description

The Mozal Aluminium Smelter is located adjacent to the 60km -long Matola River that drains a catchment area of 2 362km^2 (Electricidade de Moçambique, E.P. Environmental Impact Study, 2019). The river is one of four systems (the others being the Infulene, Umbeluzi, and Tembe) contributing freshwater flow to the Maputo Bay through the Espírito Santo Estuary. The annual flow of the Matola River is small in comparison to the other river systems and is estimated at 150 x 10^{6}m^3, or 4.76m^3/s (Electricidade de Moçambique, E.P. Environmental Impact Study, 2019). According to COWI/Fichtner (2013) and Electricidade de Moçambique, E.P. (2019), the Matola River is highly seasonal, with high flows occurring during the wet season (November to March) and negligible flow during the dry season (May to August). Further, the salinity of the system is governed by the conditions of the Espírito Santo Estuary during the dry season due to the lack of flow. As a result, flushing of the system is primarily through river runoff, and tidal activity during the wet and dry seasons, respectively (Electricidade de Moçambique, E.P. 2019).

As alluded to above, the conditions in the lower reaches of the feeder systems are affected by the conditions prevalent in the estuary and in turn, Maputo Bay.

Maputo Bay is a shallow subtropical coastal system, covering 1 280km^2 with an average depth of 10m. Deeper areas between 18-23m are found in the northern part of the bay which serves as the shipping entrance to the Port of Maputo (Ferreira and Bandeira, 2014). The prevailing winds are from the south- east and east during summer and north-east during winter (Canhanga and Dias, 2014). Freshwater flow enters the bay through five main river systems. The mean annual river flow is approximately 225 m^3/s, with the highest flow according during the wet (summer) season (approximately 400m^3/s), and peaking in February, and generally lowest during the dry (winter) season (approximately 150m^3/s (Canhanga and Dias, 2014; Sigaúque et al., 2021). The In terms of salinity and temperature patterns, the bay is generally well mixed during winter, yet during summer, horizontal and vertical gradients are evident (and strongest during neap tides), with an increase in salinity and decrease in temperature with depth (Canhanga and Dias, 2014). During winter, the vertical salinity and temperature ranges in the centre of the bay are 30.35 – 31.3 psu and almost uniform 25.8°C. During summer, salinities varied from 24 to 30 psu and temperature from 26.2°C to 25.6°C (Canhanga and Dias, 2014). Furthermore, the western portion of the bay has a greater variations in salinity in comparison to the eastern, and salinities within the bay can be up to 4.8 psu lower than the outside oceanic waters (Canhanga and Dias, 2014). These characteristics are attributed to the influence of freshwater riverine inputs and the trends intensify during significant flooding events (Canhanga and Dias, 2014). The water quality of Maputo Bay is reportedly polluted by a variety of contaminants emanating from agricultural and industrial activities and human settlement, mostly from Maputo City and the Matola industrial area.

According to Guissamulo (2008) 29.3% of the total surface of the bay is intertidal, and 60.4% is subtidal. Tidal activity is semidiurnal, but also exhibiting a significant quarter diurnal signal, leading to unequal flood-ebb pattern (Canhanga and Dias, 2014). The mean spring tidal range is 3m (max. 4m, min. 1m) while the neap tidal range is approximately 1m, with a phase lag 0.5 h (Canhanga and Dias, 2005; Sigaúque et al., 2021). Tidal currents are most intensive in the centre of the bay, attaining values ranging from 0.8 to 1.0 m s^{-1}, and much weaker areas are located along the peripheries and inflowing estuaries. Tidal activity in these areas also exhibit a temporal lag relative to the bay, creating high residence times as they are not completely drained on the ebb tide before the flood

tide picks up again. These factors make these areas vulnerable to pollution exposure (Canhanga and Dias, 2014). Sediments of the bay vary from medium-grained sand in the north and east to clay-silt in the west and

southern portions (Guissamulo and Cockcroft, 2004). The latter is attributed to river discharge which also creates a horizontal gradient in water transparency ranging from below 1m in the west to approximately 10m towards the island in the east (Guissamulo, 2008).

