WATERCOURSE AND BIODIVERSITY ASSESSMENT

PROPOSED KOPPIE MINING PROJECT, LOCATED

NEAR BETHAL IN THE MPUMALANGA PROVINCE

AUGUST 2021

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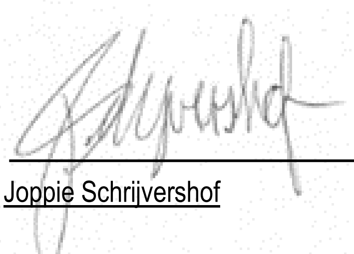
I, **Jacob Schrijvershof,** declare that -

- I act as the independent specialist in this matter;
- I do not have and will not have any vested interest (either business, financial, personal or other) in the undertaking of the proposed activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2014;
- 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 assessment relevant to this application, including knowledge of the National Environmental Management Act (Act 107 of 1998) (NEMA) and the National Water Act (Act 36 of 1998), regulations and any guidelines that have relevance to the proposed 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 report are true and correct;
- I am aware that a person is guilty of an offence in terms of Regulation 48 (1) of the EIA Regulations, 2014, if that person provides incorrect or misleading information. A person who is convicted of an offence in terms of sub-regulation 48(1) (a)-(e) is liable to the penalties as contemplated in section 49B (1) of the National Environmental Management Act, 1998 (Act 107 of 1998); and
- I understand that any false information published in this document is an offence in terms of regulation 71 and is punishable in terms of section 24F of the Act.



Joppie Schrijvershof

Executive summary

The purpose of this report is to summarise the watercourse and biodiversity findings for the Proposed Koppie Mining Project proposed on portions of the Farm Koppie 228 IS and portions of the Farm Uitgedacht 229 IS. The field survey was conducted on the 30th of September 2020 in order to assess the current watercourse and terrestrial biodiversity conditions and to expand baseline data for future reference. The farm portions are located near Bethal in the Mpumalanga Province. The proposed mining layout consists of two options to the mining establishment and includes:

- The Preferred Option is with the mining layout to be placed on Portions 3, 6, 10 and 21 of the Farm Uitgedacht 229 IS (outside wetland areas) ; and
- The Alternative Option is with the mining layout to be placed on Portions 6, 21, 27, 30 and 32 of the Farm Uitgedacht 229 IS (inside wetland areas).

The aim of this study is to ensure compliance with the general legislative requirements as part of the for the Water Use Authorisation process prescribed by the National Water Act (NWA) (Act No 36 of 1998) and National Environmental Management Act (NEMA) (Act No 107 of 1998).

The scope of work entailed determining the Present Ecological Status (PES) for the aquatic and wetland systems associated with the Proposed Koppie Mining Project. In order to make this determination, the following components were assessed:

- *In situ* water quality in accordance with guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa;
- Habitat Assessment (via the Intermediate Habitat Integrity Assessment (IHIA));
- The riparian vegetation was determined with the use of Riparian Vegetation Response Assessment Index (VEGRAI);
- Macroinvertebrates were assessed using the South African Scoring System Version 5 (SASS5) and Invertebrate Habitat Assessment System (IHAS);
- Identify and delineate any wetland areas and/or watercourses associated within the study boundary according to the Department of Water Affairs' "Practical field procedure for the identification and delineation of wetlands and riparian areas";
- Determine the Present Ecological Status (PES) and Functional Integrity of identified wetlands within a 500 m buffer around Proposed Koppie Mining Project using the WET-Health and Wet-EcoServices approach;
- Determine the Ecological Services, Importance and Sensitivity (EIS) of identified watercourses using the latest applicable approach as supported by the DWS (formally DWA);
- Determine and assess the significance of the impacts caused by the Proposed Koppie Mining Project on any associated watercourses;

- Identifying, describing and rating potential impacts/risks to the rivers/streams/wetlands and recommend mitigation measures for the identified impacts to minimise the negative impacts; enhance any positive impacts; and
- Indicate the minimum buffer required to protect any watercourses identified within the study boundary.

The scope of work entailed to the biodiversity study following:

- An examination of onsite, SANBI GIS databases on Endemic and Red Data faunal and floral species in the study area;
- A literature search on Red Data Book species predicted to occur in the study area;
- Identify potential negative impacts on any biodiversity from the proposed mine establishment and operations and assess the significance of these impacts;
- Provide recommended mitigation measures for the identified impacts in order to avert or lower the significance of the negative impacts; and
- Identify any sensitive areas present on site.

The overall results of the aquatic and wetland assessment based on the various methodologies concluded that:

- According to the desktop reference data from Department Water and Sanitation (2013) for the B11A quaternary catchment, the Joubertsvleisrpuit is classified in its present state as a **Category D (largely Modified) PES** and the Viskuile River as **Category C (moderately Modified) PES**.
- This section of the quaternary catchments is considered to be highly sensitive system for the Joubertsvlei and moderate for the Viskuile in terms of ecological importance with both being a highly ecological sensitive (DWS, 2015).
- The upstream site of the Joubertsvleispruit was dry at the time of the assessment.
- The Viskuile River was assessed which served as a reference site for the study area and is the receiving environmental from the Joubertsvleispruit flowing adjacent to the proposed mining areas.
- The *in situ* water quality assessment findings were found that the electrical conductivity levels were above recommended guideline levels for the Joubertsvleispruit and that dissolved oxygen (DO) levels were below guideline levels.
- The IHIA results recorded, placed both sites assessed within a **seriously modified state (Category E)**, where the predominant cause for concern was agriculture, erosion, grazing, damming, alien invasive plants, mining and water pollution.

- The findings for the riparian vegetation assessment revealed that riparian habitat of the area was **seriously modified (Category E)** due to the removal of species due to extensive crop cultivation.
- This SASS5 scores that the downstream site for the Viskuile River and Joubertsvleispruit was in a **seriously modified (Category E/F) state** and the upstream site of the Viskuile River was found to be **moderately modified (Category C),** due to a lack of suitable flow, which may be as a result to water abstraction and upstream impoundments.
- The habitat reaches which were assessed and found to be **inadequate**, where biotopes with limited habitat structures were present. The dominant feature of the invertebrate habitat is the mud and gravel substrate which dominates the streams under study.
- The adjusted FRAI results indicated that fish community is in a **seriously modified state (Category E)** as a result of up and downstream anthropogenic activities compounded with low flows and poor habitat availability and the presence of alien invasive species.
- Several valley bottom and depression NFEPA wetlands were identified within the area during the desktop assessment.
- Hydric soils identified within the site were classified as a sandy clay loam and the Katspruit soil form, where terrestrial soils included Clovelly and Hutton soils.
- Wetland riparian vegetation consisted of mainly of *Arundinella nepalensis*, *Phragmites australis*, *Typha capensis*, *Cyperus spp*, *Juncus effesus* and *Crinum bulbispermum*.
- Two floodplain wetland systems (HGM1 and HGM 2) were identified within the 500 m buffer of the Proposed Koppie Mining Project.
- The two floodplain wetland systems were assessed in terms of health and was found to be categorised as **largely modified (Category D)**.
- The Ecological Services of the wetland has been recorded as intermediate and the sensitivity and importance (EIS) has been recorded as moderate.
- The DWS based risk assessment (GN 509) found that the impact on the wetland areas from the Proposed Koppie Mining Project were rated as an overall **moderate impact during construction** and as an overall **high impact during operation for** the Alternative Option. The Preferred Option's an overall risk is considered **moderate impact during construction** and as an overall **moderately-high impact during operation**. This is considering and taking into account that the mitigations measures as provide being implemented appropriately, otherwise the impacts will be significantly higher for both options as indicated in the Risk Assessment. Identified impacts pertaining to erosion, sedimentation, water quality and quantity alterations and the continued spread of alien invasive species and the main concern is the placement of the proposed Adit within the wetland areas.

The overall results for the biodiversity (faunal and floral) assessment concluded:

- According to the Critical Biodiversity Areas datasets according to SANBI (2021), the majority of the proposed mining area overlaps with wetland and grassland habitat, which serves as Ecological Support Areas (ESA) and Critical Biodiversity Areas (CBAs).
- The Proposed Koppie Mining Project property boundaries falls within the Eastern Highveld Grassland.
- The Proposed Koppie Mining Project does fall within close proximity to the Amersfoort, Bethal and Carolina Important Bird Area (IBAs).
- Information on plant species recorded in that area was extracted from the POSA online database hosted by SANBI (2020), indicate that 253 plant species might occur within these areas of which 239 are endemic species.
- The desktop assessment found that the following floral species of conservation concern might occur within these areas and includes *Nerine gracilis,* (Vulnerable), *Gladiolus robertsoniae* and *Kniphofia typhoides* (Near Threatened).
- Due to the heavily transformed state of the proposed project with intensive crop cultivation, it is highly unlikely that any IUCN red listed species occur within the project footprint.
- A complete list of expected floral species for the Bethal area is given in **Appendix B**.
- Commonly observed grasses (dominant species) within the area of investigation comprised of *Imperata cylindrica* (Cogon grass), *Arundinella nepalensis* (River Grass), *Hyparrhenia hirta* (Thatching grass), *Melines repens* (Natal red top), *Eragrostis gummiflua* (Gum Grass), not favoured by cattle, was dominant and additional *Eragrostis* species were prevalent, including: *Eragrostis curvula* (Lovegrass)*, Eragrostis racemose* (Narrow Heart Love Grass) and *Eragrostis chloromelas* (Curly Leaf), *Themeda triandra* (Red Grass) and *Pogonarthria squarrosa* (Herringboe grass).
- *Crinum bulbispermum* (River Lily), is provincially protected (according to Mpumalanga Nature Conservation Act, 1998 (Act No. 10 of 1998): Schedule 11) and was found along the stream banks of the Joubertsvlei.
- Dominant alien invasive plant species identified was alien invasive *Eucalyptus tereticornis*, Black Wattle (*Acacia mearnsii*) and Grey poplar tree *(Populus canescens*,).
- From the Desktop findings the Southern African Hedgehog (*Atelerix frontalis*), Serval (*Leptailurus serval*), Brown Hyena (*Hyaena brunnea*) and Lesser Flamingo (*Phoenicopterus minor*) which is listed Near Threatened are thought to occur within these areas. The Southern Bald Ibis (*Geronticus calvus*) and Secretarybird (*Sagittarius serpentarius*) which is listed by IUCN as Vulnerable are also thought to occur within these areas.
- Mammal species that were identified during the site survey included the yellow mongoose (*Cynictis penicillata*) and ground squirrel (*Xerus spp*.). Spine from the Cape Porcupine (*Hystrix africaeaustralis*) were found within the agricultural land.
- Bird species identified during the site visit included Fan-tailed widowbird (*Euplectes axillaris*); Southern red bishop (*Euplectes orix*); Southern masked weaver (*Ploceus velatus*); Blacksmith lapwing (*Vanellus armatus*), Hadeda ibis

(*Bostrychia hagedash*), Laughing dove (*Spilopelia senegalensis*), Pin-tailed whydah *(Vidua macroura*); Helmeted guineafowl (*Numida meleagris*), Cliff Swallows (*Petrochelidon pyrrhonota*) and Indian myna (*Acridotheres tristis*). Other species include which were observed in a pan included Domestic Goose (*Anser anser subsp. Domesticus*), Grey Heron (*Ardea cinerea*), Cattle Egret (*Bubulcus ibis*), White Stork (*Ciconia ciconia*), Great Egret (*Egretta alba*), Red-knobbed Coot (*Fulica cristata*), Black-winged Stilt (*Himantopus himantopus*), Spur-winged Goose (*Plectropterus gambensis*) and Glossy Ibis (*Plegadis falcinellus*).

- Red listed faunal species of Lesser Flamingo (*Phoeniconaias minor*) were observed in one pan area (26°19'22.57"S; 29°30'56.08"E) 7 km from the proposed mining project and is listed as Near Threatened by the IUCN red list .
- All expected faunal species are listed in **Appendix A** for QDS 2629AD and 2629BC.
- From an ecological perspective these wetlands can be regarded as a **highly sensitive area** as it is a nesting and foraging area for a diversity of avifauna and aquatic life. The grasslands between the wetlands and transformed areas can be regarded as **moderately sensitive**. The remainder of the study area can be regarded as a **low sensitive** area as this represents heavily transformed landscape with croplands.
- A number of potential ecological impacts relating to proliferation of alien invasive species, loss of species of conservation concern, loss of indigenous vegetation, floral and faunal habitat and ecological structure of water resources and soil, loss of floral diversity and ecological integrity. The significance of potential impacts on biodiversity within the area was rated as a **low significance with and low to moderate without mitigation** as the area is already heavily transformed and with the implementation of a suitable rehabilitation and alien invasive plant program, could improve biodiversity in that area in the future.

Provided mitigation measures are to be implemented within an environmental management programme (EMPr) and the significance of any negative impacts reduced. Potential impacts associated with the operational phase include:

- Increased sedimentation and water quality impairment due to runoff from stockpiles and dumps;
- Water quality contamination due to runoff;
- Alteration of natural flow regime;
- Increased utilisation of aquatic resources by local population; and
- Habitat loss associated.

Mitigation measures, aimed at minimising the afore-mentioned impacts, include (but are not limited to):

- Design and implementation of a suitable stormwater system;
- Rehabilitation of the disturbed areas;

- Limiting instream sedimentation;
- Minimising pollutants entering the watercourse;
- Implement a programme for the clearing/eradication of alien species including long term control of such species;
- A 110 m buffer was implemented for the wetland systems;
- Ongoing water quality monitoring must take place every month during operational phases; and
- Biomonitoring where/if flow conditions allow for effective sampling analysis must take place bi-annually to determine any trends in ecology and hydrology.

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LIST OF ABBREVIATIONS AND ACCRONYMS

BGIS:	Biodiversity Geographic Information System
CBA:	Critical Biodiversity Areas
DEM:	Digital Elevation Model
DWAF:	Department of Water Affairs and Forestry
DWS:	Department of Water Affairs and Sanitation
EA:	Environmental Authorisation
EC:	Ecological Category
EIS:	Ecological Importance and Sensitivity
EMPr:	Environmental Management Program
ESA:	Ecological Support Areas
FRAI:	Fish Response Assessment Index
GIS:	Geographic Information System
HGM:	Hydrogeomorphic
IBA:	Important Bird Areas
IHAS:	Invertebrate Habitat Assessment System
IHIA:	Intermediate Habitat Integrity Assessment
NFEPA:	National Freshwater Priority Area
NWA:	National Water Act (Act no 36 of 1998)
PES:	Present Ecological Status
QDS:	Quarter Degree Square
REMP:	River Eco-Status Monitoring Program
RHP:	River Health Programme
SANBI:	South African National Biodiversity Institute
SASS5:	South African Scoring System

TWQRs Target Water Quality Ranges

VEGRAI: Riparian Vegetation Assessment Index

WMA: Water Management Areas

WUL: Water Use Licence

1 INTRODUCTION

1.1 Background

Oasis Environmental Specialists (Pty) Ltd was appointed by Eco Elementum (Pty) Ltd to conduct an aquatic, wetland and terrestrial ecological assessment report for the proposed mining project, which will involve the development of a new Greenfields underground coal mining operation near the towns of Bethal and Hendrina within the jurisdiction of the Msukaligwa Local Municipality and Gert Sibande District Municipality in the Mpumalanga province. The proposed mine boundary will be located on portions of the Farm Koppie 228 IS and portions of the Farm Uitgedacht 229 IS. (**Figure 1**). The field assessment was conducted on the 30st of September 2020 in order to assess the current watercourse and ecological conditions and to expand baseline data for future reference.

The mining right area is 1955.450 ha in extend and the footprint of the activity 80 ha (proposed surface infrastructure) and falls within the quarter degree square 2629AD and 2629BC. The proposed mining layout is illustrated with two options to the mining establishment:

- The Preferred Option (**Figure 2**) mining layout to be placed on Portions 3, 6, 10 and 21 of the Farm Uitgedacht 229 IS; and
- The Alternative Option (**Figure 3**) mining layout to be placed on Portions 6, 21, 27, 30 and 32 of the Farm Uitgedacht 229 IS.

1.2 Legal framework

1.2.1 National Environmental Management Act (Act No. 107 of 1998)

The EIA Regulations, promulgated under NEMA, focus primarily on creating a framework for co-operative environmental governance. NEMA provides for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by State Departments and to provide for matters connected therewith.

1.2.2 National Waste Act, 2008 (Act No. 59 of 2008)

The NEMWA aims at promoting sustainable waste management practices through the implementation of “Integrated Waste Management Planning”, where “Integrated Waste Management Planning is viewed as a holistic approach of managing waste, aimed at optimising waste management practises to ensure that the implementation thereof yields practical solutions that are environmentally, economically and socially sustainable and acceptable to the public and all relevant spheres of government".

1.2.3 National Water Act, 1998 (Act No. 36 of 1998)

The National Water Act, 1998 (Act No. 36 of 1998) (NWA) aims to provide management of the national water resources to achieve sustainable use of water for the benefit of all water users. This requires that the quality of water resources is protected as well as integrated management of water resources with the delegation of powers to institutions at the regional or catchment level. The purpose of the Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in responsible ways. Of specific importance to this application is Section 19 of the NWA, which states that an owner of land, a person in control of land or a person who occupies or uses the land which thereby causes, has caused or is likely to cause pollution of a water resource must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring and must therefore comply with any prescribed waste standard or management practices.

Regulations GN 704 dated June 1999 under the NWA, 1998 (Act 36 of 1998) stipulates that no development activities may take place within the 1:100 year floodline of a watercourse, or within 100 m of the watercourse, whichever is the furthest.

Regulations GN 509 dated August 2016 under the Section 21 c and i water uses of the NWA, 1998 (Act No 36 of 1998) stipulates the:

"Extent of a watercourse" as:

(a) The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam.

