APPENDIX E: BIODIVERSITY STUDY

WATERCOURSE ASSESSMENT AS PART OF THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) FOR THE PROPOSED BILBOES ISABELLA-MCCAYS-BUBI GOLD SULPHIDE PROJECT, ZIMBABWE

Prepared for

SLR Consulting (Africa) (Pty) Ltd

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ACRONYMS

BAS	Best Attainable State
°C	Degrees Celsius.
DWAF	(South African) Department of Water Affairs and Forestry
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMA	(Zimbabwe) Environmental Management Agency
EMC	Ecological Management Class
ESIA	Environmental and Social Impact Assessment
GIS	Geographic Information System
GPS	Global Positioning System
m	Meter
MAP	Mean Annual Precipitation
MC	Management Classes
PES	Present Ecological State
REC	Recommended Ecological Category
RMO	Recommended Management Objective
SACNASP	South African Council for Natural Scientific Professions
SAS	Scientific Aquatic Services

GLOSSARY

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Base flow:	Long-term flow in a river that continues after storm flow has passed.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, ocean or contributes to the groundwater system.
Chroma:	The relative purity of the spectral colour which decreases with increasing greyness.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Fluvial:	Resulting from water movement.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.
Hydromorphy:	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Intermittent flow:	Flows only for short periods.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
Perennial:	Flows all year round.
RAMSAR:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface

Temporary zone of wetness:	the outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year
Watercourse:	Zimbabwean legislation does not specifically define a watercourse, although it does define a wetland (see below). Thus, the definition of a watercourse is taken as that contained within the South African National Water Act, 1998 (Act No. 36 of 1998) as follows: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks.
Wetland	In terms of the definition contained within the Zimbabwean Environmental Management Act, 2002 (Act No. 13 of 2002), a wetland is defined as: "*any area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, and includes riparian land adjacent to the wetland*." This is in line with the definition contained in the Ramsar convention which defines wetlands as: "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*". As per this definition, a wetland also contains "*riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands*"

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater resource assessment as part of the Environmental and Social Impact Assessment (ESIA) for the proposed Bilboes Isabella-Mccays-Bubi Gold Sulphide Project, Zimbabwe, hereafter referred to as the "study area" (Figures 1 and 2). The study area is situated within the Bubi District of the Matabeleland Province of Zimbabwe. The A8 road is situated approximately 20 km west of the study area, whilst the A5 road is located approximately 59 km southeast of the study area.

Bilboes Holdings (Pvt) Ltd (Bilboes) currently own and operate the Isabella-McCays-Bubi Oxide Complex, which comprises three existing gold mining operations. The Isabella and McCays Mines are located in close proximity to one another, approximately 75 km north of Bulawayo, while the Bubi Mine is located approximately 20 km further north-east of the Isabella-McCays complex.

1.2 Project Description

As part of their operations, Bilboes have identified additional gold-bearing sulphide ores beneath the oxide orebody within the existing open cast pits at the Isabella, McCays and Bubi Mines. The proposed Bilboes Isabella-Mccays-Bubi Gold Sulphide Project entails the establishment of additional infrastructure required at each of the three existing mines to facilitate the extraction, handling and processing of the sulphide ores. In order to extract the sulphide ores, the existing open pits would need to be mined deeper.

The key focus of this study is on the new infrastructure, including a new processing plant and associated Tailings Storage Facility (TSF), that is required to process the gold from the sulphide ore. It is currently proposed that this new infrastructure be established near the Isabella-McCays complex. In order to facilitate the transport of the mined sulphide ore at the Bubi Mine to the new processing plant, a new 30 km haul road will also need to be established. Three alternative routes referred to as Options 1, 2 and 3, are proposed for the haul road.

Other new infrastructure associated with the proposed project includes waste rock dumps (WRDs), a new airstrip, a limestone quarry, and associated facilities at the proposed

processing plant. The planned establishment of some of the proposed infrastructure would also necessitate the diversion of an existing public road and powerline.

SAS was requested to provide a preliminary high-level analysis of any freshwater aspects or sensitivities which could potentially pose constraints to the proposed mining expansion. Additionally, the results of this investigation will contribute to an integrated Environmental and Social Management Plan (ESMP) in order to not only protect but enhance the ecology of any watercourses associated with the study area.

This preliminary assessment is limited to only the provided study area and the immediate surrounding area. Use was made of digital satellite imagery, and available spatial datasets to define the extent of any watercourses within the study area (which includes streams/rivers, and wetlands/vleis) on a desktop basis.

1.3 Project Scope

Specific outcomes in terms of this report are outlined below. It should be noted that since no assessment methods have been developed specifically for use in assessing Zimbabwean watercourses, regional 'best practice' methodologies were adapted and applied where applicable.

- Watercourses are generally considered sensitive environments that require protection. The presence of any wetland characteristics, as defined by the Zimbabwean Environmental Management Act, 2002 (Act No. 13 of 2002) and wetland/riparian characteristics by the Ramsar Commission, were used to determine which features can be considered to contain areas displaying wetland or riparian characteristics and to map the extent of these features;
- Characterisation and classification of watercourses according to the method of Ollis *et al*, (2013);
- The Present Ecological State (PES) was assessed according to the Riparian Vegetation according to the Index of Habitat Integrity (IHI) (Kleynhans *et al*. 2008);
- The Ecological Importance and Sensitivity (EIS) of the watercourses was determined according to the method described by Rountree & Kotze (2013);
- The goods and services provided by the watercourses in the study area were assessed according to the method of Kotze *et al*. (2009). This tool is used to define the breadth and degree of goods and service provision to the local community as well as to support ecological processes;

- The watercourses were mapped according to the ecological sensitivity of each watercourses hydrogeomorphic unit (HGM) in relation to the study area. In addition to the watercourse boundaries, buffers were generated and were depicted where applicable;
- A Recommended Ecological Category (REC), Recommended Management Objective (RMO) and Best Attainable State (BAS) for the watercourses based on the findings of the EIS assessment was provided;
- The PES, EIS, and goods and services provision of the watercourses were highlighted, and a preliminary set of risks that the proposed mining expansion activities could pose were developed for further assessment in the future phases of the study; and
- To identify opportunities where active management could result in an improvement of ecological resources associated with the study area.

1.4 Assumptions and Limitations

- Scientific Aquatic Services did not undertake the fieldwork assessment for this study. The information contained in this report is therefore reliant on the data provided by the Zimbabwean-based specialist (Chinho, 2018[1]), photographs of specific areas as provided by the proponent, and available desktop data including the limited academic research available for the area;
- Similarly, whilst verification of one watercourse (an unnamed tributary of the Bembezi River) was undertaken as far as possible in the field, access limitations were encountered in some sections of the study area by the specialist (Chinho, 2018), particularly within the Bubi Mine area, and therefore, extensive use was made of desktop methods including historical and current digital satellite imagery and topographic maps to refine the watercourse delineations. Whilst SAS provided guidance in this regard, SAS does not take responsibility for the accuracy of the delineations provided in this report;
- The watercourse delineations as presented in this report are regarded as a best estimate of the riparian zone boundaries, based on a combination of site conditions at the time of the assessment and on available digital satellite imagery. Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur, however, the delineations provided herein are deemed sufficient for development planning and to meet the required

[1] *Ecological Assessment For The Bilboes Isabella- Mccays- Bubi Sulphide Gold Project, Zimbabwe.* Prepared by Chinho, T. for Griynova Environmental Consultancy. December 2018. Unpublished specialist report.

authorisation conditions. If more accurate assessments are required, the watercourses will need to be surveyed and pegged according to surveying principles;

- The watercourse delineation and assessment is confined to the study area and investigation area as depicted in Figures 1 and 2, and does not include the neighbouring and adjacent properties, although land uses and possible catchment impacts occurring on surrounding properties were taken into consideration;
- Freshwater and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to obligate/facultative species. Within this transition zone, some variation of opinion on the watercourse (wetland or riparian zone) boundary may occur. However, if the delineation method takes into consideration soil morphological characteristics, vegetation indicators and topography as advocated by the (South African) Department of Water Affairs and Forestry DWAF[2] (2008), all assessors should get largely similar results;
- Availability of conservation planning spatial datasets for the area is limited and therefore the background information gathered must be considered with caution, as inaccuracies and data capturing errors may be present within these databases;
- Due to the limited data provided to SAS following the site assessment, the results of the quantitative assessments of the PES, EIS and goods and services provisioning presented in this report must be considered with caution. The results of the assessments presented herein are based on the data received, and any additional information which could be obtained from other resources (e.g. academic publications) combined with the author's professional experience. Therefore, out of necessity, certain assumptions are made with regards to conditions on site; and
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. However, it is expected that the proposed development activities have been accurately assessed and considered, based on the field observations and monitoring data in terms of freshwater ecology.

[2] The (South African) Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.

1.5 Legislative Requirements and International Guidelines

Detailed information regarding the relevant legislative requirements pertaining to the protection of freshwater resources in Zimbabwe is scarce, however, the following legislation and international guidelines were taken into consideration during this study:

- The Environmental Management Act, 2002 (Act 13 of 2002);
- The Statutory Instrument 7 of 2007 on Environmental Management Environmental Impact Assessment and Ecosystems Protection) Regulations and Government Gazette 380 of 2013;
- The Equator Principles; and
- Performance Standard 6 of the International Finance Corporation (IFC) Environmental Health and Safety Guidelines.

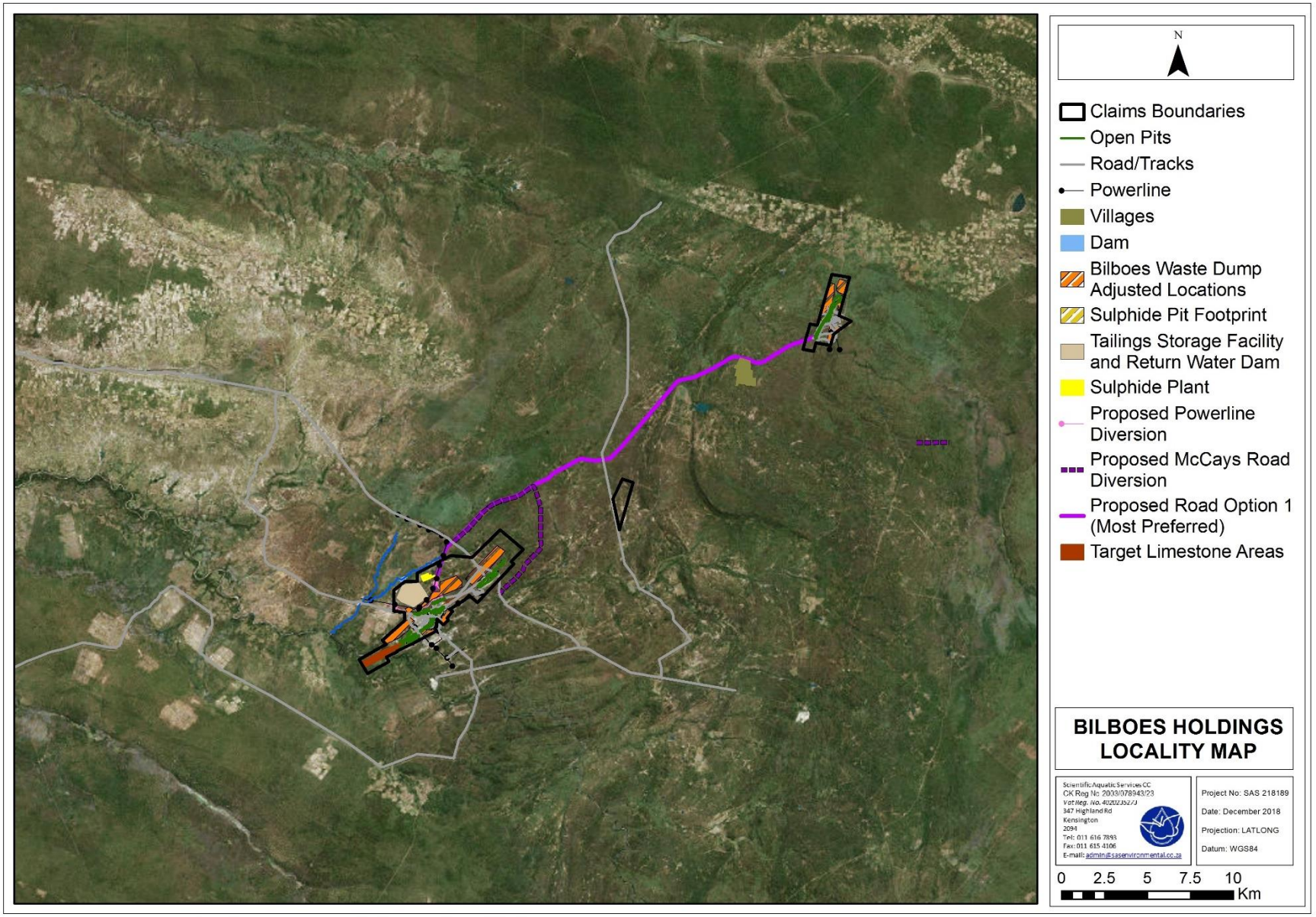


Figure 1: Location of the study area and project layout depicted on a digital satellite image in relation to surrounding areas

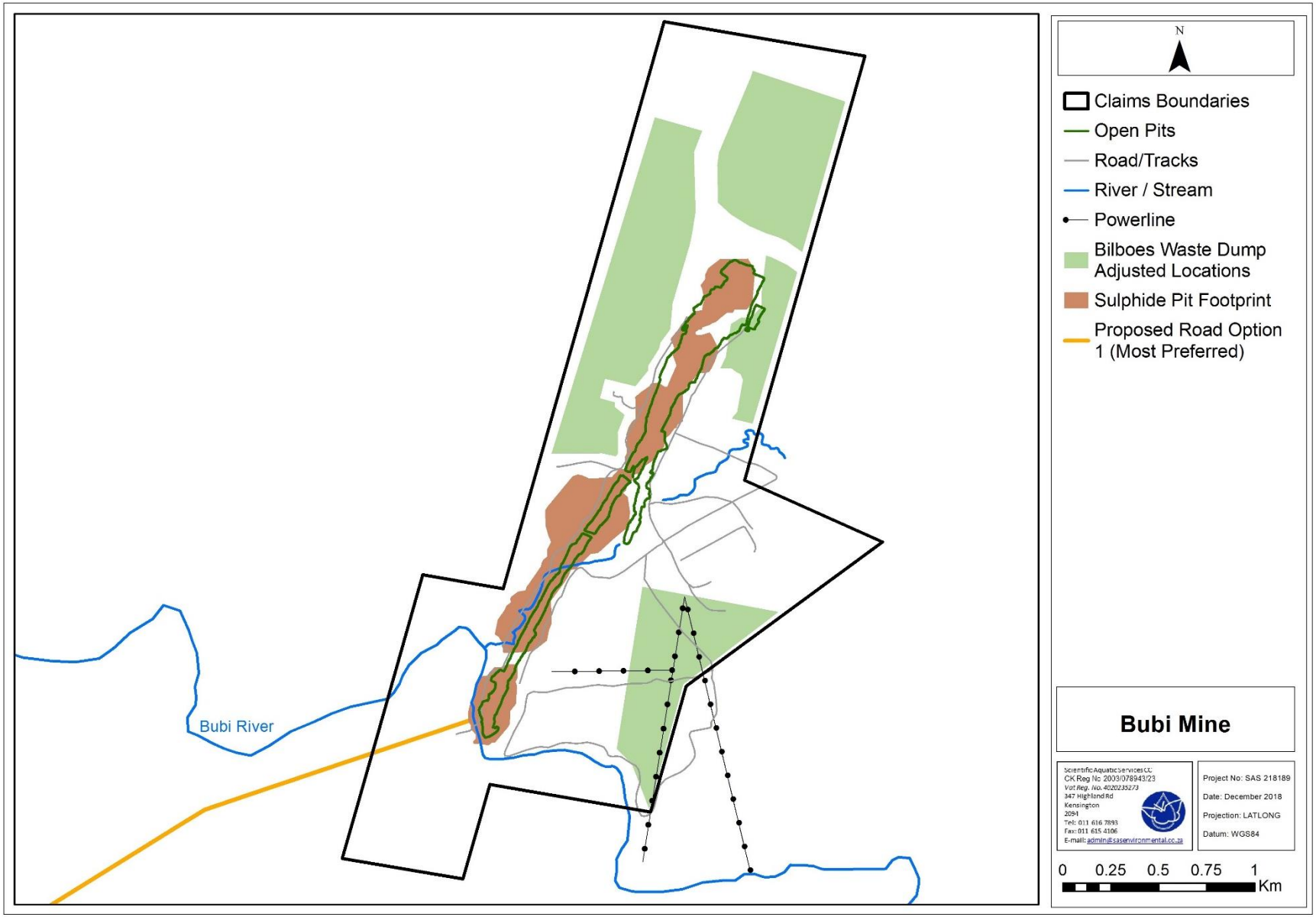


Figure 2: Proposed project layout: Bubi Mine.

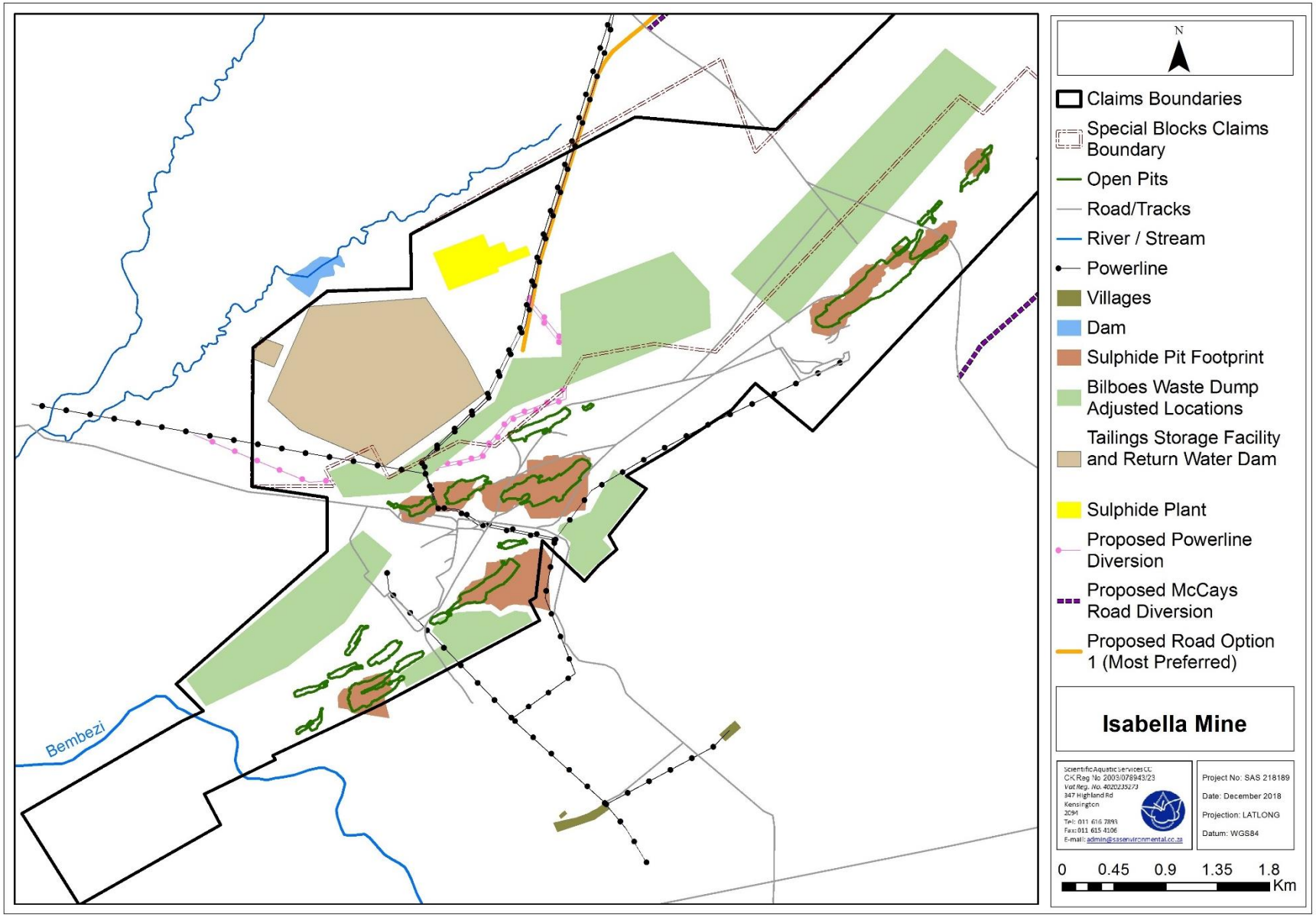


Figure 3: Proposed project layout: Isabella Mine.

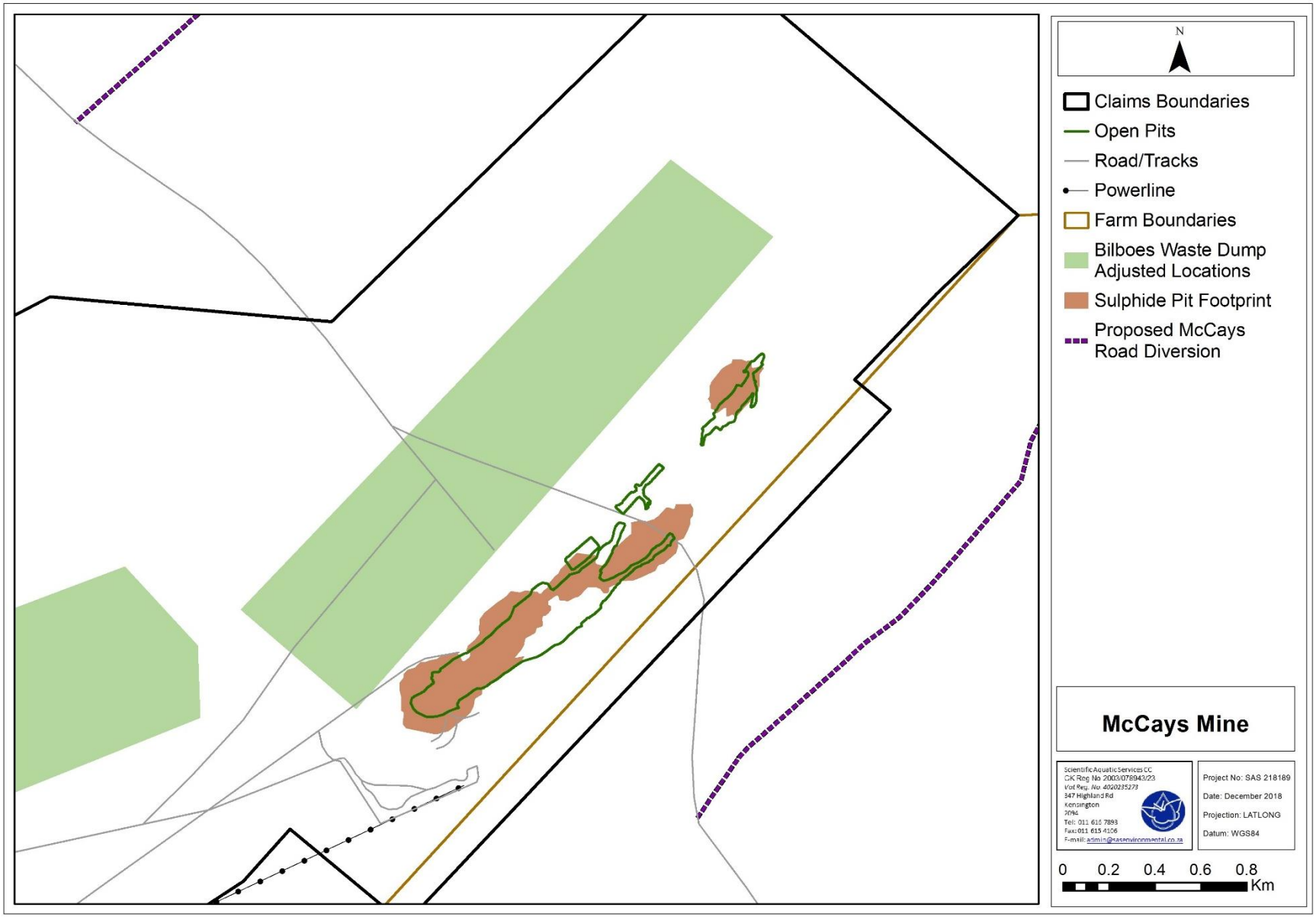


Figure 4: Proposed project layout: McCays Mine.

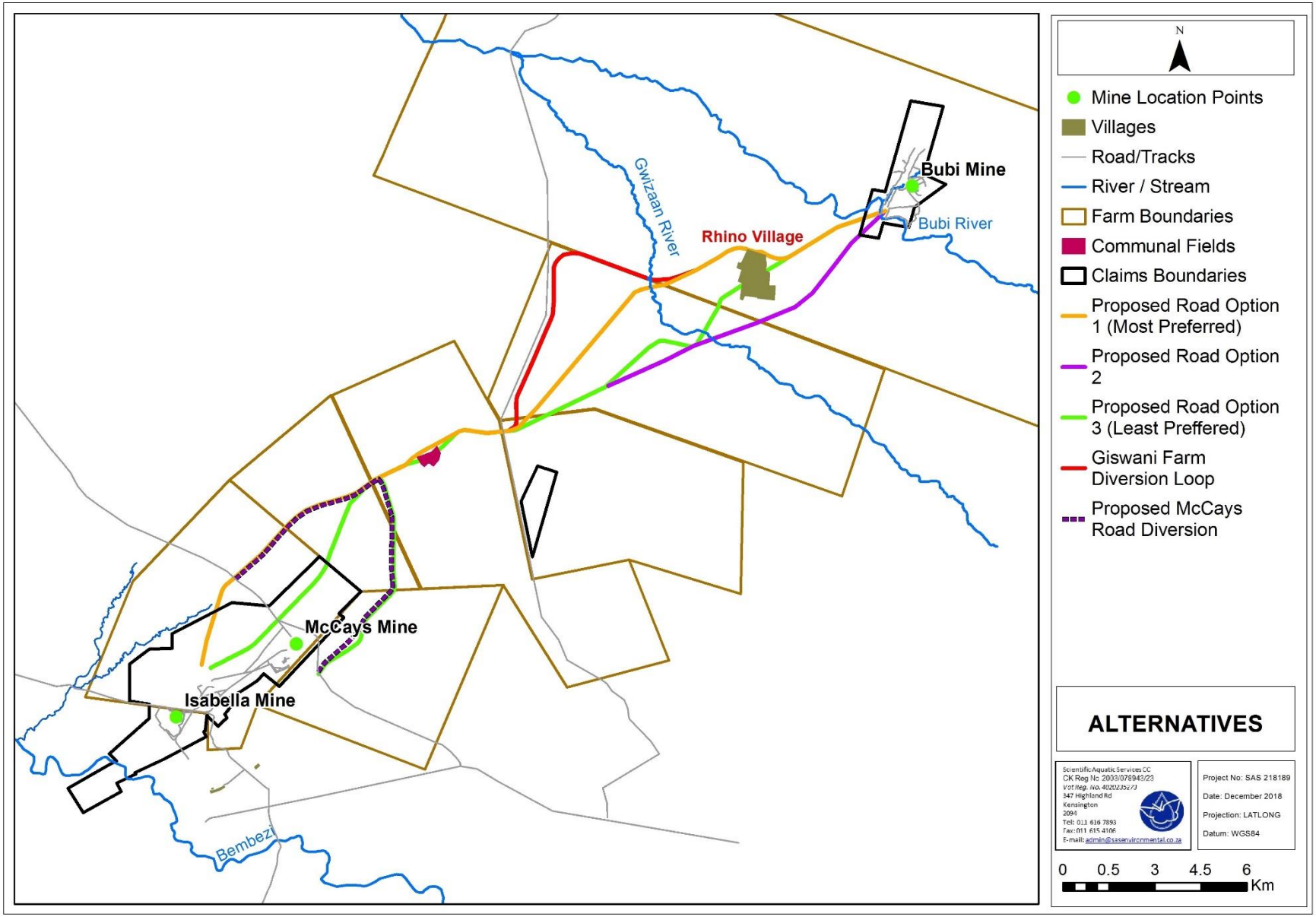


Figure 5: Proposed haul road alternatives (Options 1, 2 and 3)

2 ASSESSMENT APPROACH

2.1 Definition of Wetlands and Riparian Zones

According to Zimbabwe's Environmental Management Act, 2002 (Act 13 of 2002), wetlands are defined as: "*any area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, and includes riparian land adjacent to the wetland*."

This definition is in line with that of the Ramsar Commission, which defines wetlands as "*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres*". As per this definition, a wetland also contains "*riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands*" (Article 2.1, Ramsar Commission)[3].

According to RAMSAR, wetlands as defined above are areas which support vegetation, known as "riparian vegetation", occurring within the area between the water body and the surrounding higher lying areas. These "riparian zones of habitats" includes vegetation, known as "riparian vegetation", occurring within the area between the water body and the surrounding higher lying areas.

In order to further refine the definition of wetland and riparian habitat, regional best practice guidelines and definitions provided in neighbouring countries' legislation was also consulted. In this regard, South Africa's National Water Act, 1998 (Act No. 36 of 1998) provides the definition of both wetland and riparian habitat, as follows:

Wetland means-
"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."
Riparian habitat includes-

[3] Retrieved from http://archive.ramsar.org/cda/en/ramsar-about-faqs-what-are-wetlands/main/ramsar/1-36-37%5E7713_4000_0__ 27 October 2018

"the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas".

2.2 Delineation of Freshwater Resources

Taking the definitions above (Section 2.1) into consideration, the delineation of the watercourses was primarily undertaken using desktop methods, making use of historical and current digital satellite imagery, and was based on identifying features displaying a diversity of digital signatures. In this regard, specific mention is made of the following:

- Hydrophytic and riparian vegetation: a distinct increase in density, changes in species composition, as well as tree size near drainage lines;
- Hue: wetlands, riparian areas and drainage lines display varying chroma (colours and colour intensity) created by varying vegetation cover and soil conditions in relation to the adjacent terrestrial areas; and
- Texture: wetland and riparian areas display various textures which are distinct from the adjacent terrestrial areas, created by varying vegetation cover and soil conditions within the watercourse.

As previously mentioned, very limited field verification of these delineations was undertaken.

3 RESULTS OF THE DESKTOP ANALYSIS

The following sections contain data accessed as part of the desktop assessment. It is important to note that although all data sources used provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the subject properties' actual site characteristics. This information is, however, considered to be useful as background information to the study. Thus, this data was used as a guideline to inform the assessment and areas where increased conservation importance is indicated were focused on.

Table 1: Desktop data relating to the characteristics of the study area and surrounding region.

Aquatic Ecoregion	According to the WWF FEOW (Freshwater Ecoregions of the World, http://www.feow.org/ecoregions/details/560) classification, the study area is located within the Zambezian Highveld Aquatic Ecoregion (reference number 560). The major habitat type is listed as Tropical and subtropical upland rivers and is situated on the great Southern African central plateau (IUCN 1992). This ecoregion is delineated based on the northern subregion of the Highveld (temperate) aquatic region of Skelton (Skelton 1993) and follows the contours of the interior plateaus of Zimbabwe above about 600 m.
Main rivers or other water bodies	The Zambezi Highveld Aquatic Ecoregion includes the headwaters and highland streams of the Zambezi River basin in the north, the Save River in the east, and the Limpopo River in the south.

Climate	Although the ecoregion is within tropical latitudes it has a relatively cool climate because of its altitude (>600 m). There is a warm rainy season (November to March) followed by a cool, dry season (April to mid-August) and then a hot, dry season (mid-August to October) (Gratwicke 1999). Rainfall varies from less than 400 mm per year in the Save and Limpopo catchments to 1,000 mm in some of the central areas (Hughes & Hughes 1992).
Topography	The relatively short rivers of the ecoregion descend from the Guinean Dorsale and cross the coastal plain adjacent to the Atlantic Ocean. The rivers begin at elevations of around 500 m above sea level (asl) (and as high as 1,946m asl at Mt. Bintumani in the Loma Mountains) (Hughes & Hughes, 1992). Moving west, the gradient decreases and the landscape changes from undulating foothills to a coastal plain where riverine and floodplain lakes are common.
Freshwater Habitats (Figure 5)	The aquatic habitats found on this plateau are considered large and small rivers, numerous dambos (wetlands), a few artificial reservoirs, and isolated floodplains. The headwater streams of the Highveld are small and clear but revert to swollen and turbid rivers after the rains (Gratwicke 1999). Rivers and streams of this plateau flow in two directions with some feeding the Zambezi River system and others feeding the Save River system. Both rivers then flow through Mozambique and into the Indian Ocean. Perennially waterlogged dambos are widespread and cover approximately 12,000 km^2 (Owen 1994). Most dambos occur at an altitude above 1200 m and are associated with a mean annual rainfall greater than 800 mm. Most streams depend on dambos for their dry season flow (Magadza 2000).
Terrestrial habitats	This ecoregion falls mostly within the terrestrial Zambezian biogeographic zone and the vegetation is predominantly dry miombo woodland. Grassland occurs along the Great Dyke, a broad ridge in the centre of the ecoregion (IUCN 1992). Soils, which are largely derived from gneissic granite, are sandy, well drained, and have low fertility (Campbell 1994).
Fish Fauna	About 39 fish species live in the waters of the Zambezian Highveld. Several of the river systems, including the Pungwe and Save River, have an impoverished fish fauna (Bell-Cross & Minshull 1988). The families Alestiidae, Amphiliidae, Anguilladae, Cyprinidae, Cichlidae, Clariidae, Kneriidae, Mochokidae, Mormyridae, and Schilbeidae are represented.
Other noteworthy aquatic biotic elements	Aquatic mammals include the marsh mongoose (*Atilax paludinosus*), the African clawless otter (*Aonyx capensis*), and hippopotamus (*Hippopotamus amphibius*). About 38 aquatic amphibians; 8 aquatic reptiles, and 17 freshwater molluscs inhabit the Zambezian Highveld. Little information is available on the aquatic ecology of the numerous dambos in the region, though they are known to provide cover and food for indigenous terrestrial fauna and migratory birds (Katerere 1994). Dambos also provide a distinctive habitat for aquatic vascular plants; of the 109 dambo species recorded, eight are found exclusively in this habitat (Magadza 2000). The wetland butterfly, *Mashuna mashuna*, has been recorded in high level dambos (Gardiner 2000).
Justification for delineation	The fauna of this ecoregion is largely Zambezian. It is believed that the fish fauna originated from the more tropical equatorial region and that deteriorating ecological conditions during the Pleistocene have resulted in reduced or depauperate faunas in many rivers of this ecoregion (Bell-Cross & Minshull 1988).

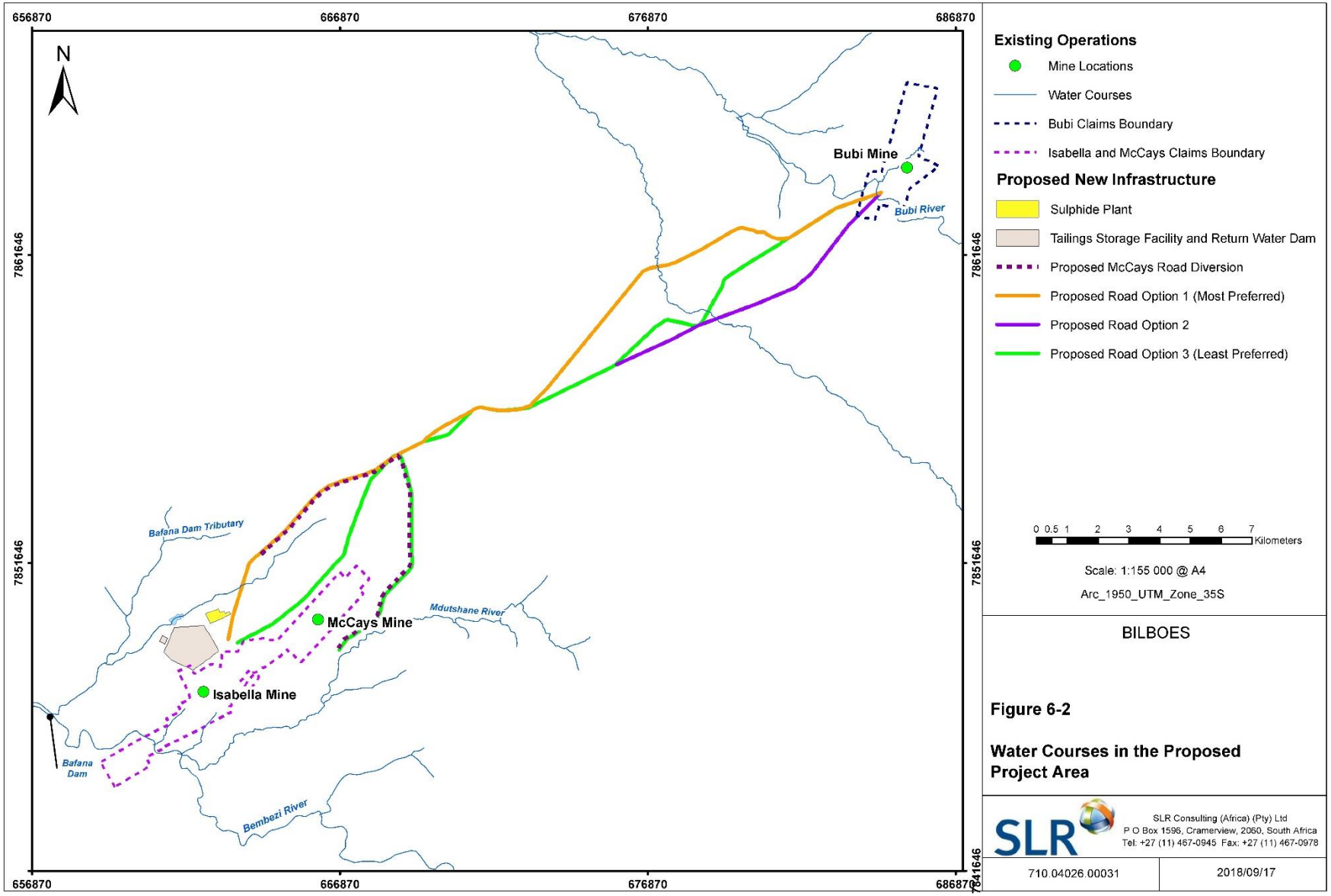


Figure 6: Watercourses associated with the study area (map courtesy of SLR Consulting, 2018).

4 RESULTS: FRESHWATER RESOURCE ASSESSMENT

4.1 Freshwater Resource System Characterisation

Several watercourses were identified within the three mining areas. According to Chino (2018) the majority of these drainage systems were ephemeral in nature, with weakly defined associated riparian zones. However, several large drainage systems are situated either within the three mine Claims Areas or within close proximity thereof. These include the following rivers:

- The Bubi River, located in the south of the Claims Area of the Bubi Mine;
- The Gwizaan River, which is a tributary of the Bubi River, located approximately 6.6 km south-west of the Bubi Mine Claims Area and traversed by Option 1 of the proposed haul road;
- The Bembezi River, located in the south of the Claims Area of the Isabella Mine; and
- The Mdutiana River located to the east of the McCays and Isabella Mines.

In addition to the above-mentioned rivers, an unnamed tributary of the Bubi River is located within the south-eastern portion of the Claims Area of the Bubi Mine. This system is weakly defined and barely discernible on digital satellite imagery. Additionally, it appears that existing mining operations have resulted in hydraulic dysconnectivity of the system, and it is thus considered possible that water no longer flows directly into the Bubi River, although any diversion – if it exists – could not be identified on a desktop level. A second unnamed tributary of the Bubi River is located approximately 2,8 km south-west of the Bubi Mine Claims Area and is traversed by two of the proposed options for the haul road (Options 1 and 3). In addition, an unnamed tributary of the Bembezi River is situated approximately 200m to the west of the Isaballa and McCays mines.