Maputo Bay contains a diversity of coastal habitats (Ferreira and Bandeira, 2014). Major habitat types include mangroves (and associated flats) (176 ha), submerged aquatic vegetation (mainly seagrass beds) (39 ha), sandy habitats (e.g. sandy beaches, sand bars and spits, and dune systems) (28 ha), rocky sandstone outcrops (0.42 ha) and coral reefs (0.12 ha) (Ferreira and Bandeira, 2014). The mangrove habitat of Maputo Bay is one of the largest areas in southern Mozambique (Paula et al., 2014). Mangrove forest is therefore the prominent vegetation type lining the margins of the bay and tidal portions of the feeder rivers, with the main area being the Espírito Santo Estuary in the west, followed by the Maputo Special Reserve Area and the Incomati Estuary in the south and the north- east corner of the bay, respectively (Paula et al., 2014). In most of the estuaries, mangroves extend approximately 15-20km upstream (Ferreira and Bandeira, 2014), and occur along the Matola River adjacent the Mozal smelter, and adjacent the Mozal terminal in the port. Seagrass beds occur mainly in the shallow water areas around the Inhaca Island-Machangulo Peninsula, on the eastern margin of the bay, and a smaller area occurs on the northwest margin between the Incomati and Espírito Santo estuaries (Ferreira and Bandeira, 2014). Sandy beaches occur mainly along the coastline, and around the island system in the eastern portion of the bay, but also occur on the southwest margin between the Espírito Santo and Maputo estuaries (Ferreira and Bandeira, 2014). The western and southern sections are generally muddy due to sediment-laden discharges from the river systems. Coral reefs and rocky outcrops are scarce and limited to the eastern island system (Ferreira and Bandeira, 2014).

Mangroves are highly specialised coastal macrophytes adapted for living in saline water, anaerobic soils and fluctuating environmental conditions associated with tidal rise and fall along the coast. The mangroves are critically important for the ecological, social and economic aspects of Maputo Bay as they provide numerous ecosystem services that are beneficial to the surrounding communities, and the functioning and integrity of Mozambique's coastal ecosystems (Paula et al., 2014). Six species of mangrove are found in Maputo Bay and its feeder systems. The most widespread species is the white mangrove, *Avicennia marina*. Other prominent species are the red mangrove, *Rhizophora mucronata*, which is found along creeks or drainage channels throughout the bay, and *Ceriops tagal* (Paula et al., 2014). The structure of the macrofauna community (crabs, snails, etc.) associated with mangroves shows a similar zonation typical of mangrove forests with different species occupying different zones, which in turn reflect differing environmental conditions, as well as degradation (Paula et al., 2014).

5.3 Overview of Aquatic Ecosystems

The following section details the findings of the site investigation covering sites where Mozal conducts various activities, and sites utilised in the Mozal water quality monitoring programme.

5.3.1 *Umbeluzi River*

The Mozal Smelter freshwater abstraction point is located on the Umbeluzi River approximately 19km upstream of the confluence with Matola and Tembe rivers. Abstraction is facilitated by a combined concrete- and rock-built weir. At this point, the Umbeluzi River comprises a bifurcated channel, with the weir stretching approximately 25m across the primary channel of flow and

riverbank at the abstraction facilities is protected from erosion with rock-filled gabion baskets. Water depth at the abstraction point is 3.5m deep. *In-situ* water quality measurements confirmed freshwater conditions, with salinity measuring 0.25psu. Although the water column appeared well mixed, with no evidence of stratification, dissolved oxygen concentrations were below 5mg/l at the surface and at depth. The aquatic and semi-aquatic vegetation at the site is characterised by typical freshwater species. Key species observed included *Phragmites australis*, *Typha*, water lily (*Nymphaea* spp.), Kariba weed *(Salvinia molesta),* and water lettuce *(Pistia stratiotes)*. The latter two are known aquatic invasive species.

Given the fishing effort noted at the site, it was deduced that this section of the river provides valuable habitat for freshwater fish species. This would be supported by the diversity of vegetation types, flows and depths observed at the site. In addition, a successful catch by an Osprey, *Pandion haliaetus*, was also observed, which provides further evidence of ecological importance of the system.

Figure 5-2 Overview of the Mozal freshwater abstraction point on the Umbeluzi River: upstream view of right bank (top left), upstream view of left bank and the abstraction structure (top right), downstream view of main channel (bottom left), and upstream view of weir (bottom right).

Figure 5-3 Overview of the Mozal freshwater abstraction point on the Umbeluzi River: upstream view of left bank showing dense reed beds (top left), Nymphaea coverage (top right), presence of water lettuce and Kariba weed in shletered areas (bottom left).