"Regulated area of a watercourse" for section 21(c) or (i) of the Act water uses in terms of this Notice means:

(a) The outer edge of the 1 in 100 year flood line and /or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;

(b) In the absence of a determined 1 in 100 year flood line or riparian area the area within **100 m from the edge of a watercourse** where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or

(c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

1.2.4 National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)

The purpose of the Biodiversity Act is to provide for the management and conservation of South Africa's biodiversity within the framework of the NEMA and the protection of species and ecosystems that warrant national protection. As part of its implementation strategy, the National Spatial Biodiversity Assessment was developed.

This Act is applicable to this application for environmental authorisation, in the sense that it requires the project applicant to consider the protection and management of local biodiversity. This report serves as an ecological assessment being undertaken to assess the flora and fauna for the proposed mining area.

In terms of the Biodiversity Act, the "developer" has a responsibility for:

- The conservation of endangered ecosystems and restriction of activities according to the categorisation of the area (not solely by listed activities as specified in the EIA regulations).
- Promote the application of appropriate environmental management tools in order to ensure integrated environmental management of activities; thereby ensuring that all development within the area is in line with ecological sustainable development and protection of biodiversity.
- Limit further loss of biodiversity and conserve endangered ecosystems.
- A person may not carry out a restricted activity involving a specimen of a listed threatened or protected species without a permit issued in terms of Chapter 7 of NEM: BA (Act No. 10 of 2004).

- Such activities include any that are "of a nature that may negatively impact on the survival of a listed threatened or protected species".

1.3 Scope of work

1.3.1 Aquatic Assessment

The scope of work entails in determining the Present Ecological Status (PES) for the aquatic environment associated with the area. In order to make this determination, the following components were assessed:

- *In situ* water quality in accordance with guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa;
- Habitat (via the intermediate habitat assessment index and Invertebrate Habitat Assessment Index);
- The riparian vegetation was determined with the use of Riparian Vegetation Response Assessment Index (VEGRAI);
- Macroinvertebrate assessment (South African Scoring System version 5) and Invertebrate Habitat Assessment System (IHAS); and
- Identifying, describing and rating potential impacts to the rivers/streams and recommend mitigation measures for the identified impacts to minimise the negative impacts; enhance any positive impacts.

The River Eco-Status Monitoring Program (REMP), formally the River Health Programme (RHP) of South Africa was developed to monitor and assess the state of the rivers within South Africa. To this end specific methodologies were designed to assess the individual components that make up the aquatic ecosystem, these were implemented within this study.

1.3.2 Wetland Delineation and Assessment

The scope of work entailed the following:

- Field visit to delineate the outer boundary of wetland/riparian habitats within a 500 m buffer from the Proposed Koppie Mining Project boundary according to the methods contained in the manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005);
- Assess and describe the health of any wetland units identified, through evaluation of indicators based on geomorphology, hydrology and vegetation as per the WET-Health methods;
- Assess and describe the Ecological Services, Importance and Sensitivity (EIS) of any wetlands identified on site;

- Identify potential negative impacts on the wetland(s) from the proposed mining project and assess the significance of these impacts;
- Provide recommended mitigation measures for the identified impacts in order to avert or lower the significance of the negative impacts.

1.3.3 **Ecological Assessment**

The scope of work entailed to the Biodiversity Assessment following:

- An examination of onsite and SANBI GIS databases on Endemic and Red Data faunal and floral species in the study area;
- A literature search on Red Data Book species predicted to occur in the study area;
- Identify potential negative impacts on any biodiversity from the mining areas and assess the significance of these impacts;
- Provide recommended mitigation measures for the identified impacts in order to avert or lower the significance of the negative impacts; and
- Identify any sensitive areas.

1.4 Assumptions and Limitations

It is difficult to apply pure scientific methods within a natural environment without limitations, and consequential assumptions need to be made. The following constraints may have affected this assessment:

- A hand-held Garmin eTrex 30 were used to delineate the watercourses had an accuracy of 3 m to 6 m;
- The findings, results, observations, conclusions and recommendations provided in this report are based on the author’s best scientific and professional knowledge as well as available information regarding the perceived impacts on the watercourses and biodiversity; and
- The assessment in determining the present ecological state (PES) of the identified system was based on a single site visit. Site visits should ideally be conducted over differing seasons in order to better understand the vegetation, hydrological and geomorphologic processes driving the characteristics of the watercourse. In order to obtain a comprehensive understanding of the dynamics of the aquatic ecosystem in an area, ecological assessments should

always consider investigations at different time scales (across seasons/years) and through replication, as river systems are in constant change; and

- The watercourse management and rehabilitation plan will need to be updated as more information about the dynamics of the system and its response to the implemented management measures are observed over time.
- **It is important to note that although this report describes the regional vegetation, vegetation previously recorded for the area (POSA) and the conservation status of the project area, very little natural vegetation occurs on the transformed areas for the project as intensive crop cultivation is currently being undertaken within these areas.**

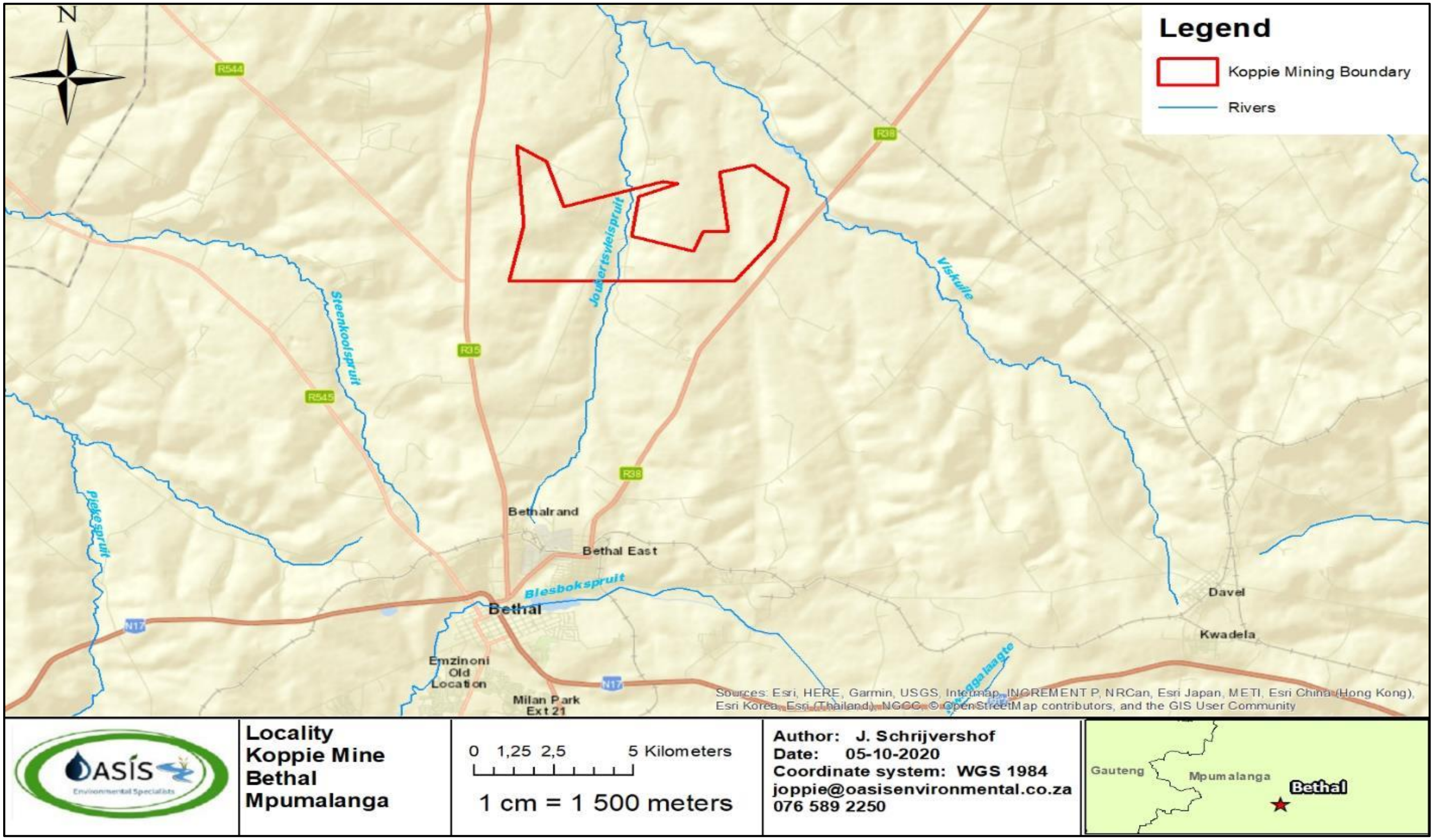


Figure 1: Locality of the Proposed Koppie Mining Project near Bethal, Mpumalanga Province.

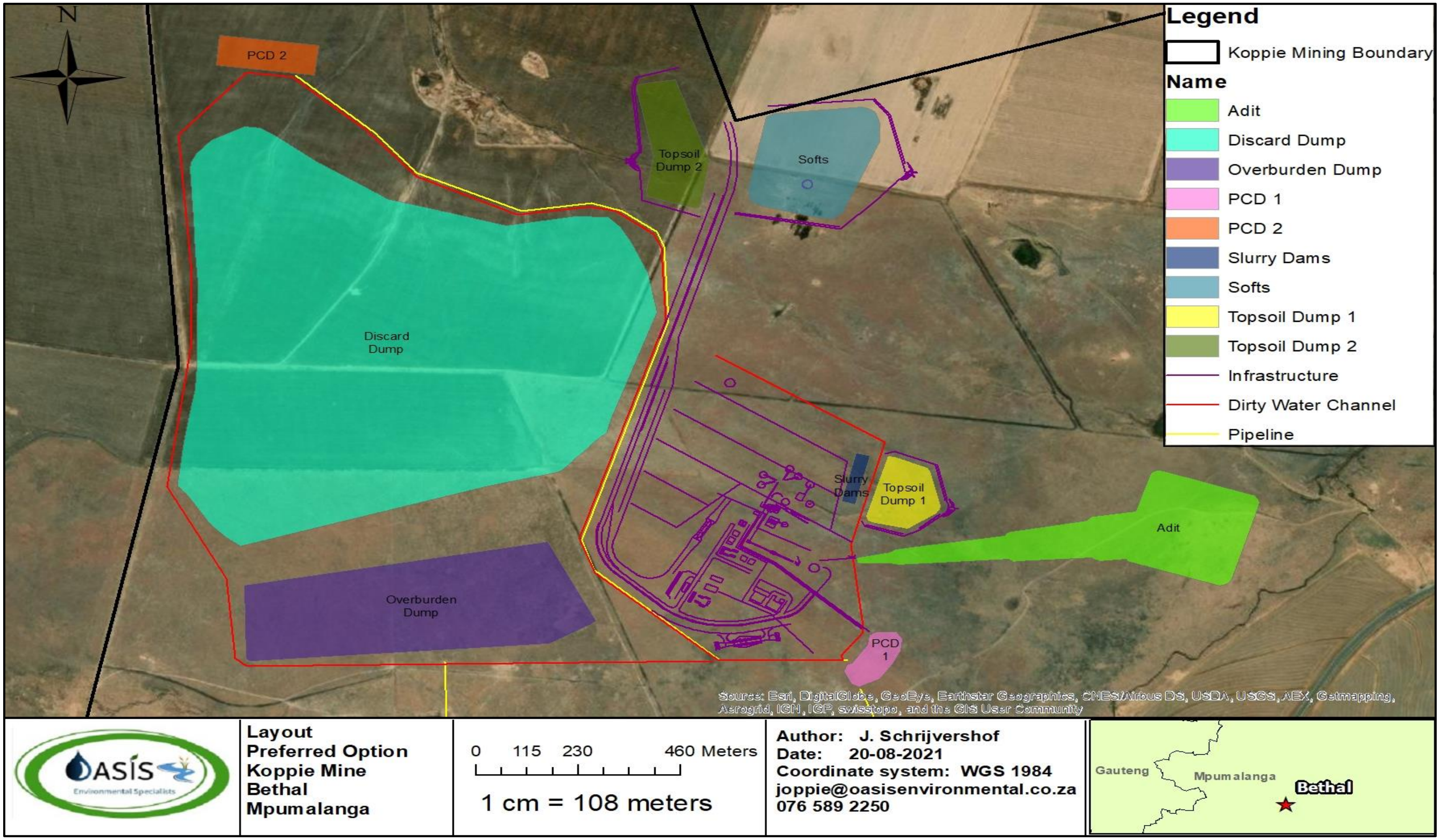


Figure 2: Layout of the Proposed Koppie Mining Project's Preferred Option.

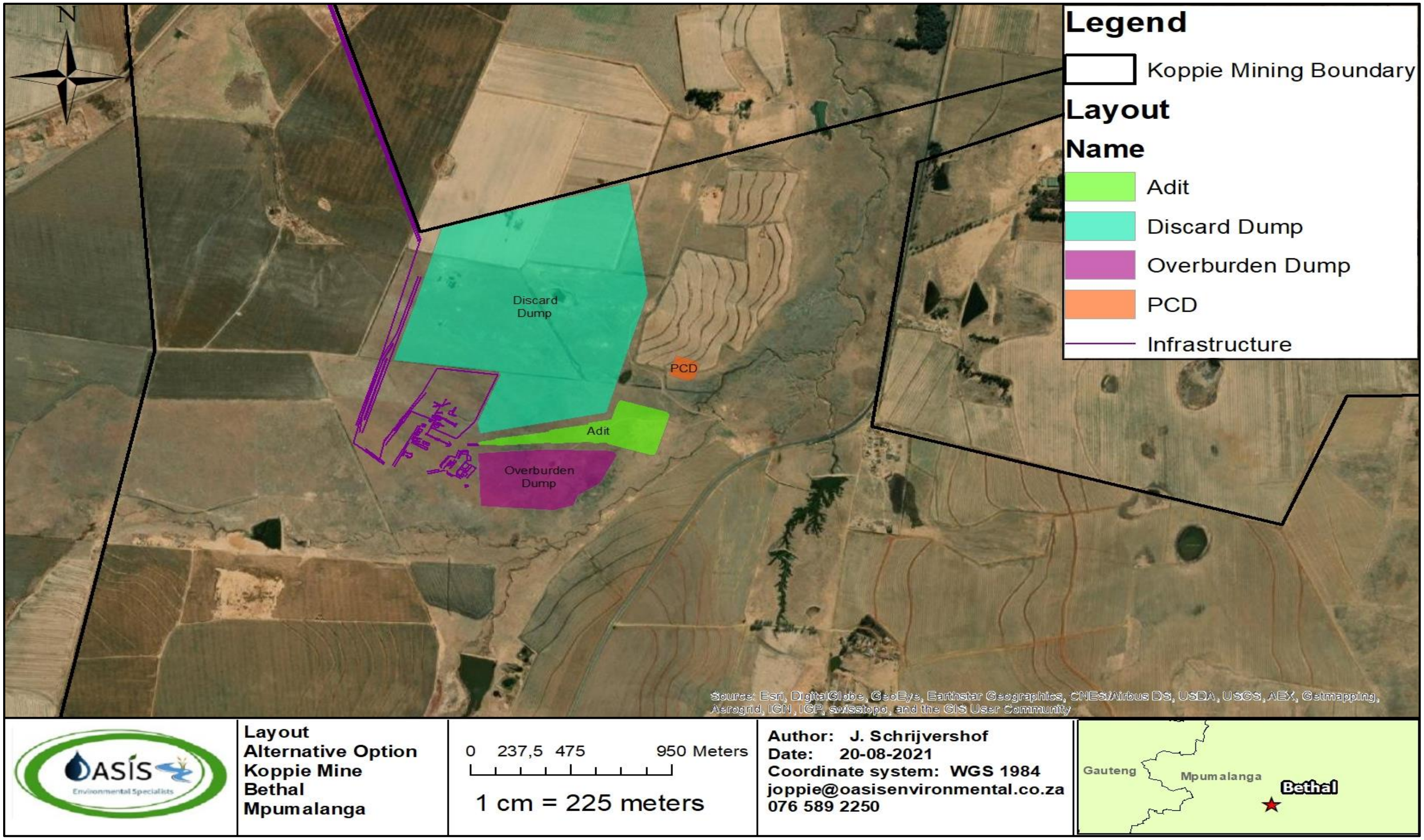


Figure 3: Layout of the Proposed Koppie Mining Project's Alternative Option.

2 METHODOLOGY

This section details the different techniques and methods utilised to obtain the data for this report in order to finally assess the aquatic and wetland conditions of the site based on the various inputs explained below.

2.1 Aquatic Assessment

2.1.1 *In situ* Water Quality

The physical and chemical properties of water that determine its suitability for a variety of uses and for the protection of the health and integrity of aquatic ecosystems refers to the quality of water (DWAF, 1996). The various water quality parameters were all taken *in situ*. These parameters include pH, temperature (°C), electrical conductivity (µS/cm), and dissolved oxygen (DO % and mg/L) using calibrated water quality meters. These values were measured using an Aquameter (model no AM-200) and Aquaprobe (model no AM-800). These parameters were compared to guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa.

2.1.2 Intermediate Habitat Integrity Assessment (IHIA)

Habitat was assessed and characterised according to section D of the "Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems, (Kemper, 1999)".

The Intermediate Habitat Integrity Assessment (IHIA) model was used to assess the integrity of the habitats from a riparian and in-stream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans 1996). The criteria used in the assessment of habitat integrity for the current study are presented in the table below (**Table 1**).

Table 1: Criteria used in the assessment of habitat integrity (Kleynhans, 1996).

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon *et al*., 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) is also included.
Channel modification	May be the result of a change in flow, which can alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or derived based on agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al*., 1992).
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. This is dependent upon the species involved and scale of colonisation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.

Criterion	Relevance
Solid waste disposal	A direct anthropogenic impact which alters habitat structurally. A general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river (Gordon *et al*., 1992). Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous[1] organic matter input will be changed. Riparian zone habitat diversity is reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

The relevant criteria are then weighted and scored according to Kleynhans (1996), as seen in **Table 2**.

[1] denoting a deposit or formation that originated at a distance from its present position.