It should be noted that none of the above-mentioned drainage systems were assessed during the field assessment, with the exception of the small unnamed tributary of the Bembezi River located to the west of the Isabella and McCays mines. Thus, the information presented in this report for the above systems is based on photographs received from the proponent during the course of this investigation. Furthermore, the Bembezi and Mdutiana Rivers were not assessed in detail in this report, as the areas within which they are situated were excluded from the scope of work. However, due consideration must be given to these systems during the planning phase, and in line with regional best practice, a 100m buffer zone should be implemented around the rivers in which mining activities must be limited, as far as possible and specific care must be taken with the design, construction and operation of all activities in

this area and with all linear infrastructure crossing the rivers. This is discussed in greater detail in Section 4.3 of this report.

Although not developed for use specifically in Zimbabwe, the publication "Classification System for Wetlands and other Aquatic Ecosystems in South Africa" (Ollis *et al,* 2013) hereafter referred to as the "classification system", provides useful input into defining the specific type of aquatic ecosystem being assessed. This aids the assessor in ascertaining various attributes of the system, such as the goods and services provision of a specific Hydrogeomorphic (HGM) type, since different HGM types provide different ecological and socio-cultural services, and to varying degrees. For example, a floodplain wetland is more likely to provide higher levels of sediment trapping than an unchannelled valley bottom wetland (Macfarlane *et al,* 2009), whilst riverine systems (such as those associated with the study area) may provide a greater degree of direct benefits to local communities. The classification system takes into consideration factors such as connectivity to the ocean, regional settings (e.g. aquatic ecoregions) and a suite of finer details such as situation within the landscape, hydrological regimes and so forth (please refer to Appendix C for further detail). Therefore, the classification system was employed in this assessment to provide guidance when ascertaining the ecological status and goods and services provision of the watercourses associated with the three mines.

All identified watercourses were classified at Levels 1 and 2 as Inland Systems (having no direct connection to the ocean) situated within the Zambezian Highveld Aquatic Ecoregion[4]. The table below summarises the classification of these watercourses at Levels 3 to 6 of the classification system:

Table 1: Summary of the Classification system for the various freshwater resource systems identified within the study area.

Drainage System	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) Unit	Level 5: Hydrological Regime	Level 6: Descriptors
Bubi River and associated tributaries	**Valley floor**: The base of a valley, situated between two distinct valley side-slopes.	**River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.	Non-perennial	Natural Freshwater Circum-neutral pH
Gwizaan River and associated tributary			Non-perennial	
Mdutiana River			Non-perennial	
Bembezi River			Perennial	
Unnamed tributary of the Bembezi river			Non-perennial	

[4] Freshwater Ecoregions of the World; http://www.feow.org/ecoregions/details/560 retrieved 31 January 2019. Please also refer to Section 3.

Based on the information contained in the biodiversity assessment report (Chinho, 2018) numerous smaller, ephemeral preferential surface flow paths occur within the mining claims areas. These smaller drainage systems either have very weakly defined riparian zones or no riparian zone at all. Therefore, based on the definition of riparian habitat according to both Ramsar and Zimbabwe's Environmental Management Act, 2002 (Act 13 of 2002), as well as the definition contained in South Africa's National Water Act, 1998 (Act No. 36 of 1998), such preferential surface flow paths are not considered, from an ecological point of view, to be watercourses. These preferential surface flow paths were therefore excluded from this assessment, nevertheless, they are likely to convey water into the downgradient watercourses, thus contributing to the recharge of the larger systems and should be considered as part of the stormwater management of the site. The significance of this contribution can only be determined by a suitably qualified hydrologist through the determination of a floodline.

The locality of these drainage systems in relation to the various mining areas is depicted in the figure below.

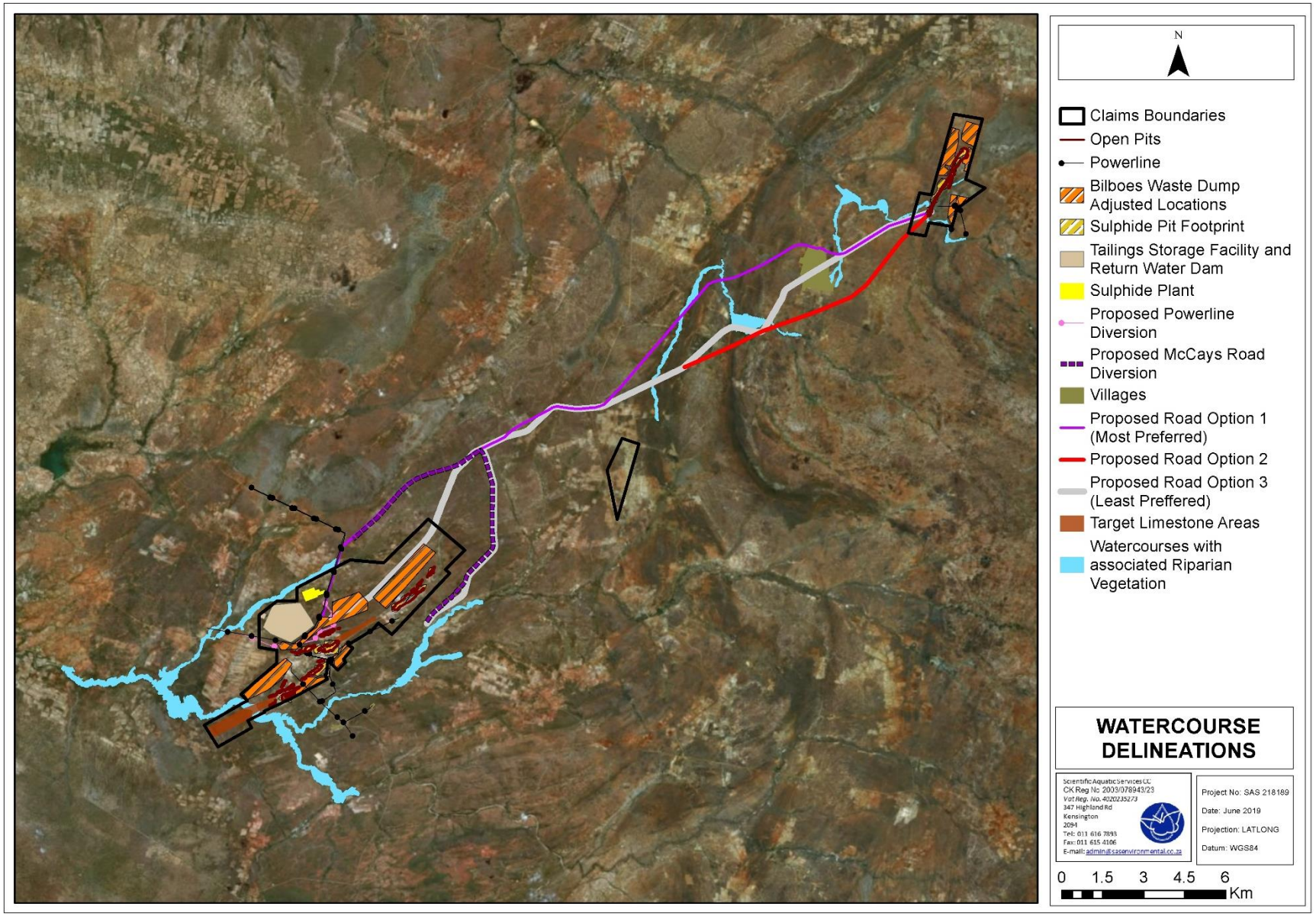


Figure 7: Location of the watercourses associated with the study area, in relation to the surrounding landscape.

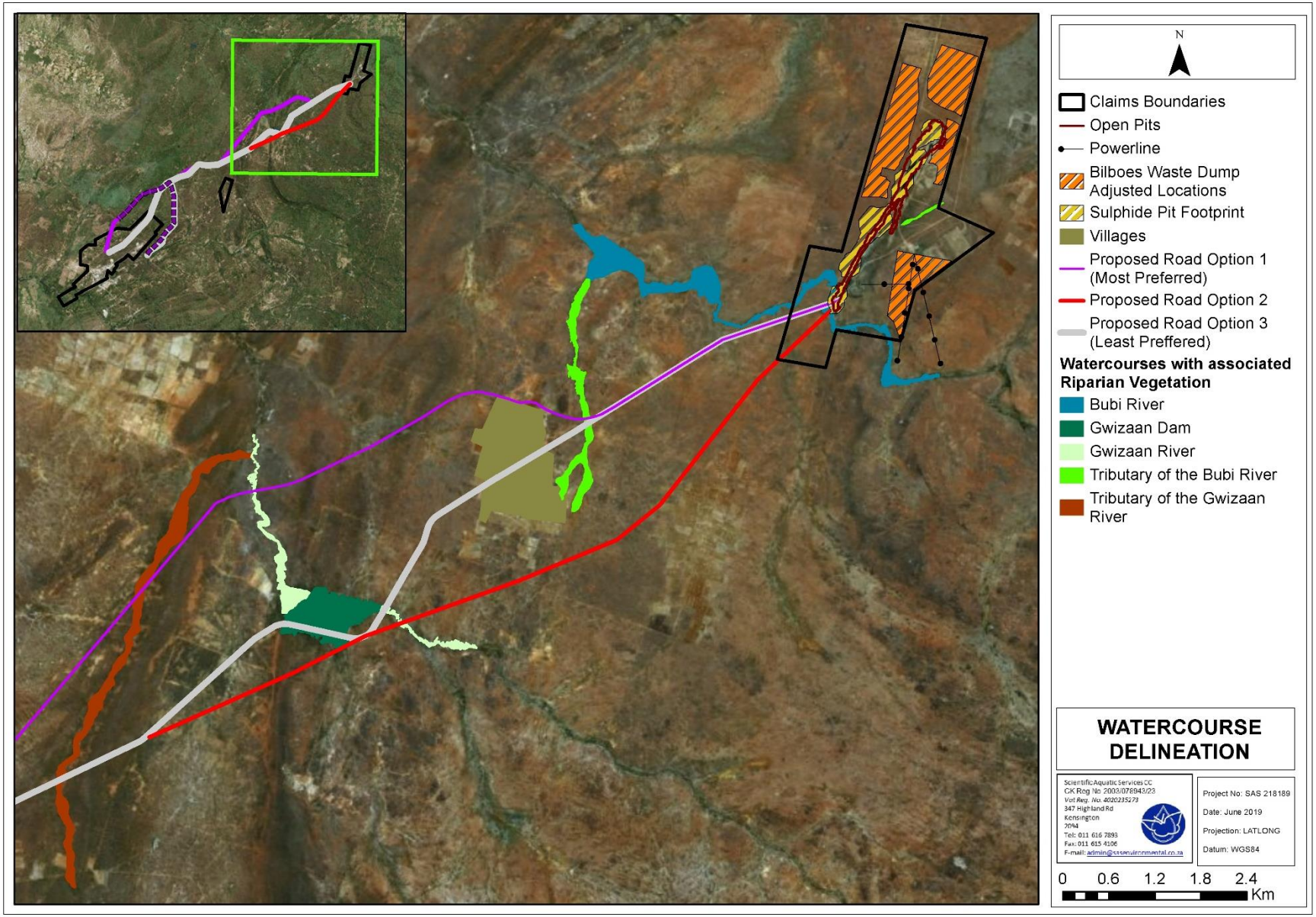


Figure 8: Location of the watercourses associated with the Bubi Mine and the northern sections of the proposed haul road alternative options, in relation to the surrounding landscape.

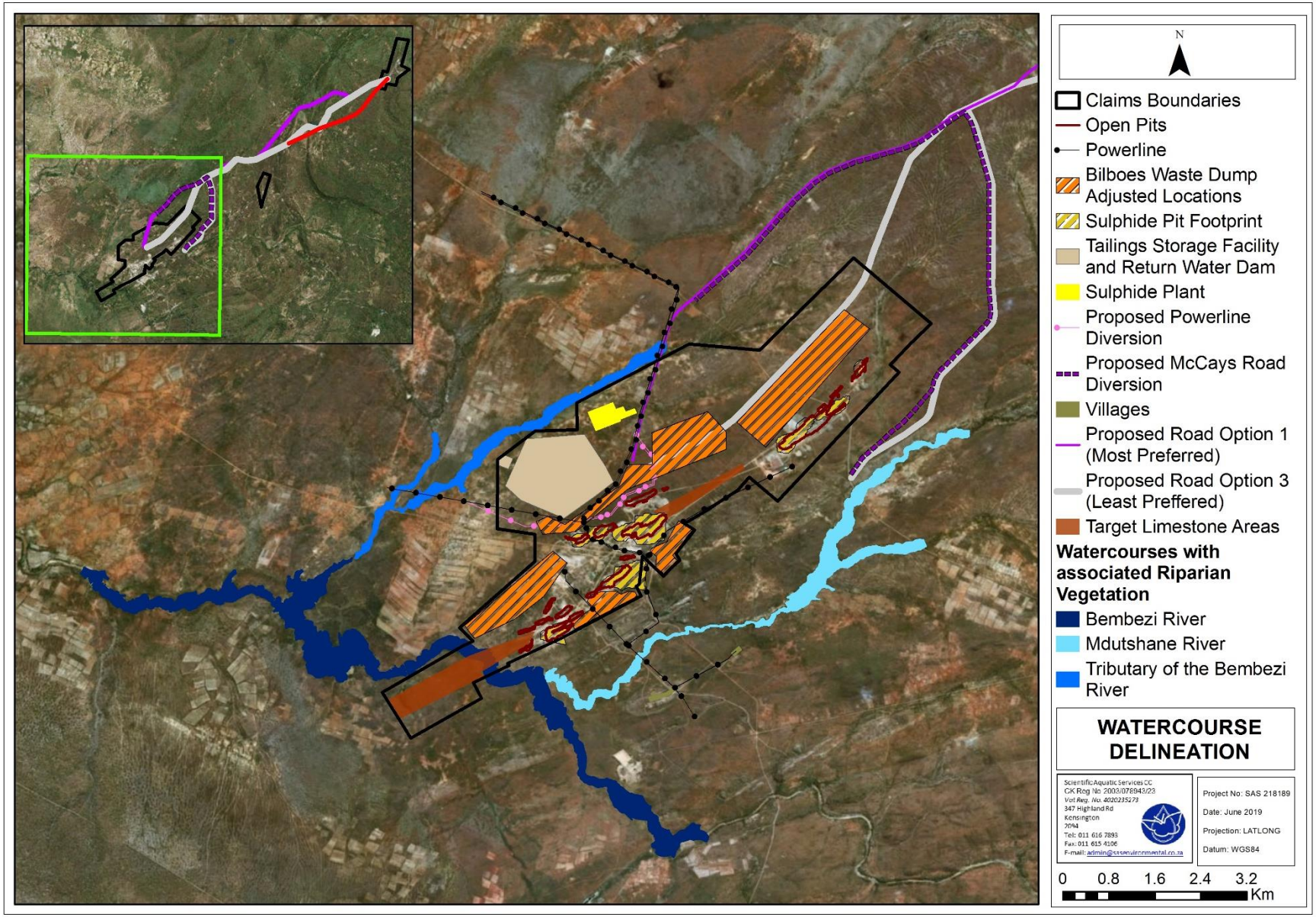


Figure 9: Location of the watercourses associated with the Isabella and McCays Mines and the southern sections of the proposed haul road alternative options, in relation to the surrounding landscape.

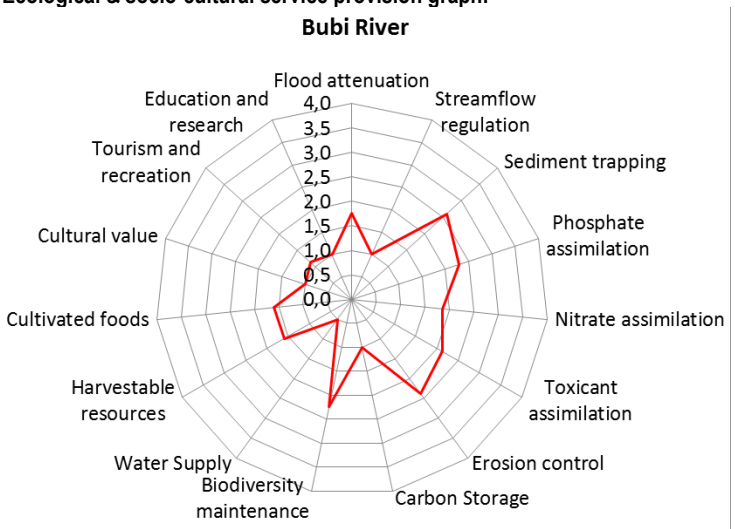
4.2 Field Verification Results

As stated in section 1.3, the field data provided to SAS was considered to be inadequate for the purposes of accurately applying various assessment indices which would provide quantitative analyses of the identified watercourses. Therefore, although these assessments were undertaken, the emphasis of this report is on the provision of a qualitative assessment of the two primary watercourses (and their respective tributaries) associated with the proposed mining areas was undertaken.

These qualitative analyses were based on the limited field data that was provided, along with information gleaned from additional resources such as academic publications. The results of the freshwater assessment are presented in the 'dashboard style' reports below, which summarise the findings of the field investigation and additional studies in terms of the relevant aspects of the freshwater ecology described above. The details pertaining to the methodology used to assess the watercourses is contained in Appendix C of this report. Additionally, the detailed scores that are used to derive the results in the dashboard style reports and results for each assessment are presented in Appendix F.

Table 2: Summary of the assessment of the Bubi River and its unnamed tributary.

Ecological & socio-cultural service provision graph:



PES discussion (IHI)	**PES Category: B (Largely Natural)** Although the IHI takes into consideration the entire reach of a system, the focus of the assessment was on the reach of the Bubi River likely to be impacted by the current and proposed mining activities at the Bubi Mine. Based on available information and digital satellite imagery, although the riparian vegetation appears relatively intact, some impacts relating to clearing of vegetation as part of existing mining operations is expected. In addition, it is apparent that some reaches of the river have become eroded and incised (albeit potentially due to natural processes), which may further impact on the riparian zone as marginal vegetation is lost as a result. Although instream impacts were not the focus of this assessment, few were apparent, with the exception of a few road crossings which may affect flow patterns when surface water is present. Overall, the reach of the river and its unnamed tributary associated with the Bubi Mine are deemed to be in a largely natural condition.
Ecoservice provision	**Intermediate** The goods and services provision of the Bubi River and its unnamed tributary are limited due to the non-perennial character of these watercourses. Local residents are unable to rely on these systems for provision of water, and as a result are unlikely to utilise any floodplains associated with the rivers for crop cultivation. Ecological services provisioned by these watercourses is also

Photograph notes	Representative photographs of the Bubi River a few metres west of the Bubi South Pit footprint area. As depicted in these photographs, some streambank incision is present; it is likely that this is due to high velocity waters during flash foods, and not necessarily anthropogenic causes. The riparian vegetation appears to be dominated by indigenous species, most likely *Searsia spp.*

Watercourse characteristics:

a) Hydraulic regime

Based on available information, the hydraulic regime of the Bubi River remains largely unimpacted, although relatively minor instream impacts such as road crossings are apparent on digital satellite imagery. Increased water inputs are anticipated during the rainy season due to vegetation losses, and in some reaches of the system, due to the increased extent of impermeable surfaces (e.g. in the vicinity of the Bubi Mine).

b) Water quality

Due to the non-perennial nature of the Bubi River, water quality could not be assessed at the time of this study. Given that the river is located largely within undeveloped areas, water quality, when present, is likely to be only marginally impacted, with impacts including possible hydrocarbon contamination from road crossings, increased nutrients (as a result of excrement by domestic livestock within the active channel) and although unconfirmed, possible indirect pollution (especially sediment) from the Bubi Mine area.

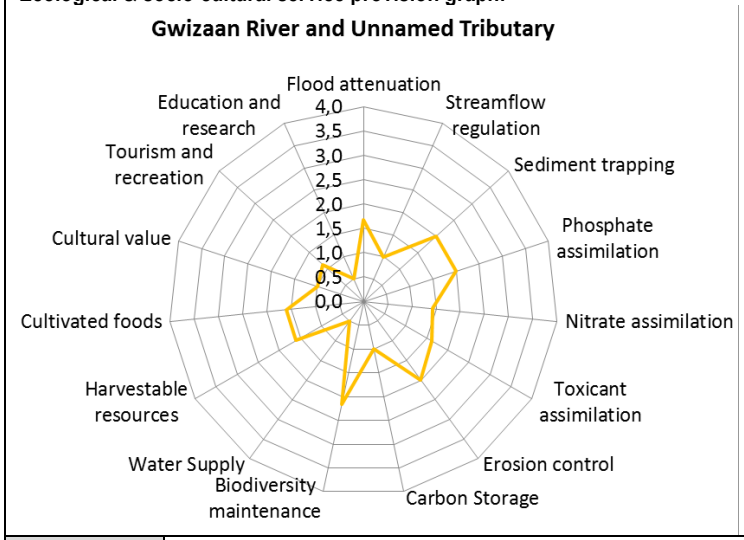
c) Geomorphology and sediment balance

As illustrated in the photographs above, some stream bank incision has occurred. Whilst the extent of this was not verifiable, it is anticipated that such incision is prevalent within the entire reach of the system, particularly in those areas which are inhabited and are thus likely to be utilised by domestic livestock. Whilst it is expected that the incision is predominantly due to natural causes, trampling by livestock may exacerbate severity or extent of incision. Sedimentation of the system is also anticipated due to exposed soils arising from vegetation losses as well as from trampling by livestock.

	limited but includes sediment trapping, some assimilation of nutrients and toxicants, biodiversity maintenance and erosion control. The degree to which the watercourses can provide such services is, however, dictated by seasonality.	**d) Habitat and biota** With the exception of vegetation losses, habitat seems to remain largely intact and comprises indigenous floral species. Connectivity does not appear to have been notably affected, although increased human presence may influence faunal utilisation of the river to some extent.
EIS discussion	A formal analysis of the EIS of these watercourses was not undertaken, since the available method is not deemed suitable in the context of Zimbabwean watercourses. Nevertheless, based on the outcome of the PES and Ecoservices assessments, it is the opinion of the specialist that these watercourses are of moderate to moderately high ecological importance and sensitivity. Efforts must therefore be made to maintain the systems – especially the Bubi River – in their Present Ecological State in order to support the ecology of the river and immediate surrounding areas.	
REC Category and RMO	**REC: B** **RMO: Maintain/Improve** **BAS: Category B** Further degradation to either system, but especially the Bubi River, must not be permitted. Future mining activities must be planned to avoid any further encroachment on the riparian zone associated with the Bubi River, or on any other watercourse in the vicinity.	**Figure 10: Example of an informal road crossing (indicated by the red arrow) across the Bubi River within the Bubi Mine Claims Area.**
Business case and Conclusion: A portion of the riparian zone associated with the Bubi River has already been impacted upon by current mining operations at the Bubi Mine. Whilst further impacts on this portion of the river are unlikely to directly affect mining operations, in a semi-arid region such as Matabeleland, impacts to the river as a result of the proposed mining activities could have significant ramifications for the livelihoods of communities downstream of the mine and must therefore be avoided. This may potentially entail refinement of the footprint area in order to avoid direct encroachment on the river, or possible point-source pollution. Mitigation measures relevant to these aspects are presented in Section 5 of this report.		

Table 3: Summary of the assessment of the Gwizaan River and its unnamed tributary.

Ecological & socio-cultural service provision graph:



PES discussion (IHI and VEGRAI)	**PES Category: B (Largely natural)** The primary modifier of the Gwazaan River is the impoundment thereof. Although the riparian zone associated with the Gwizaan River appears to be in a largely natural state, the instream habitat has been moderately modified and throughflow of water to downstream reaches will be impacted. Clearing of vegetation adjacent to the riparian areas and conversion of land to crop cultivation may also result in increased runoff and sedimentation.
Ecoservice provision	**Intermediate** As with the Bubi River, the Gwizaan River and associated tributary are likely to provide limited direct benefits (goods) to the local community due to the non-perennial nature of these watercourses. However, the Gwizaan Dam is likely to be of increase importance to the local community, and therefore the continued functioning and water quality of the river itself is of importance. Similarly, the capacity to provide various ecological services is limited.
EIS discussion	Based on the outcome of the PES and Ecoservices assessments, the EIS of the Gwizaan River and its associated tributary is likely to be of a moderate level.
REC Category and RMO	**REC: B** **RMO: Maintain/Improve** **BAS: Category B**

Photograph notes	Representative photographs of sections of the Gwizaan River, taken downstream (left) and upstream (right) of the Gwizaan Dam. It is evident from these photographs that flows are irregular, occurring only during rainfall.

Watercourse characteristics:

a) Hydraulic regime

The most significant modifier of the hydraulic regime of the Gwizaan River is the impoundment thereof, known locally as the Gwizaan Dam. This most likely results in a loss of recharge to the downstream reach of the river, although as a non-perennial system, the impact of this is likely to be limited spatially and temporally. Since both watercourses (i.e the Gwizaan River and its unnamed tributary) are non-perennial systems, abstraction from the watercourses themselves is not expected, although reliance on the dam for water during the dry season is likely. Increased water inputs in the form of stormwater runoff may occur, due to vegetation losses in the catchment.

b) Water quality

As with the Bubi River, lack of surface water at the time of this assessment meant that water quality parameters could not be assessed. However, the relatively remote locality and the lack of development in the area infers that water quality is likely to be unimpaired.

c) Geomorphology and sediment balance

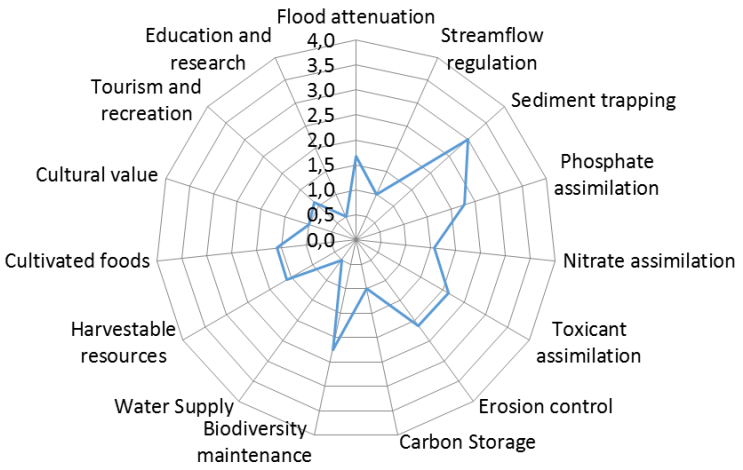
The impoundment of the river is considered a significant modifier to the geomorphological processes of the river, as this impoundment is likely to act as a sink for sediments that would otherwise be dispersed within the downstream system. This is not the only modifier however, with stream bank incision evident in isolated sections of the river. In addition, it is possible that trampling by livestock causes soil disturbances, in turn leading to erosion and sedimentation of the system. Vegetation losses (due to clearing for agricultural purposes) are also likely to be a contributor to erosion, sedimentation and increased velocity of stormwater flows entering the system leading to further incision.

	Further modifications to these systems, especially as a result of high-impact development, should be prevented. In the context of the proposed mining project, only a single haul road is currently planned to traverse the Gwizaan River and its associated tributary. If the construction and operation of this road is properly mitigated, impacts to the watercourses can be successfully minimised.	**d) Habitat and biota** Habitat appears to be in a largely natural to moderately modified condition, despite the various modifiers described above. Whilst some vegetation losses have occurred, riparian species composition seems to be dominated by indigenous species, similar to those associated with the Bubi River riparian zone.
Business case and Conclusion: The Gwizaan River and associated unnamed tributary will be traversed at some point by all three options of the proposed haul road between the Bubi and Isabella/McCays mines. Whilst the construction thereof may potentially impact on the watercourses, it can be successfully mitigated with minimal effort, provided that the relevant mitigation measures provided in Section 5 of this report are adhered to. Of particular importance is that as much as feasible, the required bridge crossing should preferably span the active channel of the watercourse, to ensure that impacts such as flow turbulence (during flow periods) is minimised while further culverts across the extent of the riparian zone are put in place to allow connectivity and hydraulic recharge of these areas in times of freshets. This must be taken into consideration during the planning/design phase.		

Table 4: Summary of the assessment of the unnamed tributary of the Bembezi River (known locally as the Gugu River).

Ecological & socio-cultural service provision graph:

Unnamed Tributary of Bembezi River



PES discussion (IHI and VEGRAI)	**PES Category: B (Largely Natural)** Although the upper reaches of this watercourse, which are in close proximity to the existing operations and proposed expansion of the McCays mine, have been subjected to various anthropogenic impacts (mostly vegetation clearing), the lower reaches appear to be in largely natural condition. This is supported by the observations made by Chinho, 2018.
Ecoservice provision	**Intermediate** As noted by Chinho (2018), the unnamed tributary of the Bembezi River is non-perennial, and according to feedback from local residents, only conveys water for a short period of time following "substantial rainfall" (Chinho, 2018). As a result, provision of goods to the community is limited as is the provision of key ecological services.
EIS discussion	The unnamed tributary is considered to be of increased ecological importance, since it contributes – albeit seasonally – to the streamflow regulation of the Bembezi River, as well as providing a faunal migratory corridor. Therefore, it is deemed to be of moderate ecological importance and sensitivity.
REC Category and RMO	**REC: B** **RMO: Maintain/Improve** **BAS: Category B**

Photograph notes	Representative photographs of a section of the unnamed tributary of the Bembezi River, depicting a low-level bridge crossing (right) which clearly becomes blocked by debris. The photograph on the left illustrates the non-perennial nature of the system.

Watercourse characteristics:

a) Hydraulic regime

As depicted in the photographs supplied (above right) one of the most obvious modifiers of the hydraulic regime of the system is the presence of a low-level bridge, which itself is likely to obstruct flows, as well as creating turbulence which in turn may lead to scouring of the stream bed at this point. Additionally, blockages in an ephemeral system such as this pose a threat to the downstream reaches of the system as if these reaches receive insufficient water, vegetation and geomorphological processes may be altered (e.g. due to unnatural accumulation of sediment).

b) Water quality

As with the above-mentioned watercourses, when surface water is present, it is likely that quality will be relatively unimpaired. Increased turbidity may occur due to the disturbances to soils in the immediate vicinity of the system, as well as airborne dust particles generated by the mining activities. It is also possible that certain nutrient levels may be increased due to utilisation by livestock, resulting in excrement within the riverbed. However, none of these aspects is likely to result in significant pollution of surface water that would affect downstream users.

c) Geomorphology and sediment balance

Sedimentation of the watercourse is expected due to the proximity of disturbances within the catchment such as mining activities, subsistence agriculture and trampling by livestock. Some erosion is apparent in the site photographs supplied; however, no other significant modifiers of the geomorphology of the watercourse are discernible on available digital satellite imagery.

	Based on the layout provided by the proponent, the proposed mining infrastructure does not encroach on the watercourse, although some surface infrastructure such as the TSF and Return Water Dam (RWD) are planned within 175m of the watercourse. Whilst this is unlikely to have a direct impact on the watercourse, it is deemed essential that no degradation be permitted as a result of indirect impacts arising from the proposed activities (e.g. contamination due to spills) and that all efforts are made to maintain the system in its PES.	**d) Habitat and biota** Habitat appears marginally fragmented in the lower reaches of the system although this fragmentation is not deemed severe. The system provides important connectivity with the larger Bembezi River, which is deemed especially important for faunal movement as well as hydraulic connectivity in the context of increase anthropogenic activity in the vicinity.

Business case and Conclusion:

The proximity of the Isabella and McCays mines to the watercourse potentially poses a threat to the ecological integrity of the watercourse, particularly with regards to possible damage to riparian vegetation and potential contamination should the TSF fail. Other potential impacts which must be considered and planned for accordingly include seepage from various containment facilities (e.g. the RWD, any stormwater dams, Pollution Control Dams and so forth). Provision must be made for the appropriate lining of containment facilities, as well as ensuring that there are adequate management measures in place to adequately manage the surge capacities of these facilities. At minimum, these containment facilities must be designed in such a way so as to contain a minimum storm event of a 24 hour 1 in 50 year flood event. Mitigation measures regarding these and other aspects are provided in Section 5 of this report; these must be considered during the planning phase to ensure that adequate financial provision is made to enable effective implementation thereof.

Additionally, if a geohydrological study has not yet been undertaken, provision must be made for a study to be undertaken in order to ascertain the potential for decant from the open pits and the formation of a groundwater pollution plume. Should either of these be shown to be likely by the study, mitigation measures provided by the geo-hydrologist must be implemented. Financial and practical provision must also be made for the ongoing monitoring of the watercourse and any post-closure decant in line with the mitigation measures stipulated both in this report and in the geohydrological study.

4.3 Legislative Requirements and Buffer Zone Recommendations

As far as could be ascertained, no detailed legislation specific to the management or protection of wetlands in Zimbabwe currently exists, and therefore guidance must be sought from the (Zimbabwean) Environmental Management Agency (EMA).

In the absence of specific legislation or protocols specific to Zimbabwe, regional 'best practice' guidelines were consulted. This included consulting both Zambian and South African legislation, since both countries border Zimbabwe, and there are similarities in freshwater ecology in all three countries.

In terms of Schedule 3 of the Zambian Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997, the following considerations are deemed relevant to this project in terms of watercourse protection:

Section 1. Ecological considerations, including:

(a) Biological diversity:

(i) Effect on number, diversity, breeding sites, etc. of flora and fauna;

(ii) Breeding populations of fish and game;

(b) Sustainable use including:

(ii) Nutrient cycles;

(iii) Aquifer recharge, water run-off rates, etc.

Section 5. Water

(1) Effects of surface water quality and quantity;

(2) Effects on underground water quality and quantity; and

(3) Effects on the flow regime of the watercourse.

South African legislation is however comprehensive when it comes to the protection of watercourses, stipulating various buffer zones according to the intended activity and can be considered regional best practice. However, whilst buffer zones are considered important to provide protection of basic ecosystem processes (in this case, the protection of freshwater ecological services), reduce impacts on watercourses arising from surrounding activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015), it should be noted that buffer zones are not considered to be effective mitigation against impacts such as water quality and quantity degradation, hydrological

changes arising from stream flow reduction, impoundments or abstraction which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

Therefore, in line with regional best practice, a 32m buffer is recommended for non-mining activities (e.g. the haul road), and 100m is recommended for mining activities (such as the TSF) and should be taken into consideration during future planning in order to ensure all non resource and geographically specific infrastructure is located within the watercourses and associated buffer zones. These buffer zones are conceptually depicted in the figures below.

Whilst these buffer zones are intended to provide protection of the watercourses by preventing unnecessary activities therein, it is acknowledged that in some cases, it may not always be practical to strictly implement the buffer zones, for example, where a road needs to cross a watercourse. In such instances, the buffer zone should be utilised as a “no-go zone” for non-essential activities, such as excluding contractor laydown or storage areas from the immediate vicinity. This is discussed in greater detail in the mitigation measures provided in Section 5 of this report.

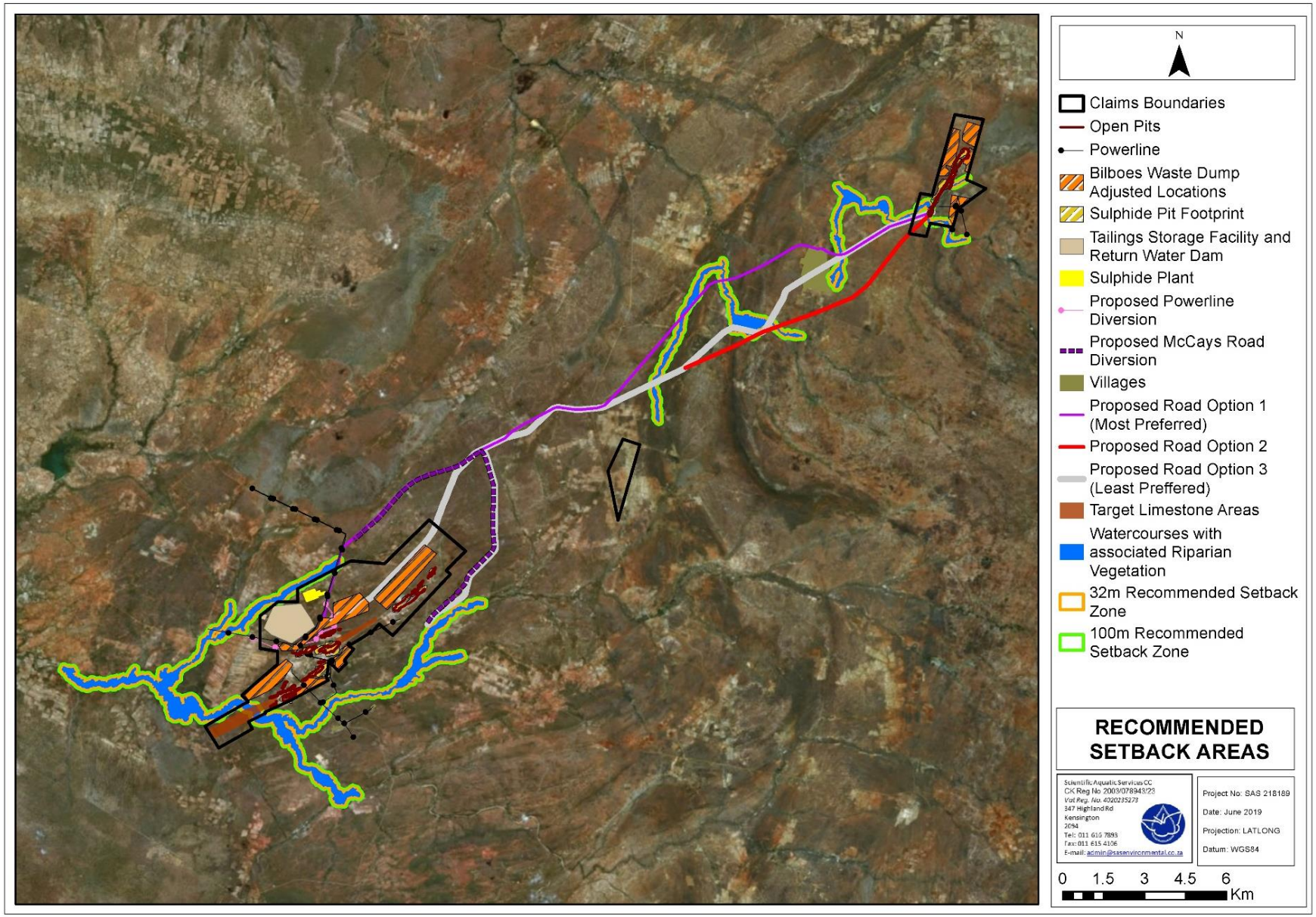


Figure 11: Conceptual depiction of the recommended buffer zones (or setback areas) around the watercourses.