5.3.2 *Matola River and tributary*

The Matola River system comprises a relatively broad, meandering channel lined with mangrove vegetation up to approximately 400m upstream of the regional railway line, where freshwater plant species become more prominent. At this point, a low-lying dirt road crossing provides a pinch-point in the floodplain, creating an impounding effect, which allows for the development of 250m-wide wetland area. At the time of the site investigation, the river flow was overtopping the dirt road, despite the presence of the three large pipe culverts; this was attributed to high seasonal rainfall in recent days preceding the site field work. The prominent wetland vegetation species observed were *P. australis, Typha* and *Juncus*. The white mangrove, *A. marina*, was observed lining the river-estuary channel below the road crossing.

Several water-associated bird species were also observed in this area including cattle egret (*Bubulcus ibis*), long-tailed cormorant (*Microcarbo africanus*), black-headed heron (*Ardea melanocephala*), and giant kingfisher (*Megaceryle maximus*).

Figure 5-4 Overview of the Matola River upstream of the railway bridge: inundated dirt road crossing and pipe culverts (top left), mixed *Phragmites-Typha* wetland (top right), white mangrove (*Avecinna marina*) (background) below the road crossing (bottom left), open water and extensive *Phragmites* reed beds (bottom right).

Based on the cursory site investigation, the lower Matola River in proximity to the Mozal Smelter site and downstream toward the bay, is estuarine in nature. That is, having a measurable saline influence, and exhibiting horizontal salinity gradient decreasing from the marine environment moving upstream. This is in agreement with other specialist work (e.g. COWI/Fichtner, 2013; Electricidade de Moçambique, E.P. 2019).

The Matola River is lined with mangrove forest, comprising predominantly white mangrove, *A. marina,* interspersed with red mangrove, *R. mucronata* (**Figure 5-5** and **Figure 5-6**). There is also evidence of the local occurrence of *Ceriops tagal*, given the presence of the propagules at the Rio Matola Bridge approximately 5km upstream of the confluence with the Umbeluzi and Tembe rivers. Setback from the channel margin are open mudflat areas that are colonised by intertidal salt marsh plant species, namely *Salicornia* sp., *Sarcocornia natalensis, Sesuvium portulacastrum, Atriplex muelleri,* and *Bassia diffusa* and halophytic grasses, such as *Sporobolus virginicus* present in higher lying areas (**Figure 5-7)**.

At the Mozal abstraction and stormwater discharge point, the Matola River is approximately 10-15m wide and confined to a steeply-sided channel, lined with *A. marina* (**Figure 5-5**). Brackish salinities (<5 psu) were measured in this area and 100m upstream. Dissolved oxygen was slightly higher and salinity lower in the bottom waters which is inverse of what is usually expected in

estuarine environments. This likely reflects the influence of the stormwater flows released from the Mozal stormwater retention facility. Surrounded by natural woodland, the retention facility provides roosting habitat for water-associated bird species, including yellow-billed stork (*Mycteria ibis*) and black-headed heron.

From the site investigation, it is evident that the extent of mangrove habitat along the river has been impacted by human settlement and visibly degraded in some areas by anthropogenic activities (e.g. wood harvesting, solid waste pollution).

Figure 5-5 Overview of the Matola River near the stormwater discharge point: *A. marina* lined estuary channel (top left and right), extensive growth of intertidal saltmarsh (bottom left), prop roots of red mangrove, *R. mucronata* (bottom right).

Figure 5-6 **Overview of the lower Matola River looking upstream: exposed mangroves and mudflats on the right bank (top left and right) and left bank (bottom left), note the predominance of *A. marina* and isolated *R. mucronata* specimen; intertidal mudflat behind the mangroves with sparse distribution of saltmarsh species (bottom right).**

Figure 5-7 **Saltmarsh habitat: *Salicornia* sp. together with *Bassia diffusa* (top left), *Sarcocornia natalensis* (top right), large mats of saltmarsh together with halophytic grass *Sporobolus pyramidalis* (bottom left), mixed assemblage of *Sarcocornia natalensis, Atriplex muelleri and Bassia diffusa* (bottom right).**

Typical, conspicuous macrofauna inhabitants of the mangrove and mudflat areas were observed (**Figure 5-8**) and these included, fiddler crabs (*Tubuca urvillei, Cranuca inversa, Paraleptuca chlorophthalmus*) the red-clawed mangrove crab (*Neosarmatium* sp.), small mud crab (*cf. Cristarma eulimene)*, mangrove snail (*Cerithidea decollata*) and mudskippers (*Periophthalmus* sp.). These species are known species documented in the mangrove forests of Maputo Bay (Paula, et al., 2014).

a) 

b) 

c) 

d) 

e) 

f) 