Table 2: Descriptive classes for the assessment of modifications to habitat integrity (Kleynhans, 1996).

Impact Category	Description	Score
None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

Table 3: Criteria and weights used for the assessment of habitat integrity (Kleynhans, 1996).

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	**100**	**TOTAL**	**100**

Scores are then calculated based on ratings received from the assessment. The estimated impacts of the criteria (**Table 3**) are then summed and expressed as a percentage to arrive at a provisional habitat integrity assessment. The scores are placed into the Intermediate habitat integrity categories (Kleynhans, 1996) as seen in **Table 4**.

Table 4: Ecological categories classes (Kleynhans, 1996).

Category	Description	Score
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A 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	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic 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

2.1.3 Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation areas are divided into two sub-zones, marginal and non-marginal zones. This is important given that riparian vegetation distribution and species composition varies in different sub-zones, which has implications for flow-related impacts. The EC of the riparian zone is then assessed using the Riparian Vegetation Response Assessment Index (VEGRAI) level 3 (Kleynhans *et al*., 2007).

Since all VEGRAI assessments are relative to the natural unmodified conditions (reference state) it is necessary and important to define and describe the reference state for the study area. This is done (in part) before going into the field, using historic aerial imagery, present and historic species distributions, general vegetation descriptions of the study area, any anecdotal data available and knowledge of the area and comparison of the study area characteristics to other comparable sections of the stream that might be in a better state. With this information, the reference (and present state) is quantified on site; the assessor reconstructs and quantifies the reference state from the present state by understanding how visible impacts have caused the vegetation to change and respond. Impacts on riparian vegetation at the site are then described and rated. It is important to distinguish between a visible / known impact (such as flow manipulation) and the response of riparian vegetation to other impacts such as erosion and sedimentation, alien invasive species and pollution. If there is no response to riparian vegetation, the impact is noted but not rated since it has no visible / known effect. These impacts are then rated according to a scale from 0 (No Impact) to 5 (Critical Impact). Once the riparian zone and sub- zones have been delineated, the reference and present states have been described and quantified (basal cover is used) and species description for the study area has been compiled, the VEGRAI metrics are rated and qualified (Kleynhans *et al*., 2007).

The riparian ecological integrity was assessed using the spreadsheet tool that is composed of a series of metrics and metric groups, each of which is rated in the field with the guidance of data collection sheets. The metrics in VEGRAI describe the following attributes associated with both the woody and non-woody components of the lower and upper zones of the riparian zone:

- Removal of the riparian vegetation;
- Invasion by alien invasive species;
- Flow modification; and
- Impacts on water quality.

Results from the lower and upper zones of the riparian vegetation are then combined and weighted with a value that reflects the perceived importance of that particular criterion in determining habitat integrity, allowing this to be numerically expressed in relation to the perceived benchmark. The score is then placed into one of six classes, namely A to F (Kleynhans *et al*., 2007).

2.1.4 Macroinvertebrates

2.1.4.1 The South African Scoring System (SASS 5)

The SASS5 is the current index used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae and Culicidae) to highly sensitive families (e.g. Oligoneuridae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value). Sampled invertebrates were identified using the “Aquatic Invertebrates of South African Rivers” Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion, 2007; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the Highveld Ecoregion (Ecoregion 11) (**Figure 4**). This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database.

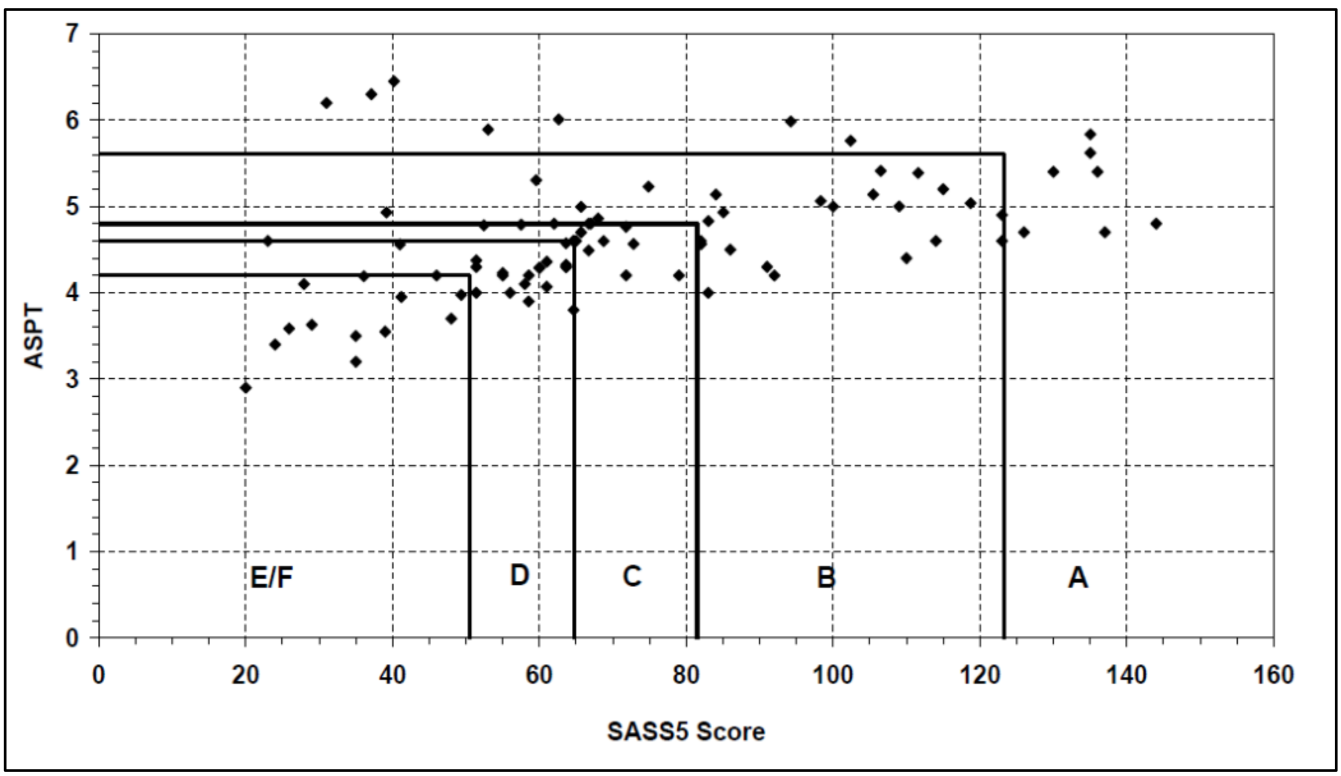


Figure 4: SASS5 Classification using biological bands calculated from percentiles from Dallas (2007) for the Highveld Ecoregion.

2.1.4.2 Invertebrate Habitat Assessment System (IHAS)

The IHAS was specifically designed to be used in conjunction with the SASS5, benthic macroinvertebrate assessment. The IHAS assesses the availability of the biotopes at each site and expresses the availability and suitability of habitat for macroinvertebrates, this is determined as a percentage, where 100% represents "ideal" habitat availability. A description based on the IHAS percentage scores is presented in **Table 5**.

Table 5: Description of IHAS scores with the respective percentage category (McMillan, 1998).

IHAS score	Interpretation
<65%	Habitat diversity and structure is inadequate for supporting a diverse aquatic invertebrate community.
65%-75%	Habitat diversity and structure is adequate for supporting a diverse aquatic invertebrate community.
>75%	Habitat diversity and structure is highly suited for supporting a diverse aquatic invertebrate community.

2.2 Wetland Assessment

For the purpose of this assessment, wetlands are considered as those ecosystems defined by the National Water Act No. 36 of 1998 as:

"*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."*

2.2.1 **Desktop Assessment**

Examination of the National Freshwater Ecosystem Priority Areas (NFEPA)'s databases were undertaken for the project. The NFEPA project aims to produce maps which provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs. FEPAs are determined through a process of systematic biodiversity planning and involved collaboration of over 100 freshwater researchers and practitioners. They are identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (MacFarlane *et al*., 2009).

The assessment of the study site involved the investigation of aerial photography, GIS databases including the NFEPA and South African National Wetland maps as well as literature reviews of the study site in order to determine the likelihood of wetland areas within this site.

The following data sources and GIS information provided in **Table 6** was utilised to inform the delineation.

Table 6: Information used to inform the desktop wetland assessment.

DATA	USE	SOURCE
Latest and Historic Google Earth ™ imagery	Used to assist with identifying potential areas within the study boundary for the presence of wetland systems.	Google Earth PRO™ On- line
River line	Mapping of watercourses outside of the study site.	Surveyor General
National Wetland Classification System	Assistance with information collection about the site and surrounding areas.	SANBI
National Freshwater Ecosystem Priority Area maps and database	Information gathering regarding the presence of FEPA wetlands on the site and within surrounding areas.	Water Research Commission, Implementation: Manual and Maps for FEPA area

2.2.2 **Field Assessment**

The wetland delineation was conducted as per the procedures described in 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1' (Department of Water Affairs, 2005) (**Figure 5**). This document requires the delineator to give consideration to four indicators in order to find the outer edge of the wetland zone:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation. Signs of wetness are characterised by a variety of aspects. These include marked variations in the colours of various soil components, known as mottling; a gleyed soil matrix or the presence of Mn/Fe concretions. **It should be noted that the presence of signs of wetness within a soil profile is sufficient to classify an area as a wetland area despite the lack of other indicators.**
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

In assessing whether an area is a wetland, the boundary of a wetland or a non- wetland area should be considered to be the point where the above indicators are no longer present. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland, to delineate the boundary of that wetland and to assess its level of functionality and health.

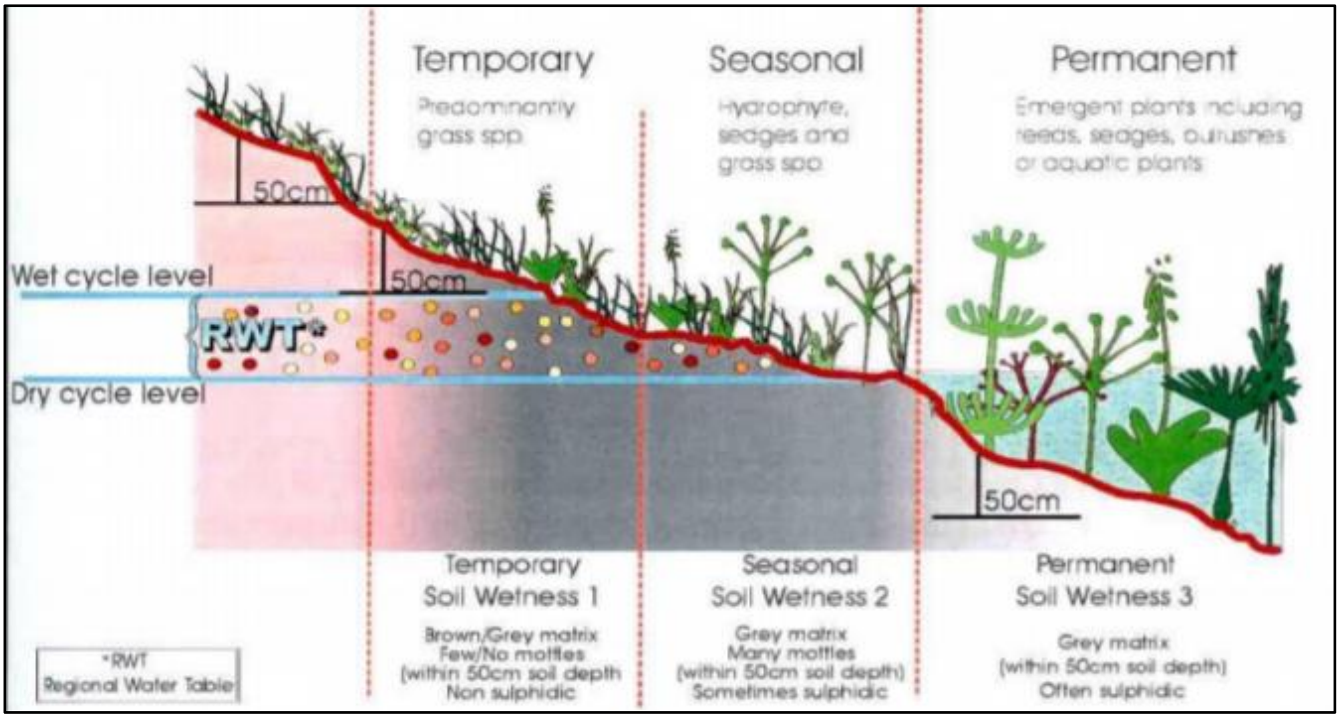


Figure 5: Different zones of wetness found in wetlands, indicating how the soil wetness and vegetation indicators change (DWAF, 2005).

2.2.3 **Wetland Functionality and Health**

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services. Many of these functional benefits contribute directly or indirectly to increased biodiversity within the transformed study area as well as downstream of the study area through provision and maintenance of appropriate habitat and associated ecological processes (**Table 7**).

Table 7: Ecosystem services provided by wetlands (Kotze *et al*, 2008).

Ecosystem services supplied by wetlands	Indirect benefits	Regulating and supporting benefits	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream.
			Streamflow regulation		Sustaining streamflow during low flow periods.
			Water quality enhanced benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters.
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters.
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters.
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
			Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter.
	Biodiversity Maintenance				Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity of the surrounding area.
	Direct benefits	Provisioning benefits	Provision of water for human use		The provision of water extracted directly from the wetland for domestic, agriculture or other purposes.
			Provision of harvestable resources		The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
			Provision of cultivated foods		The provision of areas in the wetland favourable for the cultivation of foods.
		Cultural benefits	Cultural heritage		Places of special cultural significance in the wetland, e.g., for baptisms or harvesting of culturally significant plants.
			Tourism and recreation		Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife.
Education and research					Sites of value in the wetland for education or research.

An indication of the functions and ecosystem services provided by wetlands can be assessed through the WET- EcoServices manual (Kotze *et al*., 2008) and are based on a number of characteristics that are relevant to the particular benefit provided by the wetland. A Level 2 WET-EcoServices assessment was undertaken for the wetlands occurring on site. A Level 2 assessment is the highest form of WET-Ecoservices assessment that can be undertaken and involves an on-site and desktop assessment.

Each wetland's ability to contribute to ecosystem services within the study area is further dependant on the particular wetland's Present Ecological State (PES) in relation to a benchmark or reference condition. A Level 2 Wetland Health assessment was conducted on the wetlands delineated as per the procedures described in *'Wet- Health: A technique for rapidly assessing wetland health'* (MacFarlane *et al*., 2009). This document assesses the health status of a wetland through evaluation of three main factors -

Hydrology: *defined as the distribution and movement of water through a wetland and its soils.*

Geomorphology: *defined as the distribution and retention patterns of sediment within the wetland.*

Vegetation: *defined as the vegetation structural and compositional state.*

The WET-Health tool evaluates the extent to which anthropogenic changes have impacted upon wetland functioning or condition through assessment of the above-mentioned three factors. Scores range from 0 indicating no impact to a maximum of 10 which would imply that impacts had completely destroyed the functioning of a particular component of the wetland. Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions (**Table 8**).

Table 8: Guideline for interpreting the magnitude of impacts on wetland integrity.

IMPACT CATEGORY	DESCRIPTION	RANGE
None	No discernible modification or the modification is such that it has no impact on wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a clearly adverse effect on this component of habitat integrity. Well in excess of 50% of the wetland integrity has been lost.	6 – 7.9
Critical	The modification is present in such a way that the ecosystem processes of this component of wetland health are totally / almost totally destroyed.	8– 10

The tool evaluates the health of the wetland and is determined by a score known as the Present Ecological Score. The health assessments for the hydrology, geomorphology and vegetation components were then represented by the Present Ecological State (PES) categories. The PES categories are divided into six units (A-F) based on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in **Table 9**.

Table 9: Health categories used by WET-Health for describing the integrity of wetlands.

DESCRIPTION	IMPACT SCORE	HEALTH CATEGORY
Unmodified, natural.	0 – 1.0	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1.1 - 2.0	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2.1 - 4.0	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4.1 - 6.0	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6.1 - 8.0	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.1 - 10.0	F

Since hydrology, geomorphology and vegetation are interlinked their scores have been aggregated to obtain an overall PES health score using the following formula (MacFarlane *et al*., 2009):

Health = ((Hydrology score) x3 + (Geomorphology score) x2 + (Vegetation score) x2)) ÷ 7

This gives a score ranging from 0 (pristine) to 10 (critically impacted in all respects). Hydrology is weighted by a factor of 3 since it is considered to have the greatest contribution to wetland health. Due to differences in the pattern of water flow through various hydro-geomorphic (HGM) types (**Figure 6**), the tool requires that the wetland is divided into distinct HGM units at the outset. Ecosystem services for each HGM unit are then assessed separately.

Each HGM unit is discussed on the following pages in more detail in terms of the functional integrity, Present Ecological Score and the impacts which affect these.