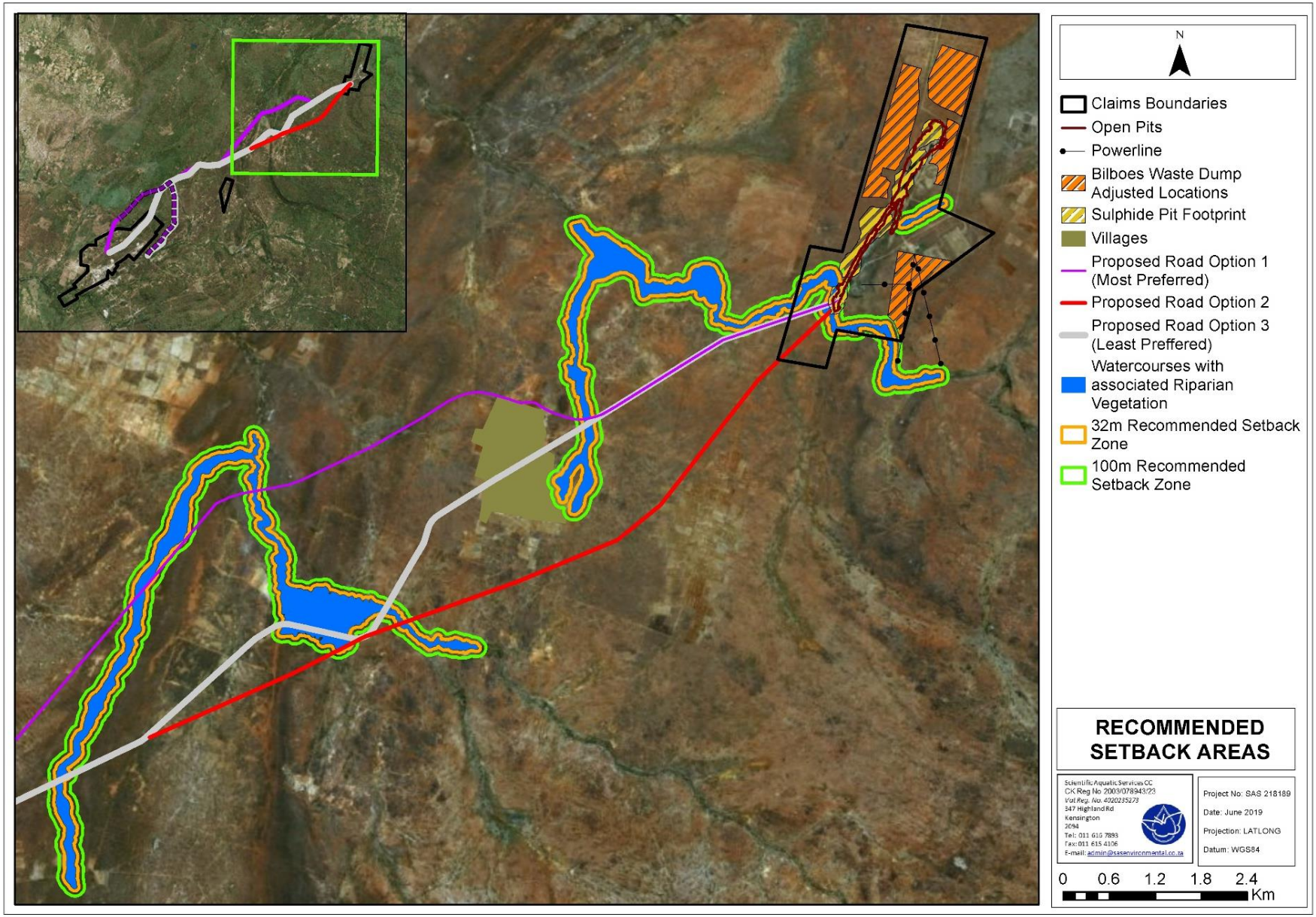


Figure 12: Conceptual depiction of the recommended buffer zones (or setback areas) around the watercourses associated with the Bubi Mine.

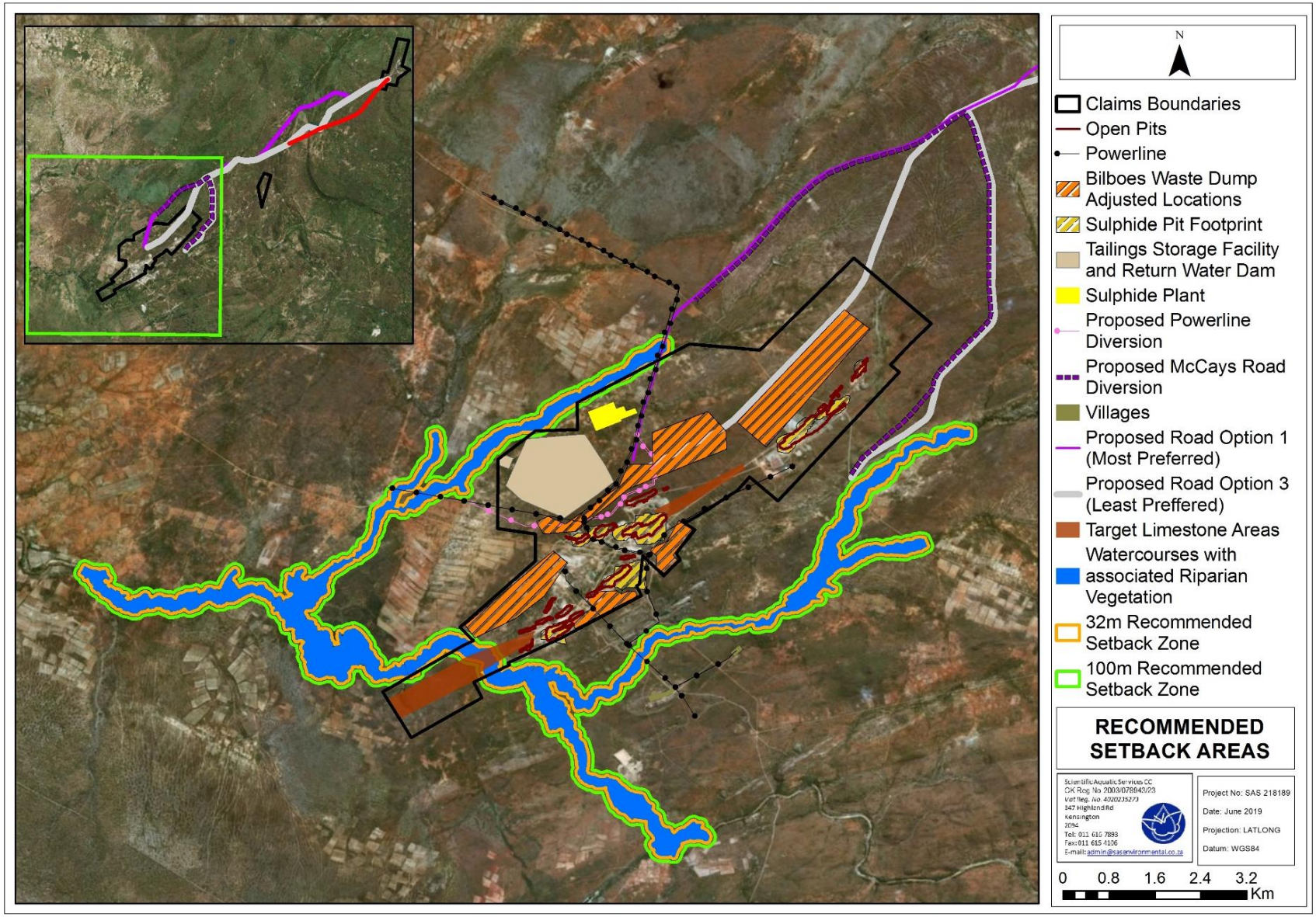


Figure 13: Conceptual depiction of the recommended buffer zones (or setback areas) around the watercourses associated with the Isabella and McCays mines.

5 RISK ASSESSMENT

A pre-defined impact assessment was applied to the various watercourses associated with the Bubi and Isabella/McCays Mines, in order to ascertain the significance of perceived impacts which may arise as a result of the proposed mining activities. Details of the method of assessment are presented in Appendix D of this report. The impact assessment was applied twice: once assuming that no mitigation is applied, and the second time to ascertain the significance of impacts assuming that a high level of mitigation takes place. It should further be noted that the impact assessment methodology has certain limitations; for example, it does not give due consideration to the sensitivity of the receiving environment, therefore, in some instances the impact significance may not be wholly accurate and fully describe the significance of the impact on the affected watercourses. Furthermore, according to the methodology when determining the consequence, there is no guidance provided as to the consequence rating if an impact is perceived to be 'permanent'. In such instances, the duration was taken to be 'long term' and the relevant consequence rating was assigned.

Four aspects of watercourse ecology are considered when assessing the impacts of the proposed mining and related construction activities:

- Loss of habitat and ecological structure (including alien plant invasion);
- Changes to ecological and sociocultural service provision;
- Hydrological function and sediment balance; and
- Impacts on water quality (when surface water is present).

Riverine systems and particularly ephemeral riverine systems (such as the drainage systems associated with the study area) or river systems that have very low flows as part of their annual hydrological cycles are particularly susceptible to changes in habitat condition. The proposed mining activities, particularly those at Bubi Mine, have the potential to lead to loss of niche habitat and/or alteration of the aquatic resources as well as the riparian habitats in the area, particularly if well-planned, cogent and site specific mitigation measures are not strictly implemented throughout the life of the project. As noted in Section 4.2, localised impacts on the Bubi River (or any other watercourses associated with the study area) could potentially have a significant ramifications for the livelihoods of downstream users, which in a semi-arid region such as Matabeleland is considered unacceptable and is avoidable with appropriate management.

For the purposes of this study, the impact assessments were applied as follows:

- To activities relating to the Bubi Mine;
- To activities relating to the construction and operation of the proposed haul road (since all three options traverse watercourses, it was not deemed necessary to assess each option separately as the overall impacts from a freshwater ecological perspective are considered similar for all three options); and
- To activities relating to the Isabella and McCays mines.

The results of these impact assessments are presented in the tables below. The following abbreviations were utilised when illustrating the various criteria (e.g. High Medium, Low):

Table 5: List of Abbreviations used in the impact assessment tables.

Abbreviation	Meaning	Abbreviation	Meaning
VH	Very High	**P**	Permanent
H	High	**Lo**	Local
M	Medium	**Po**	Possible
L	Low	**Pr**	Probable
VL	Very Low	**D**	Definite
S	Short term		

5.1 Results of the impact assessment applied to proposed activities at the Bubi Mine

The primary focus of the impact assessment was on the expansion of the existing open pits at the Bubi Mine. Whilst the precise footprint is yet to be confirmed, the layout provided by the proponent for the purposes of this study indicates that the open cast pits may potentially encroach directly into the Bubi River. Should this be the case, the impact significance will be Very High, unless extreme mitigation measures such as diversion of the river, are implemented. Nevertheless, diversion of a river channel is considered a high risk activity in itself and therefore cannot be deemed as suitable mitigation. As such, this should be considered only as a last resort with avoidance of this area for development being considered the most appropriate form of mitigation. The impact significance of a river diversion was not assessed in this study, since insufficient information is available to accurately assess this. As can be seen in the tables below, without mitigation, significance of perceived impacts ranges from Very High (without mitigation) to Insignificant (with mitigation) depending on the phase of the development. The key to lowering the impact significance from Very High to Low or

Insignificant lies in the final location and extent of the open pits to avoid the Bubi River and an associated acceptable buffer zone altogether. Should this be done, and direct impacts to the watercourse avoided therefore, the risk significance will decrease accordingly. Thus, the decrease in risk significance indicated in the tables below is based on the assumption that a high level of mitigation, and specifically optimisation of the project footprint to avoid directly encroaching on watercourses, will be implemented.

Table 6: Impact Assessment: Loss of watercourse habitat and ecological structure.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	P	R	Po	M	M	M	M	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I
Operational	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	M	P	Lo	Po	M	M	M	M	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I

Table 7: Impact Assessment: Changes to ecological and sociocultural service provision.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	P	R	Po	M	M	M	M	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I
Operational	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	M	P	Lo	Po	M	M	M	M	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I

Table 8: Impact Assessment: Hydrological function and sediment balance

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	P	R	Po	M	M	M	M	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I
Operational	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	M	P	Lo	Po	M	M	M	M	L
	Unmanaged	H	P	R	D	M	M	H	VH	VH

Closure and post closure	Managed	L	S	Lo	Po	M	H	M	VL	I

Table 9: Impact Assessment: Impacts on water quality

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	P	R	Po	M	M	M	M	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I
Operational	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	M	P	Lo	Po	M	M	M	M	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I

5.2 Results of the impact assessment applied to the proposed haul road (Options 1, 2 and 3)

Three options were presented by the proponent for the haul road between Bubi Mine and the Isabella / McCays Mines. All three options will traverse the Bubi River and the Gwizaan River and its unnamed tributary. Options 1 and 3 will traverse all of the aforementioned watercourses, and additionally will traverse the unnamed tributary of the Bubi River. Whilst road crossings can potentially be low impact activities with suitable and strict mitigation, especially for ephemeral systems, from the perspective of minimising the cumulative impact of such crossings on the freshwater ecology of the area, Option 2 is the preferred alternative from a freshwater resource management perspective. The results of the impact assessment applied to the three haul road alternatives is presented below.

Table 10: Impact Assessment: Loss of watercourse habitat and ecological structure.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Operational	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Closure and post closure	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL

Table 11: Impact Assessment: Changes to ecological and sociocultural service provision.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Operational	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Closure and post closure	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL

Table 12: Impact Assessment: Hydrological function and sediment balance

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Operational	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Closure and post closure	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL

Table 13: Impact Assessment: Impacts on water quality

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Operational	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Closure and post closure	Unmanaged	H	S	Lo	Pr	M	H	M	L	L
	Managed	L	S	Lo	Pr	M	H	L	VL	VL

5.3 Results of the impact assessment applied to the activities associated with the Isabella and McCays Mines

Several activities are proposed within the Isabella and McCays mines, including construction of a new TSF, WRDs, processing plant, airstrip, water storage and management infrastructure, limestone quarry, pipelines from the plant to the new TSF and support facilities for the processing plant and staff. Additionally, expansion of the existing open pits is proposed. The focus of the impact assessment was on the infrastructure planned in close proximity to the unnamed tributary of the Bembezi River, i.e. the new TSF and the sulphide plant. At the time of this assessment, the locality of other infrastructure such as the WRDs, was not known and therefore the possible impacts of such could not be assessed.

Table 14: Impact Assessment: Loss of watercourse habitat and ecological structure.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	Pr	M	M	M	VH	VH
	Managed	L	P	R	Po	M	M	M	VH	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Po	M	H	M	VL	I
Operational	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	M	P	Lo	Po	M	M	M	M	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I

Table 15: Impact Assessment: Changes to ecological and sociocultural service provision.

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	Pr	M	M	M	VH	VH
	Managed	L	P	R	Po	M	M	M	VH	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Po	M	H	M	VL	I
Operational	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	M	P	Lo	Po	M	M	M	M	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I

Table 16: Impact Assessment: Hydrological function and sediment balance

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	Pr	M	M	M	VH	VH
	Managed	L	P	R	Po	M	M	M	VH	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Po	M	H	M	VL	I
Operational	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	M	P	Lo	Po	M	M	M	M	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I

Table 17: Impact Assessment: Impacts on water quality

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	Pr	M	M	M	VH	VH
	Managed	L	P	R	Po	M	M	M	VH	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Po	M	H	M	VL	I
Operational	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	M	P	Lo	Po	M	M	M	M	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	VH
	Managed	L	S	Lo	Po	M	H	M	VL	I

5.4 Integrated mitigation measures

The table below highlights the key integrated mitigation measures that are applicable to all the proposed activities associated with the Bilboes mining expansions to suitably manage and mitigate the ecological impacts that are associated with the various phases. Provided that all the management and mitigation measures as stipulated in this report are implemented the overall risk to the watercourses can be acceptably managed in most instances, if not avoided altogether in some instances.

Table 18: Integrated mitigation measures applicable to the various proposed activities proposed as part of the Bilboes expansion project.

Aspect	Mitigation measures
1. Project footprint, infrastructure design and general construction phase	➢ During the planning phase, the location of the proposed haul road, farm diversion loop road and any additional access roads should take into consideration the sensitivity maps provided in Section 4.3 of this report, and wherever possible, access roads should not be planned adjacent to, or traversing, any watercourse. Should it be essential that access roads cross over any watercourse, this should be planned at existing crossing points or points of existing disturbance within the river and/or riparian zone, wherever possible; ➢ It should be ensured that no development of any infrastructure, including open pits, TSF and WRDs takes place within 100m of the Bubi, Bembezi, Gwizaan or Mdutiana Rivers, their respective tributaries, or any other delineated watercourse as far as possible, while ensuring that mining is done safely and to optimise resource abstraction as far as possible without causing irreversible harm to the watercourses of the region; ➢ All road crossings over watercourses must be kept to the bare minimum and are adequately designed (with culverts for throughflow of water) to prevent impacts on geomorphological processes, habitat, instream flow, pattern and timing of water and impacts on water quality. In this regard it is deemed specifically important to ensure that as far as possible the active channel of the rivers is spanned and that additional culverts adjacent to the active channel are developed so as to allow for recharge the riparian zone during freshets; ➢ As far as possible all construction activities should take place in the low flow season; ➢ Limit the footprint area of the construction activity of surface infrastructure to what is absolutely essential in order to minimise the loss of clean water runoff areas and catchment yield and the concomitant recharge of streams in the area; ➢ Design of infrastructure should be environmentally and structurally sound and all possible precautions taken to prevent contamination of surface and groundwater resources present; ➢ No dirty water runoff must be permitted to reach the watercourses, and appropriate clean and dirty water separation and stormwater management controls must be developed as the first part of the construction activities of each project/mining unit; ➢ It is deemed essential that the expansion of the existing open pits be undertaken in such a way as to ensure that decant is prevented for the life of the proposed mining activities and beyond closure unless measures to treat decant to background water qualities can be ensured until the quality of the decant naturally returns to these background levels; ➢ Detailed investigation of the impact of the proposed mining activities on the groundwater environment are considered imperative. The extent of the cone of dewatering needs to be determined. A suitably sized buffer needs to be placed around the freshwater systems, wherein no activities are to take place which could lead to dewatering of the system or impacts from Acid Mine Drainage (AMD); ➢ Water quality, with special mention of pH, dissolved salts and specific problematic geochemical processes like Acid Mine Drainage (AMD) need to be managed, and monitored in order to ensure that reasonable water quality occurs downstream of the mined areas to allow for the on-going survival of a riparian and aquatic community in line with the REC and RMO, and in support of Resource Quality Objectives for the major watercourses of the region; ➢ Mine design and planning must ensure that the cone of dewatering caused by underground mining (as applicable) must not lead to a reduction of stream flow or dewatering of any aquatic or riparian resources and connectivity of the freshwater resources should be maintained; ➢ All proposed access roads, fences and any additional linear infrastructure (e.g. conveyors) must cross the watercourses at the narrowest point and at a 90-degree angles. As much as possible, existing access roads and river crossings must be utilised (if necessary, upgraded) to minimise further disturbances to the watercourses; ➢ The substrate characteristics of the watercourse and instream connectivity must be maintained; ➢ Obstruction of flow should not take place or should only occur for very short periods, if absolutely essential; ➢ Restrict construction of clean and dirty water systems and within watercourses (e.g. bridge crossings) to the drier winter months to avoid sedimentation of the watercourses in the vicinity of the proposed mining project; ➢ Vehicles to be serviced at the contractor laydown area and all refueling is to take place outside of the watercourses and applicable setback zones; and ➢ Sanitation services must be provided for construction personnel, whereby at least one portable toilet will be provided per ten personnel and will be emptied regularly.

Aspect	Mitigation measures
2. Prospecting (if applicable)	➢ No drilling within 100 meters of any watercourses should take place unless essential and unless specific pollution and impact risk management has been applied; ➢ Vehicles must stay on established roads as much as possible; ➢ Areas that have been denuded for test drilling purposes must be revegetated appropriately under the supervision of a suitably qualified botanist; ➢ Appropriate erosion control measures must be established post drilling; and ➢ The disturbed area must be inspected for Alien Invasive Plants post prospecting and managed appropriately.
3. Access control	➢ During any further exploration activities or the construction phase no vehicles must be allowed to indiscriminately drive through the watercourses and vehicles must remain on designated roadways; ➢ Permit only essential construction personnel beyond approved construction areas; and ➢ All areas of increased ecological sensitivity (i.e. the watercourses and areas which are important in terms of recharge) must be designated as "No-Go" areas and be off limits to all unauthorised vehicles and personnel during all phases of the proposed mining project.
4. Hydrological drivers and consumption management	➢ Any area where decant points may be determined (if they cannot be avoided) by the geohydrological assessment, need to be very carefully managed until groundwater quality returns to pre-mining conditions; • Water levels need to be very strictly managed to keep water levels below any decant level, while ensuring that a significant cone of depression impact does not develop; • If decant will occur decant volumes and salt load could be reduced if an underground high-pressure seal is installed, to engineer requirements to reduce decant rates and volumes; • If decant will occur, all water is to be treated to background water quality values prior to release into the receiving environment; and • Upstream dewatering boreholes should be considered, with guidance from the geohydrologist for the project, in order to minimise the creation of dirty water within the pits, and this clean water should be used to recharge the watercourses downstream of the mining area; ➢ Measures to contain and reuse as much water as possible within the mine process water system must be sought, and very strict control of water consumption must take place. Detailed monitoring must be implemented and maintained to ensure that all water usage is continuously optimised; ➢ No undermining of the rivers should be permitted and no activities should take place which will cause subsidence of the landscape and thus change the drainage characteristics of the area; ➢ No dirty water runoff must be permitted to reach the riverine resources during the entire life of mine, and clean and dirty water management systems must be put in place to prevent the contaminated runoff (suspended solids and salts and water with low pH) from entering the receiving aquatic environment. Clean and dirty water runoff systems must be constructed before construction of any other infrastructure takes place; ➢ Any dirty water runoff containment facilities must remain outside of the defined riparian areas and their buffers as a measure to minimise the impact on the receiving environment; ➢ Due to the remote locality of the three mines, it is assumed that on-site waste water management will need to take place, with specific reference to management of sewage. Assuming that this will be necessary, strict control of sewage water treatment must take place and the sewage system must form part of the mine's closed process water system; ➢ All dirty water containment structures must be designed to contain a minimum storm event of a 24 hour 1 in 50 year flood event; ➢ All pollution control facilities must be managed in such a way as to ensure that storage and surge capacity is available if a rainfall event occurs; ➢ Stormwater trenches/berms must be constructed, which may be recycled and utilised within the mine water circuit (dust suppression), or pumped to a Pollution Control facility for evaporation; ➢ All storage facilities (TSF, WRDs, PCD, stockpiles) to be lined with appropriate liners to prevent seepage; ➢ Adequate stormwater management must be incorporated into the design of the proposed mining project in order to prevent erosion and the associated sedimentation of the riparian and instream areas. In this regard special mention is made of: • Sheet runoff from cleared areas, paved surfaces and access roads needs to be curtailed;

Aspect	Mitigation measures
	• Runoff from paved surfaces should be slowed down by the strategic placement of berms; and • All overburden stockpiles and waste stockpiles must have berms and/catchment paddocks at their toe to contain runoff from the facilities. ➢ Monitor all potentially affected drainage systems for changes in riparian vegetation structure related to water stress should variation in the vegetation be observed.
5. Waste and contamination management	➢ No material may be dumped, disposed of or stockpiled within any of the watercourses in the vicinity of the proposed mining project. If any spills occur, they must be immediately cleaned up; and ➢ No dirty water is to be released into the receiving environment.
6. Geomorphological drivers and habitat management	➢ All areas affected by construction or decommissioning activities must be rehabilitated upon closure of the mining expansion. All contaminated soils must be removed and disposed of at an appropriate facility. Affected areas must be reshaped to be free draining and reseeded with indigenous grasses should take place as required; ➢ Ensure that all stockpile (e.g. topsoil, Run of Mine etc) are well managed and have measures such as berms and protection with hessian sheets implemented to prevent erosion, sedimentation and eutrophication (Reno mattresses, gabions, re-vegetation etc.), which may lead to transformation of riparian and/or aquatic habitat and lead to impaired water quality; ➢ All erosion noted within any study area must be remedied immediately and included as part of an ongoing rehabilitation plan; ➢ Strict supervision of all construction activities to ensure that edge effects are minimised and that development remains within the approved footprint; ➢ During the construction and operational phases of the proposed Bilboes mining expansion, erosion berms should be installed to prevent the formation of erosion gullies as a result of the formation of any preferential surface flow paths, and the possible sedimentation of the assessed sites and surrounding freshwater systems; and ➢ The following points serve to guide the placement of erosion berms when implementing erosion control: • Where the track has slope of less than 2%, berms every 50m should be installed; • Where the track slopes between 2% and 10%, berms every 25m should be installed; • Where the track slopes between 10%-15%, berms every 20m should be installed; • Where the track has slope greater than 15%, berms every 10m should be installed.
7. Vegetation	➢ Implement alien vegetation control program within watercourse areas with special mention of water heavy tree species. Throughout the life of mine measures to control alien vegetation must be implemented and specific attention to riverine features should be paid. It is strongly recommended that an Alien Invasive Plant management plan be developed and implemented at the outset of construction activities; ➢ Limit footprint of vegetation clearing to what is essential; ➢ Retain as much indigenous vegetation as possible; and ➢ Rehabilitation and re-vegetation of disturbed areas immediately after construction.

Aspect	Mitigation measures
8. Closure	➢ It is imperative that the post-closure land is defined prior to closure. Potential rehabilitation strategies must be trialled during the operational phase to determine optimal revegetation strategies prior to closure; ➢ The following recommendations must be considered in conjunction with the recommendations of the geohydrologist. The geohydrologist recommendations must take precedence over the recommendations presented below: • Strict monitoring throughout Life Of Mine and post-closure is required in order to ensure the health and functioning of watercourses is retained and monitoring data must be proactively utilised to identify any possible pollutants entering the system. • Drilling of groundwater monitoring boreholes to monitor water levels and quality as the groundwater rebounds. ➢ Demolition footprint must be clearly demarcated and no related activities, including the movement of vehicles, must be permitted to occur outside of the footprint area; ➢ All related waste and rubble must be removed from site and disposed of according to relevant SABS standards. No waste must be permitted to enter watercourses; ➢ Edge effects such as erosion must be monitored and managed as recommended during construction and operational phases; ➢ All areas affected by stockpiling during the operational phase of the mine must be rehabilitated and stabilised using cladding or a suitable grass mix to prevent sedimentation of the watercourses in the area; ➢ Rehabilitation must ensure that riparian structure and function are reinstated in such a way as to ensure the ongoing functionality of the larger drainage systems at pre-mining levels; ➢ All areas must be resloped and an appropriate layer of topsoil reapplied and where necessary and reseeded with indigenous grasses; ➢ It is critical that ongoing monitoring of alien vegetation is maintained post-closure, as proliferation of alien vegetation in the demolition areas is expected; and ➢ Ongoing watercourse (riparian) and aquatic biomonitoring must take place throughout the closure phase of the mine and must continue into the post closure phase to define latent impacts that need to be mitigated. In this regard, it is strongly recommended that a site-specific monitoring and rehabilitation plan be developed for implementation during post-closure and beyond.

5.5 Watercourse monitoring

The following monitoring recommendations are intended to be implemented throughout all phases of the proposed mining development:

- Any areas where active erosion is observed must be rehabilitated and a system of berms and swales must be utilised to slow movement of water;
- Watercourses need to be monitored using the assessment protocols as defined below unless updated and/or more appropriate methods are developed in future:
  - PES according to the IHI method (Kleynhans, 2008) (refer to Appendix C for the method) as applicable;
  - Riparian vegetation composition and structure must be monitored using the Riparian Vegetation Response Index (VEGRAI);
  - Riparian zonation monitoring to determine whether impacts on base flow levels are occurring;
  - Water quality monitoring as part of the mine's water quality monitoring program; and
  - Monitoring of the riparian vegetation assemblage, in particular alien vegetation.
- Ongoing monitoring of the trends in ecological integrity of the assessed sites in the vicinity of the existing and proposed Bilboes mining facilities is deemed essential, in order to monitor the impacts of the mining activities of these sensitive and ecologically important systems. Aquatic biomonitoring on a bi-annual basis (during the rainfall season due to the ephemeral nature of the rivers) is recommended, preferably by a SA RHP Accredited assessor or equivalent Zimbabwean certification, in order to identify any emerging issues in the receiving environment using the following indices (or similar indices developed specifically for use in Zimbabwe in future) in the assessment:
  - Habitat assessments using IHAS (6 monthly) and the IHIA (annually);
  - Aquatic macro-invertebrates using SASS5 and the MIRAI EcoStatus tool (6 monthly, or when there is sufficient flow in the system);
  - Fish community integrity using the FRAI EcoStatus tool (annually in summer/high flow periods); and
  - Diatoms and the application of the SPI index (6 monthly, or when there is sufficient flow in the system).
- Close monitoring of water quality (surface water, groundwater and process water) must take place. Monitoring of water quality must take place monthly, during which time basic parameters such as pH, Dissolved Oxygen (DO) and Electrical Conductivity (EC)

are measured. Baseline conditions must be established when feasible, since it was not possible to do so during the course of this study;

- Should EC or pH values reach an undesirable level, suitable mitigation measures must be implemented;
- Toxicity testing of the mine's process water facilities, the groundwater and surface water resources must take place concurrently with the biomonitoring program, in order to monitor the toxicological risk of the process water system to the receiving environment and in particular the groundwater resources. These ongoing toxicological tests must be compared to baseline data to monitor and manage any emerging impacts over time. Tests must include the following test organisms as a minimum:
    - *Vibrio fischeri*;
    - *Poecilia reticulata*; and
    - *Daphnia pulex*.
- Should emergency discharge from any process water system be required, definitive toxicological testing according to the Direct Estimation of Ecological Effect Potential (DEEEP) protocol must take place, in order to define safe discharge volumes and ensure sufficient dilution; and

Results of future assessments must be compared spatially and temporally to the baseline results. If it is observed through biomonitoring information that significant negative changes are taking place in ecological integrity (Change of Class), it should be taken as an indication that the system is suffering stress and mitigatory actions should be identified and where possible, implemented.

The EMA Laboratory in Harare is able to provide a wide range of water quality analysis and is a SADCAS accredited laboratory. Should they be unable to provide DEEEP or Whole Effluent Toxicity (WET) analysis, guidance should be sought from the laboratory as to available toxicity testing that can be provided in-country or regionally.

6 CONCLUSION AND RECOMMENDATIONS

Whilst the ecological assessment of the various watercourses associated with the proposed Bilboes expansion project was undertaken largely utilising desktop methods and augmented with limited site investigation and anecdotal photography, it is apparent that these systems are relatively unimpacted and remain in a largely natural condition. Although non-perennial systems, in the context of the semi-arid environment in which they are located, it is likely that there is a certain level of reliance – albeit seasonal – on these systems by local communities. The potential impacts of mining projects in the region, whilst carrying the potential for social and economic upliftment, also have the potential to negatively impact natural resources and

thus indirectly impacting on downstream users– and in the context of this study, watercourses specifically.

Taking into consideration the PES and EIS of the assessed watercourses and their possible importance in terms of goods and services provision in the region, it is deemed essential that all possible steps be taken to prevent negative impacts arising from the proposed mining-related activities. This is especially pertinent at the Bubi Mine, where it is likely that the expansion of the existing open pits may encroach directly on the Bubi River; either resulting in outright loss of a portion of the river and causing hydraulic dysconnectivity between the upper and lower reaches, or requiring a river diversion which in itself has the potential to impact negatively on the riparian and instream ecology of the watercourse. Therefore, it is deemed critical that the mitigation measures stipulated in this report be adhered to in order to avoid any unnecessary impacts on the watercourses, some of which may potentially persist for decades. Of particular importance is the stipulation that all open pits and proposed new surface infrastructure is to remain outside of the delineated boundaries of the watercourses, as well as outside of the 100m recommended buffer zone.

7 REFERENCES

NOTE: Reliable reference material at the required level of detail and accuracy is scant, and thus verified and accurate reference material was utilised. These references are internationally accepted and although many of them do not specifically cover the study area, the species ranges and distributions overlap. Notes on ecological and biological requirements allowed the specialists to reliably extrapolate data.

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APPENDIX A: Terms of Use and Indemnity

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APPENDIX B: Legislation and International Guidelines

Section 113 of Chapter 20:27 of the Environmental Management Act, 2002 (Act 13 of 2002)	**Protection of wetlands** 1) The Minister may declare any wetland to be an ecologically sensitive area and may impose limitations on development in or around such area. 2) No person shall, except in accordance with the express written authorization of the Agency, given in consultation with the Board and the Minister responsible for water resources: a) reclaim or drain any wetland; b) disturb any wetland by drilling or tunnelling in a manner that has or is likely to have an adverse impact on any wetland or adversely affect any animal or plant life therein; c) introduce any exotic animal or plant species into the wetland. 3) Any person who contravenes subsection (2) shall be liable to a fine not exceeding level eight or imprisonment not exceeding two years or to both such fine and such imprisonment.
Equator Principles	The Equator Principles aim to ensure that all companies that apply to the Equator Principles Financial Institution (EPFI) for capital, are utilising natural resources responsibly and with focus on sustainability of their operations. The Equator Principles further aim to ensure that any development projects in foreign countries are managed to the same level as they would be in a more developed country, or the country of origin in which the development corporation is based.
International Finance Corporation (IFC) Environmental Health and Safety Guidelines	The IFC is a financial services provider which has set out to ensure that their clients act responsibly toward the environment by providing environmental, health and safety guidelines which their clients must follow and apply before lending of finance may take place. Performance Standard 6 of the IFC reflects the objectives of the Convention on Biological Diversity to conserve biological diversity and promote use of renewable natural resources in a sustainable manner. That protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. Goods and services valued by humans are often underpinned by biodiversity. Impacts on biodiversity can therefore often adversely affect the delivery of goods and services. Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organised into four types: • provisioning services, which are the products people obtain from ecosystems; • regulating services, which are the benefits people obtain from the regulation of ecosystem processes; • cultural services, which are the nonmaterial benefits people obtain from ecosystems; and • supporting services, which are the natural processes that maintain the other services. • The objectives as set out in Performance Standard 6 are: • To protect and conserve biodiversity; • To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities; and • To maintain the benefits from ecosystem services. The requirements of this Performance Standard are applied to projects: • located in modified, natural, and critical habitats; • that potentially impact on or are dependent on ecosystem services over which the client has direct management control or significant influence; or • that includes the production of living natural resources (e.g., agriculture, animal husbandry, fisheries and forestry). IFC Performance Standard 6 states that as a matter of priority, the client should seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimise impacts and restore biodiversity and ecosystem services should be implemented. Given the complexity in predicting project impacts on biodiversity and ecosystem services over the long term, the client should adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle.

	Biodiversity offsets should only be considered once all other avenues of impact avoidance, minimisation and restoration have been thoroughly investigated and where applicable implemented. A biodiversity offset should be designed and implemented to achieve measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity; however, a net gain is required in critical habitats. The design of a biodiversity offset must adhere to the “like-for-like or better” principle and must be carried out in alignment with best available information and current practices.

APPENDIX C: Method of Assessment

FRESHWATER RESOURCE ASSESSMENT APPROACH

In the absence of assessment protocols developed specifically for Zimbabwean conditions, regional best practice methods were utilised. These methods are summarised in this appendix.

Watercourse Delineation

For the purposes of this investigation, the definitions of a wetland and of a watercourse were taken from Zimbabwe's Environmental Management Act, 2002 (Act No. 13 of 2002) and from the South African National Water Act, 1998 (Act No. 36 of 1998) respectively. In terms of these Acts, the definitions are as follows:

Wetlands are: "*any area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, and includes riparian land adjacent to the wetland*." (Zimbabwe Environmental Management Act, 2002 [Act No. 13 of 2002]).

According to South Africa's National Water Act, 1998 (Act No. 36 of 1998), watercourses are defined as:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, dam or lake into which, or from which, water flows;
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse;
- and a reference to a watercourse includes, where relevant, its bed and banks.

The delineation of the watercourses associated with the proposed Bilboes Isabella-Mccays-Bubi Gold Sulphide Project was undertaken utilising desktop methods (historical and digital satellite imagery) and was based on identifying features displaying a diversity of digital signatures. In this regard, specific mention is made of the following:

- Hydrophytic and riparian vegetation: a distinct increase in density, changes in species composition, as well as tree size near drainage lines;
- Hue: wetlands, riparian areas and drainage lines display varying chroma (colours and colour intensity) created by varying vegetation cover and soil conditions in relation to the adjacent terrestrial areas; and
- Texture: wetland and riparian areas display various textures which are distinct from the adjacent terrestrial areas, created by varying vegetation cover and soil conditions within the watercourse.

Very limited field verification of these delineations was undertaken by the Zimbabwean-based specialist.

Classification System for Wetlands and other Aquatic Ecosystems in South Africa (2013)

The river encountered during site assessment was assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems, hereafter referred to as the "Classification System" (Ollis *et. al*., 2013). A summary on Levels 1 to 4 of the classification system are presented in the tables below.

Table B1: Classification System for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain

		Bench (Hilltop / Saddle / Shelf)

Table B2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems

From the classification system, Inland Systems are defined as **aquatic ecosystems that have no existing connection to the ocean**[5] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but **which are inundated or saturated with water, either permanently or periodically.** It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that is included in Level 2 of the classification system in a South African context is that of the DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et. al.,* 2005). However, for the purposes of this investigation, the Freshwater Ecoregions of the World (http://www.feow.org/ecoregions/details/560 retrieved 31 January 2019) was utilised.

[5] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

Level 3: Landscape Setting
At Level 3 of the classification system for Inland Systems, a distinction is made between four Landscape Units (Table B1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et. al.,* 2013):

- **Slope:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley;
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes;
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land; and
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units
Seven primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table B2), on the basis of hydrology and geomorphology (Ollis *et. al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat; and
- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et. al*., 2008) and WET-EcoServices (Kotze *et. al*., 2009).

Index of Habitat integrity
The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method was used to describe the Present Ecological State (PES) of the riparian habitat at each site. Note that only the riparian aspect of the IHI was calculated and the instream aspect excluded. It is also important to note that this method was applied at a high-level, utilising available photographs and digital satellite imagery, and that field verification of the assessed watercourses may yield slightly varied results.

The IHI method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table B3 below.

Table B3: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.* 2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

Wet-Ecoservices (2009)

"The importance of a water resource, in ecological, social or economic terms, acts as a modifying or motivating determinant in the selection of the management class" (DWA, 1999). The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al.* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;
- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table B4: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

Recommended Management Objective (RMO), Recommended Ecological Category (REC) and Best Attainable State (BAS) Determination

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability but carries a higher risk of ecosystem failure" (DWA, 1999).

The RMO (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the freshwater resource (sections above), with the objective of either maintaining, or improving the ecological integrity of the freshwater resource in order to ensure continued ecological functionality.

Table B6: Recommended management objectives (RMO) for water resources based on PES & EIS scores.

PES			Ecological and Importance Sensitivity (EIS)			
			Very High	High	Moderate	Low
	A	Pristine	A Maintain	A Maintain	A Maintain	A Maintain
	B	Natural	A Improve	A/B Improve	B Maintain	B Maintain
	C	Good	A Improve	B/C Improve	C Maintain	C Maintain
	D	Fair	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	Poor	D* Improve	E/F* Improve	E/F* Maintain	E/F* Maintain

***PES Categories E and F are considered ecologically unnacceptable (Malan and Day, 2012) and therefore, should a freshwater resource fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

A freshwater resource may receive the same class for the REC as the PES if the freshwater resource is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the freshwater resource.

Table B7: Description of Recommended Ecological Category (REC) classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

APPENDIX D: Impact Assessment Methodology

Evaluation of Impacts and Mitigation Measures

In order for the Environmental Assessment Practitioner (EAP) to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/ impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/ impacts have been assessed. In assigning significance ratings to potential impacts before and after mitigation the approach presented below is to be followed.

1. **Determine the impact consequence rating:** This is a function of the "intensity", "duration" and "extent" of the impact. The consequence ratings for combinations of these three criteria are given below.

2. **Determine impact significance rating:** The significance of an impact is a function of the consequence of the impact occurring and the probability of occurrence. Significance is determined using the table below.

3. **Modify significance rating (if necessary):** Significance ratings are based on largely professional judgement and transparent defined criteria. In some instances, therefore, whilst the significance rating of potential impacts might be "low", the importance of these impacts to local communities or individuals might be extremely high. The importance/value which interested and affected parties attach to impacts will be highlighted, and recommendations should be made as to ways of avoiding or minimising these perceived negative impacts through project design, selection of appropriate alternatives and / or management.

4. **Determine degree of confidence of the significance assessment:** Once the significance of the impact has been determined, the degree of confidence in the assessment will be qualified. Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact.

Criteria for Impact Assessment
The criteria for impact assessment are provided below.

Criteria	Rating	Description
Criteria for ranking of the INTENSITY (SEVERITY) of environmental impacts	**ZERO TO VERY LOW**	Negligible change, disturbance or nuisance. The impact affects the environment in such a way that natural functions and processes are not affected. People / communities are able to adapt with relative ease and maintain pre-impact livelihoods.
	LOW	Minor (Slight) change, disturbance or nuisance. The impact on the environment is not detectable or there is no perceptible change to people's livelihood.
	MEDIUM	Moderate change, disturbance or discomfort. Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way. People/communities are able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.
	HIGH	Prominent change, disturbance or degradation. Where natural functions or processes are altered to the extent that they will temporarily or permanently cease. Affected people/communities will not be able to adapt to changes or continue to maintain-pre impact livelihoods.
Criteria for ranking the DURATION of impacts	**SHORT TERM**	< 5 years.
	MEDIUM TERM	5 to < 15 years.
	LONG TERM	> 15 years, but where the impact will eventually cease either because of natural processes or by human intervention.
	PERMANENT	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such time span that the impact can be considered transient.
Criteria for ranking the	**LOCAL**	Impact is confined to project or study area or part thereof, e.g. limited to the area of interest and its immediate surroundings.