Figure 5-8 Overview of the mangrove fauna of the Rio Matola: a) Urville's fiddler crab *Tubuca urvillei*, b) Inversed fiddler crab *Cranuca inversa*, c) Green-eyed fiddler crab *Paraleptuca chlorophthalmus*, d) Uca red-clawed mangrove crab (*Neosarmatium* spp), (e) marsh crab (*cf. Cristarma eulimene*), and (f) mangrove snail (*Cerithidea decollate)*

The Mozal WWTW is located on a tributary of the Matola River that drains into the mainstem river approximately 5km downstream of the stormwater discharge point. Treated domestic wastewater is released from the maturation pond into a broad homogenous wetland area densely vegetated with *Phragmites* reeds (**Figure 5-9**). Apart from the wetland area, the majority of the natural vegetation of the surrounding landscape has been removed and replaced with human settlement.

Figure 5-9 Overview of the Mozal waste water discharge site: upstream view over the maturation pond (top left), downstream view over the maturation pond (top right), upstream view of homogenous Phragmites wetland (bottom left), discharge pipe and margin of wetland showing density of reed bed (bottom right).

5.3.3 *Espírito Santo Estuary*

The Mozal Aluminium Terminal is located in the joint estuarine channel, the Espírito Santo Estuary, in the western portion of Maputo Bay. As an inland extension of the bay, there is a strong marine influence, however during the wet summer season (i.e. when the site investigation was undertaken), salinities are known to be lower than that of sea water (<35) as a result of increased freshwater inputs (Canhanga and Dias, 2014). Twice-daily tidal fluctuations ensure that most of the estuary is well flushed. Extensive mangrove and tidal mudflat habitat occur some 800m south of the berth as part of the Catembe peninsula, while a smaller, sheltered mangrove and mudflat area occurs immediately adjacent to the grain terminal to the west of the aluminium terminal (**Figure 5-10**). However, this area appears greatly disturbed and degraded[1]. *Avicennia marina* appears to be the dominant species, with isolated occurrences of *R. mucronata*. During spring low tide, approximately 40.6ha of intertidal mudflat adjacent the terminal, as well as 8.4ha of the inner-berth area (between the berth and the quayside) become exposed (Google Earth imagery, June 2021).

Figure 5-10 Overview of the Mozal Aluminum Terminal and surrounds: Mozal berth (top left), inner berth area (top right), southward view toward Catembe pennisula mangroves (bottom left)[1], and marginal habitat including mangroves adjacent to the grain terminal (bottom right).

5.4 Red Listed Species Screening

The IBAT Proximity Report (IBAT, 2021) provides a list of 76 threatened marine/estuarine species potentially found within 50km of the Mozal Smelter (**Table 5-2**). Each species was rapidly assessed, using available databases and distribution maps, to establish the possibility and likelihood of it occurring in the marine and estuarine ecosystem in close proximity to the Mozal operations and activities.

In **Table 5-2**, the *distribution* is based on the indicated geographic range of the species therefore inferring its possible existence or presence along the Mozambique coastline including the Maputo Bay Ecosystem.

In most cases, it was assumed that if a species was found to be resident along the southern Mozambique coastline, it was likely to be found in the bay, but not necessarily in the Espirito Santo

Estuary or the Matola River. The likelihood of the species actually occurring in these different areas is dependent on the individual species habitat preferences and movements (described in available literature). The bay contains several habitats, which are not found in the estuary or Matola River,

[1] This area could not be groundtruthed due to access restrictions

e.g. coral reefs, rocky outcrops, seagrass beds, and sandy areas, etc. Thus, species with preferences for these habitats were assumed to occur most likely in the bay, e.g. Dugongs. However, it should borne in mind that the anomalous/occasional presence of these species in these areas is not impossible. Species with particular habitat preferences for mangroves, shallow subtidal and intertidal muddy environments, or euryhaline species known to use estuaries as nursery or feeding grounds, were considered likely to occur in the estuary and lower Matola River.

Through this desktop species assessment, it was estimated that 89% of the listed species are likely to occur in Mozambique coastal waters and therefore the bay; 13% of these are critically endangered (CR), 26% endangered (EN) and the remaining 60% vulnerable (VU). In the estuary, 34% are likely to occur here; 27% CR, 15% EN and 58% VU. An estimated 17% of the listed species were found likely to occur in the Matola River; 15% CR, 15% EN and 69% VU.