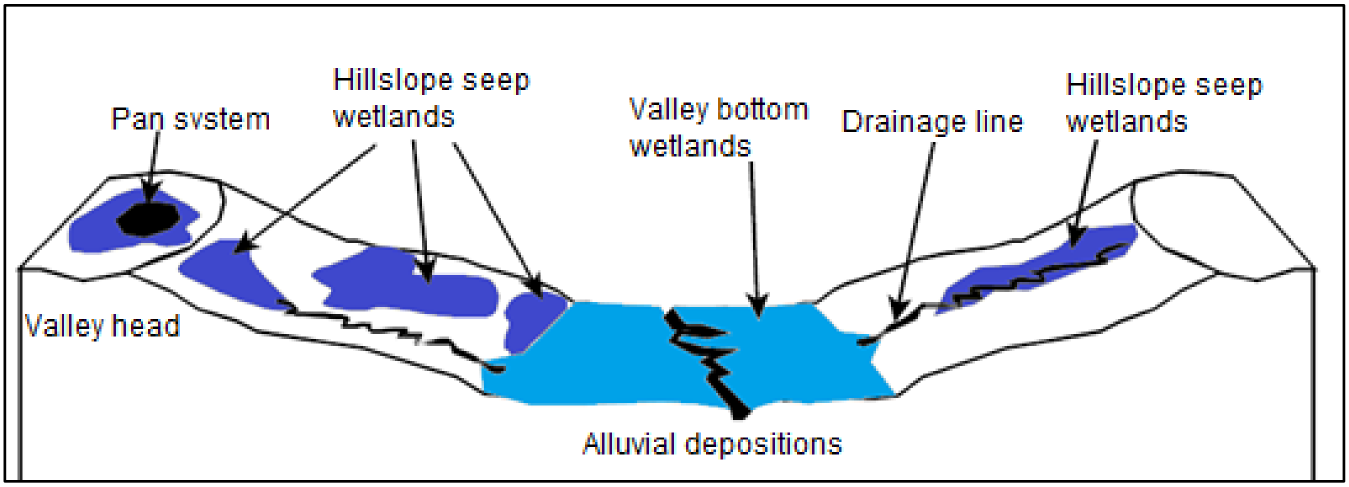


Figure 6: Diagrammatic representation of common wetland systems identified in Southern Africa (based on Kotze *et al.*, 2008).

2.3 Risk Assessment to Watercourses

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines.

The matrix assesses impacts in terms of consequence and likelihood. Consequence is calculated based on the following formula:

Consequence = Severity + Spatial Scale + Duration

Whereas likelihood is calculated as:

Likelihood=Frequency of Activity + Frequency of Incident +Legal Issues + Detection.

Significance is calculated as:

Significance \Risk= Consequence x Likelihood.

Each metric of the severity (flow regime, water quality, geomorphology, biota and habitat) and spatial scale, duration, frequency of the activity, frequency of the incident/impact and detection are rated to a 1 to 5 scale (GNR 509, of the National Water Act, 1998 (Act No. 36 of 1998) for Water Uses as Defined in Section 21(C) or Section 21(I), 2016).

The score is then placed into one of the three classes, with low risks to the watercourse will qualify for a General Authorisation (GA). Medium and high risk activities will require a Section 21(C) and (I) water use licence as per the National Water Act of 1998 (**Table 10**).

Table 10: Significance of the Section 21 C and I ratings matrix as prescribed by the National Water Act 1998 (Act No. 36).

Rating	Class	Management Description
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

2.4 Ecological Desktop Assessment

It is important to note that many parts of South Africa contain high levels of biodiversity at species and ecosystem level. At any single site there may be large numbers of species or high ecological complexity. Sites also vary in their natural character and uniqueness and the level to which they have previously been disturbed. Assessing the impacts of the mine often requires evaluating the conservation value of the site relative to other natural areas in the surrounding area. Thus, the general approach and angle adopted for this type of study is to identify any potential faunal species that may be affected by the mine. This means that the focus of this report will be on rare, threatened, protected and conservation-worthy species.
Biodiversity issues are assessed by documenting whether any important biodiversity features occur on site, including species, ecosystems or processes that maintain ecosystems and/or species. Rare, threatened, protected and conservation-worthy species and habitats are considered to be the highest priority, the presence of which is most likely to result in significant negative impacts on the ecological environment. The focus on national and provincial priorities and critical biodiversity issues is in line with National Legislation protecting environmental and biodiversity resources.

A desktop assessment was conducted to establish whether any potentially sensitive species/receptors might occur within the study area. The South African National Biodiversity Institute's online biodiversity tool, ADU (Animal Demography Unit) Virtual Museum was used to query a faunal species list (**Appendix A**) for the 2629AD and 2629BC Quarter Degree Squares (QDS) within which the study area is situated.

The South African National Biodiversity Institute's (SANBI) online biodiversity tool POSA (Plants of South Africa) was used to query floral species lists (**Appendix B**) for the Bethal area surrounding the project site. This was supplemented by researching all available books and peer reviewed websites.

The importance of a baseline study is to provide a reference condition to determine the current state of the environment and to draw comparisons between the potential of the area and current degradation from surrounding land uses. Aerial photographs and satellite imagery were used to delineate potential sensitive ecosystems or vegetation types and these areas were the focus during the field assessment.

To describe the overall site characteristics, and to identify points of interest within the site for evaluation, Google Earth Imagery and the 1:50 000 topographical maps were examined.

This was conducted by researching all available information resources including, but not limited to, the following:

- International Union for Conservation of Nature (IUCN) Red List of Threatened Species;
- The Endangered Wildlife Trust's Red List of Mammals of South Africa, Lesotho and Swaziland; and
- NEMBA List of Threatened or Protected Species (TOPS List);
- Animal Demography Unit (ADU) Virtual Museum;

- Plants of southern Africa (POSA);
- SANBI Biodiversity GIS tool; and
- Important Bird and Biodiversity Areas (IBAs) (Birdlife South Africa, 2020).

Biodiversity areas represent terrestrial and aquatic sites identified as Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESA), Other Natural Areas and No Natural Remaining Areas conducted by SANBI.

2.4.1 Critical Biodiversity Areas

Critical Biodiversity Areas are those areas required to meet biodiversity thresholds. CBA's are areas of terrestrial or aquatic features (or riparian vegetation alongside CBA aquatic features) which must be protected in their natural state to maintain biodiversity and ecosystem functioning (Desmet *et al*., 2013). According to Desmet *et al* (2013), these CBAs include:

i) Areas that need to be protected in order to meet national biodiversity pattern thresholds (target area);

ii) Areas required to ensure the continued existence and functioning of species and ecosystems (including the delivery of ecosystem services); and/or

iii) Important locations for biodiversity features or rare species.

2.4.2 Ecological Support Areas

Ecological Support Areas (ESA) are supporting zones required to prevent the degradation of Critical Biodiversity Areas and Protected Areas. An ESA may include an aquatic or terrestrial feature. ESAs can be further subdivided into Critical Ecological Support Areas (CESA) and Other Ecological Support Areas (OESA). Critical Ecological Support Areas are aquatic features, with their terrestrial buffers, which fall within priority sub-catchments, whose protection is required in order to support the aquatic and terrestrial CBAs. An example might be a river reach which feeds directly into a CBA. Other Ecological Support Areas are all remaining aquatic ecosystems (not classed as CESA or CBA), with their terrestrial buffers, which have a less direct impact on the CBA, e.g. a wetland that is geographically isolated from a CBA, but contributes to ecological processes such as groundwater recharge, thereby indirectly impacting on a CBA downstream. (Desmet *et al.*, 2010).

2.4.3 Other Natural Areas

Other Natural Areas are areas of lesser biodiversity importance whose protection is not required in order to meet national biodiversity thresholds. Other Natural Areas may withstand some loss in terms of biodiversity through the conversion of their natural state for development. However, if all Critical Biodiversity Areas are not protected, certain Other Natural Areas will need to be reclassified as Critical Biodiversity Areas in order to meet thresholds. (Desmet *et al.*, 2010).

No Natural Remaining Areas are those areas that have been irreversibly transformed through urban development, plantation and agriculture and poor land management. As a result, these areas no longer contribute to the biodiversity of the region. However, in some cases transformed land may be classified as an ESA or CBA if they still support biodiversity (Desmet *et al.,* 2010).

2.4.4 **Threatened Ecosystems**

Ecosystem threat status outlines the degree to which ecosystems are still intact or alternatively losing vital aspects of their structure, function and composition, on which their ability to provide ecosystem services ultimately depends (Driver *et al*., 2012). Ecosystem types are categorised as Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Least Threatened (LT), based on the proportion of each ecosystem type that remains in good ecological condition (Driver *et al*., 2012).

2.4.5 **Important Bird Areas**

Important Bird Areas are areas that are important for the long-term survival of threatened, restricted avian species (Birdlife South Africa, 2020). BirdLife's Important Bird and Biodiversity Area concept has been developed and applied for over 30 years. Considerable effort has been devoted to refining and agreeing a set of simple but robust criteria that can be applied worldwide.

Important Bird and Biodiversity Areas (IBAs) are:

- Places of international significance for the conservation of birds and other biodiversity;
- Recognised world-wide as practical tools for conservation;
- Distinct areas amenable to practical conservation action;
- Identified using robust, standardised criteria; and
- Sites that together form part of a wider integrated approach to the conservation and sustainable use of the natural environment.

2.5 Vegetation Assessment

A comprehensive study was carried out to document all species recorded in the area and to predict vegetation characteristics. This was augmented by a site visit and comprised of the following:

A walkover field survey of the site verifying the presence or absence of species predicted to occur on the site included:

i. Identification and location of keystone or indicator species that may be impacted;
ii. Identify important habitats, including wetlands, grasslands and savanah;
iii. Identify areas of conservation and/or ecological importance;
iv. Consider invasive alien plant status and rehabilitation potential of natural areas; and
v. An overall condition of the vegetation found in the area, including an assessment of cover and vegetation structure and were classified as vegetation communities.

2.5.1 Conservation priority and Sensitivity

The vegetation types were evaluated in terms of conservation priority according to the following categories:

- **High:** Ecologically sensitive and valuable land with high species richness and/or sensitive ecosystems and/or red data species that should be conserved. No development is to be allowed.
- **Medium-high:** Land that is partially disturbed but that is generally ecologically sensitive to development / disturbances.
- **Medium:** Land on which developments with a limited / low impact on the vegetation / ecosystem can be considered. It is recommended that certain portions of the natural vegetation be maintained in open spaces.
- **Medium-low:** Land of which small sections could be considered to be conserved, but where the area in general has little conservation value.
- **Low:** Land that has little conservation value where development will have an insignificant or no impact on the vegetation.

Sensitivity Areas that are of High and Medium-high conservation priority are regarded as High sensitivity areas in which developments should not be allowed

Areas that fall in the Medium, Medium-low and Low conservation priority categories are regarded as Low sensitivity areas in which development may be allowed.

Areas where other environmental factors such as high erodibility and steep slopes that play a significant role are regarded as Moderate sensitivity areas. Developments can be allowed in these areas if suitable mitigation measures can be implemented.

2.5.2 **Alien Invasive Plants**

Invasive alien plants are described as species which are 'non-indigenous' to an area and which have been introduced from other countries either intentionally (for domestic or commercial use) or accidentally; furthermore, they have the ability to reproduce and spread without the direct assistance of people into natural or semi-natural habitats and are destructive to biodiversity and human interests (WESSA-KZN, 2008).

Notice 3 of the National Environmental Management: Biodiversity Act 2004 (Act No, 10 of 2004) lists 379 plant species that are legally declared invasive species. Each species is assigned to one of three categories based on the level of threat posed by the species and the legal status assigned to each:

- **Category 1a –** Plant species that must be combatted or eradicated.
- **Category 1b –** Plant species that must be controlled.
- **Category 2 –** Plant species that must not be allowed to spread outside any property.
- **Category 3 –** Plant species that when occurring in riparian areas must be considered to be category 1b Listed Invasive Species and must be managed according to regulation 3 of NEM:BA, 2014

Please review NEMBA (Act 10 of 2004) for details on these species.

2.6 Faunal Assessment

2.6.1 **Avifaunal assessment**

Generally, when predicting the impacts of the mine on birds, a combination of science, field experience and knowledge from the specialist is required. More specifically the methodology used to predict impacts of the mine was as follows:

- The various data sets discussed above under "sources of information", were collected/collated and examined with the aim of determining the focal species for this study.
- The data were examined to determine the location and abundance of species which may be susceptible to impacts from the mine including both Red Data and non-Red Data.
- The broader study area was visited during a day long site visit. The site was thoroughly traversed to obtain a first-

hand perspective of the mine, and to determine which bird micro habitats are present within the study site. This involved walking, taking photographs, and the use of bird call playbacks to identify bird life present within the study area. Further to this, the observation of feathers and nests were used as species identification tools.

- All opportunist sightings were recorded throughout the study area.
- Avian micro-habitats and sensitive habitats for avifaunal communities were identified and mapped.
- The impacts of the mine on the avifaunal populations were then predicted by analysing data on impacts on wildlife around mining areas throughout South Africa.

2.6.2 **Faunal assessment**

The faunal investigation was focused on mammals, reptiles and amphibians. The following methodology was applied:

- The data sets discussed above under “sources of information” were collected/collated and examined to determine the focus species for this study;
- The data was examined to determine the possible occurrence of any Red Data and non-Red Data species;
- The site was comprehensively assessed during a field investigation to determine fauna and faunal micro habitats present within the site. This included:
  - All animals (mammals, reptiles and amphibians) seen or heard; were recorded.
  - Use was also made of indirect evidence such as animal tracks (footprints, droppings and various burrow types) to identify animals.
  - The majority of amphibians identified were calling adults as well as incidentally observed adults (under rocks, logs etc).
  - Reptiles were actively searched for under suitable refuges such as loosely embedded flat rocks, logs and stumps and identified by actual specimens observed.
- Information was supplemented by historical records, personal accounts from residents within the study area and a comprehensive literature review; and
- The impacts of the mine on faunal species were predicted and mitigation measures were proposed.

2.7 Significance of Identified Impacts on Biodiversity

Significance scoring assesses and predicts the significance of environmental impacts through evaluation of the following factors; probability of the impact; duration of the impact; extent of the impact; and magnitude of the impact. The significance of environmental impacts is then assessed considering any proposed mitigations. The significance of the impact “without mitigation" is the prime determinant of the nature and degree of mitigation required. Each of the above impact factors have been used to assess each potential impact using ranking scales as seen in **Table 11**.

Impact scores given "with mitigation" are based on the assumption that the mitigation measures recommended in this assessment are implemented correctly and rehabilitation of the site is undertaken. Failure to implement mitigation measures during operation will keep impacts at an unacceptably high level.

Unknown parameters are given the highest score (5) as significance scoring follows the Precautionary Principle. The Precautionary Principle is based on the following statement: *When the information available to an evaluator is uncertain as to whether or not the impact of the mine on the environment will be adverse, the evaluator must accept as a matter of precaution, that the impact will be detrimental*. It is a test to determine the acceptability of the mine. It enables the evaluator to determine whether enough information is available to ensure that a reliable decision can be made.

Table 11: Significance scoring used for each potential impact.

Probability	Duration
1 - very improbable 2 - improbable 3 - probable 4 - highly probable 5 - definite	1 - very short duration (0-1years) 2- short duration (2-5 years) 3 - medium term (5-15 years) 4 - long term (>15 years) 5 - permanent/unknown
Extent	**Magnitude**
1 - limited to the site 2 - limited to the local area 3 - limited to the region 4 - national 5 - international	2 – minor 4 – low 6 – moderate 8 – high 10 – very high

Significance Points = (Magnitude + Duration + Extent) x Probability. The maximum value is 100 Significance Points.

Potential Environmental Impacts are rated as high, moderate or low significance as per the following:

<30 significance points = Low environmental significance

31-59 significance points = Moderate environmental significance

>60 significance points = High environmental significance

3 BACKGROUND INFORMATION

3.1 Vegetation

Eastern Highveld Grassland

Stretches over the Mpumalanga and Gauteng Provinces, with plains between Belfast to the east and the eastern side of Johannesburg and extending southwards to Bethal, Ermelo and Piet Retief. Altitude ranges between 1520 to 1780 m, but also as low as 1300 m (**Figure 7**) (Mucina & Rutherford, 2006). Strongly seasonal summer rainfall, with very dry winters. Mean annual precipitation ranges between 650 mm to 900 mm (overall average: 726 mm) and is relatively uniform, but increases significantly in the southeast areas (Mucina & Rutherford, 2006). Incidence of frost from lasts from 13 to 42 days, but is higher at higher elevations (Mucina & Rutherford, 2006).

Slightly too moderately undulating plains, including some low hills and pan depressions (Mucina & Rutherford, 2006). The vegetation is short dense grassland dominated by the usual Highveld grass composition (*Aristida*, *Digitaria*, *Eragrostis*, *Themeda*, *Tristachya* etc.) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Senegalia caffra*, *Celtis africana*, *Diospyros lycioides* subsp *lycioides*, *Parinari capensis*, *Protea caffra*, *P. welwitschii* and *Rhus magalismontanum*) (Mucina & Rutherford, 2006).

Some 44% transformed primarily by cultivation, plantations, mines, urbanisation and dams. Cultivation may have had a more extensive impact, indicated by land-cover data (Mucina & Rutherford, 2006). No serious alien invasions are reported, but *Acacia mearnsii* can become dominant in disturbed sites, with very low erosion (Mucina & Rutherford, 2006).

Red to yellow sandy soils of the Ba and Bb land types found on shales and sandstones of the Madzaringwe Formation (Karoo Supergroup). Land types are Bb (65%) and Ba (30%) (Mucina & Rutherford, 2006). Found on younger Pleistocene to recent sediments overlying fine-grained sedimentary rocks of the Karoo Supergroup (on sediments of both Ecca and Beaufort Groups due to the large extent of the area of occurrence) as well as of the much older dolomites of the Malmani Subgroup of the Transvaal Supergroup in the northwest (Mucina & Rutherford, 2006). In the areas built by Karoo Supergroup sediments are associated with the occurrence of Jurassic Karoo dolerite dykes having a profound influence on run-off (Mucina & Rutherford, 2006).

Soils are peaty (Champagne soil form) to vertic (Rensberg soil form) (Mucina & Rutherford, 2006). The pans and wetlands forms where flow of water is impeded by impermeable soils and/or by erosion resistant features, such as dolerite intrusions (Mucina & Rutherford, 2006). Many pans of this type of freshwater wetlands are inundated and/or saturated only during the summer rainfall season, and for some months after this into the middle of the dry winter season, but they may remain saturated all year round (Mucina & Rutherford, 2006). Surface water inundation may be present at any point while the wetland is saturated and some plant species will be present only under inundated conditions, or under permanently saturated conditions

(Mucina & Rutherford, 2006). The presence of standing water should not be taken as a sign of permanent wet conditions (Mucina & Rutherford, 2006).