Criteria	Rating	Description
EXTENT / SPATIAL SCALE of impacts	**REGIONAL**	Impact is confined to the region, e.g. coast, basin, catchment, municipal region, etc.
	NATIONAL	Impact is confined to the country as a whole, e.g. South Africa, etc.
	INTERNATIONAL	Impact extends beyond the national scale.
Criteria for determining the PROBABILITY of impacts	**IMPROBABLE**	Where the possibility of the impact to materialise is very low either because of design or historic experience, i.e. ≤ 30% chance of occurring.
	POSSIBLE	Where there is a distinct possibility that the impact would occur, i.e. > 30 to ≤ 60% chance of occurring.
	PROBABLE	Where it is most likely that the impact would occur, i.e. > 60 to ≤ 80% chance of occurring.
	DEFINITE	Where the impact would occur regardless of any prevention measures, i.e. > 80% chance of occurring.
Criteria for determining the DEGREE OF CONFIDENCE of the assessment	**LOW**	≤ 35% sure of impact prediction.
	MEDIUM	> 35% and ≤ 70% sure of impact prediction.
	HIGH	> 70% sure of impact prediction.
Criteria for the DEGREE TO WHICH IMPACT CAN BE MITIGATED - the degree to which an impact can be reduced / enhanced	**NONE**	No change in impact after mitigation.
	VERY LOW	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
	LOW	Where the significance rating drops by one level, after mitigation.
	MEDIUM	Where the significance rating drops by two to three levels, after mitigation.
	HIGH	Where the significance rating drops by more than three levels, after mitigation.
Criteria for LOSS OF RESOURCES - the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable	**LOW**	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
	MEDIUM	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
	HIGH	Where the activity results in an irreplaceable loss of a resource.

Determining Consequence

Consequence attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity. The ratings and description for determining consequence are provided below.

Rating	Description
VERY HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***long term***; OR of ***high intensity*** at a ***national level*** in the ***medium term***; OR of ***medium intensity*** at a ***national level*** in the ***long term.***
HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***high intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***national level*** in the ***long term***; OR of ***high intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***regional level*** in the ***long term.***
MEDIUM	Impacts could be EITHER: of ***high intensity*** at a ***local level*** and endure in the ***medium term***;

Rating	Description
	OR of ***medium intensity*** at a ***regional level*** in the ***medium term***; OR of ***high intensity*** at a ***regional level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***local level*** in the ***long term***; OR of ***low intensity*** at a ***national level*** in the ***medium term***; OR of ***low intensity*** at a ***regional level*** in the ***long term.***
LOW	Impacts could be EITHER of ***low intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***national level*** in the ***short term***; OR of ***high intensity*** at a ***local level*** and endure in the ***short term***; OR of ***medium intensity*** at a ***regional level*** in the ***short term***; OR of ***low intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.***
VERY LOW	Impacts could be EITHER of ***low intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***; OR of ***low to medium intensity*** at a ***local level*** and endure in the ***short term.*** OR **Zero to very low intensity** with any combination of extent and duration.

Determining Significance

The consequence rating is considered together with the probability of occurrence in order to determine the overall significance using the table below.

		PROBABILITY			
		IMPROBABLE	POSSIBLE	PROBABLE	DEFINITE
CONSEQUENCE	VERY LOW	INSIGNIFICANT	INSIGNIFICANT	VERY LOW	VERY LOW
	LOW	VERY LOW	VERY LOW	LOW	LOW
	MEDIUM	LOW	LOW	MEDIUM	MEDIUM
	HIGH	MEDIUM	MEDIUM	HIGH	HIGH
	VERY HIGH	HIGH	HIGH	VERY HIGH	VERY HIGH

In certain cases it may not be possible to determine the significance of an impact. In these instances the significance is **UNKNOWN**.

Mitigation Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed construction.

- Mitigation and performance improvement measures and actions that address the risks and impacts[6] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
  - Desired outcomes are defined and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

[6] Mitigation measures should address both positive and negative impacts

APPENDIX E: Results of Field Investigation

PRESENT ECOLOGICAL STATE (PES) AND ECOSERVICES RESULTS

Table E1: Presentation of the results of the IHI assessments applied to the various watercourses.

Bubi River

RIPARIAN IHI	
Base Flows	0,0
Zero Flows	0,0
Moderate Floods	0,0
Large Floods	0,0
HYDROLOGY RATING	**0,0**
Substrate Exposure (marginal)	1,0
Substrate Exposure (non-marginal)	1,0
Invasive Alien Vegetation (marginal)	1,0
Invasive Alien Vegetation (non-marginal)	1,0
Erosion (marginal)	1,0
Erosion (non-marginal)	1,0
Physico-Chemical (marginal)	1,0
Physico-Chemical (non-marginal)	1,0
Marginal	1,0
Non-marginal	1,0
BANK STRUCTURE RATING	**1,0**
Longitudinal Connectivity	1,0
Lateral Connectivity	1,0
CONNECTIVITY RATING	**1,0**
RIPARIAN IHI %	**86,7**
RIPARIAN IHI EC	**B**
RIPARIAN CONFIDENCE	**2,0**

Unnamed Tributary: Bubi River

RIPARIAN IHI	
Base Flows	0,0
Zero Flows	0,0
Moderate Floods	0,0
Large Floods	0,0
HYDROLOGY RATING	**0,0**
Substrate Exposure (marginal)	1,0
Substrate Exposure (non-marginal)	1,0
Invasive Alien Vegetation (marginal)	1,0
Invasive Alien Vegetation (non-marginal)	1,0
Erosion (marginal)	1,0
Erosion (non-marginal)	1,0
Physico-Chemical (marginal)	1,0
Physico-Chemical (non-marginal)	1,0
Marginal	1,0
Non-marginal	1,0
BANK STRUCTURE RATING	**1,0**
Longitudinal Connectivity	1,0
Lateral Connectivity	1,0
CONNECTIVITY RATING	**1,0**
RIPARIAN IHI %	**86,7**
RIPARIAN IHI EC	**B**
RIPARIAN CONFIDENCE	**2,0**

Gwizaan River and unnamed tributary

RIPARIAN IHI	
Base Flows	0,0
Zero Flows	0,0
Moderate Floods	0,0
Large Floods	0,0
HYDROLOGY RATING	**0,0**
Substrate Exposure (marginal)	1,0
Substrate Exposure (non-marginal)	1,0
Invasive Alien Vegetation (marginal)	1,0
Invasive Alien Vegetation (non-marginal)	1,0
Erosion (marginal)	1,0
Erosion (non-marginal)	1,0
Physico-Chemical (marginal)	1,0
Physico-Chemical (non-marginal)	1,0

Unnamed tributary: Bembezi River

RIPARIAN IHI	
Base Flows	0,0
Zero Flows	0,0
Moderate Floods	0,0
Large Floods	0,0
HYDROLOGY RATING	**0,0**
Substrate Exposure (marginal)	1,0
Substrate Exposure (non-marginal)	1,0
Invasive Alien Vegetation (marginal)	1,0
Invasive Alien Vegetation (non-marginal)	1,0
Erosion (marginal)	1,0
Erosion (non-marginal)	1,0
Physico-Chemical (marginal)	1,0
Physico-Chemical (non-marginal)	1,0

Marginal	1,0
Non-marginal	1,0
BANK STRUCTURE RATING	**1,0**
Longitudinal Connectivity	1,0
Lateral Connectivity	1,0
CONNECTIVITY RATING	**1,0**
RIPARIAN IHI %	**86,7**
RIPARIAN IHI EC	**B**
RIPARIAN CONFIDENCE	**2,0**

Marginal	1,0
Non-marginal	1,0
BANK STRUCTURE RATING	**1,0**
Longitudinal Connectivity	1,0
Lateral Connectivity	1,0
CONNECTIVITY RATING	**1,0**
RIPARIAN IHI %	**86,7**
RIPARIAN IHI EC	**B**
RIPARIAN CONFIDENCE	**2,0**

Table E2: Presentation of the results of the Ecoservices assessments applied to the various watercourses.

Ecosystem service	Bubi River	Gwizaan River	Unnamed Trib: Bubi	Unnamed trib: Bembezi
Flood attenuation	1,8	1,7	1,6	1,7
Streamflow regulation	1,0	1,0	1,0	1,0
Sediment trapping	2,6	2,0	2,4	3,0
Phosphate assimilation	2,3	2,0	2,0	2,3
Nitrate assimilation	1,9	1,4	1,4	1,6
Toxicant assimilation	2,1	1,6	1,6	2,1
Erosion control	2,4	2,0	2,0	2,1
Carbon Storage	1,0	1,0	1,0	1,0
Biodiversity maintenance	2,3	2,2	2,3	2,3
Water Supply	0,5	0,5	0,5	0,5
Harvestable resources	1,6	1,6	1,6	1,6
Cultivated foods	1,6	1,6	1,6	1,6
Cultural value	1,0	1,0	1,0	1,0
Tourism and recreation	1,1	1,1	1,1	1,1
Education and research	1,0	0,5	0,5	0,5
SUM	**24,1**	**21,2**	**21,6**	**23,3**
Average score	**1,6**	**1,4**	**1,4**	**1,6**
Class	Intermediate	Intermediate	Intermediate	Intermediate

APPENDIX F: Risk Assessment and Mitigation Measures

General construction management and good housekeeping practices
Latent and general impacts which may affect the watercourse ecology and biodiversity, will include any activities which take place in relation to the operational area and possible demolition area during decommissioning, that may impact on the receiving environment. Mitigation measures for these impacts are highlighted below and are relevant to the freshwater systems identified in this report:

Construction footprint and subsequent Demolition footprint (during closure)

- All construction and subsequent demolition footprint areas should remain as small as possible. It must be ensured that the watercourse habitat is off-limits to construction vehicles and non-essential personnel;
- The boundaries of footprint areas, including contractor laydown areas, are to be clearly defined and it should be ensured that all activities remain within defined footprint areas. Edge effects will need to be extremely carefully controlled;
- Planning of temporary roads and access routes should avoid watercourses and be restricted to existing roads where possible;
- Appropriate sanitary facilities must be provided for the life of the mine and all waste removed to an appropriate waste facility;
- All hazardous chemicals as well as stockpiles should be stored on bunded surfaces and have facilities constructed to control runoff from these areas;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage;
- No fires should be permitted in or near the construction or demolition areas; and
- Ensuring that an adequate number of waste and “spill” bins are provided will also prevent litter and ensure the proper disposal of waste and spills.

Vehicle access

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Vegetation

- Proliferation of alien and invasive species is expected within any disturbed area, particularly if there is already a high incidence of alien vegetation within the study area. The vegetation may already be transformed to an extent as a result of alien plant invasion; therefore these species should be eradicated and controlled to prevent their spread beyond the study area. Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;
- Removal of the alien and weed species encountered on the property must take place in order to minimise further proliferation thereof. Removal of species should take place throughout the remainder of the operational and maintenance phases, and following the completion of the decommissioning phase; and
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
  - Footprint areas should be kept as small as possible when removing alien plant species*;* and
  - No vehicles should be allowed to drive through designated sensitive wetland areas during the eradication of alien and weed species.

Soils

- Sheet runoff from access roads should be slowed down by the strategic placement of berms;
- As far as possible, any required demolition activities should occur in the low flow season, during the drier winter months;

- As much vegetation growth as possible (of indigenous floral species) should be encouraged to protect soils;
- All soils compacted as a result of demolition activities as well as during ongoing operational activities falling outside of project footprint areas should be ripped and profiled; and
- A monitoring plan for the development and the immediate zone of influence should be implemented to prevent erosion and incision.

Rehabilitation

- Construction and subsequently, demolition, rubble must be collected and disposed of at a suitable landfill site; and
- All alien vegetation in the footprint area should be removed. Alien vegetation control should take place for a minimum period of two growing seasons after rehabilitation is completed.

APPENDIX G: Specialist information

DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden MSc (Environmental Management) (University of Johannesburg)

Amanda Mileson NDip Nature Conservation (UNISA)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Natural Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health Practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

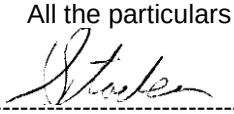
Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Kim Marais		
Postal address:	221 Riverside Lofts, Tygerfalls Boulevard, Bellville,		
Postal code:	7539	Cell:	071 413 2245
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	kim@sasenvgroup.co.za		
Qualifications	**Kim Marais** BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Member of the South African Wetland Forum		

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Amanda Mileson		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	082 569 90552
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	amanda@sasenvgroup.co.za		
Qualifications	National Diploma: Nature Conservation (University of South Africa)		
Registration / Associations	Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

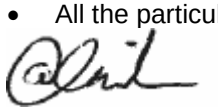
- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



Signature of the Specialist

I, Amanda Mileson, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



Signature of the Specialist

I, Kim Marais, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

Signature of the Specialist

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist with focus on Freshwater Ecology
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)
Other Business	Trustee of the Serenity Property Trust and emerald Management Trust

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP);
Accredited River Health practitioner by the South African River Health Program (RHP);
Member of the South African Soil Surveyors Association (SASSO);
Member of the Gauteng Wetland Forum;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for Wetland Assessment short course Rhodes University	2016

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leone
Central Africa – Democratic Republic of the Congo

PROJECT EXPERIENCE (Over 2500 projects executed with varying degrees of involvement)

1 Mining: Coal, Chrome, PGM's, Mineral Sands, Gold, Phosphate, river sand, clay, fluorspar
2 Linear developments
3 Energy Transmission, telecommunication, pipelines, roads
4 Minerals beneficiation
5 Renewable energy (wind and solar)
6 Commercial development
7 Residential development
8 Agriculture
9 Industrial/chemical

REFERENCES

- Terry Calmeyer (Former Chairperson of IAIA SA)
  Director: ILISO Consulting Environmental Management (Pty) Ltd
  Tel: +27 (0) 11 465 2163
  Email: terryc@icem.co.za

- Alex Pheiffer
  African Environmental Management Operations Manager
  SLR Consulting
  Tel: +27 11 467 0945
  Email: apheiffer@slrconsulting.com

- Marietjie Eksteen
  Managing Director: Jacana Environmental
  Tel: 015 291 4015

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF AMANDA MILESON

PERSONAL DETAILS

Position in Company	Ecologist
Date of Birth	15 February 1978
Nationality	Zimbabwean
Languages	English
Joined SAS	2013

MEMBERSHIP IN PROFESSIONAL SOCIETIES

South African Wetland Society
Gauteng Wetland Forum

EDUCATION

Qualifications

N.Dip Nature Conservation (UNISA)	2017
Wetland Management: Introduction and Delineation (University of the Free State)	2018
Tools for Wetland Assessment (Rhodes University)	2017
Wetland Rehabilitation (University of the Free State)	2015

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, Free State, North West, Limpopo, Northern Cape, Eastern Cape
Zimbabwe, Zambia

SELECTED PROJECT EXAMPLES

Wetland Assessments

- Baseline Aquatic and Freshwater Assessment as part of the Environmental Assessment and Authorisation Process for the N11 Ring Road, Mokopane, Limpopo Province.
- Freshwater Resource Ecological Assessment as part of the Water Use License Application Requirements for the Proposed Upgrades to the Klippan Pump Station Near Welkom, Free State Province.
- Freshwater Resource Ecological Assessment as part of the Water Use License Application Requirements for the Proposed Urania-Bronville 11kv and 132kv Powerline Corridor Near Welkom, Free State Province.
- Freshwater Assessment for the Proposed Rietrug, Distribution Line: Basic Assessment for the proposed Construction of Electrical Grid Infrastructure to support the proposed (split) Rietrug Wind Energy Facility, near Sutherland, in the Northern Cape and Western Cape Provinces.
- Freshwater Assessment for the Proposed Sutherland 2 Distribution Line: Basic Assessment for the proposed Construction of Electrical Grid Infrastructure to support the proposed (split) Sutherland 2 Wind Energy Facility, near Sutherland, in the Northern Cape and Western Cape Provinces.
- Freshwater Assessment for the Proposed Sutherland Distribution Line: Basic Assessment for the proposed Construction of Electrical Grid Infrastructure to support the proposed (split) Sutherland Wind Energy Facility, near Sutherland, in the Northern Cape and Western Cape Provinces.
- Freshwater resource delineation and ecological assessment as part of the proposed expansion of the Kudumane Mining Project, Northern Cape Province.

- Freshwater assessment as part of the environmental assessment and authorisation process for associate electrical infrastructure and a proposed pipeline for the Rooipunt Solar Thermal Power Park Project near Upington, Northern Cape.
- Present Ecological State of the Wetlands Report: Jukskei and Klip River Catchments: Monitoring and Managing the Ecological State of the Wetlands in the City of Johannesburg Metropolitan Area.
- Wetland assessment as part of the environmental assessment and authorisation process for the proposed Leandra underground coal mine.
- Freshwater ecological assessment as part of the water use licence application process for the proposed waste rock dump expansion for Impala Platinum Mine in Rustenburg, North-West Province.
- Wetland assessment as part of the water use licence application process for the Marula Platinum Mine, Limpopo Province.
- Wetland assessment as part of the environmental authorisation process for the Anglo Platinum Der Brochen Project, Limpopo Province.
- Wetland assessment as part of the environmental authorisation process for the proposed Yzermyn Coal Mining Project near Dirkiesdorp, Mpumalanga.
- Wetland assessment as part of the environmental authorisation process for the Mzimvubu Water Project, Eastern Cape.
- Wetland assessment as part of the proposed water management process at the Assmang Chrome Machadodorp Works, Mpumalanga.
- Wetland ecological assessment as part of the Section 24G application process for the Temba Water Purification Plant.

Terrestrial Assessments

- Investigation of specialist biodiversity aspects required by GDARD in the vicinity of the Apies River, downstream of the proposed construction of new outlet works at the Kudube (Leeuwkraal) Dam in Temba, Gauteng
- Terrestrial Ecological Scan as part of the environmental authorisation process for three proposed bridge upgrades near Edenvale, Gauteng
- Terrestrial Ecological Scan as part of the environmental authorisation process for the proposed Dalpark Ext 3 filling station development, Gauteng

Rehabilitation Projects

- Freshwater Resource Rehabilitation and Management Plan as part of the Environmental Authorisation Process for the Proposed Urania-Bronville 11kv and 132kv Powerline Corridor Near Welkom, Free State Province.
- Rehabilitation Plan as part of the Water Use License Application Requirements for the Proposed Upgrade of the Thabazimbi Wastewater Treatment Works (WWTW) Sewer Line, Limpopo Province.
- Wetland rehabilitation and management plan for The Hills EcoEstate, Midrand, Gauteng.
- Riparian rehabilitation and management plan for The Diepsloot River, Riversands, Gauteng.
- Riparian rehabilitation and management plan for the Apies River in the vicinity of the proposed construction of new outlet works at the Kudube (Leeuwkraal) Dam in Temba, Gauteng.

Environmental Control Officer

- Monthly specialist Environmental Control Officer (ECO) function for the monitoring of riparian crossings at Riversands Country Estate Development, Gauteng province.
- Weekly specialist Environmental Control Officer (ECO) function for the monitoring of emergency desilting and rehabilitation of existing stormwater retention dams on ERF 836 Kosmosdal ext 1, and portion 5 of ERF 115 Kosmosdal ext 4, near Centurion, Gauteng Province.

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF KIM MARAIS

PERSONAL DETAILS

Position in Company	Consultant
Date of Birth	28 August 1989
Nationality	The Netherlands
Languages	English, Afrikaans
Joined SAS	2015 – Present

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Natural Scientist with the South African Council for Natural Scientific Professions
Member of the South African Wetlands Society

EDUCATION

Qualifications

Certificate for Short course in Tools for Wetland Assessment (Rhodes University)	2018
Certificate in Environmental Law for Environmental Managers (CEM)	2014
Certificate for Introduction to Environmental Management (CEM)	2013
BSc (Hons) Zoology (Herpetology) (University of the Witwatersrand)	2012
BSc (Zoology and Environment, Ecology and Conservation) (University of Witwatersrand)	2011

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces
West Africa – Uganda

PREVIOUS EMPLOYMENT

Position	Junior Environmental Scientist
Company	ILISO Consulting (Pty) Ltd
Employment	2013 - 2015

SELECTED PROJECT EXAMPLES

Wetland Delineation and Wetland Function Assessment
Various Freshwater Assessments, including:
Wetland Offset Plan for the Cape Town International Airport, Cape Town.
Freshwater Assessment for the Swartklip Site as part of the Cape Town International Airport Wetland Offset requirements, Cape Town.
Freshwater Assessment for the proposed Heuningklip Solar Farm, Vredenburg, Western Cape.
Freshwater screening for the proposed Doornfontein Solar Farm, Velddrift, Western Cape.
Freshwater Screening for the proposed Valentia underground shooting range, Paarl, Western Cape.
Freshwater Assessment for the proposed Baden Powell Industrial development, Western Cape.
Freshwater Assessment for the decommissioning of five landfill sites within the Drakenstein Municipality, Western Cape.

Freshwater Assessment for the proposed De Hoop Residential Development, southern Paarl, Western Cape.
Freshwater assessment for the proposed Vredenburg Wind Energy Facility, Vredenburg, Western Cape.
Wetland Assessment for the proposed Excelsior Wind Energy Farm and associated powerline infrastructure, Swellendam, Western Cape.
Wetland Assessment for the sewage Bulk Service System for the Drakenstein Municipality, Paarl, Western Cape.
Freshwater screening for the proposed Vendome residential Development, Paarl, Western Cape.
Wetland Assessment for the Riverclub Development for the Val de Vie development, Paarl, Western Cape.
Wetland Assessment for the Riverfarm Development for the Val de Vie development, Paarl, Western Cape.
Wetland Assessment for the development of three agricultural dams for irrigation of crops, Cape Farms, Western Cape.
Wetland Assessment for the Willow Wood Estate Sewage pipeline upgrade, D'Urbanvale, Western Cape.
Wetland Assessment for the rectification of infilling of a freshwater feature, D'Urbanvale, Western Cape.
Freshwater Assessment for the stabilisation of the Franschhoek River embankment, Leeu Estates, Franschhoek, Western Cape.
Freshwater Assessment for the proposed Helderburg Hospital, Somerset West, Western Cape.
Freshwater Assessment for the Vergenoegd Wine Estate, Cryodon, Western Cape.
Freshwater assessment for the proposed upgrade of the community school, Elandsdift farm, Sir Lowry's Pass, Western Cape.

Various Freshwater Rehabilitation and Management Plans, including:
Detailed Method Statement for the rehabilitation and Maintenance of the wetland associated with the Gentleman's Estate Plots, Val de Vie, and Paarl, Western Cape.
Detailed method statement for the rectification and rehabilitation of a storm water system, D'Urbanvale, Western Cape.
Rehabilitation Plan for the proposed de Hoop Residential Development, Paarl, Western Cape.
Rehabilitation Plan for the proposed abstraction and storage of water from the Diep River in a 500,000m^3 dam, Durbanville, Western Cape.
Rehabilitation Plan for the proposed bulk water pipeline over the Kuils River, Belhar, Western Cape.

Water Use Authorisations and ECO input
WUA for the SANRAL N3 De Beers Pass Section within the Free State and KwaZulu-Natal.
Assistance with the WULA for the Mzimvubu Water Project, Eastern Cape.
WUA for the Excelsior Wind Energy Farm and associated powerline infrastructure, Swellendam, Western Cape.
WUA for the Golden Valley Phase II Wind Energy Facility, Eastern Cape.
WUA for the Sewage Bulk Service system for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
WUA for the Riverfarm Development for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
WUA for the Pearl Valley II Development for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
WUA for the Levendal Village for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
WUA for a residential Development, Klapmuts, Western Cape.
WUA for the Riverclub Development for the Val de Vie Polo and Lifestyle Estate, Paarl, Western Cape.
WUA for the proposed Copperton Wind Energy Facility, Northern Cape.
WUA for the proposed bulk water pipeline crossing over the Kuils River, Bellville, Western Cape.
WUA for the proposed Vergenoegd Village residential development near Crydon, Western Cape.
Validation and Verification process of three farms in Franschhoek, Western Cape.
Validation and Verification process for Farm 1165 in Durbanville, Western Cape.
WUA for the De Hoop Lifestyle Estate, Paarl, Western Cape.
WUA for the proposed Platrug Dam with storage capacity of 500,000m^3, Western Cape.
WUA for the proposed Boland Park residential development, Western Cape.

Specialist Environmental Control Work
ECO of WUL conditions for the proposed bridge and access road over the Berg River, Val de Vie Estate, and Paarl.
ECO of WUL conditions for the proposed bulk water pipeline over the Kuils River, City of Cape Town, Belhar, Western Cape.
ECO of WUL conditions for the proposed Riverclub residential development, Paarl, Western Cape.
Various specialist freshwater input into EMP's and landscape plans, Western Cape.

Faunal Assessments Faunal Screening for the proposed Brand se Baai Abalone Farm, Tronox Namakwa Sand's Mine, Western Cape. Faunal Assessment for the proposed Vergenoegd Village residential development near Crydon, Western Cape. Faunal Baseline Study for the proposed wetland offset Study at Denel Swartklip, Cape Town international Airport, Western Cape.
Public Participation and Environmental Impact Assessments Public Participation for the Environmental Impact Assessment for the Eskom Photovoltaic Plant at Arnot and Duvha Power Station. Eskom Hendrina to Gumeni sub-stations 400 kV Powerline. Co-ordination of Heritage and Ecological Assessment and updating the Construction and Operation Environmental Management Plan. Public Participation Team Leader for the Mzimvubu Dam Environmental Impact Assessment. Public Participation Process for Eskom Exemption from and Postponement of Air Emission Licence Applications. EIA for Eskom Vierfontien to Wawielpark 22 kV Transmission line refurbishing. Junior Environmental Scientist for the Hartbeespoort Waste Charge Discharge System. Public Participation Process for City of Tshwane's Bus Rapid Transit from Pretoria Station to Rainbow Junction. EIA for the Rwengaaju Model Village Irrigation Scheme in Kabarole District, Uganda. EIA for the Water supply and Sanitation system in Moroto, Bugaddem Kacheri-Lokona, Nakapelimoru and Kotido, Uganda. EIA for the Farm Income Enhancement and Forestry Conservation Project: Irrigation Scheme for Katete, Kibimba and Mubuku II, Uganda.

FAUNAL AND FLORAL ECOLOGICAL ASSESSMENTS AS PART OF AN ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESHIA) FOR THE PROPOSED ISABELLA, MCCAYS AND BUBI GOLD SULPHIDE PROJECT

Prepared for

SLR CONSULTING (AFRICA) (PTY) LTD

2019

Prepared by:	**Scientific Terrestrial Services**
Report authors:	**J. du Plessis**
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	S van Staden (Pri. Sci. Nat)
Report Reference:	**SAS 218191**
Date:	**June 2019**

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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome - usually international in origin.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animals and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the Ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a sensitive ecological feature in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the floral population.
Ecoregion:	An ecoregion is a "recurring pattern of Ecosystems associated with characteristic combinations of soil and landform that characterise that region.
Ecotone:	An ecotone is a transition area between two biomes, where two communities meet and integrate. It may be narrow or wide, and it may be local (e.g. the zone between a field and forest) or regional (e.g. the transition between forest and grassland ecosystems)
Facultative species:	Species usually found in wetlands (76 percent to 99 percent of occurrences), but occasionally found in non-wetland areas.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Obligate species:	Species almost always found in wetlands (>99 percent of occurrences).
Perennial:	Flows all year round.
RAMSAR:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status.
Riparian:	Including the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.
Species of Conservation Concern	The term SCC in the context of this report refers to all RDL (Red Data) and IUCN (International Union for the Conservation of Nature) listed species as well as protected species of relevance to the project.

ACRONYMS

CR	Critically Endangered
EAP	Environmental Assessment Practitioner
EC	Electrical Conductivity
EEZ	Exclusive Economic Zone
EN	Endangered
EPAA	Environment Protection Agency Act
ESHIA	Environmental Social and Health Impact Assessment
ESHMP	Environmental Social and Health Management Plan
IEZ	Inshore Exclusive Zone
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
LC	Least Concern
NT	Near Threatened
RDL	Red Data Listed
REC	Recommended Ecological Category
SCC	Species of Conservation Concern
STS	Scientific Terrestrial Services
VU	Vulnerable
WWF	World Wildlife Foundation

1 INTRODUCTION

1.1 Background

Scientific Terrestrial Services (STS) was appointed to conduct faunal and floral ecological assessments as part of the process to undertake an Environmental and Social Impact Assessment (ESIA) for the proposed Isabella, Mccays and Bubi Gold Sulphide Project. A single site assessment was conducted by locally appointed field ecologists, undertaken on the 10 -12th of December 2018.

Bilboes Holdings (Pvt) Ltd (Bilboes) currently own and operate the Isabella-McCays-Bubi Oxide Complex, which is comprised of three existing gold mine operations. The operations are located within the Bubi District of the Matabelaland Province of Zimbabwe. The Isabella and McCays Mines are located in close proximity to one another, approximately 75 kilometres (km) north of Bulawayo, while the Bubi Mine is located approximately 20 km further north-east of the Isabella-McCays complex. The regional and local setting of the Isabella-McCays-Bubi Oxide Complex is illustrated in Figure 1 to Figure 4 respectively.

As part of their operations, Bilboes have identified additional gold-bearing sulphide ores beneath the oxide orebody within the existing open cast pits at the Isabella, McCays and Bubi Mines. The proposed Bilboes Isabella- Mccays and Bubi Gold Sulphide Project entails the establishment of additional infrastructure required at each of the three existing mines to facilitate the extraction, handling and processing of the sulphide ores. In order to extract the sulphide ores, the existing open pits would need to be mined deeper. The key focus of this ESIA is on the new infrastructure, including a new processing plant, and associated Tailings Storage Facility (TSF), that would be required to process the gold from the sulphide ore. It is currently proposed that this new infrastructure be established near the Isabella-McCays complex. In order to facilitate the transport of the mined sulphide ore of the Bubi Mine to the new processing plant, a new 30 km haul road would also need to be established. The seperate proposed mine layouts will be termed study areas whereas the combined footprints will collectively referred to in future as the focus area.

Other new infrastructure associated with the proposed project would include, Waste Rock Dumps (WRD), a new airstrip, a limestone quarry, and associated facilities at the proposed processing plant. The planned establishment of some of the proposed infrastructure would also necessitate the diversion of an existing public road and powerlines. The entire footprint

of the three mine expansions and associated infrastructure will collectively be called the Focus Area throughout this report.

The objective of this study, is to map, consider and describe the biodiversity resources associated with the Focus area from results gathered during the survey. In addition, their integrity, ecological importance and sensitivity, including the provision of goods and services, is considered and presented. In doing so, this report must guide the proponent, Environmental Assessment Practitioner (EAP) and regulating authorities, by means of the presentation of information on the baseline conditions, as to the management of current and future mining operations from an ecological risk management point of view as well as the further studies and assessments required.

Following the assessments, the ecological risks were determined, and an analysis of the impacts associated with the project presented in Section 7 (Impact assessment). Key mitigatory measures were identified in order to minimise the potential impacts on both the local and regional biodiversity.

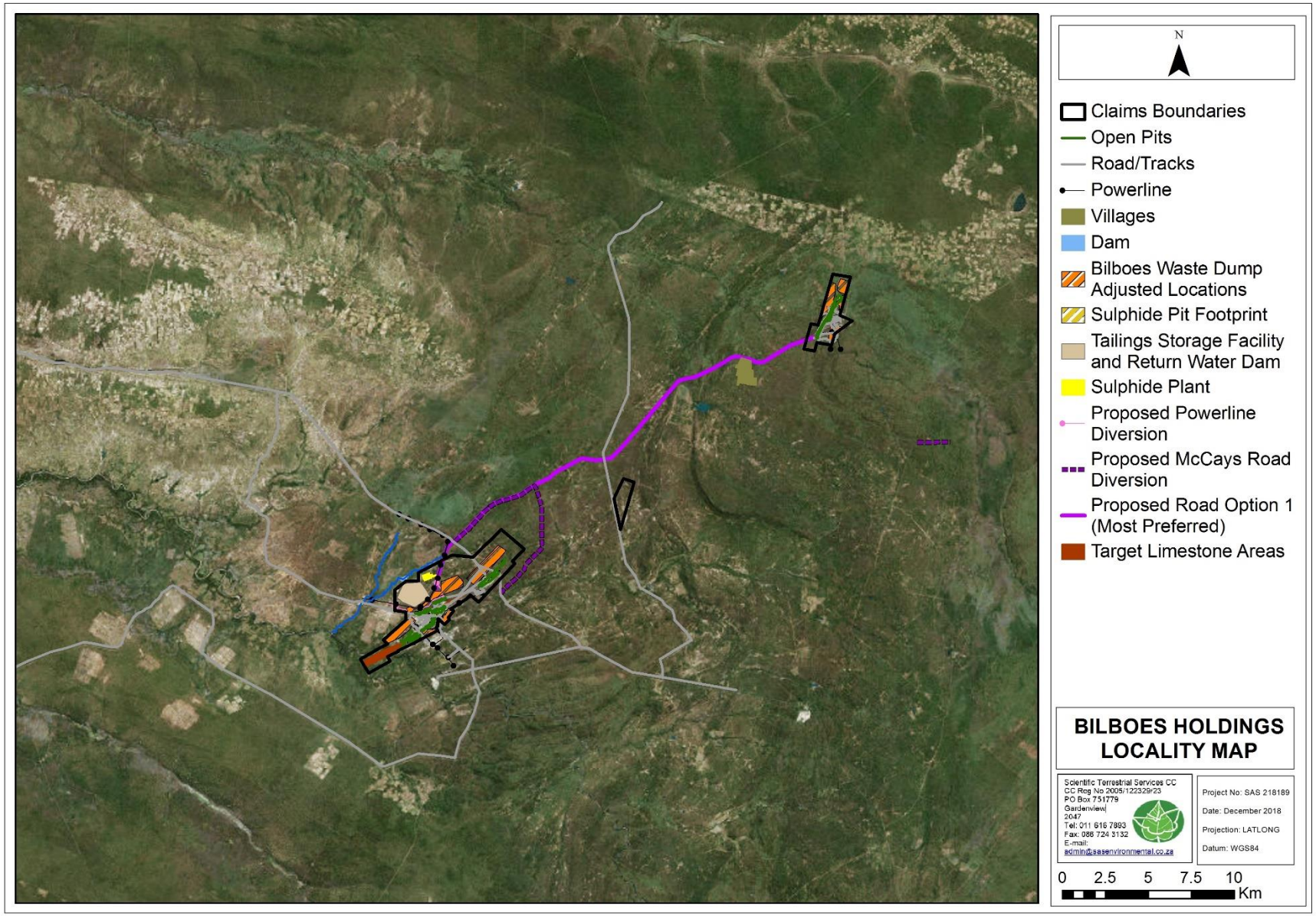


Figure 1: Digital Satellite image depicting the location of the Focus Area in relation to surrounding areas.

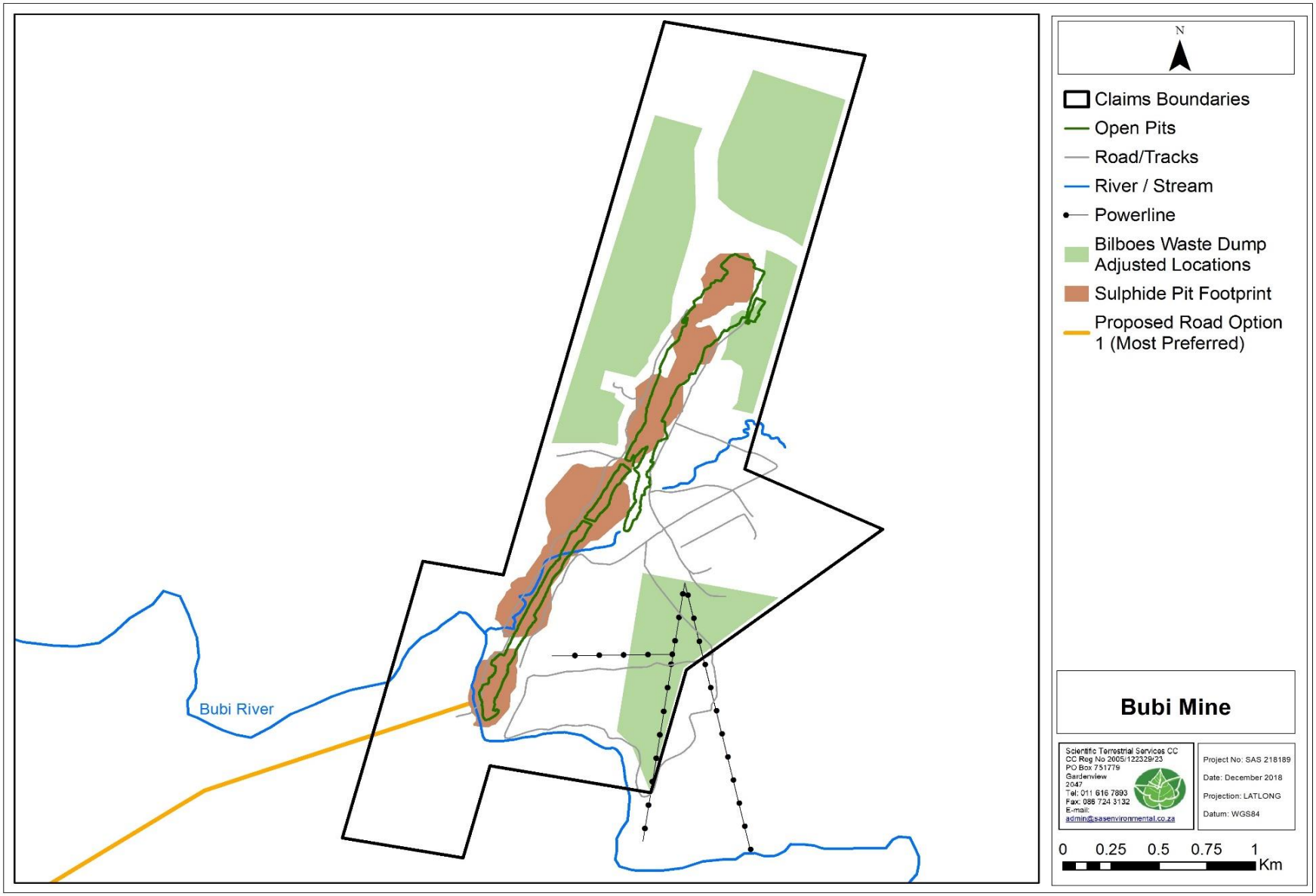


Figure *2:* The proposed layout of the Bubi Mine

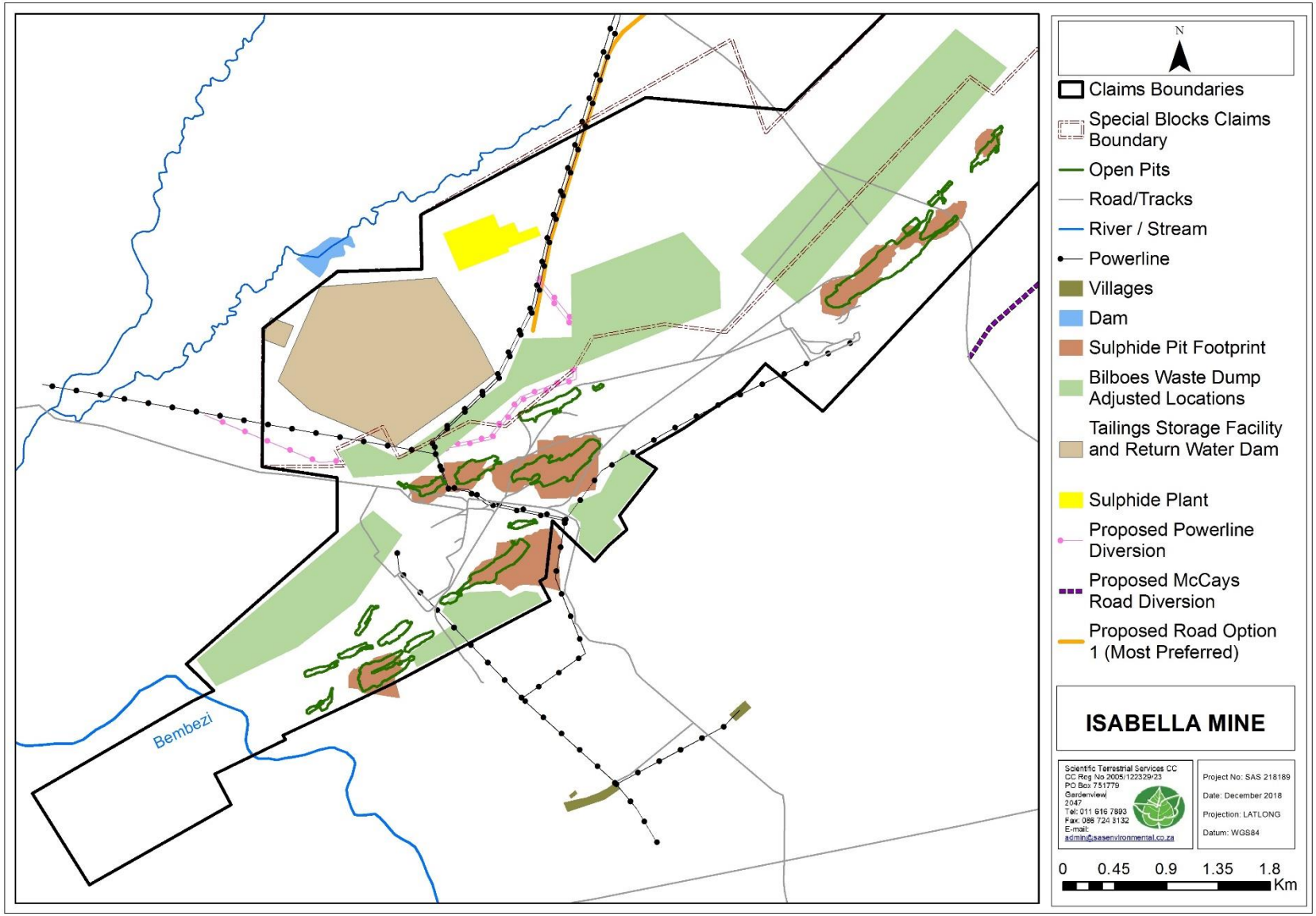


Figure 3: The proposed layout of the Isabella Mine

Figure 4: The proposed layout of the McCay's Mine

1.2 Project Scope

International Best Practice Guidelines and Zimbabwe Legislation and Regulations were utilised to inform the scope for the assessment of the biodiversity, wetland and aquatic resources associated with the proposed Bilboes Holding operations. Specific outcomes in terms of these assessments are as follows:

Terrestrial Ecological Assessment:

- Desktop assessment to collect all relevant vegetation types, Species of Conservation Concern (SCC) and any other ecological data available for the area;
- To determine and describe primary floral habitat units, communities and general ecological conditions associated with the area;
- To determine the Present Ecological State (PES) of the various habitat units;
- To conduct a floral and faunal SCC assessment, including potential for such species to occur within Focus area;
- To provide inventories of floral and faunal species as encountered on site;
- To determine ecological services provided by the resources in and around Focus area;
- To describe the spatial significance of the area with regards to surrounding natural areas;
- To identify and consider all sensitive landscapes areas where disturbance should be avoided; and
- To identify opportunities where active management could result in an improvement of ecological resources associated with Focus area.