Table 5-2 List of threatened species (IBAT 2021), their IUCN threat status, distribution, and likelihood of occurrence within the three marine and estuarine environments

Species Name	Common Name	IUCN Rank	Distribution	Maputo Bay	Espirito Santo Estuary	Matola River
Sphyrna lewini	Scalloped Hammerhead	CR	Possible	X	X	
Sphyrna mokarran	Great Hammerhead	CR	Possible	X	X	
Pristis zijsron	Green Sawfish	CR	Unknown	X	X	X
Rhynchobatus djiddensis	Whitespotted Wedgefish	CR	Possible	X	X	
Rhina ancylostoma	Bowmouth Guitarfish	CR	Possible	X	X	
Aetomylaeus bovinus	Duckbill Eagle Ray	CR	Possible	X	X	
Myliobatis aquila	Common Eagle Ray	CR	Possible	X		
Pristis pristis	Largetooth Sawfish	CR	Possible	X	X	X
Diomedea dabbenena	Tristan Albatross	CR	Possible	X		
Lethrinus mahsena	Sky Emperor	EN	Possible	X		
Argyrosomus japonicus	Dusky Meagre	EN	Possible	X	X	X
Argyrosomus thorpei	Squaretail Kob	EN	Possible	X	X	
Carcharhinus obscurus	Dusky Shark	EN	Possible	X		

Rhincodon typus	Whale Shark	EN	Possible	X		
Carcharhinus amblyrhynchos	Grey Reef Shark	EN	Possible	X		
Stegostoma tigrinum	Zebra Shark	EN	Possible	X		
Mobula thurstoni	Bentfin Devilray	EN	Possible	X		
Rostroraja alba	White Skate	EN	Possible			
Mobula kuhlii	Shortfin Devilray	EN	Possible	X		
Acroteriobatus leucospilus	Greyspot Guitarfish	EN	Possible	X	X	
Alopias pelagicus	Pelagic Thresher	EN	Possible	X		
Mobula birostris	Giant Manta Ray	EN	Possible	X		
Mobula mobular	Spinetail Devil Ray	EN	Possible	X		
Holothuria nobilis	Black Teatfish	EN	Possible	X		
Thelenota ananas	Prickly Redfish	EN	Possible	X		
Sousa plumbea	Indian Ocean Humpback Dolphin	EN	Definite	X	X	X
Morus capensis	Cape Gannet	EN	Possible	X		
Phalacrocorax capensis	Cape Cormorant	EN	Possible			
Spheniscus demersus	African Penguin	EN	Possible			

Thalassarche carteri	Indian Yellow-nosed Albatross	EN	Possible	X		
Hippocampus histrix	Thorny Seahorse	VU	Possible	X		
Epinephelus albomarginatus	White-edged Rockcod	VU	Possible	X	X	
Acanthopagrus vagus	Riverbream	VU	Possible	X	X	X
Polysteganus praeorbitalis	Scotsman Seabream	VU	Possible			
Pomatomus saltatrix	Bluefish	VU	Possible	X	X	X
Trachurus trachurus	Atlantic Horse Mackerel	VU	Possible	X		
Parablennius lodosus	Mud Blenny	VU	Possible	X	X	
Acropora willisae		VU	Possible	X		
Acropora retusa		VU	Possible	X		
Heliopora coerulea	Blue Coral	VU	Possible	X		
Acropora horrida		VU	Possible	X		
Alveopora allingi		VU	Possible	X		
Anomastraea irregularis		VU	Possible	X		
Acropora anthocercis		VU	Possible	X		
Acropora verweyi		VU	Possible	X		

Turbinaria mesenterina		VU	Possible	X		
Carcharhinus plumbeus	Sandbar Shark	VU	Possible	X	X	X
Carcharias taurus	Sand Tiger Shark	VU	Possible	X		
Dalatias licha	Kitefin Shark	VU	Possible			
Carcharhinus brevipinna	Spinner Shark	VU	Possible	X		
Carcharhinus falciformis	Silky Shark	VU	Possible			
Carcharhinus melanopterus	Blacktip Reef Shark	VU	Possible	X	X	X
Triaenodon obesus	Whitetip Reef Shark	VU	Possible	X		
Sphyrna zygaena	Smooth Hammerhead	VU	Possible	X	X	
Urogymnus asperrimus	Porcupine Ray	VU	Possible	X	X	X
Nebrius ferrugineus	Tawny Nurse Shark	VU	Possible	X		
Negaprion acutidens	Sharptooth Lemon Shark	VU	Possible	X	X	X
Rhizoprionodon acutus	Milk Shark	VU	Possible	X		
Hemipristis elongata	Snaggletooth Shark	VU	Possible	X	X	X
Odontaspis ferox	Smalltooth Sand Tiger	VU	Possible			
Halaelurus natalensis	Tiger Catshark	VU	Possible	X		
Rhinoptera javanica	Javanese Cownose Ray	VU	Not occurring			