3.2 Quaternary catchment and Land Use

The proposed mine is situated in the Klein Olifants River sub-catchment (Quaternary drainage region B11A) which falls within the Olifants catchment and the Olifants Water Management Area (**Figure 8**). The land use features within the study site are mainly agriculture in the form of subsistence farming, crops and opencast mining (**Figure 8**9. The streams in close proximity to the mining area are the Joubertsvleispruit. The Viskuile River was assessed which served as a reference site for the study and was the receiving environmental from the Joubertsvleispruit flowing adjacent to the proposed mining areas.

According to the ecological importance classification data provided as **reference data** by Department Water and Sanitation, 2013 for the quaternary catchments B11A; the Joubertsvleispruit is classified in its present state as a Category D (largely Modified) and the Viskuile River as Category C (moderately Modified). The default ecological management class for the relevant quaternary catchments is considered to be highly sensitive system for the Joubertsvlei and moderate for the Viskuile in terms of ecological importance with both being a highly ecological sensitive. The attainable ecological management class for the systems is a Category B (largely natural). A summary of the ecological integrity (health) and management categories for the unnamed tributaries in quaternary catchments B11A is presented in **Table 12**.

Table 12: Sub-Quaternary reach desktop data for the area assessed (Department Water and Sanitation, 2013).

Reach	PES Category Median	Mean EI Class	Mean ES Class	Length km	Stream Order	Attainable PES
B11A-01443 Joubertsvlei	D	Moderate	High	19	1	B
B11A-01430 Viskuile	C	High	High	32	1	B

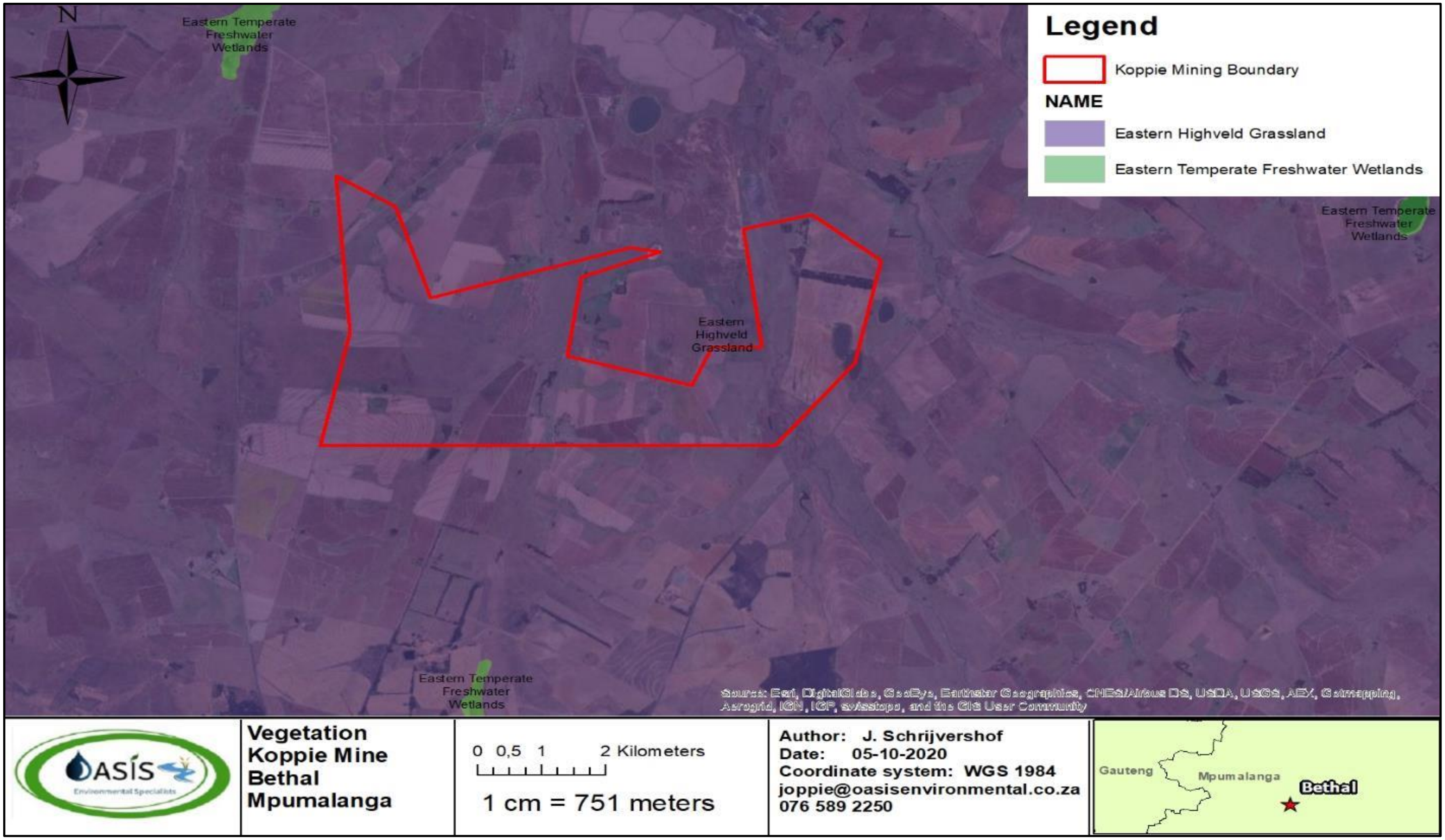


Figure 7: Proposed Koppie Mining Project - Vegetation map.

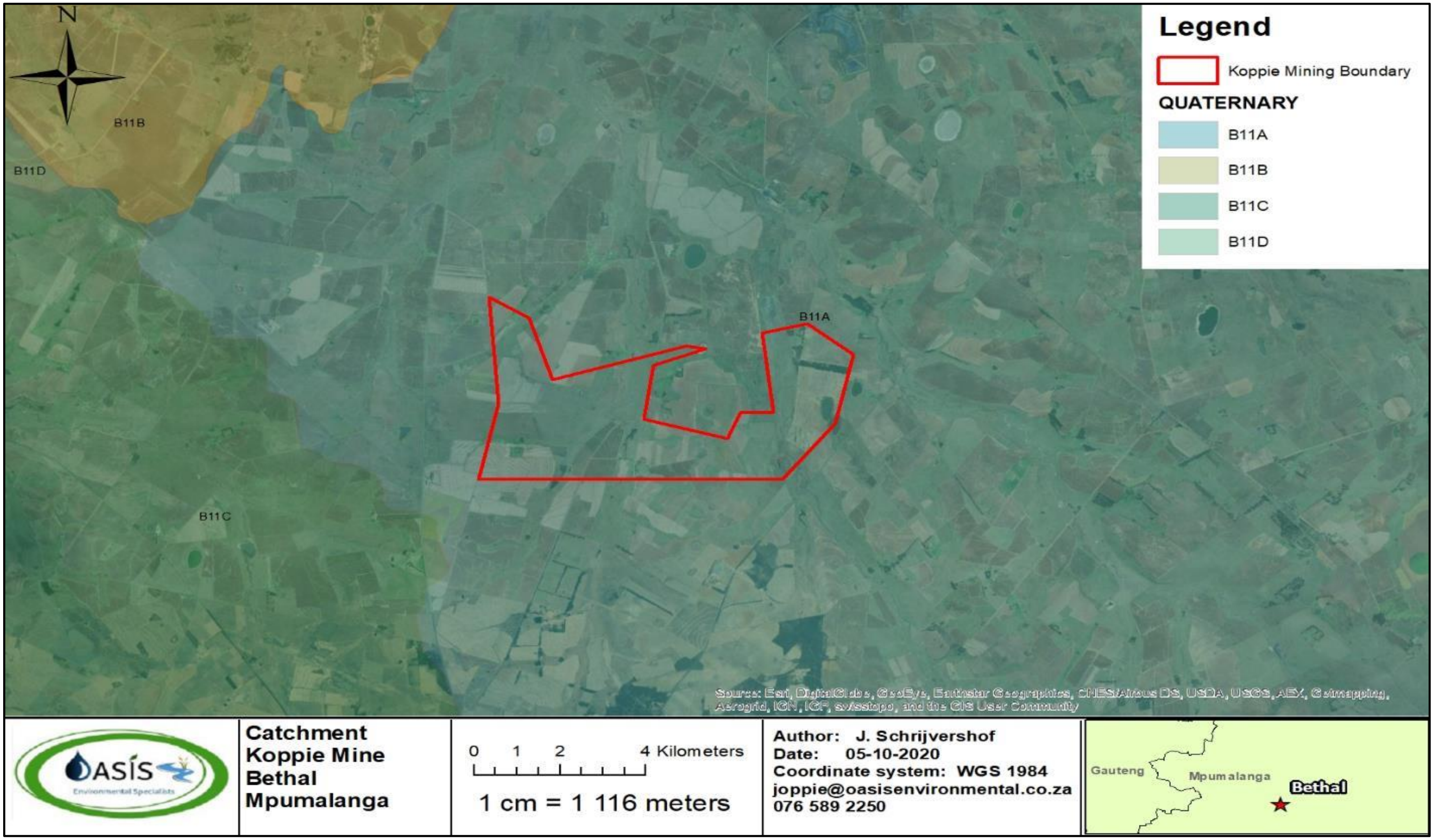


Figure 8: Proposed Koppie Mining Project - Catchment map.

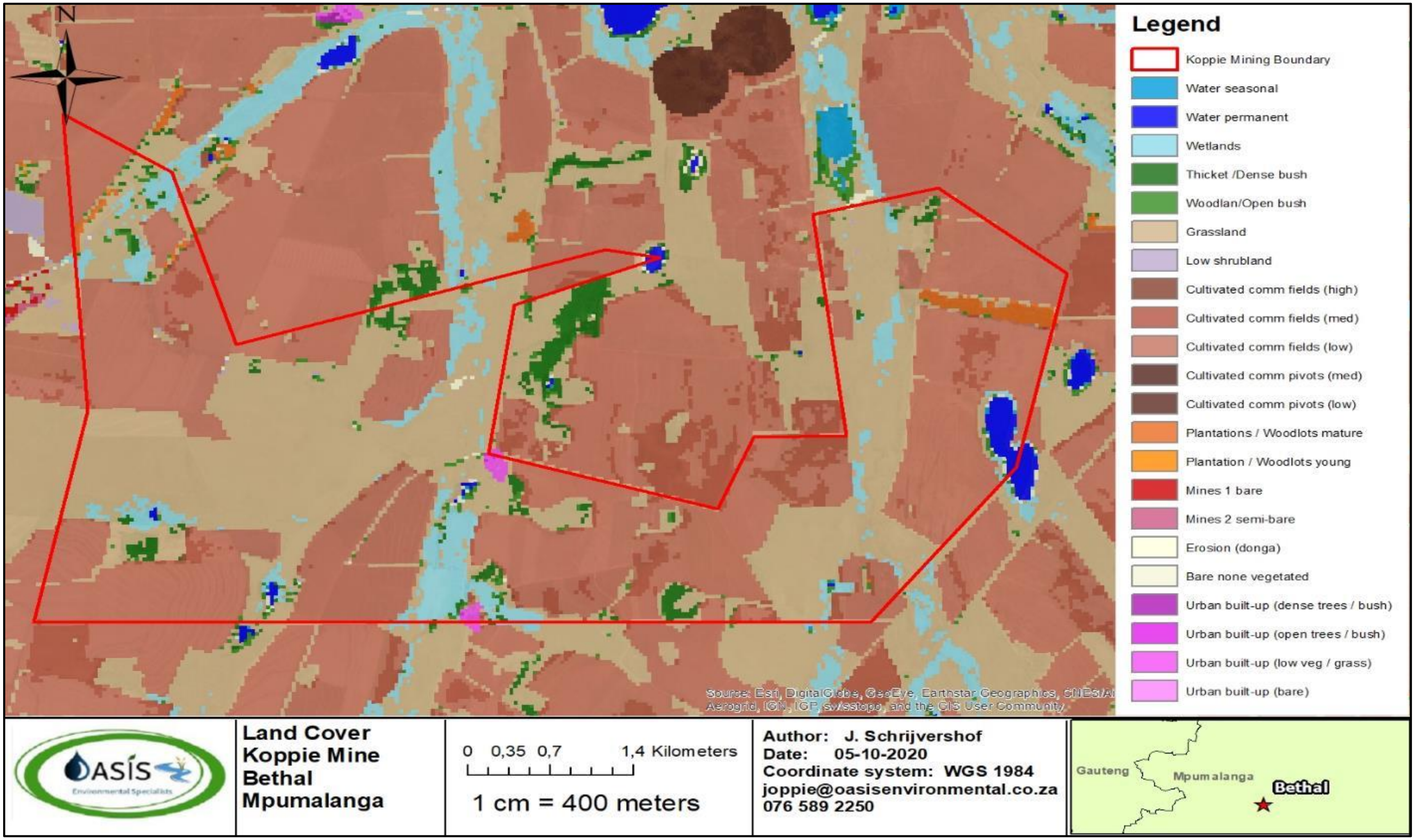


Figure 9: Proposed Koppie Mining Project – Land cover map.

3.3 Highveld Ecoregion

Kleynhans *et al*. (2005) describes the Highveld Ecoregion (11) as plains with a moderate to low relief, as well as various grassland vegetation types (with moist types present towards the east and drier types towards the west and south) (**Table 13**). Several large perennial rivers have their sources in the region for e.g. Vet, Modder, Riet, Vaal, Olifants, Steelpoort, Marico, Crocodile (east and west) and the Great Usutu (**Figure 10**).

- Mean annual precipitation: Rainfall varies from low to moderately high, with an increase from west to east.
- Coefficient of variation of annual precipitation: Moderately high in the west, decreasing to low in the east.
- Drainage density: Mostly low, but medium in some areas.
- Stream frequency: Low to medium.
- Slopes <5%: >80%, but 20-50% in a few hilly areas.
- Median annual simulated runoff: Moderately low to moderate.
- Mean annual temperature: Hot in the west and moderate in the east.

Table 13: Highveld Ecoregion attributes (Department of Water Affairs, 2012).

Main attributes	Highveld
Terrain morphology: Broad division (dominant types in bold (Primary)	Plains; Low Relief; Plains; Moderate Relief; Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to high Relief Closed Hills. Mountains; Moderate and High Relief
Vegetation types (Dominant types in bold)	Mixed Bushveld (limited); Rocky Highveld Grassland; Dry Sandy Highveld Grassland; Dry Clay Highveld Grassland; Moist Cool

Main attributes	Highveld
	Highveld Grassland; Moist Cold Highveld Grassland; North Eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Patches Afromontane Forest (very limited)
Altitude (m.a.m.s.l) (secondary)	1100-2100, 2100-2300 (very limited)
MAP (mm) (modifying)	400 to 1000
Coefficient of Variation (% of annual precipitation)	< 20 to 35
Rainfall concentration index	45 to 65
Rainfall seasonality	Early to late summer
Mean annual temp. (°C)	12 to 20
Mean daily max temp. (°C) February	20 to 32
Mean daily max temp. (°C) July	14 to 22
Mean daily min. temp. (°C): February	10 to 18
Mean daily min. temp. (°C): July	-2 to 4
Median annual simulated runoff (mm) for quaternary catchment	5 to >250

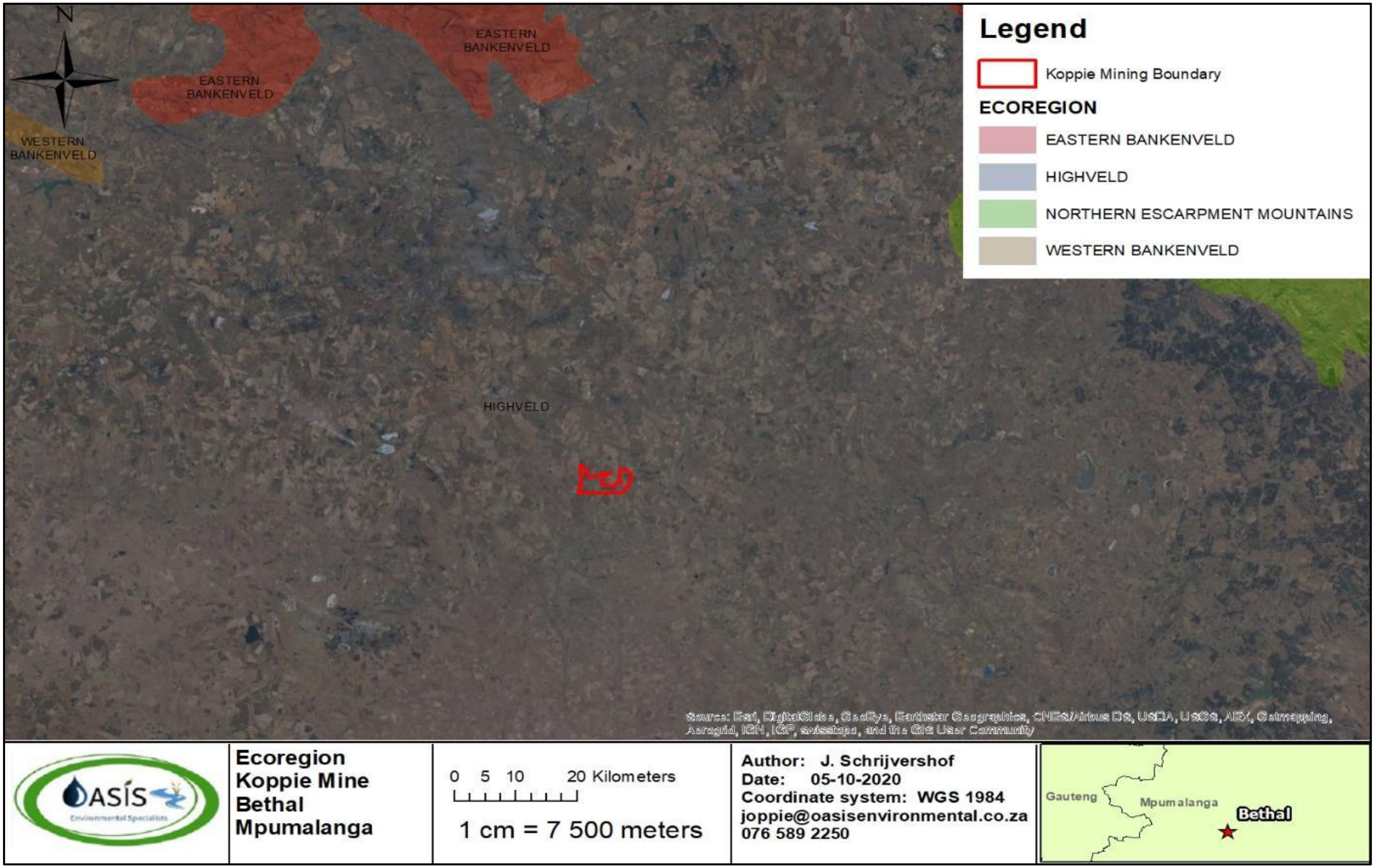


Figure 10: Proposed Koppie Mining Project - Ecoregion map.