1.3 Assumptions and Limitations

The following points serve to indicate the assumptions and limitations regarding the aquatic assessment:

- **Field verification:** Ecological studies were undertaken by local Zimbabwean specialists, as such Scientific Terrestrial Services assumes that appropriate methodologies were applied and sufficient effort put into data collection and results obtained from the field technicians are accurate;
- **Access constraints:** Local specialists indicated that access of some farm portions were not possible at the time of the survey. However, the results obtained at the various assessment points were consistent and hence it is deemed likely that the results obtained are largely representative of the focus area as a whole, and deemed adequate to provide the required level of understanding of the systems for the study;

- **Biodiversity mapping constraints:** The biodiversity resource delineations as presented in this report are regarded as a best estimate of the resource boundaries based on the site conditions at the time of the assessment. Limitations in the accuracy of the delineation due to limitations in access in the dense vegetation are, however, considered acceptable. Due to the reasonably high quality, high resolution digital aerial imagery of the site, accurate delineation of features using desktop mapping methods was possible in combination with site observations and field mapping exercises;

1.4 Legislative Requirements

The following legislative requirements were considered during the assessment:

- The National Environmental Policy (Act No. 13 of 2002);
- The Forest Act (Act 37 of 1990);
- The Parks and Wildlife Act (Act no 294 of 1979);
- Mines and Minerals Act (Act No 48 of 1973);
- International Finance Corporation (IFC) Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources (2012); and
- International Finance Corporation (IFC) Environmental Health and Safety General Guidelines (2007).

The details of each of the above, as they pertain to this study, are provided in Appendix A of this report.

2 ASSESSMENT APPROACH

Initially, a desktop study was undertaken to gather background information regarding the site and its surrounding areas. This involved consulting maps, aerial photographs and digital satellite images in order to determine broad habitats and sensitive sites; a literature review concerning habitats, vegetation types, floral and faunal species distributions and identifying the status of the compiled species lists include potential floral and faunal Species of Conservation Concern (SCC), alien and invasive floral species as well as medicinal species. Detailed explanations of the floral methods of assessment are provided in Appendix A of this report.

2.1 Sensitivity Mapping

All the ecological features of the focus area were considered and sensitive areas were delineated with the use of a Global Positioning System (GPS) to augment the mapping of the features undertaken from aerial photography. A Geographic Information System (GIS) was

used to project these features onto aerial photographs and topographic maps. The sensitivity map should guide the design and layout of proposed future activities. Due to access constraints and the extent of Focus area, extrapolation for the extents of the features was undertaken by comparing “ground-truthed” data to high resolution aerial photography, in order to map features across the Focus area.

3 RESULTS OF THE DESKTOP ANALYSIS

The following section contains data accessed as part of the desktop assessment. It is important to note, that although all data sources used provide useful and often verifiable high-quality data, the various databases do not always provide an entirely accurate indication of the actual biodiversity characteristics of the Focus area.

3.1 World Database on Protected Areas

According to the World Database on Protected Areas (UNEP-WCMC, 2016), the Gwampa State Forest is situated to the north of the focus area. The Parks and Wildlife Act of 1975 states that the purposes of National Parks are (GoZim 1975):

a) To preserve and protect the natural landscape and scenery;

b) To preserve and protect wildlife and plants and the natural ecological stability of wild life and plant communities for the enjoyment, education and inspiration of the public.

All of these reserves as Designated as National Forests, and as such according to The National Forest Act, 2015 (Act No 4 of 2015), all land comprised in a National Forest shall be used for:

(a) the security of forest resources of national importance;

(b) the conservation of ecosystems and biological diversity;

(c) improved forest resource management and sustainable utilisation of forest resources; and

(d) the management of major water catchments and head waters, subject to the Water Resources Management Act, 2011 (No. 21 of 2011).

According to Section 47 Forest Act, 2015 (Act No 4 of 2015), the Minister may, by statutory instrument, on the recommendation of the Director for the purposes of conserving any species

of flora, particularly having regard to its rarity, economic significance or its role in assessing the health of an ecosystem and generally for the conservation of biological diversity—

(a) declare a kind or category of flora to be protected flora; and

(b) prohibit or regulate the felling, cutting, burning, injury, taking or removal of any protected flora, generally or during a specified period and throughout or in a specified area of the Republic.

3.2 Terrestrial Ecoregions

According to the World Wildlife Fund (WWF, 2001), the north-eastern portion of the focus area occurs within the Southern African Bushveld (AT0717) terrestrial ecoregion, while the remaining south western portion of the focus area occurs within the Zambezian Baikiaea woodlands (AT0726) (Figure 5). The sections below briefly describe the characteristics of the terrestrial ecoregions. It must be noted that these ecoregions were delineated using desktop methods and are of low resolution and therefore often not accurate to a site-specific level.

3.2.1 Southern African Bushveld

The Southern African Bushveld forms part of the vast savannas that cover much of southern Africa. Low levels of endemic flora or fauna are associated with this ecoregion, but is characterised by large mammals and rich bird life typical of African savannas. Dominant anthropogenic activities associated with the ecoregion includes cattle ranching and urban expansion from the nearby. Ecotourism has become a major land-use activity in the bushveld and has led to the establishment of many small nature reserves and private game parks in the area, which enhance the conservation status of this ecoregion.

3.2.1.1 Biodiversity Features

The Southern African Bushveld falls within the savanna biome, where this is the dominant vegetation of Africa, occupying 54% of southern Africa (Cowling *et al*. 1997), 60% of sub-Saharan Africa (Scholes and Walker, 1993), and 12% of the global land surface (Scholes and Hall, 1996). Savannas are generally characterised by trees and grasses as their main growth form (Scholes and Walker, 1993). To the north, east, and west the ecoregion borders other savanna ecoregions and is mainly differentiated because of its high elevation (700 m to 1,100 m).

The Southern African Bushveld is distributed throughout the southeast of Botswana, southern Zimbabwe and northern South Africa. It has a well-defined southern boundary, the Highveld Grassland which is a cool, high-elevation (1,500 to 2,000 m) grassland which is exposed to frequent, severe frosts in winter. In the east, the ecoregion is bound by the mountain ranges of the Drakensberg, Strydpoortberg and Soutpansberg. The Zambezian and Mopane

Woodland ecoregion is dominant in the low-lying areas to the east of these mountain ranges. The western and northern boundaries are less well defined. In the west the climate becomes increasingly arid, where the soils are more fertile. The savannas characteristic of this moister environment are termed "moist broad-leafed savannas" or "semi-deciduous forests" (Cowling *et al*. 1997) and include the Zambezian Baikiaea Woodland and the Southern Miombo Woodland ecoregions.

The Southern African Bushveld is characterised with hot, wet summers and cool, dry winters. It has an average annual rainfall of between 350 mm to 750 mm (Nix, 1983). As a result, the temperatures in the bushveld are higher than on the more elevated highveld and range from –3° C to 40° C, with an average of 21° C. Another distinguishing characteristic is the relative lack of frost in the bushveld.

Studies undertaken by Cowling *et al*. (1997) divided the vegetation of this ecoregion into "mixed savanna" and "mopane savanna." The Mopane savanna extends from south-eastern Botswana into the main plateau of Zimbabwe and down into the north of South Africa, known as the Tuli Block. Around Bulawayo in Zimbabwe, the vegetation transforms into tree savanna of approximately 6 m in height with a good grass cover. *Hyparrhenia filipendula* and *H. dissolute* are the most common grass species. *Terminalia sericea* (Silver Cluster Leaf) is the dominant tree, intermixed with varying proportions of *Burkea africana*. To the north of this, Vachellia species, such as *Vachellia nilotica*, *V. karroo* and *V. rehmanniana*, become dominant. In the southwest of the ecoregion, on the Springbok Flats, a distinctive type of vegetation, the clay thorn bushveld, grows (Low and Rebelo, 1996). This veld type is associated with the unusual basalt-derived clays of the flats characterised by open savanna dominated by many Vechellia and Senegalia species, such as *Vachellia tortilis, V. nilotica, V. gerrardii, V. karroo* and *Senegalia nigrescens*. Dense, tall, and coarsely tufted grasses such as. Turf grass (*Ischaemum afrum*), deck grass (*Sehima galpinii*), and canary millet (*Setaria incrassata*) are predominant.

3.2.1.2 Current Status

In Zimbabwe, this vegetation type is mainly protected in the Matopos National Park (425 km^2). The Matobo Hills are an essential water catchment area which is known for their unique geological formations, dominated by many granite inselbergs, or kopjes, interspersed with caves. As many as forty raptor species are found here and over 85 mammal species have been recorded here, including small but well-protected populations of black and white (*Ceratotherium simum*) rhinoceros. Finally the region has great cultural and archaeological significance, and has been inhabited from the Stone Age to the present.

3.2.1.3 Types and Severity of Threats

There are fewer threats to the north of the ecoregion in Botswana and Zimbabwe, where low-intensity goat and cattle farming are the major impacts. The removal of dead wood for firewood may also negatively impact obligate tree-hole nesting birds and small mammals (du Plessis, 1995). In large areas of Botswana and Zimbabwe, wildlife contributes significantly to the local economy. Wildlife utilization was originally mostly licensed trophy hunting, but is now increasingly oriented toward non-consumptive recreation and tourism. This trend should improve the conservation status in the north of the ecoregion.

There are four exotic plant species that have invaded the Southern African Bushveld. These are *Jacaranda mimosifolia*, *Lantana camara*, *Melia azedarach*, and *Morus alba*. The impacts of these invasive species here is not as serious a threat as it is in other ecoregions in southern Africa (such as the Lowland Fynbos and Renosterveld ecoregion).

3.2.1.4 Justification of Ecoregion Delineation

The Southern African Bushveld, stretching from Bulawayo in the north to Pretoria in the south, combines White's (1983) '*Colophopsermum mopane* woodland and scrub woodland' and 'South Zambezian undifferentiated woodland,' which includes portions 'Kalahari deciduous Vachellia and Senegalia wooded grassland and deciduous bushland.' Lying on a plateau, it has a higher elevation gradient than surrounding ecoregions to the west, north, and east. The Highveld forms a distinct southern boundary, with even higher elevations between 1,500 to 2,000 m.

This ecoregion forms part of larger complex of Caesalpinoid woodland ecoregions that support wet and dry miombo, mopane, thicket, dry forests, Baikiaea woodland, and flooded grassland habitats, among others. The dominance of Caesalpinoid trees is a defining feature of this bioregion (i.e., a complex of biogeographically related ecoregions). Major habitat types (e.g., mopane and miombo) and the geographic separation of populations of large mammals are used to discriminate ecoregions within this larger region. All of these ecoregions contain habitats that differ from their assigned biome or defining habitat type. For example, patches of dry forest occur within larger landscapes of miombo woodlands in several areas. More detailed biogeographic analyses should map the less dominant habitat types that occur within the larger ecoregions.

3.2.2 Zambezian Baikiaea woodlands

Deep Kalahari sands occur in a wide belt along the Angolan-Namibian border across to Zimbabwe, supporting dry deciduous forest dominated by *Baikiaea plurijuga.* The hot, semi-arid climate and nutrient-poor soils mean that this region is not suitable for farming, and thus it has retained some of its natural vegetation. Over 160 mammal species are found here, including ungulates and large predators. However, settlements occur along rivers, and the valuable *Baikiaea plurijuga* is sought after for the timber trade.

3.2.2.1 Location and General Description

This ecoregion is a mosaic of dry deciduous *Baikiaea plurijuga*-dominated forest, thicket and secondary grassland. The area falls within the Zambezian centre of endemism and coincides largely with White's (1983) Zambezian dry deciduous forest and scrub forest. This ecoregion forms a belt on deep Kalahari sands along the Angola-Namibia border, extending in a straight line to southwestern Zimbabwe. A portion of this ecoregion extends northwards, along the Zambia-Angola boundary. It is defined and shaped by a number of factors. The limits of the Kalahari sand delineate the east and western extent of this belt, while the southern boundary is limited by frost, and to the north, as rainfall increases the vegetation transcends into evergreen Cryptosepalum forests and miombo woodland. Around the Barotse floodplain, seasonal waterlogging or flooding suppresses tree growth, and Baikiaea woodlands give way to grasslands. While the distribution of the forest, woodland, savanna and grassland elements is partly determined by edaphic and climatic factors, disturbance factors such as fire, logging, and agriculture play an increasing role in the spread of secondary savanna and grassland.

The area lies on an extensive plain of 800 m to 1,000 m in elevation and is drained by the Upper Zambezi rivers and their numerous tributaries. The ecoregion overlies deep Kalahari sands of aeolian origin. Fossil dunes deposited in the Pleistocene and extensive dambos (shallow, seasonally inundated pans or vleis) that have formed in river valleys and dune troughs are a characteristic feature of the ecoregion. Soils are very deep and free-draining with virtually no clay or silt. They absorb all the incidental rainfall or receive lateral seepage water (White 1983) and remain moist throughout the year. They are able to support forest and woodland vegetation despite the low rainfall in parts of the ecoregion. Because of their extremely low clay content, these soils only hold nutrients where there is organic matter. Exposure of the soil surface to the sun through clearing and burning of the vegetation destroys much of the organic matter, and such areas tend to remain bare (Bingham, 1995).

The ecoregion experiences a hot, semi-arid climate. Mean annual rainfall ranges from less than 400 mm in the drier southwest to more than 600 mm in the eastern parts of Zimbabwe. Annual rainfall increases to about 800 mm in the northernmost parts of the ecoregion in Angola and Zambia, and is strongly concentrated from November to April. The mean maximum temperature is between 27° and 30° C and the mean minimum temperature ranges from about 9° to 12° C.

The Zambezian Baikiaea Woodland ecoregion represents a transition from moist southern savanna woodlands to dry southwestern deserts. Based on an analysis of the distribution of woody species occurring in Zambia, (White, 1965, in Werger and Coetzee 1978) recognized three centres of endemism within the Zambezian regional centre of endemism: the Katangan, Zambezi, and Barotse. The Barotse region is comprised of Baikiaea vegetation and associated *Loudetia spp*. grasslands. It is defined by species confined to Kalahari sand, and the dominant tree species, Zambezian teak or mukusi (*Baikiaea plurijuga*), is endemic to it.

There is considerable floristic variation in Baikiaea vegetation, particularly towards the edges of the ecoregion. Nearly all the species are deciduous, but there is considerable variation from species to species and from year to year. *Baikiaea plurijuga* is the dominant tree species characterizing the ecoregion, though logging and fires have removed it from many areas and the boundary with surrounding woodlands and savanna communities is often difficult to recognize. In well-developed Baikiaea communities, species of Brachystegia and Julbernardia and *Colophospermum mopane* (species typical of miombo and mopane woodlands) are totally absent (Werger and Coetzee, 1978). *Baikiaea plurijuga* is the sole dominant, forming a fairly dense, dry, semi-deciduous forest with trees up to 20 m in height. There is a dense and shrubby lower story of *Combretum engleri*, *Pteleopsis anisoptera*, *Pterocarpus antunesii*, *Guibourtea coleosperma*, *Dialium engleranum*, *Strychnos spp*., *Parinari curatellifolia*, *Ochna pulchra*, *Baphia massaiensis* subsp. *obovata*, *Diplorhynchus condylocarpon*, *Terminalia brachystemma*, *Burkea africana*, *Copaifera baumiana* and *Bauhinia petersiana* subsp *serpae*. Lianas and climbers are also common in the understory, including *Combretum elaeagnoides*, *C. celastroides*, *Dalbergia martinii, Senegalia ataxacantha*, *Friesodielsia obovata*, and *Strophanthus kombe*. Smaller shrubs are scattered beneath the thicket. The herb layer is only conspicuous during the rainy season (White, 1983). Grasses vary from sparse to dense and include *Leptochloa uniflora*, *Oplismenus hirtellus*, *Panicum heterostachyum*, and *Setaria homonyma*. Other conspicuous herbs are *Aneilema johnstonii* and *Kaempferia rosa*. Epiphytes and mosses are virtually absent.

Among the interesting phenomenon in the ecoregion are dwarf forests of *Baikiaea plurijuga* – 1 to 1.5 m in height – which are found in the Sesheke District in western Zambia. These forests are situated on dambos and are surrounded by normally sized Baikiaea forest (Werger and Coetzee 1978). The dwarf Baikiaea have a peculiar growth form in response to impeded water drainage in the lower soil strata, which results in reduced aeration of the soils.

The Baikiaea forests and woodlands are easily penetrated by fire, especially in the late dry season, and if there is a significant amount of grass and shrubby undergrowth. After frequent fires, a dense shrub layer develops, which is dominated either by shrubs and climbers or by grasses and herbs. When fire damage is severe or after cultivation, *Baikiaea plurijuga* can disappear completely, as it is rather sensitive to fire and does not regenerate easily in frequently burned sites.

3.2.2.2 Biodiversity Features

This ecoregion is an area of moderate species richness for most taxonomic groups. While floristically it falls within its own centre of endemism (as discussed above), the fauna of the area hves low levels of endemism as the area largely represents a merging of elements from the southern savannas, the arid southwest and the miombo woodlands.

More than 160 mammal species occur in the ecoregion. These include several large predator species such as lion (*Panthera leo*), leopard (*P. pardus*), african wild dog (*Lycaon pictus*), cheetah (*Acinonyx jubatus*) and spotted hyena (*Crocuta crocuta*). Ungulates include zebra (*Equus burchelli*), roan antelope (*Hippotragus equinus*), sable antelope (*H. niger*), bushbuck (*Tragelaphus scriptus*), kudu (*T. strepsiceros*), sitatunga (*T. spekei*), reedbuck (*Redunca arundinum*), impala (*Aepyceros melampus* subsp. *melampus*), common duiker (*Sylvicapra grimmia*), oribi (*Ourebia ourebi*), steenbok (*Raphicerus campestris*), eland (*Taurotragus oryx*), blue wildebeest (*Connochaetes taurinus*), buffalo (*Syncerus caffer*), hartebeest (*Alcelaphus buselaphus*), giraffe (*Giraffa camelopardalis*), tsessebe (*Damaliscus lunatus*), waterbuck (*Kobus ellipsiprymnus*), puku (*K. vardoni*) and lechwe (*K. lechwe*). Other mammals of interest are elephant (*Loxodonta africana*), black rhinoceros (*Diceros bicornis*), white rhinoceros (*Ceratotherium simum*) (both now rare in the ecoregion), hippopotamus (*Hippopotamus amphibius*) and honey badger (*Mellivora capensis*).

With more than 400 recorded bird species, this ecoregion's avifauna is characterized by moderately high species richness but low endemism. According to Winterbottom's (1978) zoogeographical subdivision of southern Africa, the Baikiaea woodland mosaic makes up

most of the south-eastern parts of a transition zone from the Central Highlands District to the South West Arid Kalahari Woodlands District. The ecoregion's avifauna is largely derived from the districts to the north and south of it. A variety of habitats exists in the ecoregion and directly adjacent to it, which boosts bird diversity. The many rivers, dambos and wetlands form an important network of aquatic habitats for resident and migrating birds (Barnes, 1998).

Baikiaea woodlands are the preferred habitat of the Bradfield's hornbill (*Tockus bradfieldi*), which is near-endemic to the ecoregion and fairly common. Southern ground hornbill (*Bucorvus leadbeateri*) also occurs here. The ecoregion provides essential habitat for the rare and vulnerable black-cheeked lovebird (*Agapornis nigrigenis*), which is confined to medium-altitude mopane woodland in South Zambia and extreme northern Zimbabwe (Hilton-Taylor, 2000). It occurs only where the mopane woodland is contiguous with Baikiaea dominated woodland. Birds spend the dry season in the mopane woodland (though not evergreen, *Colophospermum mopane* stays green far into the dry season) and feed on the young leaves of *Pterocarpus antunesiana* in the Baikiaea woodlands in the rains (Collar and Stuart, 1985). It is extremely localized within available habitat. This species was massively exploited in the 1920s due to its popularity with the pet trade, and it seems that its populations have never fully recovered. Although it is officially protected, it is still subject to illegal trapping.

The ecoregion has a rich variety of raptor species including secretarybird (*Sagittarius serpentarius*), white-backed vulture (*Gyps africanus*), lappet-faced vulture (*Torgos tracheliotus*), white-headed vulture (*Trigonoceps occipitalis*), hooded vulture (*Necrosyrtes monachus*), lesser kestrel (*Falco naumanni*), Dickinson's kestrel (*F. dickinsoni*), African hobby falcon (*F. cuvierii*), bateleur (*Terathopius ecaudatus*), tawny eagle (*Aquila rapax*), martial eagle (*Polemaetus bellicosus*), and african hawk eagle (*Hieraaetus spilogaster*). Riparian vegetation supports Pel's fishing owl (*Scotopelia peli*) (Barnes, 1998).

In the wetlands and riverine areas within the ecoregion, a great variety of water birds is found. Two rare and threatened species are noteworthy: wattled crane (*Bugeranus carunculatus*) and slaty egret (*Egretta vinaceigula*, VU) which have a wide distribution but are confined to floodplains and are sensitive to disturbance.
The ecoregion is home to 87 recorded reptile species, including 7 species of amphisbaenidae or worm-lizards of the genera Zygaspis, Monopeltis, and Dalophia, two of which are near-endemic. One amphibian is near-endemic to the ecoregion namely the please add common name (*Bufo kavangensis).*

3.2.2.3 Current Status

The ecoregion is fairly sparsely settled with fewer than five people per km^2 in most areas. In the least populated areas, population densities are probably less than one person per km^2. As a result of the scattered human population and the arid nature of the environment, much of the habitat has not been modified or fragmented. However, especially in Zambia, Angola and Zimbabwe, timber logging together with frequent wildfires has significantly reduced the area of mature Baikiaea woodland and forest.

Close to eight percent of the ecoregion is covered by ten protected areas falling into all five countries where Baikiaea woodland is found. There are three protected areas in Angola, Bikuar and Mupa National Parks, and Luiana Partial Reserve, four in Namibia, Mudumu Nature Reseve, Mahango and Caprivi Game Reserve, and Popa Game Park, and Kazuma Pan and Hwange national parks in Zimbabwe plus Simoa Ngwezi National Park in Zambia. In addition to these parks where Baikiaea woodland is the dominant vegetation type, Chobe National Park in Botswana and Khaudom National Park in Namibia have some areas of Baikiaea woodland in their north-eastern most parts. Most of the West Zambezi Game Management Area (GMA), which extends over 38,070 km^2 in the southwestern corner of Zambia, falls into the ecoregion. Although the aim is to manage the area for game and enforce strict control of hunting via a licensing system, there is little game left, and protection of intact habitat or biodiversity is not really an objective of the GMA. Mudumu, Mahango and Hwange are among areas in the southern African subregion (this excludes Angola and Zambia) listed as Globally Important Bird Areas (IBA) (Barnes, 1998).

Among the protected areas of the ecoregion, fauna and flora is well represented, with some of the largest and most stable populations of large mammal species in the region. These include large herds of elephant and buffalo, as well as endangered predators such as cheetah, leopard and wild dog. Black and white rhinoceros have been reintroduced to Hwange, and their numbers are slowly increasing in the intensive protection zone within the park (Barnes, 1998).

3.2.2.4 Types and Severity of Threats

Poaching is a serious and widespread problem in this ecoregion, even within protected areas. Resources for anti-poaching operations are often limited. In Angola and the Caprivi Strip, the long civil war and military operations along the Namibia-Angola border have significantly worsened the poaching situation. Military firearms from these operations are acquired in Zambia, where they present a real threat to poaching-control efforts. Commercial poaching by

outsiders is a big problem in Sioma Ngwezi and the surrounding GMA, with very little game remaining in the latter. Cross-border smuggling of wildlife products in this remote area, where security levels are low, is also a major concern for wildlife management and protection (Simasiku *et al.* 1996).

Annual migration routes of animals in protected areas are often blocked by park borders, international boundaries and human settlements (particularly along rivers). None of the parks in the ecoregion cover the entire migratory ranges of animals such as wildebeests and elephants, and protection in surrounding areas including Zambia's West Zambezi Game Management Area is insufficient or non-existent. Several protected areas do not extend to rivers, where animals migrate in search of drinking water. Game from the Sioma Ngwezi National Park migrates eastward to the Zambezi, which does not fall within the national park, although the West Zambezi Game Management Area extends as far as the river. Similarly, game from the Caprivi and Hwange Parks migrate to the Cuando and Gwai Rivers respectively. Along these rivers are settlements where crop damage, livestock attacks by predators, and concern about game as hosts for tsetse fly cause conflict between conservation efforts and farmers in the area surrounding game reserves. Illegal hunting is difficult to control in these areas, and commercial poachers from other areas are thought to use settlements near rivers as a base for their operations in the dry season (Simasiku *et al*. 1996). Cattle fences (e.g. those erected in Botswana between the Caprivi Strip and the Okavango Delta in 1995 to control the spread of cattle lung disease) can cause increased rates of mortality when animals are cut off from grazing and water resources.

Timber logging is a threat to the Baikiaea woodland and forest habitats, as well as to Baikiaea plurijuga as a species. Annual production of mukusi timber peaked at 100,000 cubic meters in the 1930s and again in 1964 with the construction of railway lines (Bingham, 1995). Since the mid-1970s, logging has declined to around 20,000 cubic meters per year, largely due to a decline of harvestable timber (van Gils, 1988). In Zambia, a recent inventory found no more exploitable reserves in the prime teak forest areas of Sesheke District (Bingham, 1995), and the same applies to Zimbabwe outside protected areas. Such exploitation has destroyed large forest areas, with little hope of recovery because opening the forest results in the invasion of grasses and fires. However, pressure on timber resources in the ecoregion is increasing with rising South African and Namibian timber demands (Simasiku *et al*. 1996). Recently, the conservation status of *Baikiaea plurijuga* in Zambia was revised (Bingham *et al*. 2000) and changed from category LR-nt (lower risk, near threatened) to VU (vulnerable, with population reductions of at least 20 percent over the last three generations) as a result of exploitation and

habitat destruction. The status of Baikiaea in the other countries – especially in Angola and Namibia, where the most extensive stands occur – is not certain.

Clearing for agriculture also affects the Baikiaea woodlands and forests, though this is limited in large parts of the ecoregion by the low levels of rainfall. The nutrient-poor sandy soils necessitate shifting cultivation. Uncontrolled bushfires are common and frequent in the ecoregion, and this makes the forests and woodlands particularly vulnerable to logging and clearing, as regeneration of forest vegetation, and *B. plurijuga* in particular, is hindered.

Presently, tourism development in some areas is unregulated, and much of it is in the form of fishing and safari hunting. In Zambia, both types of development have been observed without adherence to restrictions and licences. The Sioma Ngwezi National Park has no distinct boundary, no official entry point and no tourism infrastructure, and hence does not generate any revenue with which to support its conservation activities. There seems to be a general trend of selling licenses for tourism development and timber logging to people, including foreigners, living outside the region where conservation is taking place (Simasiku et al. 1996). Among local communities, this is causing resentment and a lack of cooperation, which is prerequisite for effective wildlife and natural resource management in areas outside reserves. There has been a recent trend toward community-based wildlife conservation and management programs in Zimbabwe (CAMPFIRE), Zambia (ADMADE) and Namibia (WWF's LIFE Programme).

3.2.2.5 Justification of Ecoregion Delineation

Lying within the Barotse center of the Zambezian Regional Center of Endemism (White, 1983), the Zambesian Baikiaea Woodlands ecoregion follows White's (1983) 'Zambezian dry deciduous forest and secondary grassland.' It is dominated by Baikiaea vegetation associated with deep Kalahari sands. The southern boundary is limited by frost and drier desert, while the northern boundary borders Cryptosepalum forests and miombo woodland. The ecoregion is primarily defined as the center of endemism for Baikiaea vegetation, dominated by the endemic Zambezian teak or mukusi (*Baikiaea plurijuga*).

This ecoregion is part of larger complex of Caesalpinoid woodland ecoregions that support wet and dry miombo, mopane, thicket, dry forests, Baikiaea woodland, and flooded grassland habitats, among others. The dominance of Caesalpinoid trees is a defining feature of this bioregion (i.e., a complex of biogeographically related ecoregions). Major habitat types (e.g., mopane and miombo) and the geographic separation of populations of large mammals are

used to discriminate ecoregions within this larger region. All of these ecoregions contain habitats that differ from their assigned biome or defining habitat type. For example, patches of dry forest occur within larger landscapes of miombo woodlands in several areas. More detailed biogeographic analyses should map the less dominant habitat types that occur within the larger ecoregions.

3.3 BIOMES (WWF, 2001a)

The Focus area falls within the Tropical & Subtropical Grasslands, Savannas & Shrublands Biome. It must be noted that these biomes were delineated on a desktop level and are of low resolution and therefore often not accurate to a site-specific level.

3.3.1 Tropical & Subtropical Grasslands, Savannas & Shrublands

Large expanses of land in the tropics do not receive enough rainfall to support extensive tree cover. The Tropical and Subtropical Grasslands, Savannas, and Shrublands are characterized by rainfall levels between 900-1,500 mm per year. However, there may be great variability in soil moisture throughout the year. Grasses dominate the species composition of these ecoregions, although scattered trees may be common. Large mammals that have evolved to take advantage of the ample forage typify the biodiversity associated with these habitats.

Biodiversity Patterns

Diverse large mammal assemblages in abundant aggregations can be a characteristic feature. Most vertebrates display relatively widespread distributions. Plant alpha diversity is typically low, but in some regions beta diversity and gamma diversity can be very high.

Minimum Requirements

Large natural landscapes are necessary to allow large grazers and their associated predators to track seasonal rainfall or to migrate to new areas during periodic droughts; large-scale fire events also necessitate the conservation of larger natural landscapes. Some large predators, such as wild dogs of Africa, require large natural areas to persist due to home range size and sensitivity to humans. Sources of water are critical for many species.

Sensitivity to Disturbance

Restoration potential in these systems are high; but plowing, overgrazing by domestic livestock, and excessive burning can quickly degrade and alter natural communities. Alteration

of surface water patterns can have significant impacts on the persistence of many vertebrate species. Furthermore, many species are highly sensitive to low intensity hunting or other human activities.

3.4 Vegetation Types

The vegetation type associated with the north eastern portion of the focus area is Zambezian Baikaea Woodland, whilst the south eastern portion is considered to be Forest Transitions and whereas the southern portions of the study area is generally comprised of the South African Bushveld vegetation type according to Vegetation Map of White, (1983) (Figure 5).

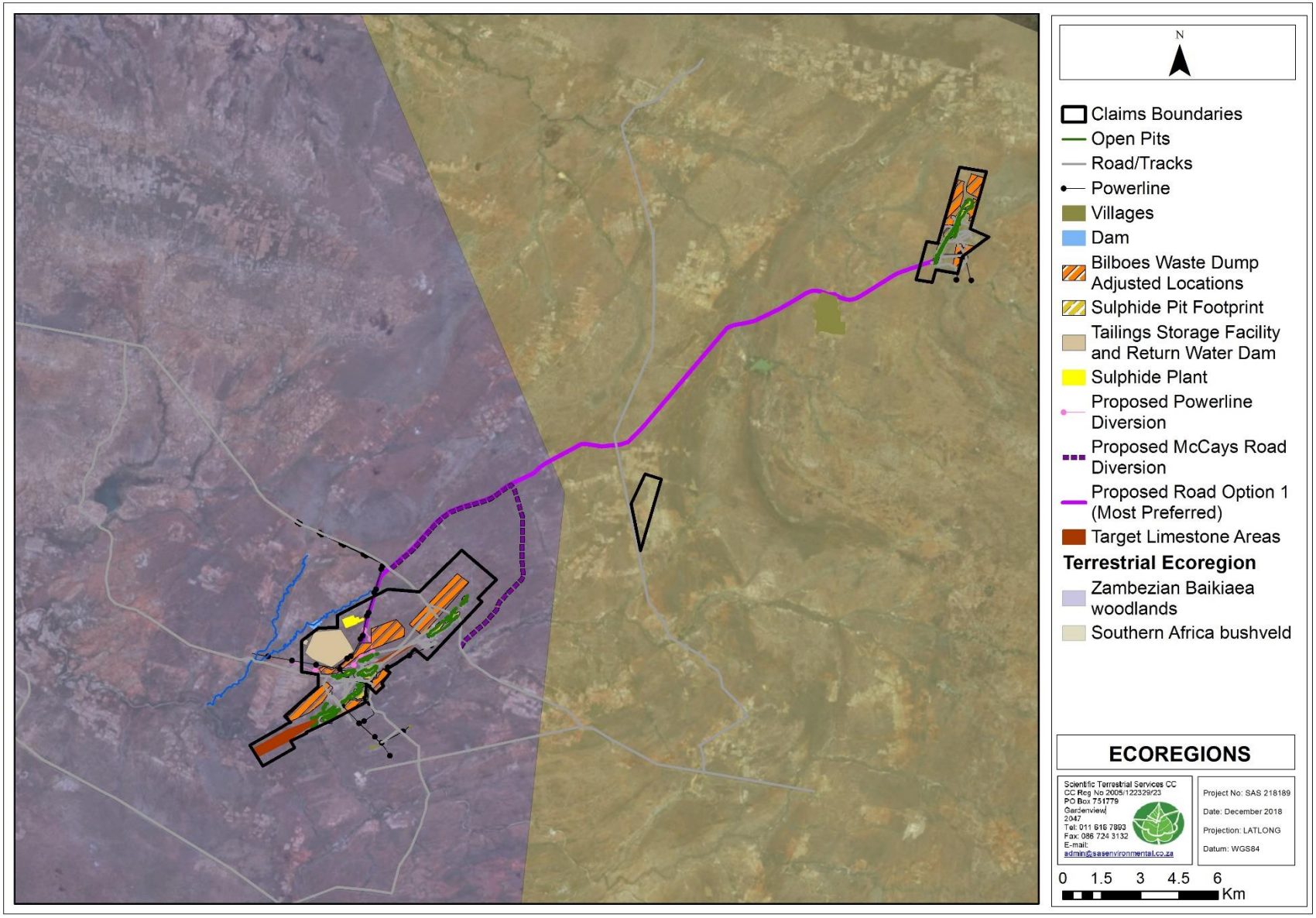


Figure 5: Ecoregions associated with the Focus Area

4 RESULTS OF FLORAL ASSESSMENTS

During the field assessment, two major habitat units were confirmed, which comprised of various dominant vegetation types. These habitat units are:

- South African Bushveld;
  - Dominated by Acacia woodland;
- Zambezian Baikiaea Woodlands - comprised of three major vegetation types namely:
  - Acacias;
  - Baikiaea woodland; and
  - *Brachystegia boehmii;*
- Freshwater resources; and
- Transformed Habitat.

The habitat units associated with the proposed Bubi, Isabella and Mccay's mines are described in the sections below (Figure 6 to 8) . The methodology for calculating the floral habitat sensitivity of each habitat unit is presented in Appendix A.