Taeniurops meyeni	Blotched Fantail Ray	VU	Possible	X		
Carcharhinus albimarginatus	Silvertip Shark	VU	Possible	X		
Himantura uarnak	Reticulate Whipray	VU	Possible	X	X	X
Alopias superciliosus	Bigeye Thresher	VU	Possible	X		
Pateobatis jenkinsii	Jenkins' Whipray	VU	Possible	X		
Mobula alfredi	Reef Manta Ray	VU	Possible	X	X	
Aetobatus ocellatus	Spotted Eagle Ray	VU	Possible	X	X	
Stichopus herrmanni	Curryfish	VU	Possible	X		
Actinopyga echinites	Deep Water Redfish	VU	Possible	X		
Zostera capensis	Dwarf Eelgrass / Seagrass	VU	Definite	X	X	
Dugong dugon	Dugong	VU	Definite	X		
Procellaria aequinoctialis	White-chinned Petrel	VU	Possible	X		
Caretta caretta	Loggerhead Turtle	VU	Possible	X	X	X
Dermochelys coriacea	Leatherback Turtle	VU	Possible	X		

6. RISK ASSESSMENT

The biodiversity assessment process allowed for the following to be undertaken:

1) the *potential* impacts that Mozal's activities in its Area of Influence may have on both terrestrial and aquatic biodiversity to be identified;
2) the receptors of these impacts (i.e. species and habitats, with a particular focus on Red Listed species) to be identified; and
3) whether these impacts were resulting in adverse impacts for biodiversity on the ground to be determined.

Possessing the above the information can allow for a simple biodiversity risk assessment to be undertaken, which identifies the material impacts on biodiversity and the materiality of the risks for biodiversity. For the purposes of this study material impacts are those that are occurring on site, whilst the materiality of a risk is considered to be whether the risk exists, and the severity of the risk in terms of its impacts on biodiversity (i.e., no material risk, low risk, high risk). The risk assessment presented is adapted from South32's Risk and Opportunity Analysis for Biodiversity, with additional components considered and some components excluded. It must be noted that stakeholders were not engaged in the biodiversity assessment as, given the highly urbanised nature of the setting, indigenous communities are not anticipated to be adversely impacted by the site's impacts on biodiversity.

Risk component	**Rationale**	**Risk rating**
Operational activities/impacts		
Power supply	Overhead powerlines may pose a risk to some species of birds. The area is unlikely to be an important supporting habitat for birds and this is not expected to be a common occurrence	Low
Stockpiling of basement material	Stockpiling of basement material creates an area of disturbance and may potentially result in soil contamination. This disturbance is confined to a small area and does not appear to have had a notable effect on biodiversity in the broader area.	Low
Smelting activities	The smelting of aluminium can create air pollution which may adversely affect some sensitive species. There was little evidence to indicate plants on site were under notable stress	Low
General site operational activities	The routine running of the site may lead to both noise and light pollution. There is insufficient information available to assess the severity of this. However, lighting	

	is confined to the smelter site's operational area, with the open area unlit, thus reducing the impact on fauna. Additionally, the area surrounding the site is highly urbanised, likely contributing to noise and light pollution, making it challenging to isolate any impacts that may arise and attribute these to Mozal's activities.	
Transport of materials	Where goods are transported, there is always a risk of vehicle – wildlife collisions. Given the highly urbanised nature of the setting it is highly unlikely that much wildlife will be roaming in the area.	Low
Freshwater and saline water abstraction	The abstraction of water may result in modification of habitats, flow and physico-chemical water quality. Moreover, organisms may be pumped up during abstraction. The biodiversity observed at abstraction sites did not appear to be notably impacted.	Low to moderate
Discharge of treated domestic effluent	The discharge of treated effluent may result in contamination of the water and organic and nutrient loading. The biodiversity observed at abstraction sites did not appear to be notably impacted.	Low
Discharge of stormwater	The discharge of water may alter physico-chemical water quality and flow conditions. It may also result in fluoride contamination. The discharge of water was found to be having some impact on water quality conditions. There was some evidence of degradation at the discharge point, but this was attributable to other activities, such as harvesting of wood.	Low to moderate
Shipping terminal	The activities at the shipping terminal may lead to noise disturbance, pollution and possible introduction of alien species. Given the low shipping traffic associated with the terminal and the presence of surrounding terminals, it is not anticipated that Mozal's activities will have notable impact on biodiversity.	Low
Impact receptors/biodiversity		
IUCN protected areas within the Area of Influence	None	Low
Other areas of conservation importance in the Area of Influence	None	Low