4 RESULTS

A site assessment was conducted on the 30th of September 2020. The sampled sites are illustrated in the **Figure 11 and Figure 12** and the coordinates is provided in **Table 14**. During the site visit it was evident that alien invasive plant infestation and extensive crop cultivation affected the functionality of the watercourses within the area. It must be noted that the study sites had stagnant water in certain sections of the stream at the time at the assessment. Litter and sewage from a small community was observed within the .upstream site for the Joubertsvleispruit. This site was dry at the time of the assessment, where the downstream site and the Viskuile River has pockets of water at the time of the assessment.

Table 14: Coordinates for the aquatic study site at Proposed Koppie Mining Project.

Site	Coordinates	
Viskuil US	26°19'42.53"S	29°33'30.51"E
Viskuil DS	26°16'50.94"S	29°30'34.70"E
Joubert US	26°20'22.75"S	29°30'6.81"E
Joubert DS	26°18'11.30"S	29°30'5.91"E

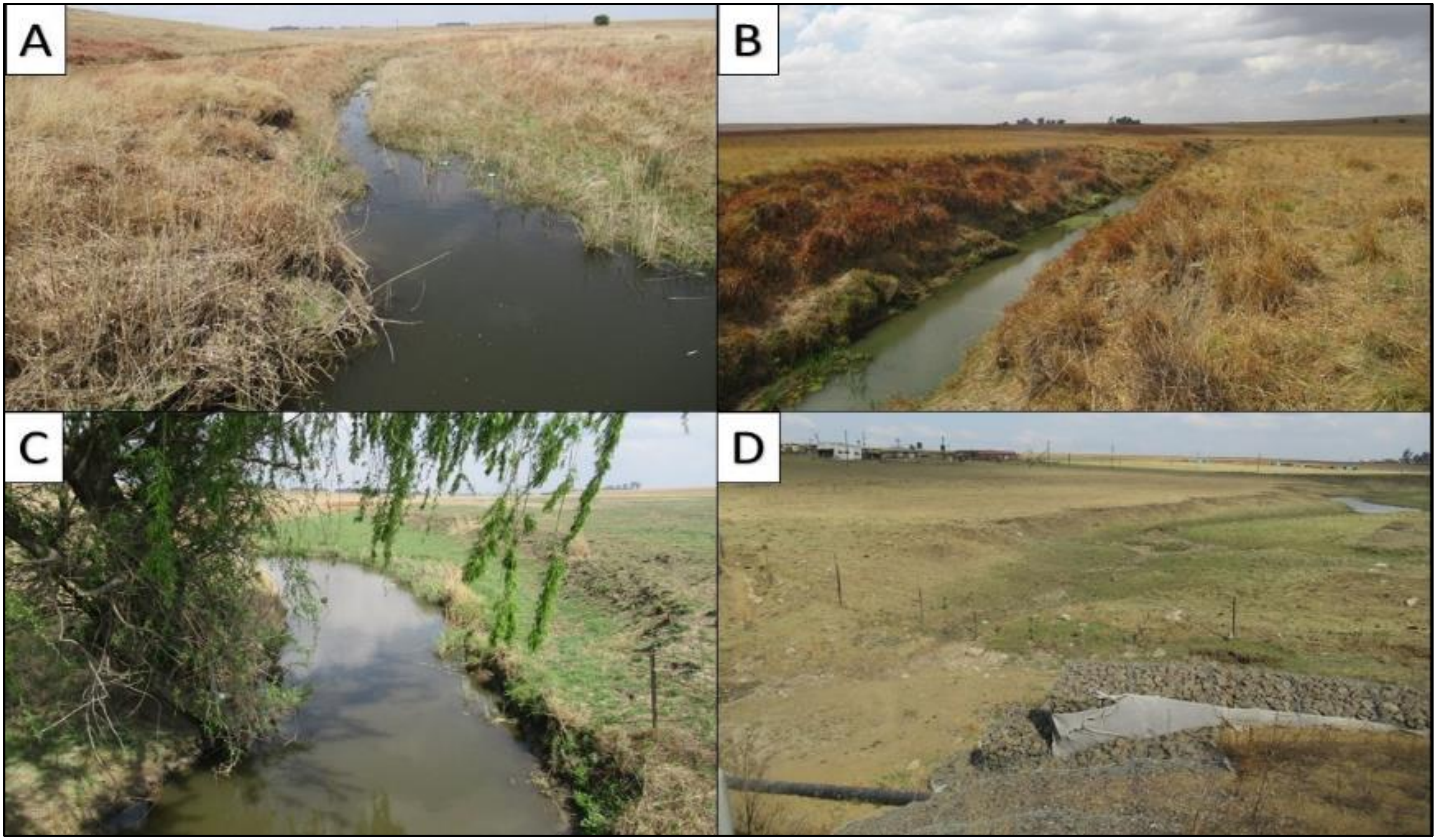


Figure 11: The biomonitoring sites assessed associated with the Proposed Koppie Mining Project where (A) represents the upstream site of the Viskuile River (Viskuil US); (B) the downstream site of the Viskuile River (Viskuile DS); (C) the downstream site of the Joubertsvleispruit (Joubert DS); and (D) the upstream site of the Joubertsvleispruit (Joubert US) which was dry at the time of the assessment.

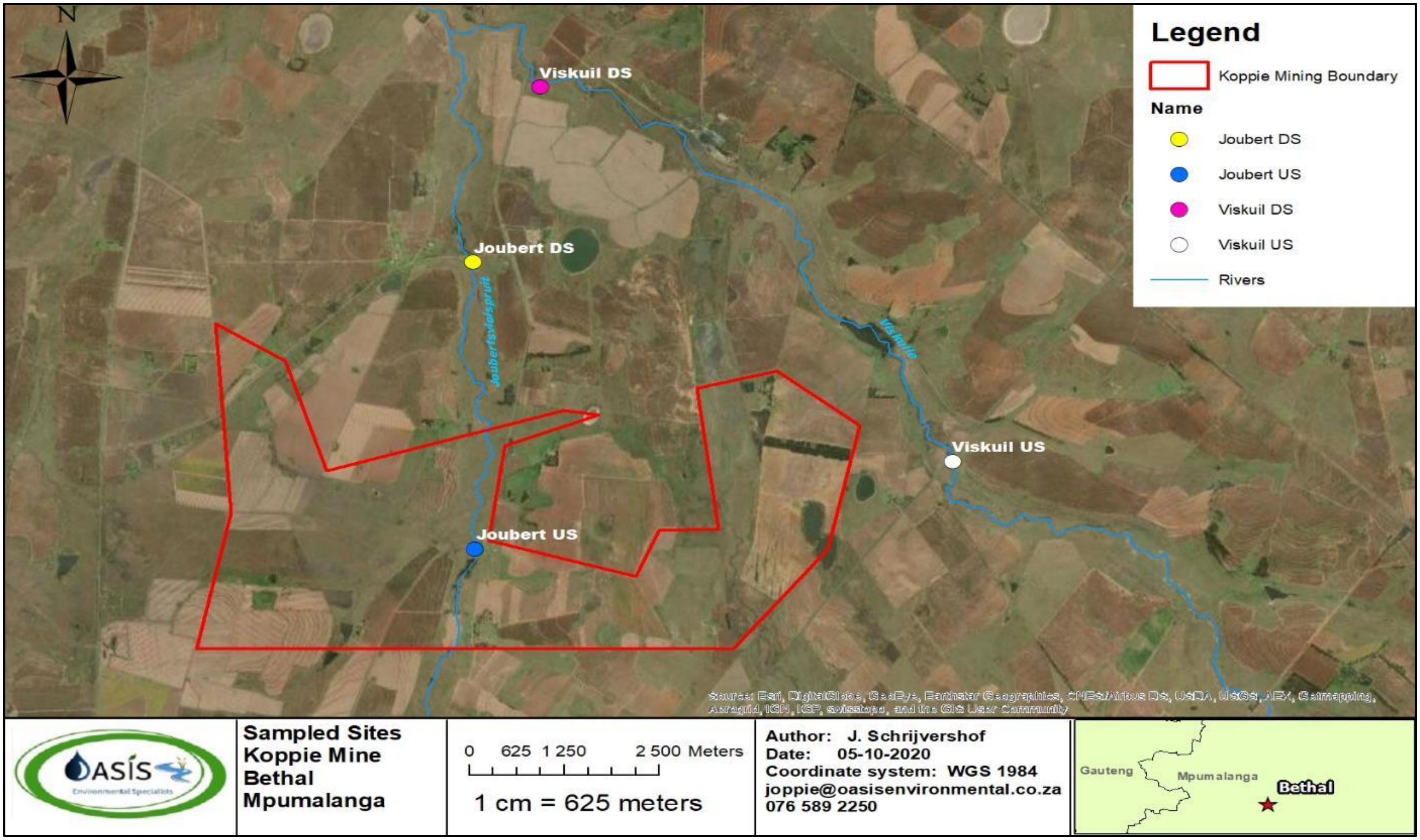


Figure 12: Proposed Koppie Mining Project - Sample localities of the biomonitoring points on the Viskuile River and the Joubertsvleispruit.

4.1 *In Situ* Water Quality

In situ water quality variables was within **unacceptable** limits compared to the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa. The pH remained relatively constant throughout the sites and within the neutral range. Temperatures were relatively stable, where electrical conductivity levels were above recommended guideline levels for the Joubertsvleispruit. Dissolved oxygen (DO) levels were below guideline levels at both upstream and downstream sites (**Table 15**). Extensive mining and agriculture were observed at the time of the assessment at the sample locations.

It must be noted that *in situ* water quality testing cannot identify specific chemicals for the basis for the health determination of a river system.

Table 15: *In situ* water quality results of the stream at the Proposed Koppie Mining Project sites compared to guidelines of the Target Water Quality Ranges (TWQRs) for aquatic ecosystems of South Africa.

Constituents	Guideline values (TWQRs)	Joubert US	Joubert DS	Viskuil US	Viskuil DS
pH	6.5-9,5	Dry	8.81	7.89	9.91
Temp (°C)	5-30		18.50	19.50	21.10
Conductivity (µS/cm)	<700		719	671	485
Dissolved Oxygen (%)	>80%		40.3	56.2	70.8
Dissolved Oxygen (mg/L)	>6		3.15	4.30	5.25

4.2 Intermediate Habitat Integrity Assessment (IHIA)

The IHIA results recorded, placed both sites assessed within a **seriously modified state (Category E)**. A category of E indicates that the loss of natural habitat, biota and basic ecosystem functions is extensively transformed from reference conditions. The predominant cause for concern was agriculture, erosion, grazing, damming, alien invasive plants, mining and water pollution.

The IHIA assesses the number and severity of anthropogenic impacts and the damage they potentially inflict on the habitat integrity of aquatic ecosystems. The results of the IHIA are presented below in **Table 16**.

Table 16: Overall IHIA instream and riparian results for the sites of Koppie Coal Mine.

INSTREAM CRITERIA	WEIGHT	Joubert US	Joubert DS	Viskuil US	Viskuil DS	Average	Score
Water abstraction	14	20	15	13	19	16,75	9,38
Flow modification	13	19	16	14	17	16,50	8,58
Bed modification	13	18	19	16	18	17,75	9,23
Channel modification	13	20	18	14	19	17,75	9,23
Water quality	14	18	18	18	18	18,00	10,08
Inundation	10	11	12	10	20	13,25	5,30
Exotic macrophytes	9	9	11	14	14	12,00	4,32
Exotic fauna	8	9	9	9	9	9,00	2,88
Solid waste disposal	6	14	12	12	13	12,75	3,06
TOTAL	100						**37,94**
RIPARIAN ZONE CRITERIA	**WEIGHT**	**Joubert US**	**Joubert DS**	**Viskuil US**	**Viskuil DS**	**Average**	**Score**
Indigenous vegetation removal	13	20	20	21	20	20,25	10,53
Exotic vegetation encroachment	12	19	16	21	20	19,00	9,12
Bank erosion	14	18	16	16	20	17,50	9,80
Channel modification	12	20	17	16	21	18,50	8,88
Water abstraction	13	20	14	15	15	16,00	8,32
Inundation	11	12	12	12	19	13,75	6,05
Flow modification	12	20	14	14	17	16,25	7,80
Water quality	13	14	14	14	14	14,00	7,28
TOTAL	100						**32,22**
Overall				**35,08**			

4.3 Riparian Vegetation Assessment Index (VEGRAI)

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for Watercourses. Vegetation also forms a central part of the watercourse component in the National Water Act, Act 36 of 1998. Disturbances included the presence of alien invasive species, erosion and grazing within the area.

Hydrophytic riparian vegetation consisted of mainly of *Imperata cylindrica*, *Phragmites australis*, *Typha capensis, Cyperus spp*. *Juncus spp*. and *Crinum bulbispermum* (Orange River Lilly) (**Figure 13**).

Figure 13: Overall view of riparian vegetation associated with the watercourses in the study area on the Joubertsvlei River .

The findings for the vegetation assessment revealed that riparian habitat of the area was **seriously modified (Category E)** (**Table 17**). The entire study area has been disturbed as a result of crop cultivation, alien invasive plant species and overgrazing in the marginal and non-marginal zones.

Table 17: VEGRAI score for the riparian vegetation of the Joubertsvlei river reaches associated with the Proposed Koppie Mining Project.

Site	Proposed Koppie Mining Project
Marginal	21,3
Non-Marginal	24
LEVEL 3 VEGRAI (%)	**22,1**
VEGRAI EC	**E**
AVERAGE CONFIDENCE	2,9

4.4 Macroinvertebrates

4.4.1 South African Scoring System (SASS5)

During this survey; no sensitive organisms were sampled at any of the study sites. Sampled invertebrates included the *Oligochaeta, Potamonautidae, Hydracarina, Beatidae, Caenidae, Trycorythidae Coenagrionidae, Gomphidae, Lebillulidae, Belastomaidae, Corixidae, Gerridae, Nepidae, Notonectidae, Veliidae, Dytiscidae, Gyrinidae, Ceratopogonidae, Chironomidae, Culicidae, Simuliidae and Lymnaeidae,* families. This SASS5 scores for both downstream sites indicate that the stream is **seriously modified (Category E/F) (Figure 14)**. The majority of highly pollution tolerant organisms indicates the pressure from extensive pollution and lack of suitable flow, which may be as a result to water abstraction and upstream impoundments. The upstream site of the Viskuile River was found to be **moderately modified (Category C)** as this point is in close proximity to the water source. This point serves as a good reference point for future Biomonitoring Assessments as it is also the receiving environment for the Joubertsvlei system.

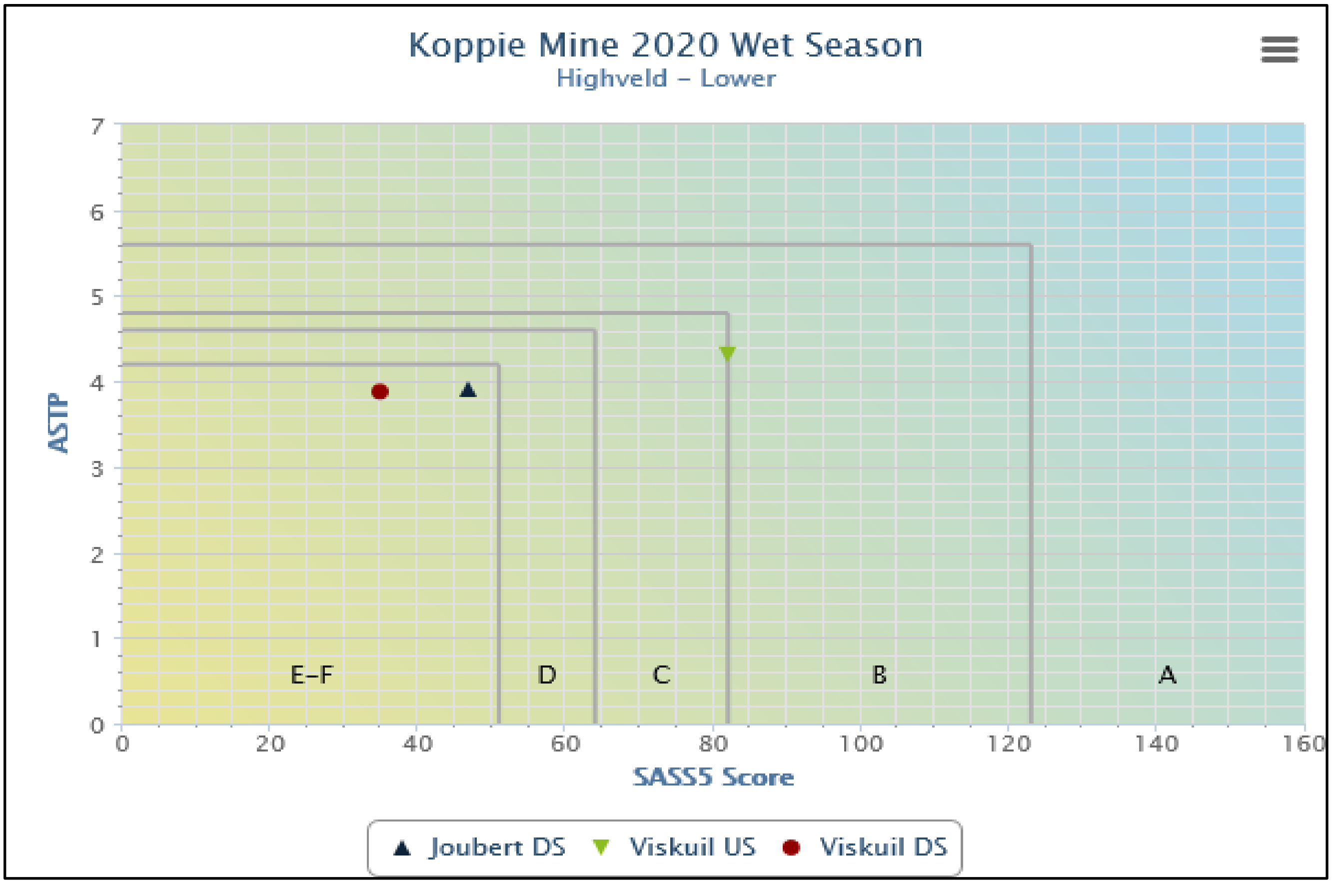


Figure 14: SASS 5 Classification using biological bands calculated from percentiles from Dallas (2007) for the sampled site at the Proposed Koppie Mining Project in accordance with the Highveld Ecoregion as reference.