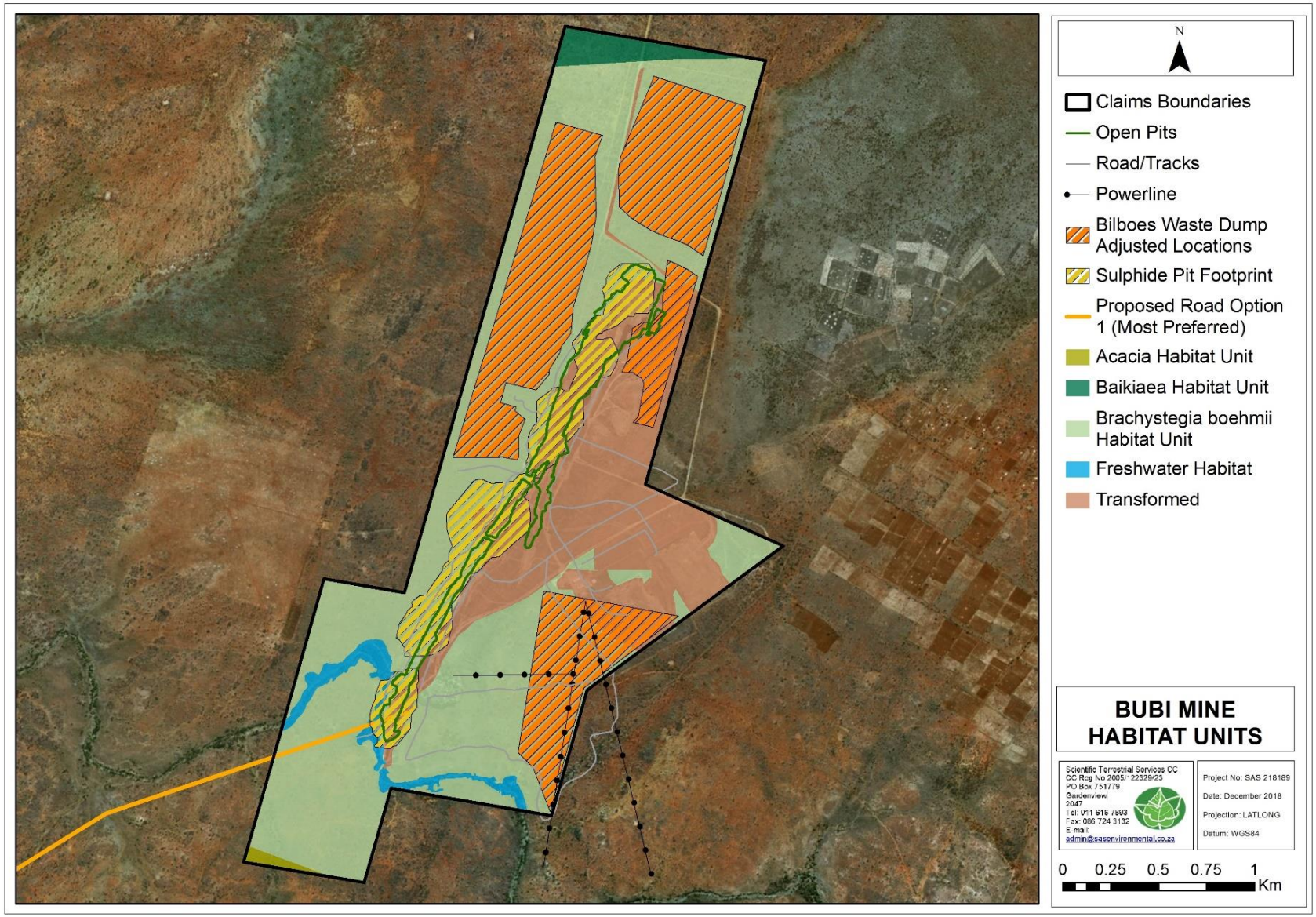


Figure 6: Dominant vegetation Types associated with the Bubi Mine

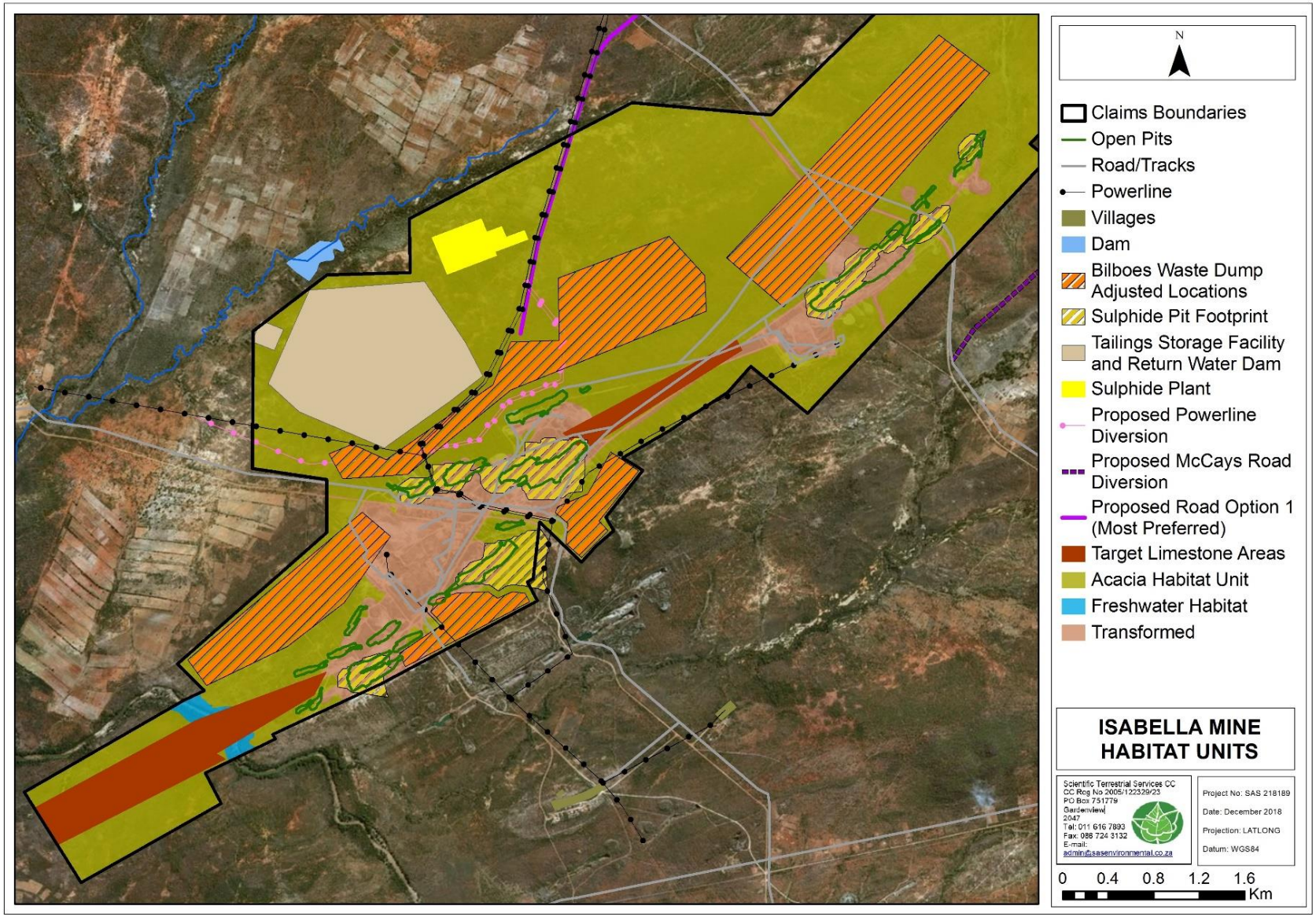


Figure 7: Dominant Vegetation Types associated with the Isabella Mine

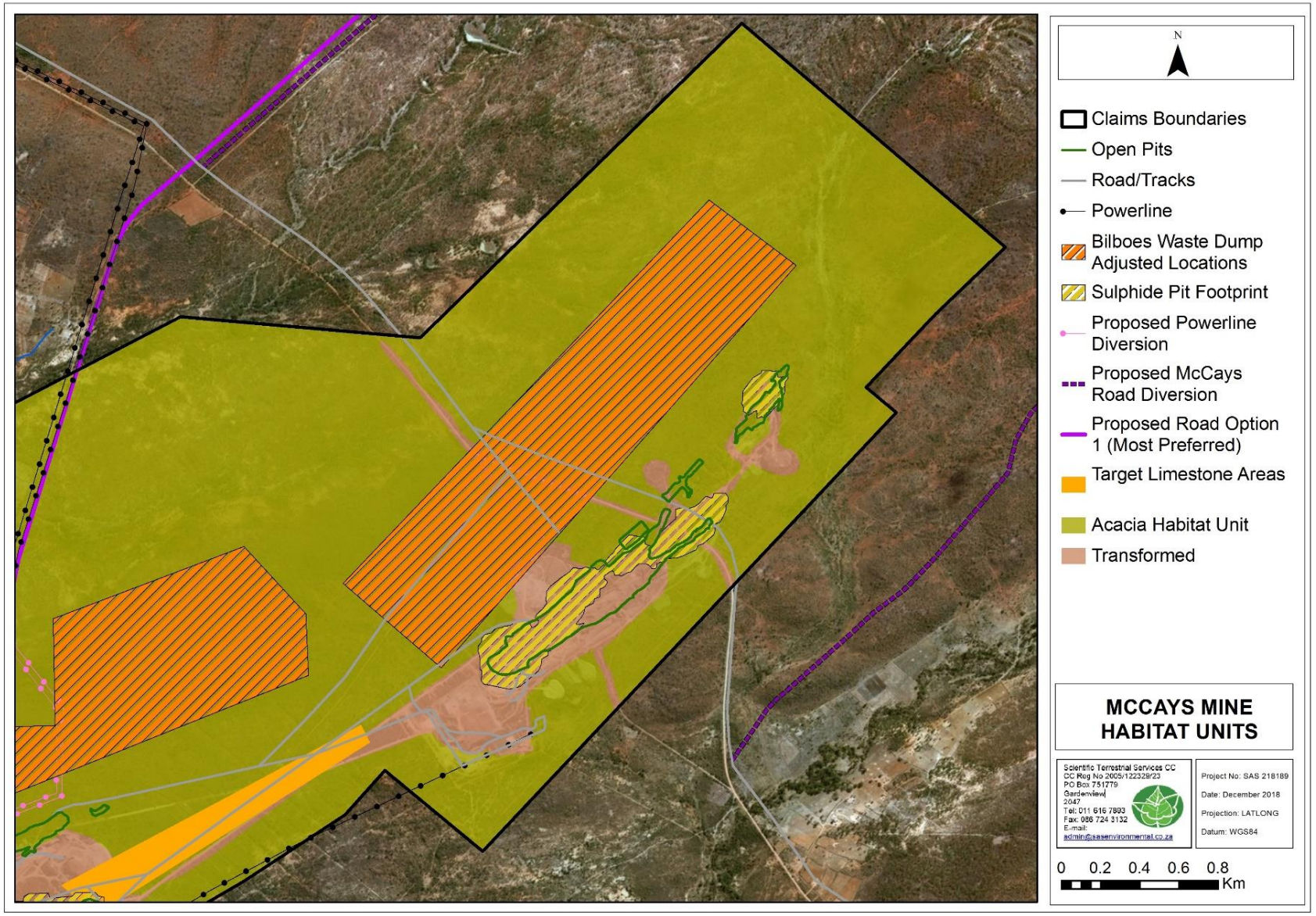


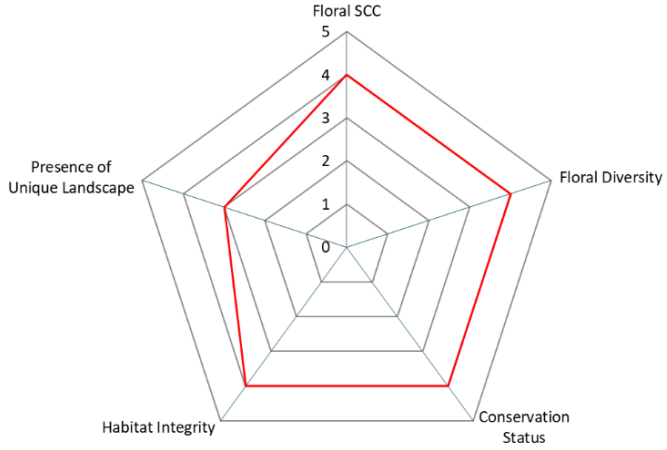
Figure 8: Dominant Vegetations Types associated with the McCay's Mine

4.1 South African Bushveld

Table 1: Floral Assessment Result of the South African Bushveld Habitat Unit

Habitat Unit: South African Bushveld:	**Floral Habitat Sensitivity**	**Moderately High**
	Notes on Photograph: Visual representation of the South African Bushveld Habitat Unit.	

Floral Habitat Sensitivity Graph:



Floral Species of Conservation Concern (SCC)	Two floral SCCs were recorded throughout the habitat unit at the time of the survey namely *Combretum imberbe* (Leadwood, NYBA) and *Senegalia nigrescens* (Knob Thorn, NYBA). *Combretum imberbe* is generally associated with all bushveld and forest regions, often growing along streams and rivers, the leaves are often eaten by browsers such as *Tragelaphus strepsiceros* (kudu), *Sylvicapra grimmia* (grey duiker), *Loxodonta africana* (elephant) and *Giraffa camelopardalis* (giraffe). *Senegalia nigrescens* has a wide distribution range often associated with deep sandy soils common in widely spaced stands. These trees form host plants of hole nesting bird species and larvae of the dusky charaxes butterfly.
General Habitat Description	This vegetation type spans most of the focus area, where *Colophospermum mopane* (Mopane) was the dominant vegetation, with *Combretum hereroense* (Russet Bushwillow), *Combretum imberbe* (Leadwood), *Senegalia nigrescens* (Knob Thorn) and *Dalbergia melanoxylon* (African Blackwood) scattered throughout the habitat unit. Differing levels of disturbance and plant re-establishment was observed during the site assessment. A single Alien Invasive Plant (AIP) species was observed within the habitat unit namely *Lantana camara* (Common Lantana), although only one individual was observed, the likelihood that this species will encroach within the area is deemed to be low.

Business Case and Conclusion:

The South African Bushveld habitat unit's sensitivity is considered moderately-high, due to the unique landscape of the vegetation contributing to floral species diversity and the presence of floral SCC. The proposed activities and the access roads will lead to the further loss of sensitive and endemic floral species and preferred habitat of floral SCC within the area. The habitat is considered to largely intact, with the majority of the area still in good condition, as such the following conditions should be implemented:

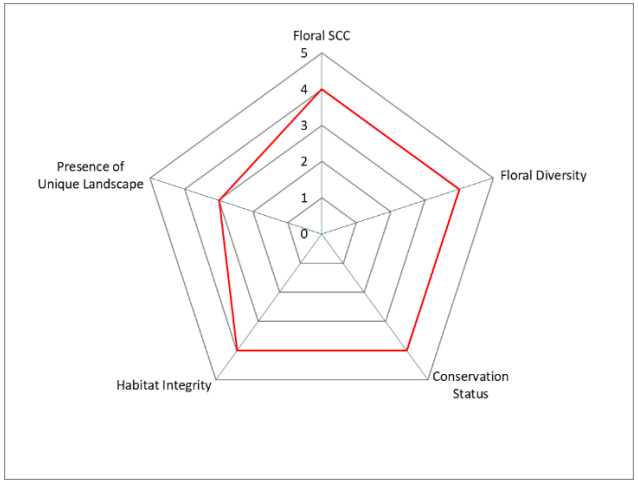
- Due to the low success rate of relocation of *Senegalia nigrescens* as well as other SCC, it is recommended that if approval is obtained for the proposed mining activities a suitably qualified botanist be appointed to assist in a walk through of the intended mining areas, recommending alternatives if high abundances of floral SCC are observed within study areas, and to assist with the necessary permit applications; and
- It is considered imperative that an AIP plan is compiled and implemented for the co0nstruction and operational phases, as well as post closure to ensure that the remaining natural habitat is not further degraded as a result of AIP proliferation.

4.2 Zambezian Baikiaea Woodland

Table 2: Floral Assessment Result of the Zambezian Baikiaea Woodland Habitat Unit.

Habitat Unit: Zambezian Baikiaea Woodland	**Floral Habitat Sensitivity**	**Moderately High**
	Notes on Photograph: Visual representation of the Zambezian Baikiaea Woodland Habitat Unit	

Floral Habitat Sensitivity Graph:



Floral Species of Conservation Concern (SCC)	Two floral SCCs were recorded throughout the habitat unit at the time of the survey namely *Combretum imberbe* (Leadwood, NYBA) and *Senegalia nigrescens* (Knob Thorn, NYBA).
General Habitat Description	Common tree species observed within this habitat unit included: *Adansonia digitata* (Baobab), *Vangueria infausta* (Velvet wild meddler), *Lannea discolor* (Live long), *Euphorbia tirucalli linn* (Milk bush), *Pterocarpus angolensis* (Mukwa), *Amaranthus gangeticus* (Red amaranth), *Ziziphus mucronata* (Buffalo thorn), *Peltophorum africanum* (African wattle). The general habitat associated with this habitat unit remains largely natural although slight fragmentation has occurred due to agricultural activities, low cost urbanisation and historic mining activities

Business Case and Conclusion:

The Zambezian Baikiaea Woodland habitat unit's sensitivity is considered moderately-high, due to the unique landscape of the vegetation contributing to floral species diversity and the presence of floral SCC. The proposed activities and the access roads will lead to the further loss of sensitive and endemic floral species and preferred habitat of floral SCC within the area. The habitat is considered to largely intact, with the majority of the area still in good condition, as such the following conditions should be implemented:

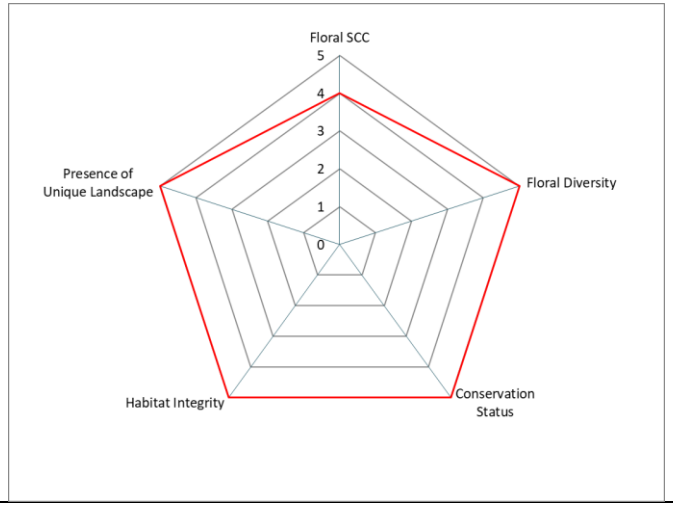
- Due to the low success rate of relocation of *Senegalia nigrescens* as well as other SCC, it is recommended that if approval is obtained for the proposed mining activities a suitably qualified botanist be appointed to assist in a walk through of the intended mining areas, recommending alternatives if high abundances of floral SCC are observed within focus areas, and to assist with the necessary permit applications; and
- It is considered imperative that an AIP plan is compiled and implemented for the co0nstruction and operational phases, as well as post closure to ensure that the remaining natural habitat is not further degraded as a result of AIP proliferation.

4.3 Freshwater habitat

Table 3: Floral Assessment Result of the Freshwater Habitat Unit.

Habitat Unit: Freshwater	**Floral Habitat Sensitivity**	**High**
	Notes on Photograph: Visual representation of the Freshwater Habitat Unit	

Floral Habitat Sensitivity Graph:



Floral Species of Conservation Concern (SCC)	Two SCCs were distributed throughout the habitat unit namely *Combretum imberbe* (Leadwood) and *Senegalia nigrescens* (Knob Thorn).
General Habitat Description	The floral diversity of this habitat unit was classed high with several Tree species were recorded within this habitat unit including *Vachellia erubescens* (Blue thorn), *Vachellia gerrardii* (Grey haired acacia), *Vachellia karoo* (Sweet thorn), *Albizia amara (*Bitter albizzia), *Azanza garckena* (Snot apple), *Berchemia zeyheri* (Pau-rosa), *Boscia albitrunca* (Rough-leaved Shepherds tree), *Brachystegia spiciformis* (Msasa), *Cissus cornifolia* (Black wild grape).

Business Case and Conclusion:

The Bubi River and associated tributaries Present Ecological State range from Moderately Modified to Moderately High as determined in the freshwater assessment compiled by Scientific Aquatic Services (2019). High diversities of tree species were recorded within the Freshwater Resources Habitat Unit with very limited alien invasive plant proliferation evident within the photographs supplied by the mining personnel. as such the following conditions should be implemented:

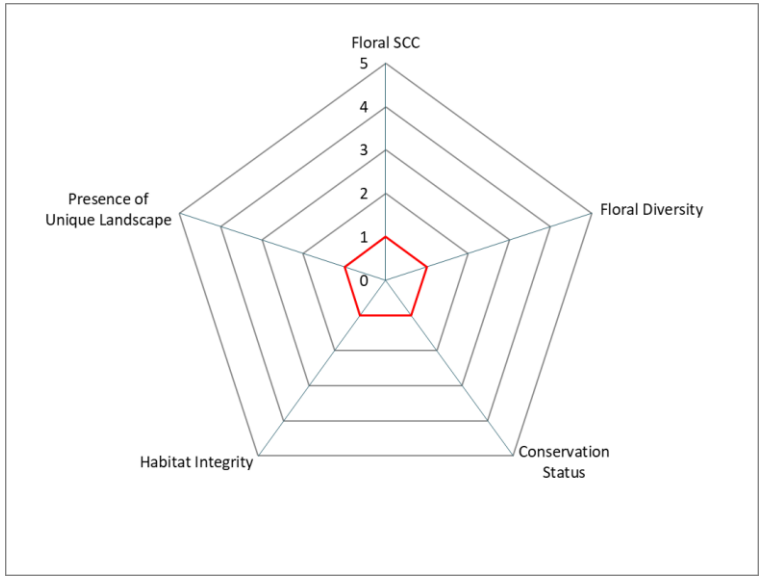
- It is recommended that no construction activities occur within this habitat unit or within the associated buffers.
- The freshwater habitat unit should be designated as a conservation area and small scale rehabilitation should be undertaken to optimise the watercourses ecological state and service provision. Rehabilitation initiatives should include (but not be limited to):
  - Erosion control;
  - AIP control and management;
  - Reinstatement of indigenous riparian and wetland vegetation; and
- Monitoring for water quality.

4.4 Transformed Vegetation

Table 4: Floral Assessment Result of the Transformed Habitat Unit

Habitat Unit: Transformed	**Floral Habitat Sensitivity**	**Low**
	Notes on Photograph: Visual representation of the Freshwater Habitat Unit	

Floral Habitat Sensitivity Graph:



Floral Species of Conservation Concern (SCC)	No floral species of conservation concern were observed in this habitat unit. Transformation due to agricultural, urban activities in the surrounding areas and mining activities associated with the focus area has caused a low likelihood of occurrence.
General Habitat Description	This habitat unit was dominated by *Dichrostachys cinerea* (Sickle Bush) with limited undergrowth and scattered Vachellia and Senegalia species. Other species observed within this habitat unit included: *Colophospermum mopane* (Mopane), *Bauhinia variegate* (Orchid Tree), *Flueggea virosa, Sclerocarya birrea* (Marula), *Combretum apiculatum* (Red Bushwillow) and *Combretum hereroense* (Russet Bushwillow).

Business Case and Conclusion:

Tree diversity in this habitat unit is limited due to the encroachment of *Dichrostachys cinerea* (Sickle Bush).

- The Transformed habitat unit should be managed to improve the ecological state and service provision. Rehabilitation initiatives should include (but not be limited to):
  - Erosion control;
  - AIP control and management;
  - Biodiversity Action Plan.

4.5 Floral Species of Conservation Concern Assessment

An assessment considering the presence of any floral species of conservation concern (SCC), as well as suitable habitat to support any such species was undertaken. Threatened species are species that are facing a high risk of extinction. Any species classified in the IUCN categories as Critically Endangered (CR), Endangered (EN) or Vulnerable (VU) is a threatened species. SCC are species that have a high conservation importance floristic diversity and include not only threatened species, but also those classified in the categories Extinct in the Wild (EW), Regionally Extinct (RE), Near Threatened (NT), Critically Rare, Rare Not Yet Been Assessed (NYBA) and Declining.

The following protected species as listed in the Parks and Wildlife Act (1975):

Table 5: Floral SCC identified during the assessment.

Scientific name	Common Name	Habitat Unit	IUCN Status
Combretum imberbe	Leadwood	South African Bushveld, Zambezian Baikiaea Woodlands and Freshwater Habitat	NYBA
Senegalia nigrescens	Knob thorn	South African Bushveld, Zambezian Baikiaea Woodlands and Freshwater Habitat	NYBA

NYBA : Not Yet Been Assessed

In total, two (2) floral SCC were identified during the assessment. The species listed in the table above are all under pressure due to habitat loss and overutilization for timber purposes.

This places further emphasis on actively protecting those habitat units in which they occur whilst avoiding further impacts on sensitive habitats where possible. The inclusion of alien and invasive floral control measures into the biodiversity action plan will significantly add to the protection of floral SCC, especially in the more sensitive habitat units. The above measures will contribute to mitigating the current impacts of mining on floral SCC and associated habitat and also partly offsetting the historical impact caused by vegetation clearing and flooding of valleys for mining purposes.

4.6 Exotic and Invasive Species

Alien floral species in focus area was mainly associated with villages, agricultural and mining disturbances. The table below lists the exotic and invader species identified during the assessment along with their basic methods of control. Furthermore, a priority category for control is assigned for each species according to its invasion potential. It is recommended that an alien and invasive plant control plan be developed and incorporated into the biodiversity action plan to control priority species.

Table 6: Exotic or invasive species identified during the assessment.

Scientific name	Common name	Priority for Control	Control
Lantana camara	Lantana	High	Mechanical control, herbicide

4.7 Medicinal Plant Species

The table below presents a list of plant species with traditional medicinal value, plant parts traditionally used and their main applications, which were identified during the field assessment.

The majority of the medicinal species listed below are all considered to be common to the region and were encountered throughout the focus area, especially within the Mopane Woodland habitat unit.

Table 7: Traditional medicinal plants identified during the field assessment. Medicinal applications and application methods are also presented.

Scientific name	Local name	Plant part used	Medicinal use
Colophospermum mopane	Mopane	Roots, Bark	A concentrated liquor made from the wood may be used for the treatment of inflamed eyes
Combretum apiculatum	Red Bushwillow	Bark, gum	A concentrated liquor made from the leaves used through an enema for stomach disorders. The gum of the plant is also edible but not very palatable.
Dichrostachys cinerea	Bushveld Sickle Bush	Leaves, roots	The inner bark may be used as a treatment for tooth ache and stomach troubles, chewed roots can be used as treatment for scorpion stings and snakebites
Grewia monticola	Grey Raisin	Roots	The ripe fruit is edible, tea can be made using the leaves.
Sclerocarya birrea subsp *caffra*	Marula	Bark, Roots	A strong liquor made from the bark can be used to treat dysentery, diarrhoea and prophylactically malaria. The inner bark is known to show antihistaminic action against insect bites. Essence from the leaves can be used to treat burns and abscesses.

5 RESULTS OF FAUNAL ASSESSMENT

5.1 Habitat Description

Habitat integrity combined with the overall availability of resources for faunal species is a large determining factor of species diversity and abundance, as well as influencing the likelihood of SCC occurrence. The focus area was assessed in terms of the current levels of habitat integrity and habitat provision for faunal species as is outlined below. After investigation, it is evident that four faunal habitat units exist within the Focus Area, namely: The South African Bushveld, Zambezian Baikiaea Woodlands, Freshwater Habitat and the Transformed Habitat Unit. Refer to Figures 6 to 8.

The **South African Bushveld Habitat Unit** is mainly comprised of *Colophospermum mopane* (Mopane) with very limited undergrowth. This habitat unit promotes the occurrence of mammal, reptile and avifaunal species.

Figure 9: Visual representation of the South African Bushveld Habitat Unit

The **Zambezian Baikiaea Woodlands** is associated with a diversity of tree species, which promote higher diversity of avifaunal species. Good undergrowth is also associated with this habitat unit where most of the invertebrates were recorded.

Figure 10: Visual representation of the Zambezian Baikiaea Woodland

The **Freshwater Habitat** unit generally comprises ephemeral/ event driven streams. The likelihood of amphibian life occurring in this habitat unit is deemed to be low due to the ephemeral nature of the watercourses associated with this habitat unit. This habitat unit still serves as a migratory corridor for other wildlife such as mammals and reptiles, and provides good foraging for avifauna.

Figure 11: Visual representation of the freshwater Habitat Unit

The **Transformed Habitat** unit generally comprises haul road and established mining areas. Faunal occurrence within this habitat unit is low. Although occasional foraging may take place of all the taxon units.

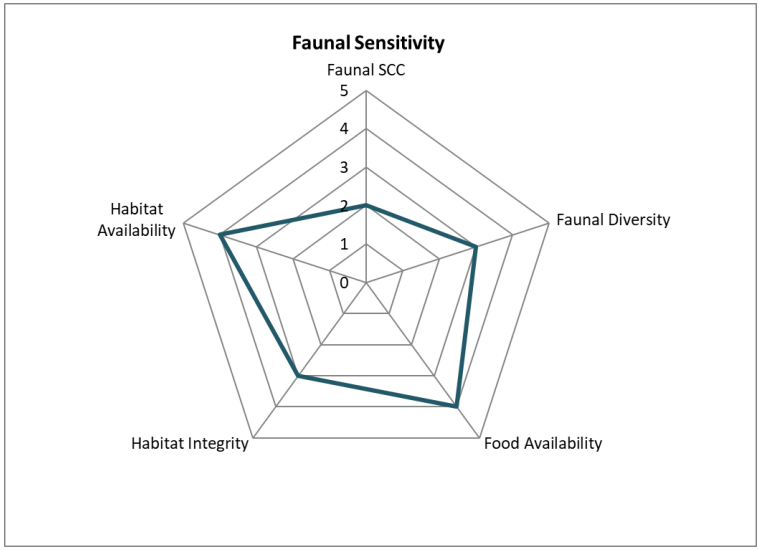
Figure 12: Visual representation of the Transformed Habitat Unit

5.2 Findings per Taxon

The tables below present the findings of the survey for mammals, avifauna, reptiles, amphibians, general invertebrates and arachnids in relation to the above habitat types. Data for all classes are presented in a ‘dashboard’ format discussing all relevant ecological parameters in a concise manner. The method for determining the habitat sensitivity for each taxon is described in Section 6.

5.3 Mammals

Table 8: Mammal assessment for the Focus Area

<table>
<tr><td>Faunal Class: Mammals</td><td>Faunal Habitat Sensitivity</td><td>Moderately High</td><td rowspan="2">Faunal SCC/Endemics/TOPS/</td><td rowspan="2"> 
Although no SCC were observed during the site assessment, literature reviews indicate that a number of species may occur within focus area. three protected mammals are expected to occur namely: Proteles cristatus (Aardwolf, LC) (Worldatlas, 2019), Otocyon megalotis (Bat-eared Fox, LC) (Wikipedia, 2019) and Parahyaena brunnea (Brown Hyaena, NT) (Sanbona, 2018), Refer to Section 5.9 for the full list of potential SCC</td></tr>
<tr><td colspan="3">Faunal Sensitivity Graph:
 
</td></tr>
<tr><td colspan="3"></td><td>General Mammal Discussion</td><td>Only common mammal species were recorded during the survey which included Papio ursinus (Chacma Baboon) and Sylvicapra grimmia (Common Grey Duiker).

Other common species expected to occur in the focus area include: Chlorocebus pygertythrus (Vervet Monkey), Paraxerus flavovittis (Striped Bush Squirrel), Nycteris grandis (Large Slit Faced Bat), Kerivoula lanosa (Lesser Woolly Bat), Elephantulus myurus (Eastern Rock Elephant Shrew), Dendromus melanotis (Grey Climbing Mouse), Cynictis penicillate (Yellow Mongoose), Potamochoerus larvatus (Bush pig), Galago moholi (Southern lesser Galago), Oreotragus (Klipspringer), Tragelaphus strepsiceros (Kudu), Garelerras anguinea (Slender mongoose), Ichneumia albicauda (White Tailed Mongoose), Hystix africaeaustralis (Cape Porcupine), Pedetes capensis (Southern African Springhare), Paraxerus cecapi (Tree Squirrel) and Phacochoerus africus (Warthog).

The habitat within the focus area provides a range of viable food resources for mammal species including seasonal fruits and seeds. The high abundances of invertebrates, reptiles and arachnids further provide food sources to omnivorous and carnivorous mammal species inhabiting focus area.

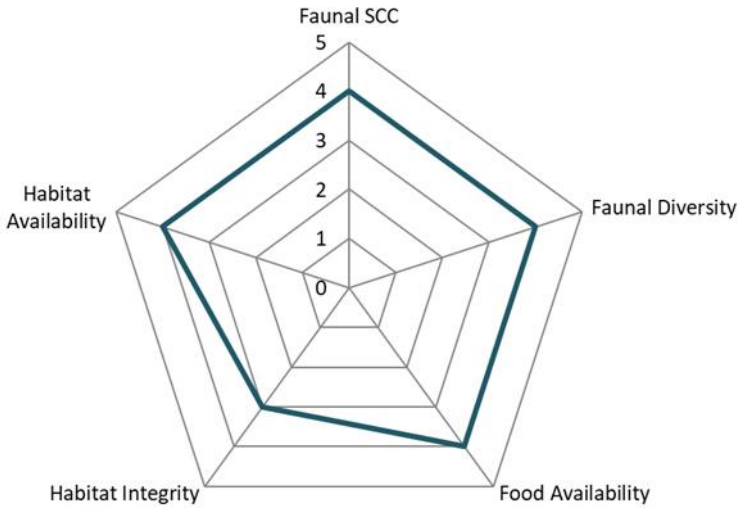
Habitat integrity is considered intermediate, due to the historic and current habitat clearing in the region for both subsistence agriculture, urban and mining activities. These clearing activities have resulted in a noted loss of habitat connectivity within the region, limiting mammal dispersal and habitat usage to a degree.

Habitat availability is considered to be moderately high, although habitat connectivity has been affected as a result of anthropogenic activities. The remaining mopane shrub provides suitable habitat for a diverse array of faunal species, both terrestrial and arboreal</td></tr>
</table>

Business Case, Conclusion and Mitigation Requirements:	The overall mammal habitat sensitivity is considered moderately high with a number of SCC likely to occur within the proposed mining areas. Issues of concern in terms of the mining activities for mammal species: ➢ *Proteles cristatus* (Aardwolf, LC), *Otocyon megalotis* (Bat-eared Fox, LC) and *Parahyaena brunnea* (Brown Hyaena, NT) are nocturnal generally associated with dry open habitats. They use burrows as shelter during the daylight hours of the day. It is recommended that a qualified faunal ecologist conducts a walkabout of the intended mining areas before construction commences to establish presence and guide relocation practices if found, if there are any cubs/pups present then no construction activities should take place, the ecologist should then recommend a non-disturbance buffer around dens; ➢ Disturbance and loss of habitat, limiting habitat connectivity and hindering species migration and movement in the focus area; and ➢ Driving of vehicles to the mining sites may result in faunal collisions and increased mortalities. In order to minimise the impact to mammal species, the following mitigatory actions are recommended: ➢ The footprint areas of all proposed surface infrastructure areas must be minimised to the absolute essential; ➢ Disturbance of and direct persecution of SCC must be avoided; ➢ No hunting or trapping should take place within the focus area; ➢ Down lighting should be used wherever possible to limit the night glow effect and the amount of light emitted from the mine so as to limit insect attraction and consequently the attraction of bat species; and ➢ An Alien and Invasive Plant (AIP) Control Plan must be developed and implemented during all phases of development, to manage the proliferation of AIPs within the focus area.

5.4 Avifauna

Table 9: Avifaunal assessment for the Focus area

<table>
<tr><td>Faunal Class: Avifauna</td><td>Faunal Habitat Sensitivity</td><td>Moderately High</td><td rowspan="2">Faunal SCC/Endemics/TOPS/</td><td rowspan="2"> 
Three species of conservation concern were observed during the field assessment including: Aquila nipalensis (Steppe Eagle, EN), Circaetus cinereus (Brown Snake Eagle, LC) and Laphaetus occipitalis (Long Crested Eagle, LC)[1]. Refer to Section 5.9 for a comprehensive list of potential SCC.</td></tr>
<tr><td colspan="3">Faunal Sensitivity Graph:
 
</td></tr>
<tr><td colspan="3"></td><td>General Avifaunal Discussion</td><td>The focus area presented a moderately high diversity of avifaunal species, from seed-eaters and insectivorous birds to larger raptors. Avifaunal diversity appears to be negatively affected by the current anthropogenic activities in the form of habitat destruction from low cost housing developments and agricultural activities. Common avifaunal species observed during the survey included: Coracias caudatus (Lilac Breasted Roller), Cuculus gularis (Africa Cuckoo), Corythaixoides concolor (Grey Go-away Bird), Dicrurus adsimilis (Fork Tailed Drongo) and Lamprotornis chalybaeus (Greater Blue Eared Starling). For the full list of avifauna observed in the focus area refer to Appendix G.

Habitats associated with the focus area provide a variety of food sources for avifaunal species. The Mopane shrubs associated with the South African Bushveld habitat unit provides ideal hunting grounds for raptor species and smaller species that prefer wooded microhabitats. Whereas the non-perennial riparian areas associated with the Freshwater Habitat unit provides increases the likelihood of occurrence of waterfowl.

The habitat integrity for the focus area is considered to be intermediate. Although vegetation has been cleared for mining and rural developments, sufficient areas of useable habitat remain, which avifauna are capable of moving between and utilising.

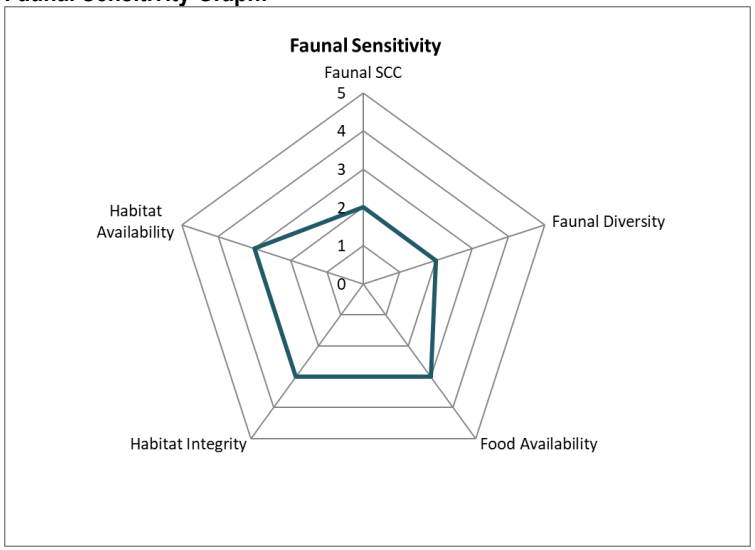
Habitat availability is considered to be moderately high, with most of the habitat units still providing viable areas for breeding. The freshwater habitat unit provides appropriate habitat for occasional SCC visits and common waterfowl.</td></tr>
</table>

[1] All photographs presented in this table were sourced from the internet.

Business Case, Conclusion and Mitigation Requirements:	The overall avifaunal habitat sensitivity is considered moderately high with three avifaunal SCC likely to be temporarily displaced as a result of the proposed mining areas. The proposed mining activities may result in the displacement of avifaunal species, either temporarily or permanently from some areas. Issues of concern in terms of the mining activities in terms of Avifauna: ➢ *Aquila nipalensis* (Steppe Eagle) is a winter migrant to South East Africa predominantly feeding on mole rats and Red billed Quelea. Nests of this species are generally in the form of large platforms established ground level although they do utilize tree canopies for nesting purposes (IUCN, 2019) Prior to vegetation clearing activities a thorough walk through should be undertaken by a recognised ecologist to determine presence and then recommend a non-disturbance buffer around nests *Circaetus cinereus* (Brown Snake Eagle) are locally common nomadic species, generally associated with grassland and savannah biomes, this species often nests in tree canopies, prior to vegetation clearance the areas should be inspected for the presence of nests; ➢ *Laphaetus occipitalis* (Long Crested Eagle) are locally common and generally associated with woodlands, plantations and forest edges and along watercourses, nests in tree canopies, prior to vegetation clearance the areas should be inspected for the presence of nests; and ➢ Driving of vehicles to the mining sites through the open bush will place ground and other low-level nesting species at increased levels of risk. Nestlings may be driven over/trampled leading to a loss of species abundance and diversity. In order to minimise the impact to avifaunal species, the following mitigatory actions are recommended: ➢ The footprint areas of all proposed surface infrastructure areas must be minimised to what is absolutely essential; ➢ Disturbance of and direct persecution of SCC must be avoided; ➢ Clearance of the mining areas should ideally occur outside of the nesting season of *Aquila nipalensis* (Steppe Eagle) (August to October) as far as possible so as to avoid disturbance of nests on the ground while lowering the risk of nest abandonment. Therefore, should construction be conducted during the periods (January – May), there is a lower risk of disturbing mating/nesting individuals of this species; ➢ No poisons are to be used for small mammal pest control as poisoned small mammals may be consumed by raptors, owls or scavenging species which may lead to the death of such avifauna; ➢ An Alien and Invasive Plant (AIP) Control Plan must be developed and implemented during all phases of development, to manage the proliferation of AIPs within the focus area

5.5 Amphibians

Table 10: Amphibian assessment for the Focus Area

<table>
<tr><td>Faunal Class: Amphibians</td><td>Faunal Habitat Sensitivity</td><td>Intermediate</td><td>Faunal SCC/Endemics/TOPS/</td><td>No amphibian SCC were observed during the site assessment, the likelihood of SCCs occurring in the freshwater habitat unit is low due to the lack of non-woody marginal vegetation and the ephemeral nature of the watercourses.</td></tr>
<tr><td colspan="3">Faunal Sensitivity Graph:
 
</td><td>General Avifaunal Discussion</td><td> 

No amphibian species were observed during the survey, although common amphibian species expected to occur in the watercourses during the wet season, associated with the focus area includes: Sclerophrys garmani (Garman’s Toad) (Tyrone Ping, 2019) , Schismaderma carens (African Split-skin Toad) (Wikipedia, 2019), and Chiromantis xerampelina (Grey Foam-nest Tree Frog) (Inaturalist, 2019).