Red Listed species present in the Area of Influence	None recorded, but may possibly occur	Low to moderate
Important habitat	The site does not possess any notably important habitat	Low
Ecological corridor	The site is surrounded by transformed land and is thus unlikely to act as an important ecological corridor	Low

Based on the risks associated with Mozal's activities, and the actual biodiversity present within its Area of Influence, the materiality of the risk for biodiversity can be considered to be **low**. Although it is anticipated that the activities within the company's Area of influence (including the smelter site, abstraction points, bulk terminal, WWTW and electrical transmission corridor) are likely to have relatively low impacts on biodiversity, there are a number of recommendations that can be implemented to protect the biodiversity on site. It must be noted that the majority of adverse impacts for biodiversity would have occurred during the construction phase of the project. Additionally, there is no available biodiversity baseline against which to assess how biodiversity in the area has been impacted by Mozal SA's activities. These are discussed in greater detail below.

7. BIODIVERSITY RECOMMENDATIONS

Industrial sectors across the globe are increasingly using the mitigation hierarchy framework to guide their activities in order to limit negative impacts on biodiversity, with the goal being no net loss of biodiversity, or net gain relative to a predetermined baseline (Arlidge et al., 2018). The hierarchy has the following key steps 1) avoid, 2) minimize, 3) remediate and 4) offset (**Figure 7-1**). Step 1 - avoidance- would be carried out prior to project design and would involve designing the project in such a manner that it avoids impacts on biodiversity (Arlidge et al., 2018). The second step – minimization – should be implemented prior to and during project development and involves the implementation of measures to ensure impacts on biodiversity are minimised (Arlidge et al., 2018). The third step – remediation – largely applies to project closure and requires that measures are implemented remediate the project's footprint. The fourth and final step – offsetting - requires that any residual impacts not addressed by the first three steps are offset elsewhere (Arlidge et al., 2022).

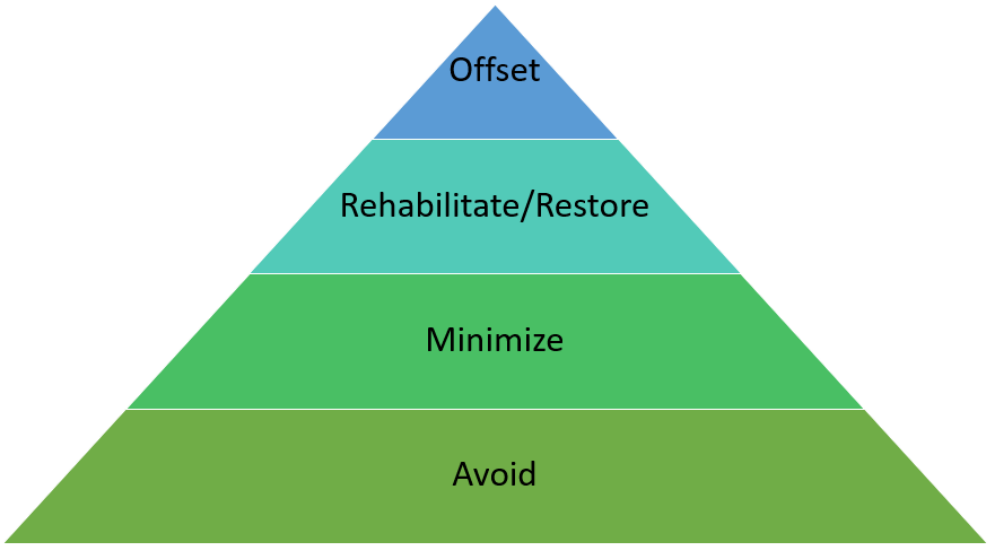

Figure 7-1 Steps in the mitigation hierachy

Typically, measures to protect biodiversity in line with the mitigation hierarchy would be designed during the EIA and planning phases of the project. There are, however, a number of recommendations that can be proposed for Mozal in line with some components of the mitigation hierarchy. Some of the key recommendations for protecting and/or enhancing biodiversity within the company's Area of Influence are as follows:

- There is the possibility that soils in the vicinity of the area where stockpiling occurs may be contaminated. It is proposed that soil sampling in the area be undertaken to verify this.
- The powerlines that service the property and run north towards the Maputo substation may pose a collision risk to a number of bird species. Bird diverting devices should be installed in an effort to reduce this risk. A record of bird – powerline collisions should be kept in order to assess whether the risk of collisions is material.
- Lighting systems at each of the operational areas should be designed to minimise light pollution. This will involve the use of LED lights and angling of light bulbs downwards, rather than up towards the sky.
- There are a number of invasive alien plants present on site. These pose a risk to native biodiversity, often outcompeting indigenous species. It is recommended that alien plant clearing take place on site, as per the methods outline in the Alien Species Baseline Report (GroundTruth, 2022).
- Should the decision be made to clear any more land on site, it is suggested that a targeted plant assessment be carried out by a relevant specialist and any species of conservation concern be identified and, where possible, translocated to an appropriate site. This will likely require obtaining relevant permissions and permits.
- In some areas of the smelter site grass has become moribund (i.e., it has reached its maximum growth and died back, resulting in the accumulation of dead material on the soil surface which prevents the growth of new plant material). If it is possible to do so in a safe and controlled

manner, consideration should be given to undertaking a controlled burn. Alternatively, this gras could be mowed.

- There are concerns that water discharged from the smelter site and WWTW may result in some pollution of aquatic systems. Mozal monitors the quality of this water to ensure that it is compliant and should continue to do so.
- Fish and other aquatic organisms might potentially be sucked up by pipes during abstraction. Flow velocities should be low enough to prevent this.
- Biodiversity on site should be monitored on an ongoing basis and any notable observations recorded so that impacts from activities may be better understood.

8. KEY CONCLUSIONS

- This study aimed to characterise and define the biodiversity features within and surrounding the site (including the estuarine and marine environment) that may potentially be affected by its activities, with a particular focus on natural and/or sensitive communities and the Red Listed Species identified in the IBAT Proximity Report for the site.
- The study assessed the biodiversity associated with Mozal's various operational areas that constitute its Area of Influence, namely the smelter site, the bulk terminal at the Port of Matola, the freshwater abstraction point on the Umbeluzi River, the saline abstraction point and discharge point on the Matola River and the wastewater treatment works on the tributary of the Matola River.
- Given the distribution of these sites, this assessment focused on terrestrial, marine and estuarine species. As limited assessable habitat was available at the abstraction points and bulk terminal, the terrestrial biodiversity assessment primarily focused on the smelter site
- The site's operational activities were reviewed to assess the impacts that these may potentially have on biodiversity. These were reviewed in conjunction with the biodiversity associated with the operational areas in order to assess the materiality of these impacts. Overall, Mozal's operations are anticipated to have little material risk for biodiversity.
- Impacts that may occur include electrocution of avifauna due to the presence of powerlines, invasion by alien plant species due to habitat disturbance and harm to vegetation due to air pollution.
- The smelter site is largely transformed with relatively terrestrial vegetation present. The vegetation present on site is primarily woodland and mixed grassland, though a small patch of forest is present.
- Mozal is surrounded by a highly urbanized and industrialised area. It is thus highly unlikely that the site plays an important role as a corridor for species. Furthermore, the site is fenced in such a manner that movement of species will be inhibited.
- The site was found to possess a moderately diverse suite of plant species, comprising both indigenous and alien species. None of the species identified were found to be a of significant conservation importance.

- Few faunal species were present on site. The site is small and does not possess sufficient habitat to support large mammal species. However, the failure to find small species, such as amphibians and reptiles may be due to either cryptic or nocturnal habits. Additionally, field investigations were undertaken in the rain- conditions not ideal for a number of species.
- Although the IBAT reports a number of terrestrial species that may occur on site, thiis unlikely for the majority due to poor habitat suitability, including limited area size. Species that may potentially occur on site are species that are able to move freely, namely birds, or species that may prove difficult to find in field, namely plants and insects.
- The freshwater habitat at the Umbeluzi river is thought to offer valuable habitat for freshwater species
- The water at the saline water abstraction/discharge point was found to be brackish in nature and the habitat typified by mangrove habitat which has been impacted by anthropogenic activities
- In terms of marine and estuarine species, 89% of the listed species are likely to occur in Mozambique coastal waters and therefore the bay; 13% of these are critically endangered (CR), 26% endangered (EN) and the remaining 60% vulnerable (VU). In the estuary, 34% are likely to occur here; 27% CR, 15% EN and 58% VU. An estimated 17% of the listed species were found likely to occur in the Matola River; 15% CR, 15% EN and 69% VU

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