4.4.2 **Invertebrate Habitat Assessment System (IHAS).**

The invertebrate habitat assessment is presented below in **Table 18**.

Table 18: IHAS results for the macro-invertebrate habitat available at the biomonitoring sites associated with Proposed Koppie Mining Project.

	Joubert DS	Viskuil US	Viskuil DS
IHAS Score	56	59	53
EC Rating	**Inadequate**		

The habitat reaches which were assessed and found to be **inadequate**, where biotopes with limited habitat structures were present. The dominant feature of the invertebrate habitat is the mud and gravel substrate which dominates the streams under study. Generally, no stones in or out of current biotope were found to be available throughout the stream with extensive erosion present. Some fringing vegetation were sampled at the study sites.

4.4.3 **Fish Assessment (FRAI).**

The SQR fish data available for that specific reach had seven species of fish expected to occur within that stretch of river according to DWS (2013). Although two indigenous and one exotic fish species were sampled in the Joubertsvlei and Viskuile systems (**Figure 15**), some were observed to surface at the downstream site and are listed in **Table 19**.

The FRAI assessment was adjusted to suit the site-specific requirements with the frequencies of occurrence (FROC) of particular species adjusted from the expected species list, where seven species of fish were expected, but only 3 sampled and 1 more observed (Kleynhans *et al*., 2007). The FRAI score have been adjusted according to the following factors: sampling effort, habitat type, cover combination, stream lengths, water quality and the presence of exotic fish species.

The adjusted FRAI results indicated that fish community is in a **seriously modified state (Category E)** as a result of up and downstream anthropogenic activities compounded with low flows and poor habitat availability. The very low diversity of fish species confirms that the water quality as well as the instream habitat of the associated the aquatic system was heavily impacted on (**Table 20**).

Table 19: The Frequency of Occurrence (FROC) for the fish species expected to occur vs sampled/observed fish species for the study area associated with the river reaches of the Joubertsvlei and Viskuile assessed.

Fish Species	Excepted FROC	FROC
Barbus anoplus	1	0
Barbus paludinosus	1	0
Labeobarbus polylepis	3	1
Clarias gariepinus	2	1
Gambusia affinis	1	1
Micropterus salmoides	1	1
Pseudocrenilabrus philander	1	1
Tilapia sparrmanii	1	0

Table 20: FRAI score for the Proposed Koppie Mining Project study area associated with the river reaches assessed.

Automated	
FRAI (%)	42,0
EC: FRAI	D/E
Adjusted	
FRAI (%)	39,4
EC: FRAI	E

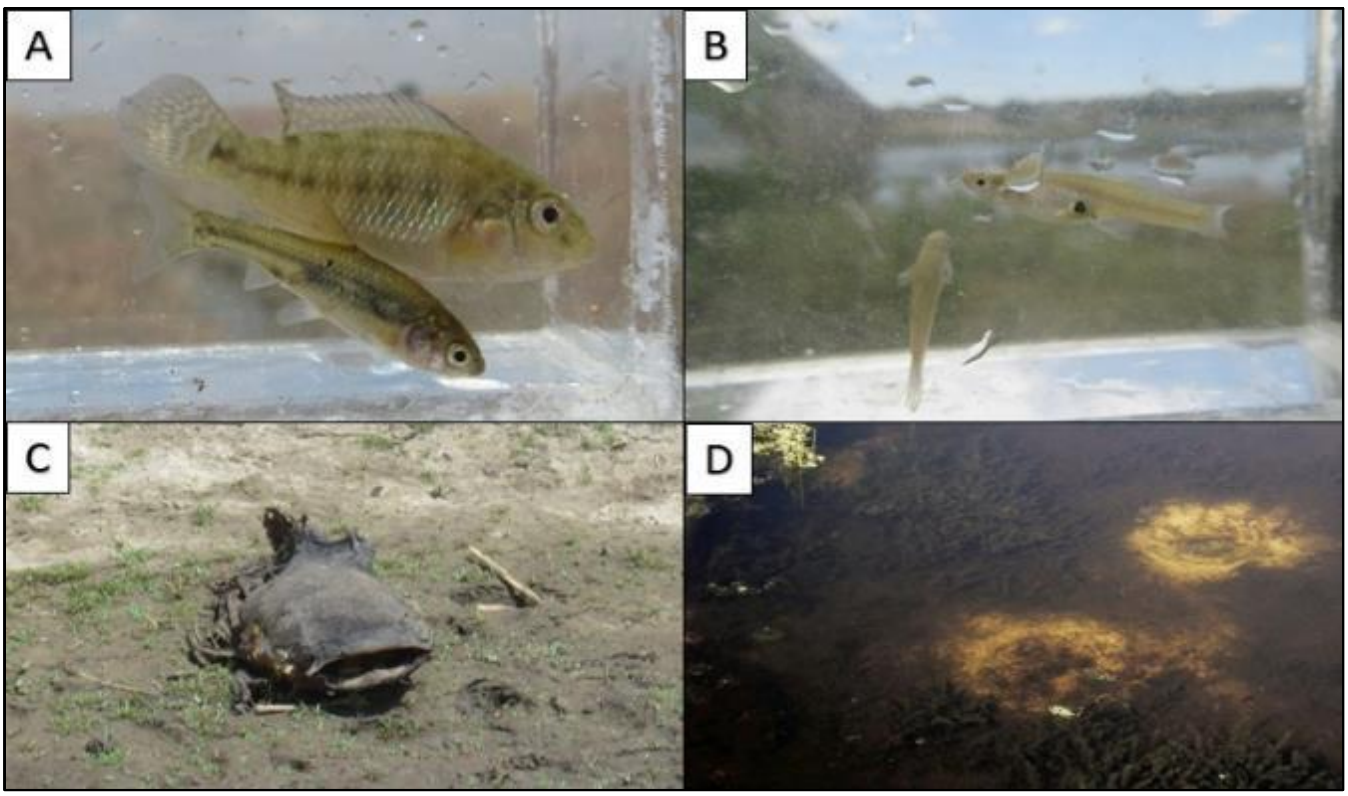


Figure 15: (A) Southern Mouthbrooder (*Pseudocrenilabrus philander*) and Smallscale Yellowfish (*Labeobarbus polylepis*); (B) exotic Mosquito Fish (*Gambusia affinis*); (C) Sharptooth Catfish (*Clarias gariepinus*) observed and (D) spawning beds of alien invasive Largemouth Bass (*Micropterus salmoides*).

4.5 Wetland Delineation and Assessment

This section provides the findings of the various methodologies utilised during the wetland assessment.

4.5.1 Desktop Assessment

Examination of the National Freshwater Ecosystem Priority Areas (NFEPA) database were undertaken for the Proposed Koppie Mining Project. The NFEPA project aims to produce maps which provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. They were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (MacFarlane *et al*., 2009). Identification of FEPA Wetlands are based on a combination of special features and modelled wetland conditions that include expert knowledge on features of conservation importance as well as available spatial data on the occurrence of threatened frogs and wetland-dependent birds.

Several valley bottom and depression NFEPA wetlands were identified within the area during the desktop assessment (**Figure 16**).

However, ground-truthing the existence and condition of FEPA wetlands is important to understand local conditions which have an impact on the wetland system, their functional integrity and health.

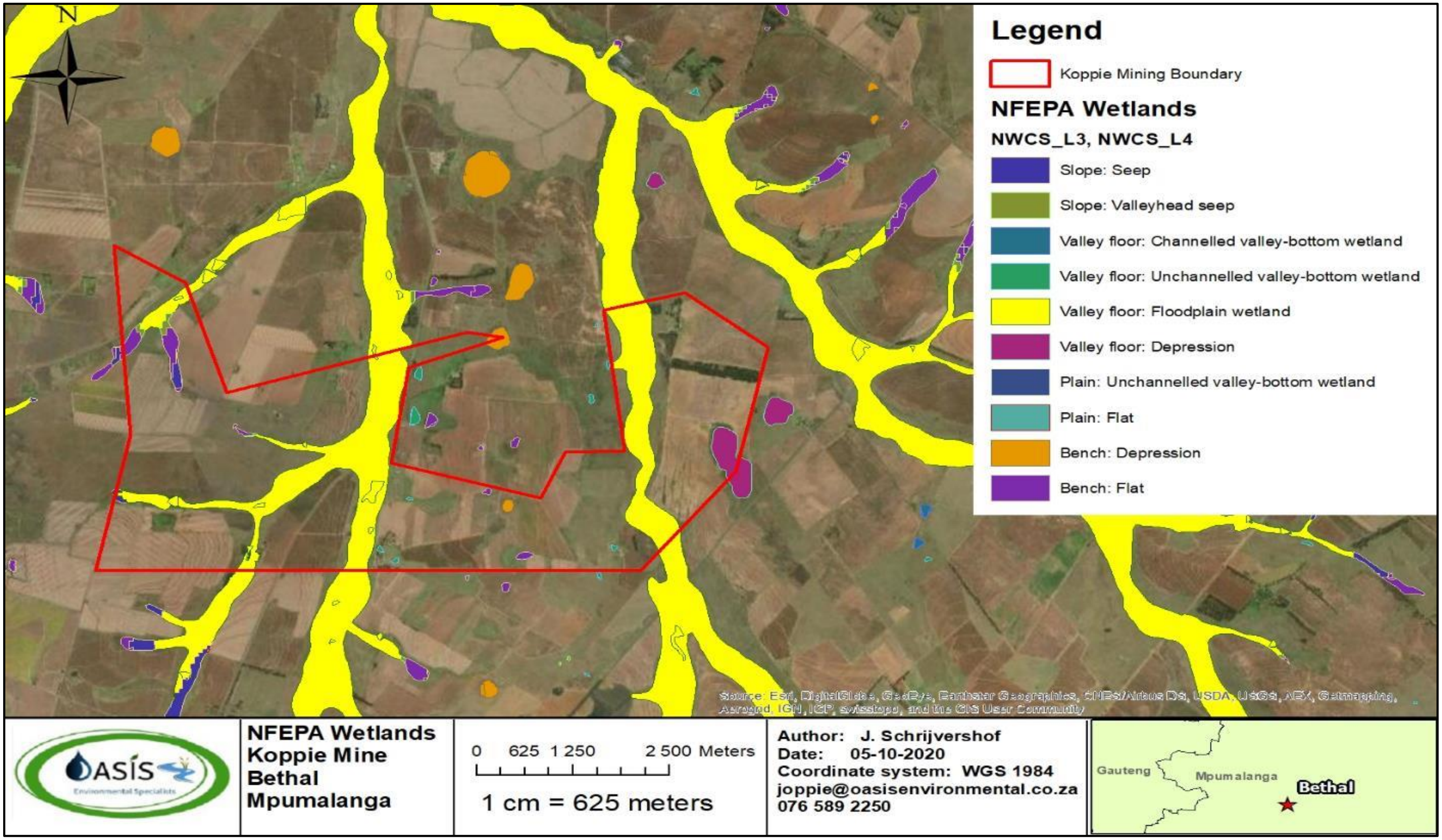


Figure 16: Proposed Koppie Mining Project - NFEPA Wetland map.

4.5.2 **Terrain indicator**

The topography of an area is generally a good practical indicator for identifying those parts in the landscape where wetlands are likely to occur. Generally, wetlands occur as a valley bottom unit however wetlands can also occur on steep to mid slopes where groundwater discharge is taking place through seeps (DWAF, 2005). In order to classify a wetland system, the localised landscape setting must be taken into consideration through ground-truthing of the study site after initial desktop investigations (Ollis *et al*., 2014).

The study site can be characterised as having rolling hills with relatively steep sloping topography. The site ranges in altitude from 1593 m to 1717 m above sea level. A Digital Elevation Model (DEM) of the aerial photography of the site revealed 2 valleyfloors in the landscape cutting in the proximity to the proposed mining areas (**Figure 17**). These areas identified during the desktop assessment where then assessed in more detail during the field investigation and confirmed to be floodplain wetlands.

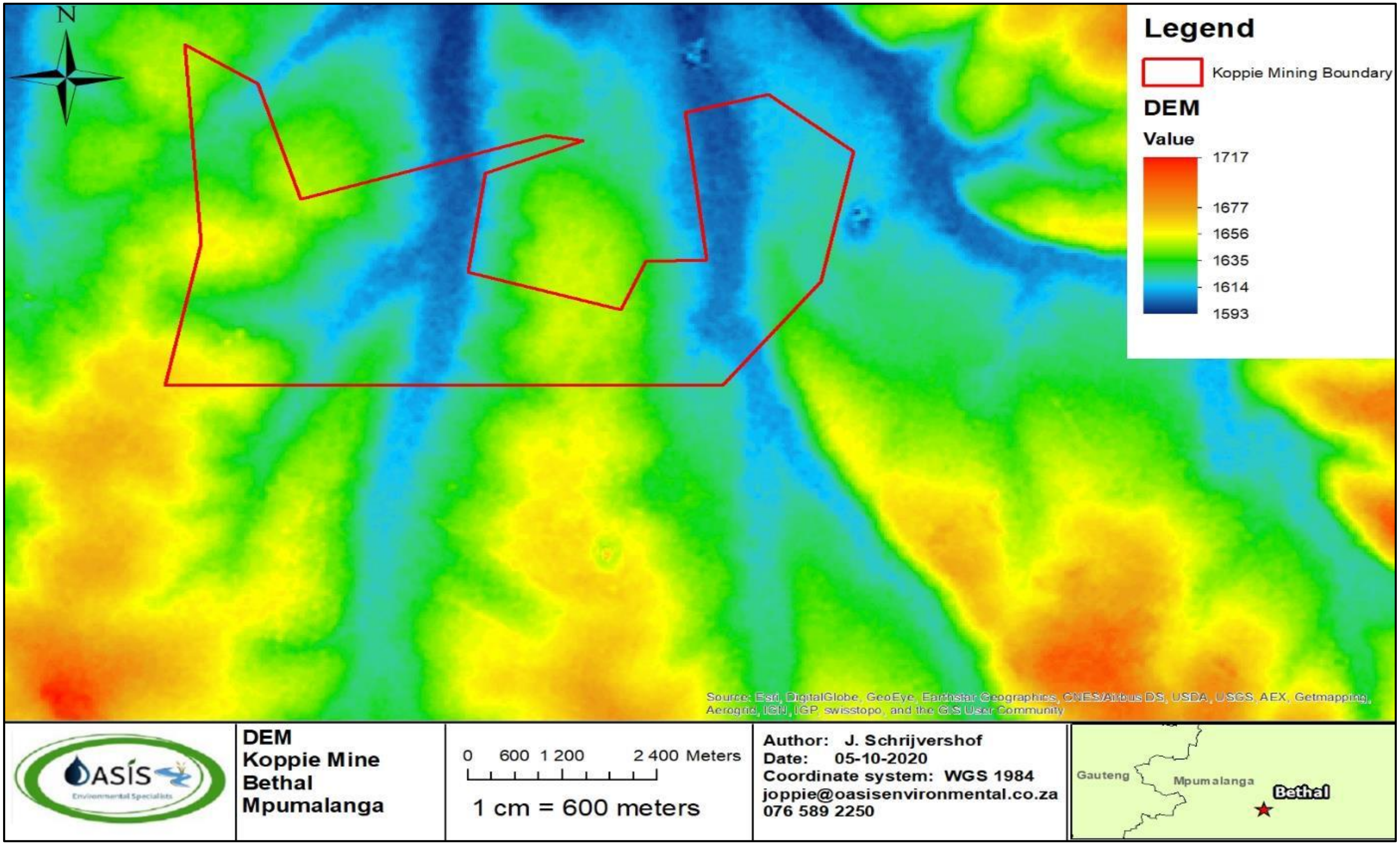


Figure 17: Proposed Koppie Mining Project - Digital Elevation Model map.

4.5.3 Soil wetness and soil form indicator

Wetland areas were identified and mainly delineated according to the presence of hydric (wetland) soil types. Hydric soils are defined as those which show characteristics (redoximorphic features) resulting from prolonged and repeated saturation. Characteristics include the presence of mottling (i.e. bright insoluble manganese and iron compounds) a gleyed matrix and/or Mn/Fe concretions.

The presence of redoximorphic features are the most important indicator of wetland occurrence, as these soil wetness indicators remain in wetland soils, even if they are degraded or desiccated (DWAF, 2005). Redoximorphic features are soil characteristics which develop as a result of prolonged and repeated saturation. It is important to note that the presence or absence of redoximorphic features within the upper 500 mm of the soil profile alone is sufficient to identify the soil as being hydric, or non-hydric (Collins, 2005).