The freshwater habitat unit of the focus area will inherently allow for high insect abundance, which is likely to provide a stable food supply for many amphibian species throughout the focus area.

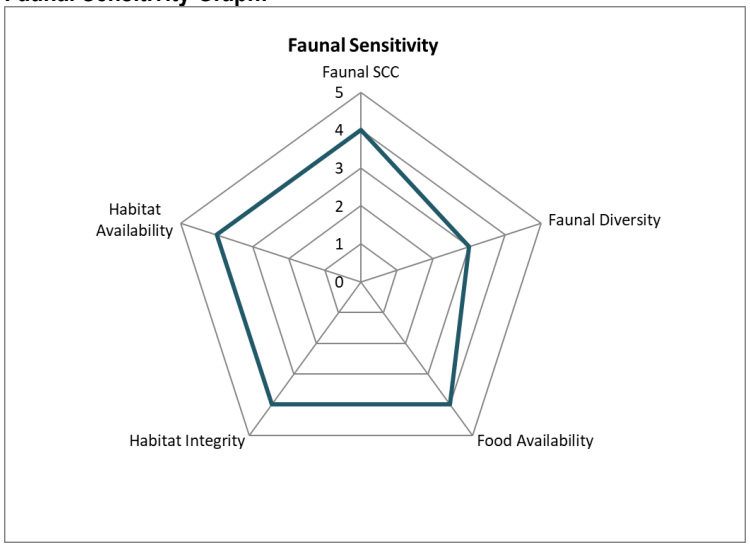
Habitat integrity is considered intermediate due to the extent of the ephemeral streams associated with the focus area. Although anthropogenic activities has resulted in the clearing of vegetation, water related habitat connectivity is still considered sufficient, allowing for the movement and breeding of amphibian species within the various habitats.

It must, however, be noted that due to the state of the ephemeral streams, habitat will only be available during the wet season.</td></tr>
</table>

Business Case, Conclusion and Mitigation Requirements:	The overall amphibian habitat sensitivity is considered intermediate. No amphibian species were observed during the field assessment, while historical information points to a moderately low diversity and abundance within the focus area. The proposed mining activities located within and in close proximity of the watercourses may pose a threat to amphibian species. Issues of concern in terms of the mining activities in terms of amphibian species: ➢ Disturbance and loss of habitat within the freshwater resources, as a result of mining activities. In order to minimise the impact to amphibian species, the following mitigatory actions are recommended: ➢ It must be ensured that the delineated freshwater systems including the applicable buffer zones are excluded from mining activities, and that all edge effects are appropriately managed to ensure that the freshwater systems are not impacted upon; and ➢ Through management of the freshwater resources, habitat for amphibians can be conserved. Please refer to the freshwater ecological assessment prepared by Scientific Aquatic Services (2019) for additional mitigation measures that must be implemented.

5.6 Reptiles

Table 11: Reptile assessment for the Focus Area

<table>
<tr><td>Faunal Class: Amphibians</td><td>Faunal Habitat Sensitivity</td><td>Moderately- High</td><td rowspan="2">Faunal SCC/Endemics/TOPS/</td><td rowspan="2"> 
One reptile SCC protected by The Parks and Wildlife Act (Act no 294 of 1979), has been recorded previously in the focus area namely Python sebae (African Rock Python)(Inaturalist, 2019).</td></tr>
<tr><td colspan="3">Faunal Sensitivity Graph:
 
</td></tr>
<tr><td colspan="3"></td><td>General Avifaunal Discussion</td><td>Common reptile species observed during the survey include: Acanthocercus atricollis (Blue Head Tree Agama), Bitis arietans (Puff Adder), Dendroaspis polylepis (Black Mamba), Ichnotropis capensis (Cape Rough Scaled Lizard) and Varanus albigularis (Rock Monitor).

Other common species expected to occur within the area include: Platysaurus intermedius (Common Flat Lizard), Agama kirkii (Kirk's Rock Agama), Trachylepis margaritefera (Rainbow Skink), Stigmochelys pardalis (Leopard Tortoise), Naja mossambica (Mozambique Spitting Cobra), Chameleo dilepis (Flap-necked Chameleon) and Kinixys spekii (Speke's Hinged Backed Tortoise)

The potential of small mammals and insect abundance of the focus area indicates that there is suitable food resources to sustain a large diversity snakes and lizard species within the focus area.

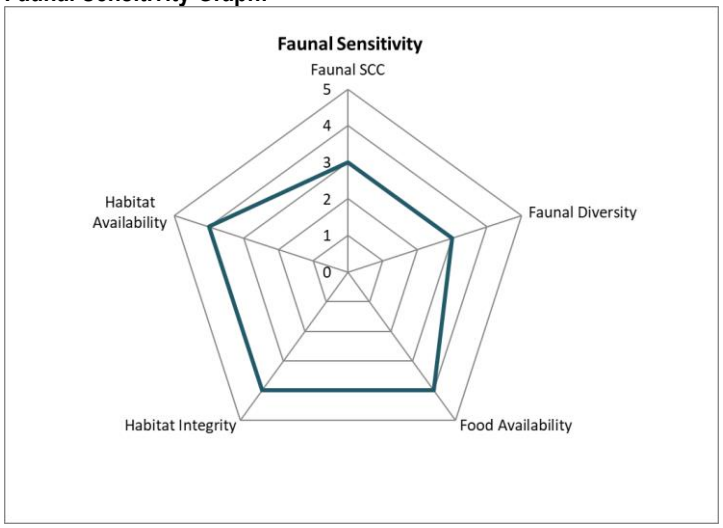
The habitat integrity is considered to be moderately high for reptiles. The South African Bushveld, Zambezian Baikiaea woodland and freshwater habitat units offer habitat for a variety of reptile species.

Reptiles are inherently adaptable and capable of surviving in a myriad of habitats. The focus area provides suitable habitat for both reptiles and their prey with suitable areas of refuge and foraging still found throughout the focus area.</td></tr>
</table>

Business Case, Conclusion and Mitigation Requirements:	The overall reptile habitat sensitivity is considered moderately high with one reptile SCC being observed within the focus area. The proposed mining activities may result in the displacement of reptile species, either temporarily or permanently from some areas. Issues of concern in terms of the mining activities in terms of reptile species: ➢ Mining activities in close proximity of the South African Bushveld, Zambezian Baikiaea woodland and freshwater habitat units will pose a threat to the reptile SCC *Python sebae* (African Rock Python), which frequent old aardvark/ aardwolf burrows generally associated in softer soils for shelter; ➢ Tortoises will be unable to move out the way of an approaching vehicle to avoid collision, leading to a possible increased mortality rate of these reptiles in the mining areas; and ➢ Disturbance and loss of habitat will result in the displacement of reptile species as well as the impact of their required food resources in the mining areas. In order to minimise the impact to reptile species, the following mitigatory actions are recommended: ➢ Vehicles should utilise designated roads only and may not indiscriminately drive within the habitat units.; ➢ Personnel working at the mine are to be educated and made aware about snakes in the area, and that they are not harmed; ➢ No hunting/killing or trapping/capturing (unless for specific relocation reasons) is to occur within the focus area; ➢ Nominated personnel/volunteers working at the mine should be trained on how to catch, handle and relocate snakes that are found within the mine premises; and ➢ The footprint areas of all surface infrastructure must be minimised to what is essential.

5.7 Invertebrates

Table 12: Invertebrate assessment for the Focus Area

<table>
<tr><td>Faunal Class: Invertebrates</td><td>Faunal Habitat Sensitivity</td><td>Moderately- High</td><td>Faunal SCC/Endemics/TOPS/</td><td>No Invertebrate SCC were observed at the time of the survey. No invertebrate SCC have been previously recorded by the relevant databases in this area.</td></tr>
<tr><td colspan="3">Faunal Sensitivity Graph:
 
</td><td>General Avifaunal Discussion</td><td>Common species of invertebrates observed during the assessment included: Odontotermes badius (Flying termites), Acrida acuminata (Common Stick Grasshopper), Calidea dregii (Rainbow Shield bug), Phymateus morbillosus (Common milkweed locust), Diplognatha gagates (Large black Nest chaffer), Locustana pardalina (Brown locust), Platypleura quadraticollis (Bush Cicada), Danaus chrysippus (African Monarch) and Apis mellifera (Honey bee). Refer to Appendix F for the detailed list of observed species.

The food and habitat availability of the focus area is considered Moderately – High, the collective habitat units provide a wide range of niche habitats for invertebrate species. The habitat integrity of the focus area remains largely intact even though impacts of historic mining and agriculture are present within the focus area</td></tr>
<tr><td>Business Case, Conclusion and Mitigation Requirements:</td><td colspan="4">The overall invertebrate habitat sensitivity is considered Moderately High, no SCC were observed during the assessment.

Issues of concern in terms of the mining activities with regards to invertebrates:

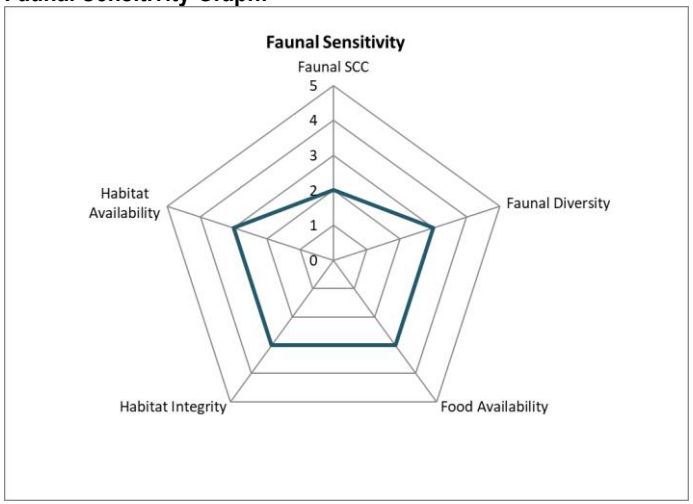
➢ Vegetation disturbance and trampling as a result of vehicle and personnel movement will result in disturbance and possible decreased food resources for many invertebrate species, while also possibly destroying eggs and pupae that are located both on the vegetation as well as in the soil; and
➢ Ground-dwelling insect's species may be trodden on or driven over during mining activities. Although the immediate effect of such may not be apparent, widespread impacts such as associated impacts on breeding individuals through habitat destruction and disturbance may lead to a decreased abundance in the following season.

In order to minimise the impact to insect species, the following mitigatory actions are recommended:

➢ Downlighting and as few external lights as possible should be used for all lighting requirements, yellow lights of lower frequencies are to be used to limit insect attraction; and
➢ As far as possible and where feasible pockets of natural vegetation between buildings and mine infrastructure must be left intact and not cleared ;
➢ The footprint areas of all surface infrastructure must be minimised to what is essential.</td></tr>
</table>

5.8 Arachnids

Table 13: Arachnid assessment for the Focus Area

<table>
<tr><td>Faunal Class: Arachnids</td><td>Faunal Habitat Sensitivity</td><td>Intermediate</td><td>Faunal SCC/Endemics/TOPS/</td><td>No Arachnid SCC were observed during the survey. No arachnid SCC has been recorded in this area.</td></tr>
<tr><td colspan="3">Faunal Sensitivity Graph:
 
</td><td>General Avifaunal Discussion</td><td>  
Arachnid species are notoriously hard to detect over a relatively short period of time, which can often lead to the under estimation of diversity and abundance. No arachnids were observed during the field assessment although several common species are expected to occur within the focus area namely: Nephila fenestrate (Hairy Golden Orb-weaving Spider), Nephila senegalensis (Banded-legged Golden Orb-web Spider) (Flickr, 2009) and Ceratogyrus dolichocephalus (Cranial Horned Baboon Spider) (Birdspiders.com, 2019).

Insect species and small reptiles are considered to be the primary food source for many of the arachnids within the Focus Area. Arachnids that are predominantly ground dwelling will either actively hunt their prey or utilise ambush/trap techniques in order to acquire prey items. Web building species will rely primarily on the numerous airborne insects for food. Many arachnid species only venture out during the safety of night, opting to seek refuge under rocks, bark and dead trees during the day. Areas of refuge such as within the focus area were provided under dense shrubs as well as fallen trees and logs.</td></tr>
</table>

Business Case, Conclusion and Mitigation Requirements:	The overall arachnid habitat sensitivity is considered moderately high, with the focus area providing high levels of habitat and food resources necessary for supporting a burgeoning arachnid community. Issues of concern in terms of the mining activities with regards to arachnids: ➢ Vegetation clearance and ground levelling will result in the loss of arachnids which have constructed webs within the vegetation, as well as those arachnids which have constructed burrows underneath and between the vegetation; and ➢ Ground-dwelling arachnids may be trodden on or driven over during mining activities, of particular concern is *Ceratogyrus dolichocephalus* (Cranial Horned Baboon Spider). which will retreat into its burrow at the first sign of danger. Although the immediate effect of such may not be apparent, widespread impacts such as associated impacts on breeding individuals may lead to a decreased abundance in the following season. In order to minimise the impact to reptile species, the following mitigatory actions are recommended: ➢ Personnel working at the mine are to be educated and made aware of larger spiders and scorpions, and that they are not to be harmed; ➢ Mine workers are to be educated on how to safely and carefully capture and relocate such species should they be found within mine buildings / offices ➢ As far as possible natural vegetation between buildings must be left intact and not cleared; ➢ Prior to the clearing of vegetation footprint specific assessments are to be undertaken in order to mark the locations of baboon spider burrows. Once marked, the spiders should be carefully excavated and relocated to similar habitat in the vicinity of the mine, but outside of the development footprint. All relocations are to be overseen by a suitably qualified specialist

5.9 Faunal Species of Conservational Concern Assessment

During field assessment, it is not always feasible to identify or observe all species within the focus area, largely due to the secretive nature of many faunal species, possible low population numbers, varying habits of species and dense vegetation cover. As such, and to specifically assess an area for faunal SCC, a Probability of Occurrence (POC) matrix is used, utilising a number of factors as outlined in Appendix A to determine the probability of faunal SCC occurrence within focus area. Species listed below whose known distribution ranges and habitat preferences according to the IUCN of the focus area, were taken into consideration. The species listed below are considered to have an increased probability of occurring within the focus area.

Table 14: Faunal SCC expected in the Focus Area

Scientific Name	Common Name	Threat Status	POC %
	Mammals		
Proteles cristatus	Aardwolf	LC	60
Otocyon megalotis	Bat-eared Fox	LC	60
Parahyaena brunnea	Brown Hyaena	NT	60
	Avifauna		
Aquila nipalensis	Steppe Eagle	EN	70
Circaetus cinereus	Brown Snake Eagle	LC	70
Laphaetus occipitalis	Long Crested Eagle	NYBA	60
Falco vespertinus	Red-footed Falcon	NT	60
Sagittarius serpentarius	Secretary Bird	VU	60
Terathopius ecaudatus	Bateleur	NT	60
	Reptiles		
Python sebae	African Rock Python	NYBA	60

The above listed species all have a relatively high probability of occurring within Focus Area. The above listed species are most likely to occur within all the habitat units excluding the Transformed Habitat Unit, notably the within the freshwater habitat as these habitat provides suitable vegetation cover for discrete movement of animals, refuge areas, as well as areas for foraging and nesting (birds).

6 SENSITIVITY MAPPING

The figure and table below illustrate the areas considered to be of increased ecological sensitivity. The areas are depicted according to their sensitivity in terms of the presence or

potential for floral and faunal SCC, habitat integrity and levels of disturbance, threat status of the habitat type, the presence of unique landscapes and overall levels of diversity. The table below presents the sensitivity of each identified habitat unit along with an associated conservation objective and implications for development.

Table 15: A summary of sensitivity of each habitat unit and implications for the proposed development.

Habitat Unit	Sensitivity	Conservation Objective	Development Implications
South African Bushveld	**Moderately High**	Preserve and enhance the biodiversity of the habitat unit	This habitat unit is of moderately high ecological sensitivity and if current land-uses persist, its sensitivity is unlikely to change. Two floral species of conservation concern were recorded in this habitat unit namely *Combretum imberbe* (Leadwood, NYBA) and *Senegalia nigrescens* (Knob thorn, NYBA). Appropriate mitigation such as an alien invasive management plan and rehabilitation plan may lessen the pressure on this habitat unit and allow floral communities to progress through the stages of ecological succession to eventually become climax bushveld communities.
Zambezian Baikiaea Woodlands,	**Moderately High**	Preserve and enhance the biodiversity of the habitat unit	This habitat unit is of Moderately High ecological sensitivity, however if current land-uses persist, its sensitivity is likely to decrease due to increasing pressure on these woodlands for firewood and timber. Two floral species of conservation concern were recorded in this habitat unit namely *Combretum imberbe* (Leadwood, NYBA) and *Senegalia nigrescens* (Knob thorn, NYBA). It is recommended that a Biodiversity Action Plan (BAP) be developed which will address the threats to this habitat unit within the focus area and improve its ecological condition through management of edge effects and allowing natural revegetation in cleared areas through ecological succession as per the closure plan.
Freshwater Resources	**High**	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.	This habitat unit is of high ecological sensitivity, and further impacts must be avoided where possible. It is recommended that a biodiversity action plan be developed, which will address the threats to this habitat unit within focus area and improve its ecological condition through management of impacts including alien and invasive species management, especially focussing on *L. camara.* These measures will improve the condition of the unaffected watercourses and aid in offsetting the impact of future mining activities which may encroach upon this habitat unit through the clearance of new mining areas although should be avoided if possible).
Transformed Areas.	**Low**	Optimise development potential.	This habitat unit is of low ecological sensitivity. It is recommended that the rehabilitation plan is compiled to improve current state of this habitat unit.

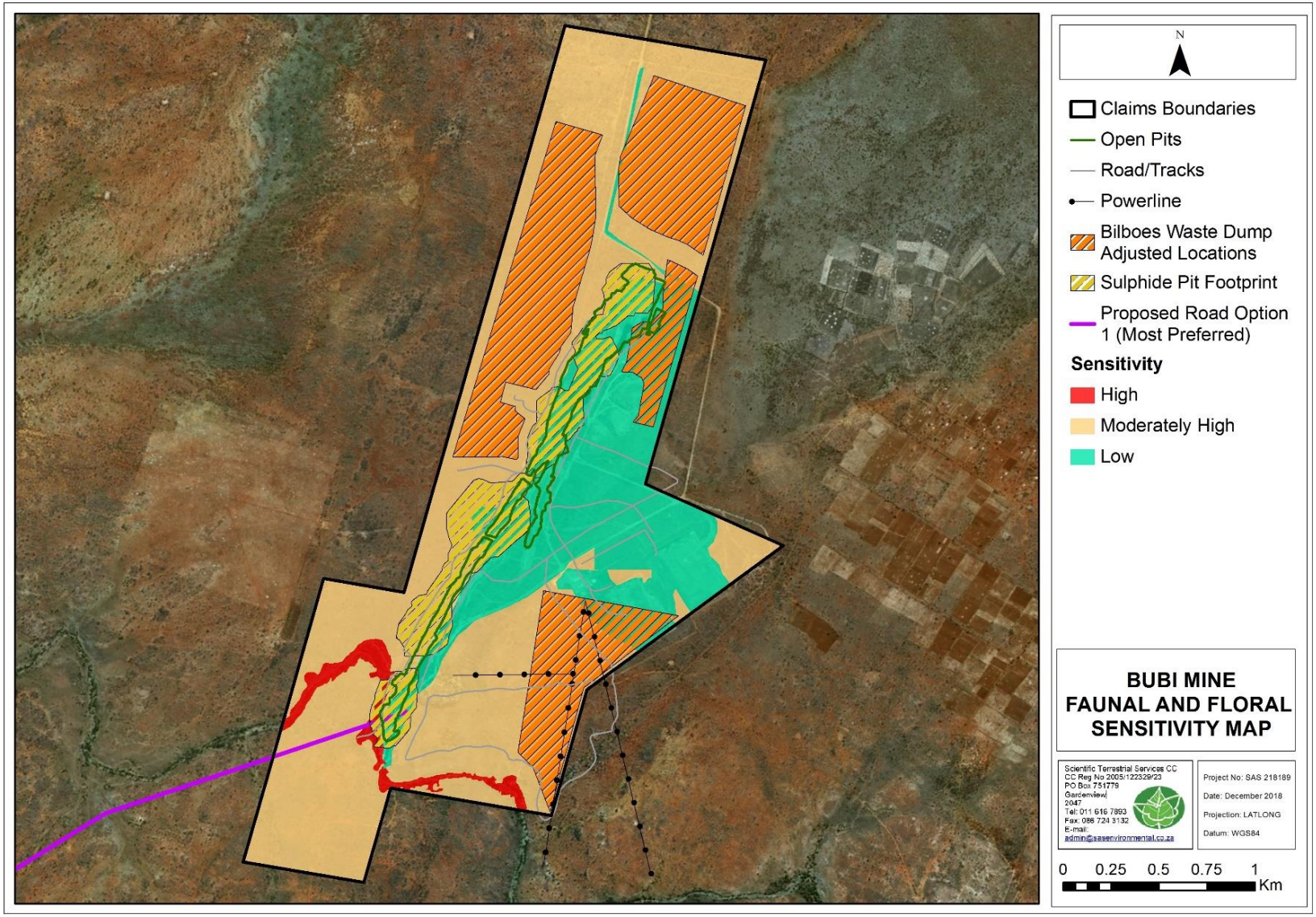


Figure 13: Sensitivity map for Bubi Area

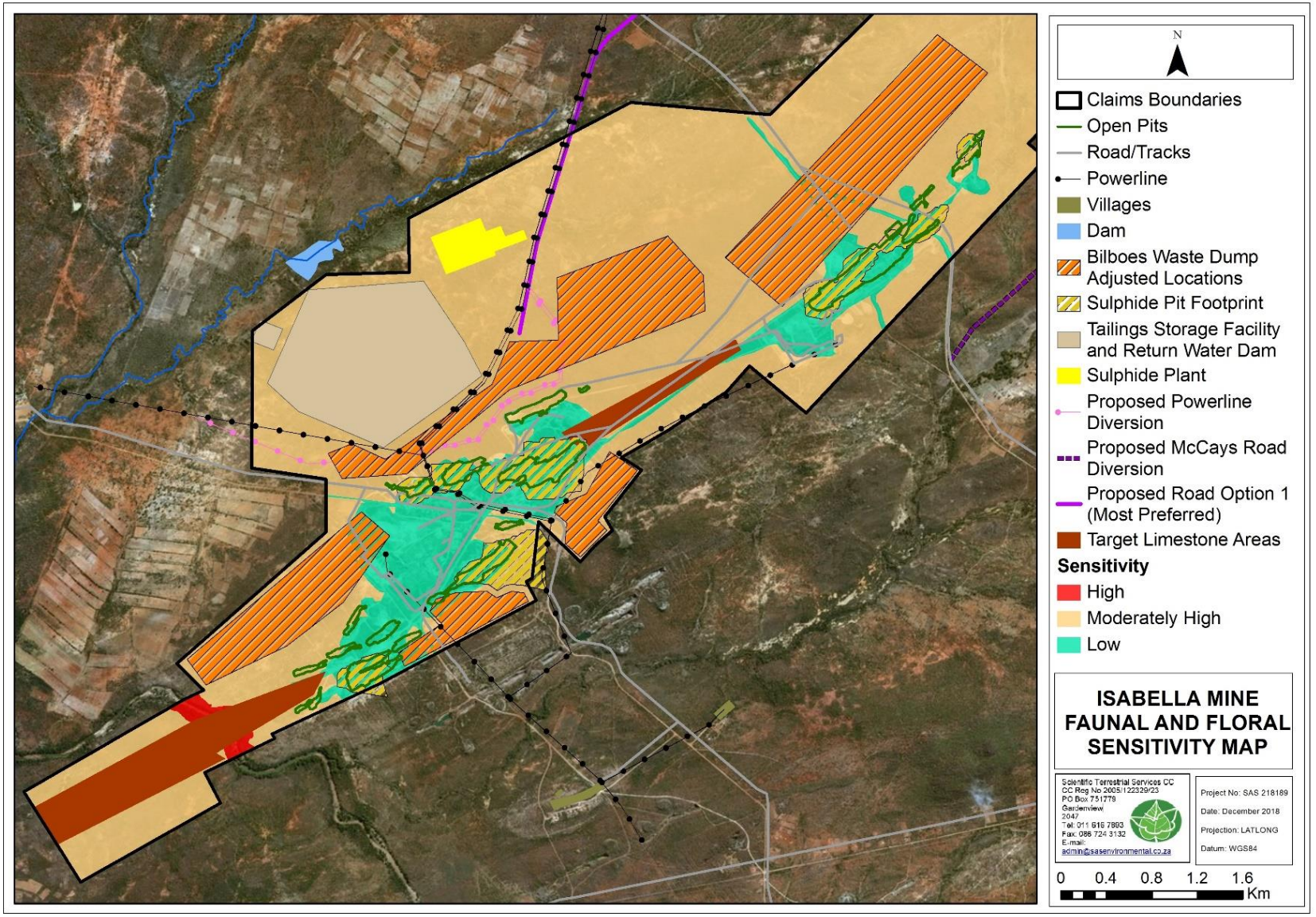


Figure 14: Sensitivity for the Isabella Mine

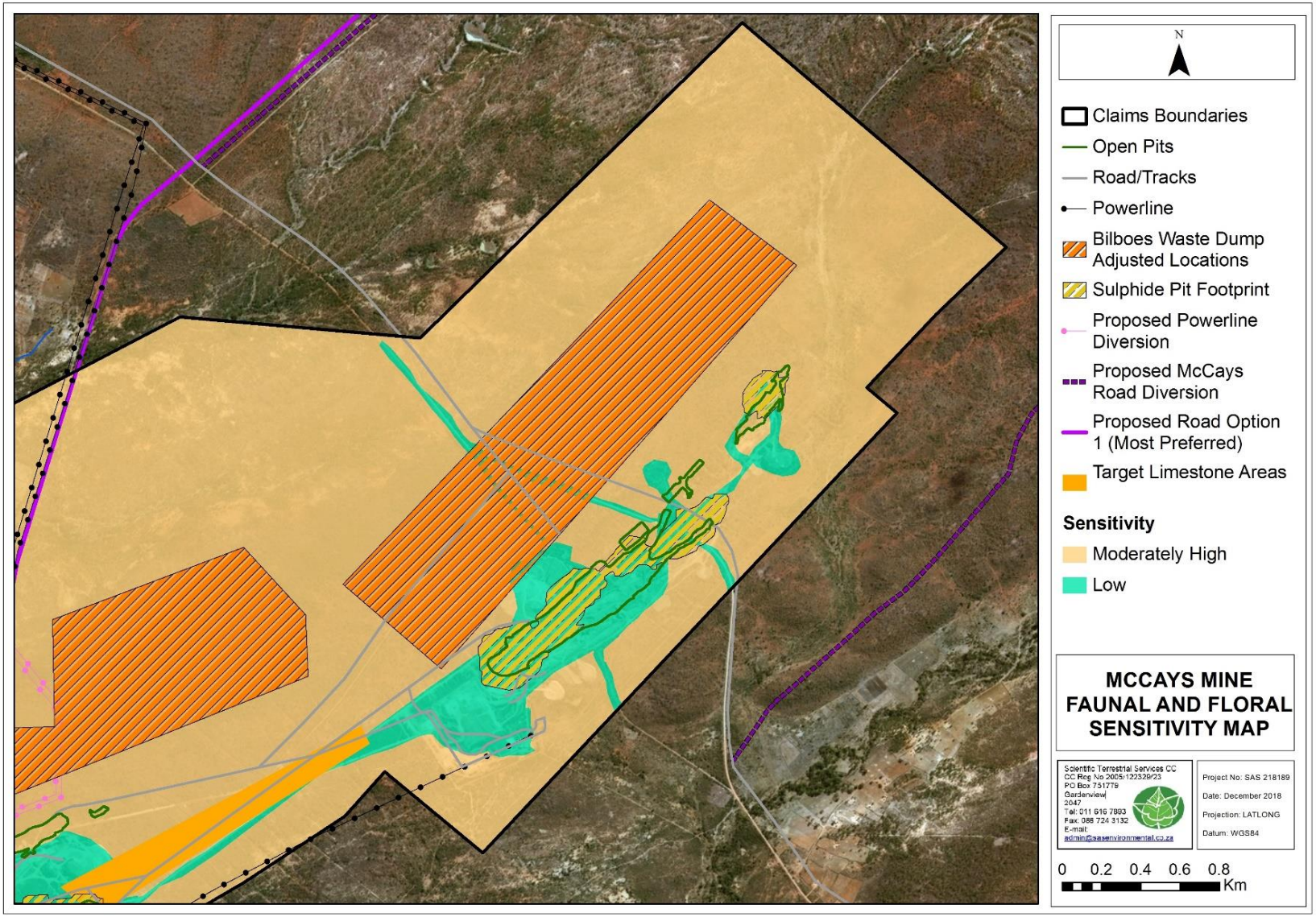


Figure 15: Sensitivity of the Mccay's Mine

7 IMPACT ASSESSMENT

7.1 Impact Assessment

In order for the Environmental Assessment Practitioner (EAP) to allow for sufficient consideration of all environmental impacts, impacts are assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed.

7.2 Biodiversity Impact Assessment: Bubi Mine

7.2.1 IMPACT: Loss of Faunal and Floral Habitat

The table below indicates the perceived impact significance associated with the various activities and developments associated with the Bubi Mine in terms of habitat loss, both prior to and post mitigation measures for all phases of the proposed project.

Table 16: **Assessment of impact: Loss of habitat**

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Operations	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M

This impact can be considered of a high significance prior to the implementation of mitigation measures, decreasing in significance across all phases with the implementation of mitigation measures. Impacts on floral and faunal habitat in the proposed development areas is inevitable, however with cogent and well planned infrastructure plans and construction

methods these impacts can be minimised. If mitigatory actions are employed the severity, extent and the duration of the impact will become reduced to a medium level.

7.2.2 IMPACT: Loss of Faunal and Floral Diversity

The table below indicates the perceived impact significance associated with the various activities in terms of the loss of faunal and floral diversity, both prior to and post mitigation measures for all phases of the proposed project.

Table 17: Assessment of impact: Loss of species diversity

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Operations	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L

This impact can be considered of a high significance without mitigation during all the respective phases, however with the implementation of mitigation measures the overall spatial scale and severity of impacts can be reduced to low. Should infrastructure footprints be kept outside of the sensitive watercourses then it likely that the overall impacts can be even further reduced, notably during the construction phase.

7.2.3 IMPACT: Loss of Sensitive Faunal and Floral Species

The table below indicates the perceived impact significance associated with the various activities in terms of the loss of sensitive faunal and floral species, both prior to and post mitigation measures for all phases of the proposed project. This impact can be considered of a High significance prior to the implementation of mitigation measures due to the presence of floral SCC within the footprint area, whilst reducing to low significance levels with the implementation of appropriate mitigation.

Table 18: Assessment of impact: Loss of sensitive species

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Operations	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L

7.3 Biodiversity Impact Assessment: Isabella Mine

7.3.1 IMPACT: Loss of Faunal and Floral Habitat

The table below indicates the perceived impact significance associated with the various activities and developments associated with the Isabella Mine in terms of habitat loss, both prior to and post mitigation measures for all phases of the proposed project.

Table 19: Assessment of impact: Loss of habitat

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Operations	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M

This impact can be considered of a high significance prior to the implementation of mitigation measures due to the largely natural state of the habitat units associated with the Isabella Mine, decreasing in significance across all phases with the implementation of mitigation measures. Impacts on floral and faunal habitat within the proposed development areas is considered inevitable, however with cogent and well planned infrastructure plans and construction methods these impacts can be minimised to a medium significance. If mitigatory actions are employed the severity, extent and the duration of the impact will become reduced.

7.3.2 IMPACT: Loss of Faunal and Floral Diversity

The table below indicates the perceived impact significance associated with the various activities in terms of the loss of faunal and floral diversity, both prior to and post mitigation measures for all phases of the proposed project.

Table 20: Assessment of impact: Loss of species diversity

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Operations	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	M	S	Lo	Pr	M	H	L	M	M

This impact can be considered of a high significance without mitigation during all the respective phases due to the high level of floral SCC observed during the assessment and high likelihood of faunal SCC occurring, however with the implementation of mitigation measures the overall spatial scale and severity of impacts can be reduced to medium.

7.3.3 IMPACT: Loss of Sensitive Faunal and Floral Species

The table below indicates the perceived impact significance associated with the various activities in terms of the loss of sensitive faunal and floral species, both prior to and post mitigation measures for all phases of the proposed project. This impact can be considered of a High significance prior to the implementation of mitigation measures, whilst reducing to low significance levels with mitigation.

Table 21: Assessment of impact: Loss of sensitive species

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Operations	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L
Closure and post closure	Unmanaged	H	P	R	D	M	M	H	VH	H
	Managed	L	S	Lo	Pr	M	H	L	L	L

7.4 Biodiversity impact assessment: Mccays Mine

7.4.1 IMPACT: Loss of Faunal and Floral Habitat

The table below indicates the perceived impact significance associated with the various activities and developments associated with the Mccay's Mine in terms of habitat loss, both prior to and post mitigation measures for all phases of the proposed project. This impact can be considered of a medium significance prior to the implementation of mitigation measures, reducing to low significance with applied recommended mitigation.

Table 22: Assessment of impact: Loss of habitat

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Operations	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Closure and post closure	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L

This impact can be considered of a medium significance prior to the implementation of mitigation measures, reducing to low significance with applied recommended mitigation.

7.4.2 IMPACT: Loss of Faunal and Floral Diversity

The table below indicates the perceived impact significance associated with the various activities in terms of the loss of faunal and floral diversity, both prior to and post mitigation measures for all phases of the proposed project.

Table 23: Assessment of impact: Loss of species diversity

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial	Probability	Degree of Confidence	Degree to which impact can	Loss of Resources	Consequen	Significance
Pre-construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Operations	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L
Closure and post closure	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	L	L

This impact can be considered a medium significance without mitigation during the all the associated phases, however with the implementation of mitigation measures the overall spatial scale and severity of impacts will still have a low significance with recommended mitigation measures employed on the local fauna observed in the footprint area.

7.4.3 IMPACT: Loss of Sensitive Faunal and Floral Species

The table below indicates the perceived impact significance associated with the various activities in terms of the loss of sensitive faunal and floral species, both prior to and post mitigation measures for all phases of the proposed project. This impact can be considered of a Medium significance prior to the implementation of mitigation measures, whilst reducing to very low significance levels with mitigation.

Table 24: Assessment of impact: Loss of sensitive species

Construction Phase	Management	Intensity / Severity	Duration	Extent / Spatial scale	Probability	Degree of Confidence	Degree to which impact can be mitigated	Loss of Resources	Consequence	Significance
Pre-construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Construction	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Operations	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	VL	VL
Closure and post closure	Unmanaged	M	S	Lo	Pr	M	H	L	M	M
	Managed	L	S	Lo	Pr	M	H	L	VL	VL

Probable latent Impacts

Two sensitive species were identified in the terrestrial assessment, namely the NYBA floral species *Combretum imberbe* (Leadwood) and *Senegalia nigrescens* (Knob Thorn). Due to the low success rate of relocation of *Senegalia nigrescens* it is recommended that if approval is obtained a suitably qualified botanist be appointed to assist in a walk through of the intended mining areas, recommending alternatives if too high abundances of floral SCC are observed, and to assist with the necessary permit applications . The faunal species *Aquila nipalensis* (Steppe Eagle, EN), *Circaetus cinereus* (Brown Snake Eagle, LC) and *Laphaetus occipitalis* (Long Crested Eagle, LC) and *Python sebae* (African Rock Python, NYBA) are expected to occur in the focus area which will likely be displaced due to construction and operational activities. Prior to vegetation clearing activities a thorough walk through should be undertaken by a recognised biodiversity ecologist to determine presence of potential SCC.

7.5 Integrated Impact Mitigation

The table below highlights the key integrated mitigation measures that are applicable to all the proposed activities associated with the Bilboes mining expansions in order to suitably manage and mitigate the ecological impacts that are associated with the various phases. Provided that all the management and mitigation measures as stipulated in this report are implemented the overall risk to faunal and floral diversity, habitat and sensitive species can be adequately mitigated and minimised.

Table 25: A summary of the integrated mitigatory requirements for the terrestrial habitat

Project phase	*Construction Phase*
Impact Summary	*Loss of faunal and floral habitat, species and sensitive species*
Management Measures	***Proposed mitigation and management measures:***
	- Vegetation outside of the proposed footprints is not to be cleared; - Through managing the floral biodiversity and addressing alien and invasive floral species habitat for medicinal species can be protected and improved. The option of cultivating medicinal species, especially reintroducing medicinal species which no longer occur within focus area, could also be considered and historic impacts associated with mining activities such as vegetation clearance and flooding of valleys can be mitigated. - Removal of Combretum imberbe (Leadwood) and Senegalia nigrescens (Knob Thorn), is to be actively avoided as far as possible. Where this is not feasible, permits will need to be obtained and an attempt to relocate small trees (<1.5m) should be undertaken; - Prior to vegetation clearance activities a site inspection/walkdown of the footprint area is to be undertaken and the occurrence of SCC is to be marked. This is particularly important in terms of nesting avifauna, where large trees with active nests are to be marked and recorded; - Removal/ cutting down of large trees (>4m) should be avoided as far as possible, notably in the riparian areas, as these are considered important for large raptors and roosting avifaunal species, which cannot

	be readily replaced through rehabilitation;As far as possible the proposed development areas should be accessed through the existing roads and large pathway network, minimizing the need to clear additional areas and potential habitat fragmentation; - All areas of increased ecological sensitivity, outside of the mining footprint should be designated conservation areas and managed accordingly. These areas are to be considered as No-Go areas and be off-limits to all unauthorised construction vehicles and personnel - Vegetation clearance and commencement of construction activities should either be scheduled to coincide with low rainfall conditions when erosive stormwater is anticipated to be limited or alternatively stormwater controls must be established at the start of construction and dust suppression implemented; - Prior to the commencement of construction activities on site an AIP Management/Control Plan should be compiled for implementation throughout the construction and operational phases and sufficient funding be available to implement the AIP plan throughout the mining operation; - A suitably Biodiversity Action Plan must be compiled in order to ensure no net loss of watercourses, no irreversible impacts to SCC and to ensure AIP are actively controlled. This plan should be undertaken prior to commencement of any construction activities; - Excavated topsoil must be stored with associated native vegetation debris for subsequent reuse for rehabilitation; All soils compacted as a result of construction activities falling outside of the proposed infrastructure areas should be ripped and profiled. Special attention should be paid to alien and invasive plant control within these areas; *Disturbed areas that will not form part of the future mining footprint are to be immediately rehabilitated as per the rehabilitation plan. When rehabilitating a footprint site, it is imperative that as far as possible the habitat that was present prior to disturbances is recreated, so that faunal species that were displaced by vegetation clearing activities are able to recolonize the rehabilitated area; - Spills and /or leaks from construction equipment must be immediately remedied and cleaned up so as to ensure that these chemicals do not enter into the freshwater resources; - No hunting/trapping or collecting of floral species by construction personnel is allowed. Furthermore, local residents should be educated as to the impacts of over-harvesting and excessive utilization of natural resources; - Suitably qualified and nominated mining/construction personnel should undergo a snake handling course in order to safely remove any snakes that are encountered during construction activities; - Where slow moving terrestrial species are located, if they are threatened by construction activities or vegetation clearance, they are to be carefully relocated to similar habitat in the study area by a suitably qualified specialist. Such location and removal activities are particularly important to slow moving reptile species and arachnids - No informal fires by construction personnel are allowed; and
Project phase	*Operational and Closure Phase*
Impact Summary	*Loss of faunal and floral habitat, species and sensitive species*
Management Measures	**Proposed mitigation and management measures:**
	- Ensure strict access control and patrol boundary fences to ensure perimeter fences are in good stead whilst removing any poachers snares encountered in the study area - Ecological footprint of open cast pits is to remain as small as possible whilst allowing for economical and optimal extraction of the material; - Blasting should ideally be done during mid-afternoon and not early mornings or late afternoon/ evenings when faunal species are most active; - A blast and vibration assessment is recommended in order to limit the potential impact on fauna associated with the proposed mining areas; - An effective dust management plan must be designed and implemented in order to mitigate the impact of dust on floral species throughout the operational phase; - All construction related waste and material is to be disposed of at a registered waste facility; and *No waste or construction rubble is to be disposed of in the surrounding natural habitats. - Stockpiles, discard dumps and PCD positions, and their expansion as material is deposited, should be kept as small as possible to limit unnecessary habitat loss and may not exceed the area as demarcated in this assessment;

	- As far as possible existing roads should be utilised. Where new roads are necessary, they are to be located as far as possible in the already disturbed areas; - Speed restrictions to be placed on all vehicles within the study area to limit faunal and vehicle collisions; - Drivers to be educated about the presence and importance of faunal species and instructed to actively avoid collisions with faunal species, regardless of size. In particular drivers are to be aware of the increased risk of possible vehicle collisions with smaller slower moving species that may cross the roads as well as faunal SCC that are likely to be more active during dusk and dawn. - Continually monitor the operational activities and infrastructure areas associated with the retreating of the tailings so as to ensure that further disturbance of the surrounding habitat is not occurring; - Ensure that no unnecessary clearing of habitat occurs during the operational phase; - No hunting/trapping of faunal species or collecting of plants is allowed within the operational zones; - No informal fires by operational personnel are allowed. A Fire Management Plan (FMP) should be set in place to ensure that any fires occurring within the study area can be managed and / or stopped before significant damage to the environment occurs;; - Following heavy rains, infrastructure areas, tailings dams and access roads are to be inspected for signs of erosion or spills, which if found must be immediately rectified through appropriate control measures; - Monitor the success of rehabilitation efforts of disturbed areas seasonally; - Continue with and update the alien and invasive plant control plan accordingly; - Lighting pollution and its effect on fauna (with special mention of invertebrates, bats and avifauna) must be effectively mitigated with the following guidelines in mind with due cognizance take of health and safety requirements: • Downward facing lights must be installed and limited to absolutely essential areas; • Covers/light diffusers must be installed to lessen the intensity of illumination where possible; and *Outside lights are to utilise bulbs of varying wave lengths that do not attract insects. - Bird flappers and diverters are to be placed on all overhead powerlines in order to increase their visibility; *Powerlines should ideally not be placed in areas of high avifaunal use or along known large raptor flight paths; - Continue monitoring of rehabilitation activities for a minimum period of 5 years following the mine closure or until an acceptable level of habitat and biodiversity re-instatement has occurred, in such a way as to ensure that natural processes and veld succession will lead to the re-establishment of the natural wilderness conditions which are analogous to the pre-mining conditions of the area. This should be incorporated into the Biodiversity Action Plan.

8 CONCLUSION

Scientific Terrestrial Services (STS) was appointed to conduct faunal, floral, and Freshwater ecological assessments as part of the process to undertake an Environmental, Social and Health Impact Assessment (ESHIA) and develop an Environmental, Social and Health Management Plan (ESHMP) for the proposed Bilboes operations. A single site assessment was undertaken by local specialists on the 10 -12th of December 2018.

VEGETATION

Sensitivities were determined based on the current status, habitat availability within the vegetation types and through observations of the abundance and diversity of floral and faunal species present at the time of the assessment. The occurrence of Species of Conservation Concern (SCC), the presence or absence of CBAs and ESA, the ecological importance of vegetation and the degree of disturbance encountered as a result of historical activities were also taken into consideration:

Four habitat units were observed within the focus area namely, the South African Bushveld, The Zambezian Baikiaea Woodland, Freshwater Resources and the Transformed Habitat Unit.

Floral composition of the Zambezian Baikiaea Woodland and South African Bushveld were rated moderately high with two floral SCCs observed within the habitat units namely *Combretum imberbe* (Leadwood, NYBA) and *Senegalia nigrescens* (Knob thorn, NYBA). The freshwater habitat unit was rated high in sensitivity with similar diversity of tree species found within the Zambezian Baikiaea Woodland. Impacts from the proposed mining areas range from High to Medium during all phases prior to mitigation.

Due to the low success rate of relocation of *Senegalia nigrescens* it is recommended that if approval is obtained a qualified floral ecologist be appointed to assist in a walk through of the intended mining areas, recommending alternatives if too high abundances of floral SCC are observed, and to assist with the necessary permit applications

FAUNA

The following general conclusions were drawn on completion of the faunal assessment:

Four species of conservation concern were observed during the field assessment including: *Aquila nipalensis* (Steppe Eagle, EN), *Circaetus cinereus* (Brown Snake Eagle, LC), *Laphaetus occipitalis* (Long Crested Eagle, LC) and *Python sebea* (African Rock Python, NYBA). Based on the size and variability of the focus area it is highly likely that more faunal SCC may frequent the area on either a permanent basis or for foraging purposes. Impacts

from the proposed mining activities were calculated high in all phases prior to mitigation, with appropriate mitigation employed impacts may be reduced to low levels.

The objective of this study was to provide sufficient information on the faunal ecology of the area, together with other studies on the physical and socio-cultural environment, in order for the Environmental Assessment Practitioner (EAP) and the relevant authorities to apply the principles of Integrated Environmental Management (IEM) and the concept of sustainable development. It is the opinion of the ecologists that this study provides the relevant information required in order to implement IEM and to ensure that the best long-term use of the ecological resources in the study area will be made in support of the principle of sustainable development

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APPENDIX A: Legislative Requirements

The Natural Resources Act (Act No. 13 of 2002)

This act makes provision for the conservation and improvement of the natural resources of Zimbabwe to provide for the determination of appeals by the Administrative Court; to proved for the construction of works on Communal Land for the conservation of natural resources; and for matters incidental to the foregoing.

This Act includes the following proposed activities:

- Removal of soil or water work and prohibition of injury thereof;
- Discharge of storm-water and compensation for damage.

The National Environmental Policy (Act No. 13 of 2002)

The purpose of the act is to provide environmental governance by establishing principles for decision making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state; To provide for certain aspects of the administration and enforcement of other environmental management laws; and to provide for matters connected with Section 3 of Act 56 of 2002.

The Forest Act (Act 37 of 1990)

The purpose of this Act is to establish a commission for the administration, control and management of State forests, to provide for the transfer of certain assets belonging to the Government to the said Commission; to provide for the setting aside of State forests and for the protection of private forests, trees and forest produce.

- To establish a Mining Timber Permit Board; and to control the cutting and taking of timber for mining purposes;
- To provide for the conservation of timber resources and the compulsory afforestation of private land;
- To regulate and control trade in forest produce including the use of trade names and marks in connection with forest produce; and
- To regulate and control the burning of vegetation; and for other purposes connected with the foraging.

The Parks and Wildlife Act (Act no 294 of 1979)

The purpose of this Act is to establish a Parks and Wildlife Board, to confer functions and impose duties on the Board, overseeing the following activities:

- To Provide for the establishment of national parks, botanical reserves, botanical gardens, sanctuaries, safari areas and recreational parks;
- To make provision for the preservation, conservation, propagation or control of wild life, fish and plants of Zimbabwe and the protection of her natural landscape and scenery;
- To confer privileges on owners or occupiers of alienated land and custodians of wild life, fish and plants; and
- To give certain powers to intensive conservation area committees and to provide for matters incidental to or connected with the foregoing.

Mines and Minerals Act (Act No 48 of 1973)

The purpose of this Act is to consolidate and amend the law relating to mines and minerals and the disposing of minerals, mineral oils and natural gasses, notwithstanding the dominium or right which any person may posses in and to the soil on or under which such minerals, mineral oils and natural gasses are found or situated.

International Finance Corporation (IFC) Environmental Health and Safety Guidelines and Performance Standards (2007)

The IFC is a financial services provider which has set out to ensure that their clients act responsibly toward the environment by providing environmental, health and safety guidelines which their clients must follow and apply before lending of finance may take place.

Performance Standard 6 of the IFC reflects the objectives of the Convention on Biological Diversity to conserve biological diversity and promote use of renewable natural resources in a sustainable manner. That protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development.

Ecosystem services valued by humans are often underpinned by biodiversity. Impacts on biodiversity can therefore often adversely affect the delivery of ecosystem services. Ecosystem services are the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organised into four types:

(i) provisioning services, which are the products people obtain from ecosystems;
(ii) regulating services, which are the benefits people obtain from the regulation of ecosystem processes;
(iii) cultural services, which are the nonmaterial benefits people obtain from ecosystems; and
(iv) supporting services, which are the natural processes that maintain the other services.

The objectives as set out in Performance Standard 6 are:

- To protect and conserve biodiversity;
- To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities; and
- To maintain the benefits from ecosystem services

The requirements of this Performance Standard are applied to projects

- located in modified, natural, and critical habitats;
- that potentially impact on or are dependent on ecosystem services over which the client has direct management control or significant influence; or
- that includes the production of living natural resources (e.g., agriculture, animal husbandry, fisheries and forestry).
-

IFC performance standard 6 states that as a matter of priority, the client should seek to avoid impacts on biodiversity and ecosystem services. When avoidance of impacts is not possible, measures to minimise impacts and restore biodiversity and ecosystem services should be implemented. Given the complexity in predicting project impacts on biodiversity and ecosystem services over the long term, the client should adopt a practice of adaptive management in which the implementation of mitigation and management measures are responsive to changing conditions and the results of monitoring throughout the project's lifecycle.

Biodiversity offsets should only be considered once all other avenues of impact avoidance, minimisation and restoration have been thoroughly investigated and where applicable implemented. A biodiversity offset should be designed and implemented to achieve measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity; however, a net gain is required in critical habitats. The design of a biodiversity offset must adhere to the "like-for-like or better" principle and must be carried out in alignment with best available information and current practices.

International Finance Corporation (IFC) Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources of 2012

Performance Standard 6 recognises that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as "the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.

The objective of this Performance Standard include:

- To protect and conserve biodiversity;
- To maintain the benefits from the ecosystem services;
- To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.

The Scope of application:

- The applicability of this Performance Standard is established during the environmental and social risks and impacts identification process. The implementation of the actions necessary to meet the requirements of this Performance Standard is managed through the clients Environmental and Social Management System (ESMS), the elements of which are outlined in Performance Standard 1; and
- Based on the Risks and Impacts identification process, the requirements of this Performance Standard are applied to projects (i) located in modified, natural and critical habitats; (ii) that potentially impact on or are dependent on ecosystem services over which the client has direct management control or significant influence; or (iii) that include the production of living natural resources (e.g. agriculture, animal husbandry, fisheries, forestry).

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The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and STS CC and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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APPENDIX B: Floral method of Assessment

Floral Species of Conservational Concern Assessment

Prior to the field visit, a record of floral SCC and their habitat requirements was acquired from SANBI for the Quarter Degree Square in which the focus area is situated, as well as relevant regional, provincial and national lists. Throughout the floral assessment, special attention was paid to the identification of any of these SCC as well as the identification of suitable habitat that could potentially support these species.

The Probability of Occurrence (POC) for each floral SCC was determined using the following calculations wherein the distribution range for the species, specific habitat requirements and level of habitat disturbance were considered. The accuracy of the calculation is based on the available knowledge about the species in question, with many of the species lacking in-depth habitat research.

Each factor contributes an equal value to the calculation.

Distribution						
	Outside of known distribution range					**Inside known distribution range**
Site score						
EVC 1 score	0	1	2	3	4	5
Habitat availability						
	No habitat available					**Habitat available**
Site score						
EVC 1 score	0	1	2	3	4	5
Habitat disturbance						
	0	**Very low**	**Low**	**Moderate**	**High**	**Very high**
Site score						
EVC 1 score	5	4	3	2	1	0

[Distribution + Habitat availability + Habitat disturbance] / 15 x 100 = POC%

Vegetation Surveys

Vegetation surveys were undertaken by first identifying different habitat units and then analysing the floral species composition that was recorded during detailed floral assessments using the step point vegetation assessment methodology. Different transect lines were chosen throughout the entire focus area within areas that were perceived to best represent the various plant communities. Floral species were recorded and a species list was compiled for each habitat unit. These species lists were also compared with the vegetation expected to be found within the relevant vegetation types as described in Section 4, which serves to provide an accurate indication of the ecological integrity and conservation value of each habitat unit (Evans & Love, 1957; Owensby, 1973).

Floral Habitat Sensitivity

The floral habitat sensitivity of each habitat unit was determined by calculating the mean of five different parameters which influence floral communities and provide an indication of the overall floristic ecological integrity, importance and sensitivity of the habitat unit. Each of the following parameters are subjectively rated on a scale of 1 to 5 (1 = lowest and 5 = highest):

- **Floral SCC:** The confirmed presence or potential for floral SCC or any other significant species, such as endemics, to occur within the habitat unit;
- **Unique Landscapes:** The presence of unique landscapes or the presence of an ecologically intact habitat unit in a transformed region;
- **Conservation Status:** The conservation status of the ecosystem or vegetation type in which the habitat unit is situated based on local, regional and national databases;
- **Floral Diversity:** The recorded floral diversity compared to a suitable reference condition such as surrounding natural areas or available floristic databases; and
- **Habitat Integrity:** The degree to which the habitat unit is transformed based on observed disturbances which may affect habitat integrity.

Each of these values contribute equally to the mean score, which determines the floral habitat sensitivity class in which each habitat unit falls. A conservation and land-use objective is also assigned to each sensitivity class which aims to guide the responsible and sustainable utilization of the habitat unit in question. In order to present the results use is made of spider diagrams to depict the significance of each aspect of floral ecology for each vegetation type. The different classes and land-use objectives are presented in the table below:

Table A1: Floral habitat sensitivity rankings and associated land-use objectives.

Score	Rating significance	Conservation objective
1> and <2	Low	Optimise development potential.
2> and <3	Moderately low	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.
3> and <4	Intermediate	Preserve and enhance biodiversity of the habitat uni surrounds while optimising development potential.
4> and <5	Moderately high	Preserve and enhance the biodiversity of the habitat limit development and disturbance.
5	High	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.

APPENDIX C: Faunal Method of Assessment

Faunal Assessment Methodology

It is important to note that due to the nature and habits of fauna, varied stages of life cycles, seasonal and temporal fluctuations along with other external factors, it is unlikely that all faunal species will have been recorded during the site assessment. The presence of human habitation nearby the focus area and the associated anthropogenic activities will have an impact on faunal behaviour and in turn the rate of observations.

Mammals

Medium to large mammal species were recorded during the field assessment with the use of visual identification, spoor, call and dung. Specific attention was paid to mammal SCC as listed by the International Union for the Conservation of Nature (IUCN).

Avifauna

Avifaunal species listed for the associated pentads (SABAP2) were compared with the recent field survey of avifaunal species identified on the Focus area. Field surveys were undertaken utilising a pair of Bushnell 10x50 binoculars and bird call identification techniques were utilised during the assessment in order to accurately identify avifaunal species. Specific attention was given to avifaunal SCC listed on a regional and national level, as well as those identified by the IUCN.

Reptiles

Reptiles were identified during the field survey. Suitable applicable habitat areas (wetland areas and fallen dead trees) were inspected and all reptiles observed were recorded. The data gathered during the assessment along with the habitat analysis provided an accurate indication of which reptile species are likely to occur on the Focus area. Specific attention was given to reptile SCC listed by the IUCN.

Amphibians

Identifying amphibian species is done by the use of direct visual identification along with call identification technique. Amphibian species flourish in and around wetland, riparian and moist grassland areas. It is unlikely that all amphibian species will have been recorded during the site assessment, due to their cryptic nature and habits, varied stages of life cycles and seasonal and temporal fluctuations within the environment. The data gathered during the assessment along with the habitat analysis provided an accurate indication of which amphibian species are likely to occur within the Focus area as well as the surrounding area.

Invertebrates

Whilst conducting transects through the Focus area, all insect species visually observed were identified, and where possible photographs taken. Furthermore, at suitable and open sites within the Focus area sweep netting was conducted, and all the insects captured identified.

It must be noted that due to the cryptic nature and habits of insects, varied stages of life cycles and seasonal and temporal fluctuations within the environment, it is unlikely that all insect species will have been recorded during the site assessment period. Nevertheless, the data gathered during the assessment along with the habitat analysis provided an accurate indication of which species are likely to occur in the Focus area at the time of survey.

Arachnids

All suitable habitat areas where spiders and scorpions are likely to reside were searched. Specific attention was paid to searching for Mygalomorphae arachnids (Trapdoor and Baboon spiders) as these arachnids are generally considered to have low population numbers and are hard to locate.

Faunal Species of Conservational Concern Assessment

The Probability of Occurrence (POC) for each faunal SCC was determined using the following four parameters:

- Species distribution;
- Habitat availability;
- Food availability; and
- Habitat disturbance.

The accuracy of the calculation is based on the available knowledge about the species in question. Therefore, it is important that the literature available is also considered during the calculation.

Each factor contributes an equal value to the calculation.

Scoring Guideline				
Habitat availability				
No Habitat	**Very low**	**Low**	**Moderate**	**High**
1	2	3	4	5
Food availability				
No food available	**Very low**	**Low**	**Moderate**	**High**
1	2	3	4	5
Habitat disturbance				
Very High	**High**	**Moderate**	**Low**	**Very Low**
1	2	3	4	5
Distribution/Range				
Not Recorded		**Historically Recorded**		**Recently Recorded**
1		3		5

[Habitat availability + Food availability + Habitat disturbance + Distribution/Range] / 20 x 100 = POC%

Faunal Habitat Sensitivity

The sensitivity of the Focus area for each faunal class (i.e. mammals, birds, reptiles, amphibians and invertebrates) was determined by calculating the mean of five different parameters which influence each faunal class and provide an indication of the overall faunal ecological integrity, importance and sensitivity of the Focus area for each class. Each of the following parameters are subjectively rated on a scale of 1 to 5 (1 = lowest and 5 = highest):

- **Faunal SCC:** The confirmed presence or potential for faunal SCC or any other significant species, such as endemics, to occur within the habitat unit;
- **Habitat Availability:** The presence of suitable habitat for each class;
- **Food Availability:** The availability of food within the Focus area for each faunal class;
- **Faunal Diversity:** The recorded faunal diversity compared to a suitable reference condition such as surrounding natural areas or available faunal databases; and

- **Habitat Integrity:** The degree to which the habitat is transformed based on observed disturbances which may affect habitat integrity.

Each of these values contribute equally to the mean score, which determines the suitability and sensitivity of the Focus area for each faunal class. A conservation and land-use objective is also assigned to each sensitivity class which aims to guide the responsible and sustainable utilization of the Focus area in relation to each faunal class. The different classes and land-use objectives are presented in the table below:

Table A1: Faunal habitat sensitivity rankings and associated land-use objectives.

Score	Rating significance	Conservation objective
1> and <2	Low	Optimise development potential.
2> and <3	Moderately low	Optimise development potential while improving biodiversity integrity of surrounding natural habitat and managing edge effects.
3> and <4	Intermediate	Preserve and enhance biodiversity of the habitat unit surrounds while optimising development potential.
4> and <5	Moderately high	Preserve and enhance the biodiversity of the habitat unit development and disturbance.
5	High	Preserve and enhance the biodiversity of the habitat unit, no-go alternative must be considered.

APPENDIX D: Impact Assessment Methodology

Evaluation of Impacts and Mitigation Measures

Specialists will use the proposed standard convention for assessing the significance of impacts provided below. In assigning significance ratings to potential impacts before and after mitigation the approach presented below is to be followed.

- **Determine the impact consequence rating:** This is a function of the "intensity", "duration" and "extent" of the impact. The consequence ratings for combinations of these three criteria are given below.
- **Determine impact significance rating**: The significance of an impact is a function of the consequence of the impact occurring and the probability of occurrence. Significance is determined using the table below.
- **Modify significance rating (if necessary):** Significance ratings are based on largely professional judgement and transparent defined criteria. In some instances, therefore, whilst the significance rating of potential impacts might be "low", the importance of these impacts to local communities or individuals might be extremely high. The importance/value which interested and affected parties attach to impacts will be highlighted, and recommendations should be made as to ways of avoiding or minimising these perceived negative impacts through project design, selection of appropriate alternatives and / or management.
- **Determine degree of confidence of the significance assessment:** Once the significance of the impact has been determined, the degree of confidence in the assessment will be qualified. Confidence in the prediction is associated with any uncertainties, for example, where information is insufficient to assess the impact.

Criteria for Impact Assessment

The criteria for impact assessment are provided below.

Criteria	Rating	Description
Criteria for ranking of the INTENSITY (SEVERITY) of environmental impacts	**ZERO TO VERY LOW**	Negligible change, disturbance or nuisance. The impact affects the environment in such a way that natural functions and processes are not affected. People / communities are able to adapt with relative ease and maintain pre-impact livelihoods.
	LOW	Minor (Slight) change, disturbance or nuisance. The impact on the environment is not detectable or there is no perceptible change to people's livelihood.
	MEDIUM	Moderate change, disturbance or discomfort. Where the affected environment is altered, but natural functions and processes continue, albeit in a modified way. People/communities are able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support.
	HIGH	Prominent change, disturbance or degradation. Where natural functions or processes are altered to the extent that they will temporarily or permanently cease. Affected people/communities will not be able to adapt to changes or continue to maintain-pre impact livelihoods.

Criteria	Rating	Description
Criteria for ranking the DURATION of impacts	**SHORT TERM**	< 5 years.
	MEDIUM TERM	5 to < 15 years.
	LONG TERM	> 15 years, but where the impact will eventually cease either because of natural processes or by human intervention.
	PERMANENT	Where mitigation either by natural processes or by human intervention will not occur in such a way or in such time span that the impact can be considered transient.
Criteria for ranking the EXTENT / SPATIAL SCALE of impacts	**LOCAL**	Impact is confined to project or Focus area or part thereof, e.g. limited to the area of interest and its immediate surroundings.
	REGIONAL	Impact is confined to the region, e.g. coast, basin, catchment, municipal region, etc.
	NATIONAL	Impact is confined to the country as a whole, e.g. South Africa, etc.
	INTERNATIONAL	Impact extends beyond the national scale.
Criteria for determining the PROBABILITY of impacts	**IMPROBABLE**	Where the possibility of the impact to materialise is very low either because of design or historic experience, i.e. ≤ 30% chance of occurring.
	POSSIBLE	Where there is a distinct possibility that the impact would occur, i.e. > 30 to ≤ 60% chance of occurring.
	PROBABLE	Where it is most likely that the impact would occur, i.e. > 60 to ≤ 80% chance of occurring.
	DEFINITE	Where the impact would occur regardless of any prevention measures, i.e. > 80% chance of occurring.
Criteria for determining the DEGREE OF CONFIDENCE of the assessment	**LOW**	≤ 35% sure of impact prediction.
	MEDIUM	> 35% and ≤ 70% sure of impact prediction.
	HIGH	> 70% sure of impact prediction.
Criteria for the DEGREE TO WHICH IMPACT CAN BE MITIGATED - the degree to which an impact can be reduced / enhanced	**NONE**	No change in impact after mitigation.
	VERY LOW	Where the significance rating stays the same, but where mitigation will reduce the intensity of the impact.
	LOW	Where the significance rating drops by one level, after mitigation.
	MEDIUM	Where the significance rating drops by two to three levels, after mitigation.
	HIGH	Where the significance rating drops by more than three levels, after mitigation.

Criteria	Rating	Description
Criteria for LOSS OF RESOURCES - the degree to which a resource is permanently affected by the activity, i.e. the degree to which a resource is irreplaceable	**LOW**	Where the activity results in a loss of a particular resource but where the natural, cultural and social functions and processes are not affected.
	MEDIUM	Where the loss of a resource occurs, but natural, cultural and social functions and processes continue, albeit in a modified way.
	HIGH	Where the activity results in an irreplaceable loss of a resource.

Determining Consequence

Consequence attempts to evaluate the importance of a particular impact, and in doing so incorporates extent, duration and intensity. The ratings and description for determining consequence are provided below.

Rating	Description
VERY HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***long term***; OR of ***high intensity*** at a ***national level*** in the ***medium term***; OR of ***medium intensity*** at a ***national level*** in the ***long term.***
HIGH	Impacts could be EITHER: of ***high intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***high intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***national level*** in the ***long term***; OR of ***high intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***regional level*** in the ***long term.***
MEDIUM	Impacts could be EITHER: of ***high intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***medium intensity*** at a ***regional level*** in the ***medium term***; OR of ***high intensity*** at a ***regional level*** in the ***short term***; OR of ***medium intensity*** at a ***national level*** in the ***short term***; OR of ***medium intensity*** at a ***local level*** in the ***long term***; OR of ***low intensity*** at a ***national level*** in the ***medium term;*** OR of ***low intensity*** at a ***regional level*** in the ***long term.***
LOW	Impacts could be EITHER of ***low intensity*** at a ***regional level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***national level*** in the ***short term***; OR of ***high intensity*** at a ***local level*** and endure in the ***short term***; OR of ***medium intensity*** at a ***regional level*** in the ***short term***; OR of ***low intensity*** at a ***local level*** in the ***long term***; OR of ***medium intensity*** at a ***local level*** and endure in the ***medium term.***
VERY LOW	Impacts could be EITHER of ***low intensity*** at a ***local level*** and endure in the ***medium term***; OR of ***low intensity*** at a ***regional level*** and endure in the ***short term***; OR of ***low to medium intensity*** at a ***local level*** and endure in the ***short term.*** OR **Zero to very low intensity** with any combination of extent and duration.

Determining Significance

The consequence rating is considered together with the probability of occurrence in order to determine the overall significance using the table below.

		PROBABILITY			
		IMPROBABLE	POSSIBLE	PROBABLE	DEFINITE
CONSEQUENCE	VERY LOW	INSIGNIFICANT	INSIGNIFICANT	VERY LOW	VERY LOW
	LOW	VERY LOW	VERY LOW	LOW	LOW
	MEDIUM	LOW	LOW	MEDIUM	MEDIUM
	HIGH	MEDIUM	MEDIUM	HIGH	HIGH
	VERY HIGH	HIGH	HIGH	VERY HIGH	VERY HIGH

In certain cases it may not be possible to determine the significance of an impact. In these instances the significance is **UNKNOWN**.

APPENDIX E: Protected Flora

Scientific name	Common Name	IUCN status
Acrostichum aureum	Mangrove fern	LC
Adiantaceae		
Amaryllidaceae		
Cyrtanthus (all species)		
Dierama (all species)		
Apocynaceae		
Adenium obesum var multiflorum	Impala Lilly	NA
Pachypodium saundersii	Lundi Star	NA
Arecaceae (Palmae)		
Borassus aethiopum	Borassus Palm	LC
Raphia farinifera	Raffia Palm	LC
Asclepiadaceae		
Hoodia lugardii		NA
Tavaresia barklyi	Devil's Trumpet	NA
Cupreseaceae		
Juniperus procera	African Juniper	LC
Cyatheaceae		
Alsophila (All Species)		
Euphorbiaceae		
Euphorbia davyi		NA
Euphorbia decidua		NA
Euphorbia memoralis		NA
Euphorbia wildii	Wild Euphorbia	NA
Flacourtiaceae		
Bivinea jalbertii		NA
Liliaceae		
Aloe (All species and natural Hybrids)		
Gloriosa superba	Flame Lily	LC
Orchidaceae (all species of epiphytic or lithophytic orchids)		
Passifloraceae		
Adenia fruticosa	Green Stem	NA
Adenia spinosa	Elephants Foot	NA
Polypodiaceae		
Platycerium alcicorne		NA
Zamiaceae		
Encephalartos (All species)		

APPENDIX F: Protected Fauna

Scientific name	Common Name	IUCN status
Mammals		
Proteles cristatus	Aardwolf	LC
Otocyon megalotis	Bat-eared Fox	LC
Acinonyx jubatus	Cheetah	VU
Oryx gazella	Gemsbok	LC
Alcelaphus lichtensteinii	Lichtenstein's Hartebeest	NA
Manis temmincki	Pangolin	VU
Diceros bicornis	Black Rhinoceros	CR
Ceratotherium simum	Square-lipped Rhinoceros	NT
Hippotragus equinus	Roan	LC
Reptiles		
Python sebae	African Rock Python	LC
Birds		
Hieraaetus spilogaster	African Hawk Eagle	LC
All bustards and Korhaans		
All Cranes		
All Flamingos		
All pelicans		
All Storks		
All Vultures		
Hieraaetus dubius	Ayre's Hawk Eagle	NA
Terathopius ecaudatus	Bateleur	NT
Aquila verreauxii	Black Eagle	LC
Circaetus cinereus	Brown-Snake Eagle	LC
Stephanoaetus coronatus	Crowned Eagle	NT
Haliaeetus vocifer	Fish Eagle	LC
Scopus umbretta	Hamerkop	LC
Falco biarmicus	Lanner Falcon	LC
Lophaetus occipitalis	Long-crested Eagle	LC
Polemaetus bellicosus	Martial Eagle	VU
Pandion haliaetus	Osprey	LC
Falco peregrinus	Peregrine Falcon	LC
Sagittarius serpentarius	Secretary Bird	VU
Falco fasciinucha	Taita Falcon	VU
Aquila rapax	Tawny Eagle	VU

APPENDIX G: Floral Species List

Table B1: Floral species encountered during the field assessments.

Species	Common Name	South African Bushveld	Zambezian Baikiaea Woodland	Freshwater Resource	Transformed Areas
Calophospernum mopane	Mopane	X	X	X	X
Sclerocarya birrea	Marula	X	X	X	
Combretum imberbe	Leadwood	X	X	X	
Combretum apiculatum	Red Bushwillow		X	X	
Combretum heroroense	Russet Bushwillow		X	X	
Dichrostachys cinera	Bushveld Sicklebush		X	X	
Flueggea virosa	Snowberry Tree		X	X	X
Lannea stuhlmanni	False Marula	X	X	X	
Cassia abreviata	Long Pod Cassia	X	X	X	
Terminalia sericea	Silver Cluster Leaf		X	X	
Bauhnia varigeta	Mountain Ebony		X	X	
Grewia monticola	Grey Raisin	X	X	X	
Grewia occidentalis	Cross Berry		X	X	
Searsia lancea	Sumac		X	X	
Strychnos spinosa	Spiny Monkey-orange		X	X	
Albizia amara	Bitter Albizia	X	X	X	
Kigelia africana	Sausage Tree	X	X	X	
Senegalia nigrescens	Knob Thorn		X	X	
Vachellia rehmanniana	Silky Thorn Tree		X	X	
Vachellia nilotica	Scented-pod thorn		X	X	
Senegalia burkei	Black Thorn		X	X	

APPENDIX H: Faunal Species List

Mammal species observed

Scientific name	Common Name	IUCN Status
Papio ursinus	Chacma Baboon	LC
Sylvicapra grimmia	Grey Common Duiker	LC

LC = Least Concern

Avifaunal species observed

Scientific name	Common Name	IUCN Red List Status
Aquila nipalensis	Steppe Eagle	EN
Buphagus erythrorhynchus	Red Billed Oxpecker	NA
Circaetus cinereus	Brown Snake Eagle	LC
Coracias caudatus	Lilac Breasted Roller	LC
Cuculus gularis	Africa Cuckoo	LC
Corythaixoides concolor	Grey Go-away Bird	LC
Dicrurus adsimilis	Fork Tailed Drongo	LC
Lamprotornis chalybaeus	Greater Blue Eared Starling	LC
Laphaetus occipitalis	Long Crested Eagle	LC
Merops hirundineus	Swallow Tailed Bee Eater	LC
Merops nubicoides	Southern Carmine Bee Eater	LC
Milvus migrans	Black Kite	LC
Milvus parasitus	Yellow Billed Kite	NA
Numida meleagris	Helmeted Guinea Fowl	LC
Oriolus larvatus	Black Headed Oriole	LC
Orionops plumatus	White Crested Helmeted Shrike	NA
Oxylophytes Vaillantii	Leivaillants cuckoo	NA
Ploceus cucullatus	Village Weaver	LC
Polyboroides typus	African Harrier Hawk	LC

Scientific name	Common Name	IUCN Red List Status
Psophocichla litsitsirupa	Groundscraper Thrush	LC
Pycnonotus tricolor	Dark Capped Bulbul	NA
Quelea	Red Billed Quelea	LC
Spermestes cucullatus	Bronze mannikin	NA
Streptopelia capicola	Cape Turtle Dove	LC
Streptopelia senegalensis	Laughing Dove	LC
Terpsiphone viridis	African Paradise Flycatcher	LC
Tockus rufirostris	Southern Red Billed Hornbill	NA
Turtur chalcospilos	Emerald Spotted Wood Dove	LC

LC = Least concerned, NYBA = Not yet been assessed by the IUCN; *Species observed by mine personnel.

Reptile species observed

Scientific name	Common Name	IUCN Status
Acanthocercus atricollis	Blue Head Tree Agama	LC
Bitis arietans	Puff Adder	NA
Dendroaspis polylepis	Black Mamba	LC
Ichnotropis capensis	Cape Rough Scaled Lizard	NA
Python sebae	Rock Python	LC
Varanus albigularis	Rock Monitor	NA

LC = Least Concerned, NYBA = Not yet been assessed by the IUCN.

Invertebrate species observed

Scientific Name	Common Name	IUCN Status
Acrida acuminata	Common Stick Grasshopper	NA
Acrotyleus spp	Burrowing Grasshopper	
Aphodius spp	Miniature Dung Chafer	
Apis mellifera	Honey Bee	NA
Calidea dregii	Rainbow Shield Bug	NA

Scientific Name	Common Name	IUCN Status
Danaus chrysippus	African Monarch	NA
Diplognatha gagates	Large Black Nest Chafer	NA
Locustana pardalina	Brown Locust	NA
Odontotermes badius	Flying Termites	NA
Phymateus morbillosus	Common Milkweed Locust	NA
Platypleura quadraticollis	Bush Cicada	NA

NYBA = Not Yet Been Assessed

APPENDIX I: DETAILS, EXPERTISE AND CURRICULUM VITAE OF SPECIALISTS

1. (a) (i) Details of the specialist who prepared the report

Stephen van Staden	MSc Environmental Management (University of Johannesburg)
Christopher Hooton	BTech Nature Conservation (Tshwane University of Technology)
Jacobus Johannes du Plessis	B(Hons) Zoology (University of Johannesburg)

1. (A). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	Scientific Terrestrial Services		
Name / Contact person:	Stephen van Staden		
Postal address:	29 Arterial Road West, Oriel, Bedfordview		
Postal code:	2007	Cell:	082 442 7637
Telephone:	011 616 7893	Fax:	011 615 6240/ 086 724 3132
E-mail:	stephen@sasenvgroup.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

- I act as the **independent specialist (reviewer)** in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

I, Christopher Hooton, declare that -

- I act as the **independent specialist (reviewer)** in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

I, Jacobus Johannes du Plessis, declare that -

- I act as the **independent specialist** in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct

SCIENTIFIC TERRESTRIAL SERVICES (STS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist, Aquatic Ecologist
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)
Other Business	Trustee of the Serenity Property Trust

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)

Accredited River Health practitioner by the South African River Health Program (RHP)

Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum

Member of IAIA South Africa

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for wetland Assessment short course Rhodes University	2016

COUNTRIES OF WORK EXPERIENCE

South Africa – All Provinces

Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia

Eastern Africa – Tanzania Mauritius

West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona

Central Africa – Democratic Republic of the Congo

PROJECT EXPERIENCE (Over 2500 projects executed with varying degrees of involvement)

1 Mining: Coal, Chrome, PGM's, Mineral Sands, Gold, Phosphate, river sand, clay, fluorspar
2 Linear developments
3 Energy Transmission, telecommunication, pipelines, roads
4 Minerals beneficiation
5 Renewable energy (wind and solar)
6 Commercial development
7 Residential development
8 Agriculture
9 Industrial/chemical

REFERENCES

- Terry Calmeyer (Former Chairperson of IAIA SA)
  Director: ILISO Consulting Environmental Management (Pty) Ltd
  Tel: +27 (0) 11 465 2163
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- Marietjie Eksteen
  Managing Director: Jacana Environmental
  Tel: 015 291 4015

SCIENTIFIC TERRESTRIAL SERVICES (STS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF CHRISTOPHER HOOTON

PERSONAL DETAILS

Position in Company	Ecologist
Date of Birth	24 June 1986
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2013

EDUCATION

Qualifications

BTech Nature Conservation (Tshwane University of Technology)	2013
National Diploma Nature Conservation (Tshwane University of Technology)	2008

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Eastern Cape, Western Cape, Northern Cape, Freestate
Zimbabwe

SELECTED PROJECT EXAMPLES

Faunal Assessments

- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Mzimvubu Water Project, Eastern Cape.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Setlagole Mall Development, North West.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Expansion and Upgrade of the Springlake Railway Siding, Hattingspruit, Kwa-Zulu Natal.
- Faunal assessment as part of the environmental assessment and authorisation process for the proposed Styldrift tailings storage facility, return water dams, topsoil stockpile and other associated infrastructure, North West.
- Faunal assessment as part of the environmental assessment and authorisation process for the development of a proposed abalone farm, Brand se Baai, Western Cape.
- Faunal assessment as part of the environmental assessment and authorisation process for the development of a proposed abalone farm, Doringbaai, Western Cape.
- Vegetation composition and subsequent loss of carrying capacity for the Rand Water B19 and VG Residue Pipeline Project, Freestate.
- Faunal assessment as part of the environmental assessment and authorisation process for the Evander Shaft 6 Plant Upgrade, New Tailings Dam Area and Associated Tailings Delivery and Return Water Pipeline, Evander, Mpumalanga.

Previous Work Experience

- Spotted Hyaena Research Project, Phinda Private Game Reserve, KwaZulu Natal.
- Camera Trap Survey as part of the Munyawana Leopard Project, Mkuze Game Reserve, KwaZulu Natal.
- Lowveld Wild Dog Project, Savé Valley Conservancy, Zimbabwe.
- Lion collaring and Tracking as part lion management program, Savé Valley Conservancy, Zimbabwe.
- Junior Nature Conservator, Gauteng Department of Rural Development and Land Reform.

SCIENTIFIC TERRESTRIAL SERVICES (STS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF JACOBUS JOHANNES DU PLESSIS

PERSONAL DETAILS

Position in Company	Ecologist
Date of Birth	7 August 1991
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2018

EDUCATION

Qualifications

BSc Zoology and Botany (University of South Africa)	2015
BHons Zoology (University of Johannesburg)	2017

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Free State
Namibia
Uganda

SELECTED PROJECT EXAMPLES

Faunal Assessments

- Faunal Assessment for the proposed mining of Theta, Iota and Browns Hill, Pilgrims rest, Mpumalanga;
- Faunal Assessment for the proposed Royal Sheba Mine, Baberton, Mpumalanga;
- Biodiversity Assessment for the proposed The Dual Colliery, Musina Area, Limpopo
- Ecological Scan for the proposed upgrade of the Rondebult Sewer, Gauteng;
- Ecological Scan for the proposed Zandspruite Secondary School, Zandspruite, Gauteng;
- Ecological Scan for the proposed Mixed Use Township Development, Randburg, Gauteng;
- Biodiversity assessment for the expansion of the Overlooked Colliery near Delmas, Mpumalanga
- Biodiversity assessment for the proposed R101 interchange, the on-ramp C fencing area and the D3519 additional reserve, Mokopane, Limpopo;
- Vegetation screening and baseline ecological assessment for rural road upgrades in Hluhluwe, Kwazulu-Natal;
- Desktop biodiversity assessment for a proposed desalination plant, Elysium, Kwazulu-Natal;
- Baseline Biodiversity Assessment for the upgrade of Retention Dams, Germiston, Gauteng;
- Baseline Biodiversity Assessment for a proposed 100 hectare photovoltaic power plant, Mariental, Namibia;
- Desktop Biodiversity Assessment for a Commercial Office Park, Lusaka, Zambia;
- Baseline Biodiversity Assessment for Polokwane Smelter, Polokwane, Limpopo;
- Baseline Biodiversity Assessment for Mortimer Smelter, Rustenburg, North-West; and
- Baseline Biodiversity Assessment for the Pecanwood Estates, Hartebeespoort, North-West.

Previous Work Experience

- Head of Aquatics – Environmental Assurance (October 2017- September 2018);
- Intern at The Biodiversity Company (January 2016 – July 2017);
- Demonstrator for first years at the University of Johannesburg (2015)
- Assessor/ Trainer at the South African Wildlife College (7 contracts during 2012-2014).