Hydric soils identified within the site were classified as a sandy clay loam (**Figure 18**) and the Katspruit soil form (**Figure 19**). Katspruit is a widely encountered wetland soil in South Africa (Fey, 2010). Alluvial soils were identified within the heavily eroded channel areas (**Figure 20**).

Terrestrial soils sampled were dominated by Clovelly (**Figure 21**) and Hutton soils (**Figure 22**). Soil properties identified on site are shown below (**Table 21**).

Table 21: Information used to inform the wetland delineation for the wetlands identified within 500 m of the Proposed Koppie Mining Project boundary.

Soil Form and Horizons		Soil	Zone of wetness	Observations
Hydric Soil				
Katspruit	Orthic A G Horizon	Clay	Permanent, Seasonal and Temporary zone	Gleyed matrix, clay soil identified. Mottling is also prominent in the G horizon at the temporary zones.
Sandy Clay Loam	Orthic A Unspecified with signs of wetness	Sandy Clay	Permanent, Seasonal and Temporary zone	Gleyed matrix, sandy-clay soil identified. No mottling was found
Terrestrial Soil				
Clovelly	Orthic A Hard Rock	Sandy	None	Yellow structureless soil with no signs of saturation observed. No mottling was observed in the profiles examined
Hutton	Orthic A Red Apedal	Sandy	None	Terrestrial soil identified outside of wetland areas. Red apedal soils identified on the tops of hills. No mottling was identified in these soils as the sandy nature of the soils ensures a quick infiltration of surface water.

Figure 18: Hydric soils included a Sandy Clay Loam soil form associated with the seasonal and temporary wetland areas.

Figure 19: Hydric soils included Katspruit soil form associated in the wetland areas.

Figure 20: Alluvial soils associated with the channel areas.

Figure 21: Clovelly soils were identified and dominant outside of the wetland systems within the grasslands.

Figure 22: Hutton soils were identified and dominant outside of the wetland system within the grasslands and agricultural land.

4.5.4 **Vegetation indicator**

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act, Act 36 of 1998. However, using vegetation as a primary wetland indicator requires an undisturbed condition (DWAF, 2005). Disturbances were however noted in the wetland systems making it difficult to rely solely on vegetation as a wetland indicator. Disturbances included the presence of alien invasive species, damming, mining and erosion within the area.

Wetland riparian vegetation consisted of mainly of *Arundinella nepalensis*, *Phragmites australis*, *Typha capensis*, *Cyperus spp*, *Juncus effesus* and *Crinum bulbispermum* (**Figure 23**).

Figure 23: Riparian plant *Crinum bulbispermum* (Orange River Lilly).

4.5.5 **Wetland Delineation**

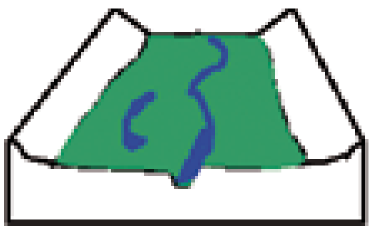
The wetlands identified on the sites were categorised according to the National Wetland Classification System for South Africa (Ollis *et al*., 2013). Wetland areas were classified as a hydrogeomorphic (HGM) units. An HGM unit is a recognisable physiographic wetland-unit based on the geomorphic setting, water source of the wetland and the water flow patterns (MacFarlane *et al*., 2009).

Two floodplain wetland systems (HGM 1 and HGM 2) were identified within the 500 m regulated area of the Proposed Koppie Mining Project. The floodplain wetlands associated with the Joubertsvleispruit and its tributaries is depicted as HGM 1 and HGM 2. One artificial wetland was delineated as a result of seepage and the area was found to be heavily disturbed with excavation activities.

A description of all these wetland types is given in **Table 22**.

Several historical wetlands were identified in proximity to the floodplain systems, according to historical aerial imagery, however showed no wetland characteristics according to vegetation and soil features. These wetlands have been transformed into cultivated land.

Table 22: Wetland hydrogeomorphic (HGM) types (Kotze *et al*., 2008).

HGM Unit	Description	Source of water maintaining the wetland	
		Surface	Subsurface
Floodplain 	Valley bottom areas with a well-defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*

Precipitation is an important water source and evapotranspiration an important output in all of the above settings Water source:

* Contribution usually small

*** Contribution usually large

*/ *** Contribution may be small or important depending on the local circumstances

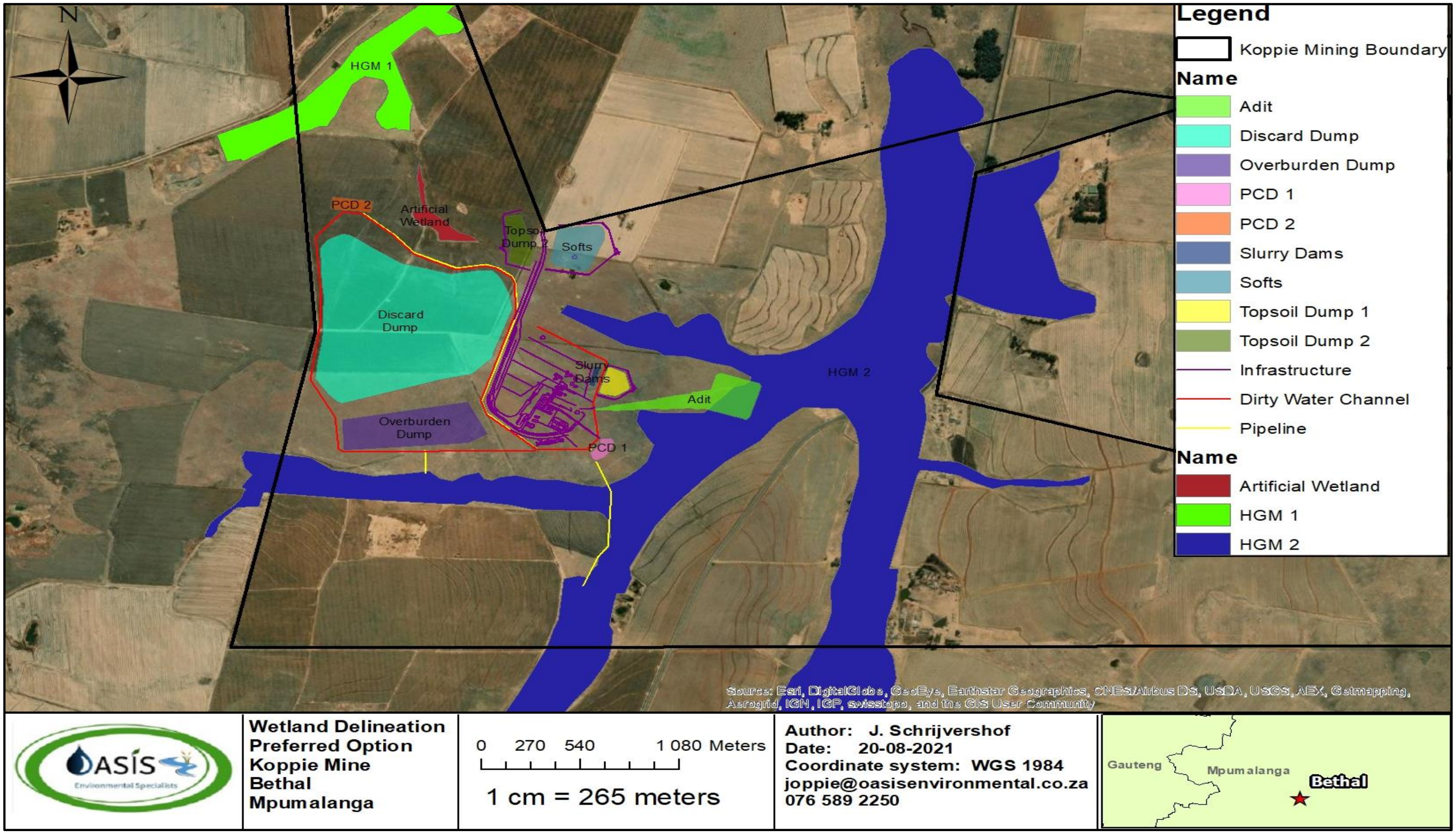


Figure 24: Proposed Koppie Mining Project - Wetland delineation map for the Preferred Option.

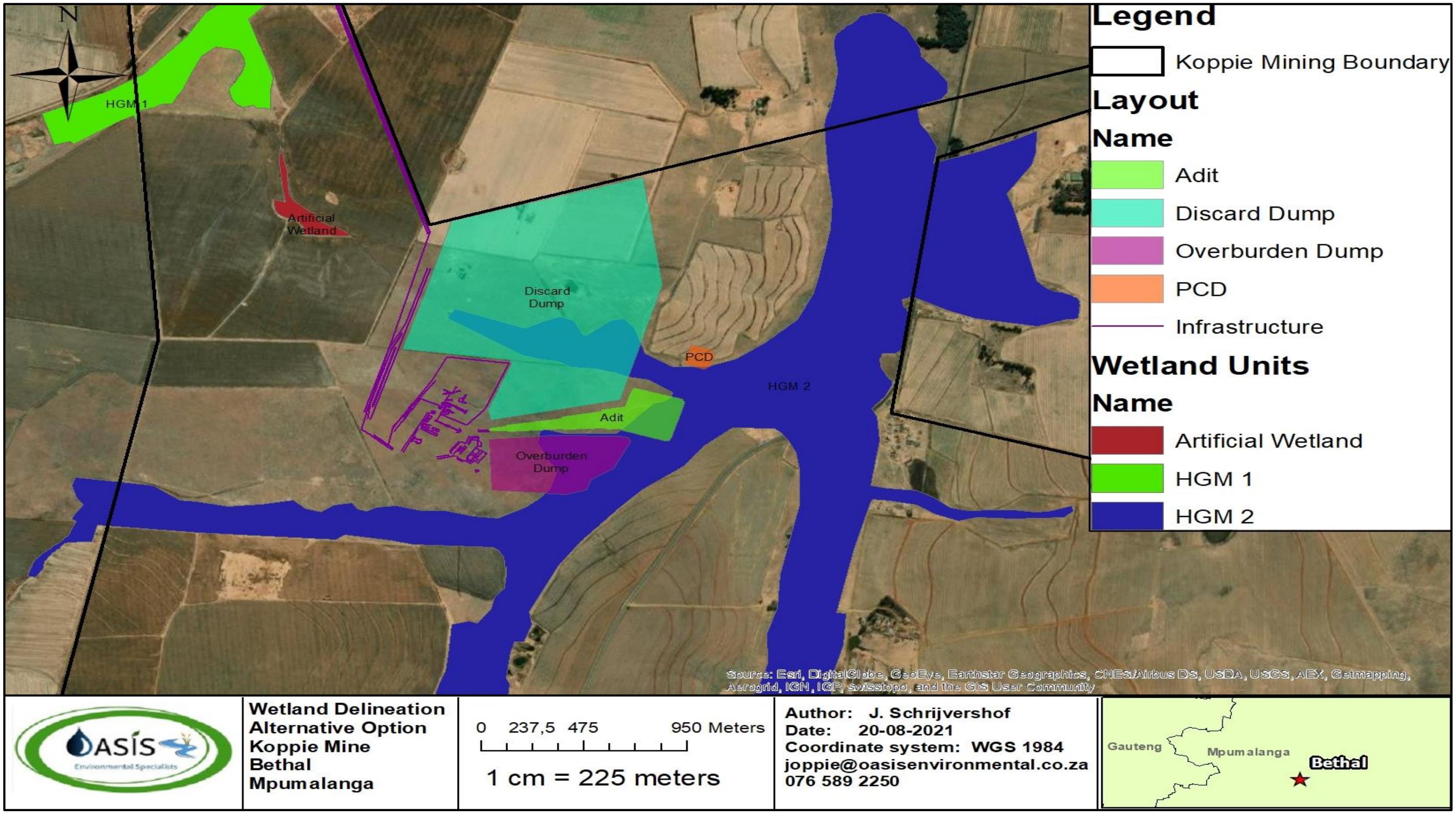


Figure 25: Proposed Koppie Mining Project - Wetland delineation map for the Alternative Option.

4.1 Wetland Functional and Health Assessment

4.1.1 Wetland Ecological Importance and Sensitivity

The associated Hydro-geomorphic (HGM) unit is discussed on the following pages in more detail in terms of the functional integrity, Present Ecological Score and the impacts which affect wetland functionality.

The Ecological Services of the wetland survey has been recorded the floodplain wetlands as **intermediate** and the sensitivity and importance (EIS) has been recorded as **moderate** (**Table 23 and Table 24**). Although only one avifaunal red-data species were identified during the site investigation, the majority of these systems provide habitat for a number of floral and faunal species (**Figure 26**). The presence of open water and vegetation provides a suitable area for breeding, feeding, and protection for some faunal and floral species.

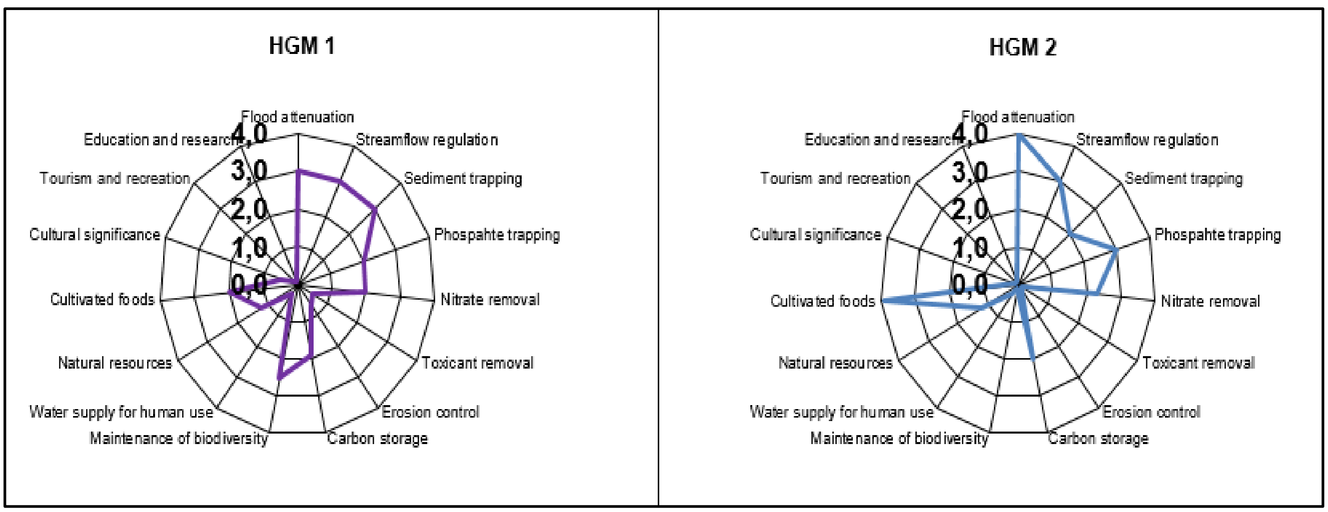


Figure 26: Eco-Services of the HGM units found in the regulated area of the Proposed Mining Project

Table 23: Summary of the Ecological Services of the four wetland systems for Proposed Koppie Mining Project.

Condensed summary sheet	HGM 1		HGM 2	
	Overall score	Confidence rating	Overall score	Confidence rating
Flood attenuation	3,0	4.0	4,0	4.0
Streamflow regulation	3,0	3	3,0	4
Sediment trapping	3,0	3	2,0	4
Phospahte trapping	2,0	3	3,0	3
Nitrate removal	2,0	2	2,3	3
Toxicant removal	0,5	3	0,1	3
Erosion control	0,7	4	0,2	4
Carbon storage	1,9	3	2,0	3
Maintenance of biodiversity	2,5	2	0,1	4
Water supply for human use	0,3	2	0,3	3
Natural resources	1,2	3	1,2	3
Cultivated foods	2,0	3	3,9	3
Cultural significance	0,5	3	0,1	3
Tourism and recreation	0,1	3	0,1	3
Education and research	0,1	3	0,1	3
Threats	1,8	3	2,3	3
Opportunities	0,2	3	0,2	3
Overall	**1,5**	**2,9**	**1,5**	**3,3**

Note: <0.5 Low; 0.5-1.5 Moderately low; 1.5-2.5 Intermediate; 2.5-3.5 Moderately high; and >3.5 High

Table 24: Summary of the Ecological Importance and Sensitivity of the wetland systems associated with the Proposed Koppie Mining Project.

ECOLOGICAL IMPORTANCE AND SENSITIVITY:		
Ecological Importance	Score (0-4)	*Confidence (1-5)*
Biodiversity support	**2,30**	*4,00*
Presence of Red Data species	**2,20**	*4,00*
Populations of unique species	**2,40**	*4,00*
Migration/breeding/feeding sites	**2,30**	*4,00*
Landscape scale	**1,74**	*3,80*
Protection status of the wetland	**2,10**	*4,00*
Protection status of the vegetation type	**1,50**	*3,00*
Regional context of the ecological integrity	**1,90**	*4,00*
Size and rarity of the wetland type/s present	**2,00**	*4,00*
Diversity of habitat types	**1,20**	*4,00*
Sensitivity of the wetland	**2,37**	*3,00*
Sensitivity to changes in floods	1,40	*4,00*
Sensitivity to changes in low flows/dry season	2,70	*2,00*
Sensitivity to changes in water quality	3,00	*3,00*
ECOLOGICAL IMPORTANCE & SENSITIVITY	**2,14**	***3,60***
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**2,13**	***2,13***
DIRECT HUMAN BENEFITS	**1,83**	***3,00***
Overall	**2,03**	**2,91**

None, Rating = 0 rarely sensitive to changes in water quality/hydrological regime; Low, Rating =1 One or a few elements sensitive to changes in water quality/hydrological regime; Moderate, Rating =2 some elements sensitive to changes in water quality/hydrological regime; High, Rating =3 Many elements sensitive to changes in water quality/ hydrological regime; Very high, Rating =4 Very many elements sensitive to changes in water quality/ hydrological regime

4.1.2 Floodplain Wetlands

Three floodplain wetland systems (HGM 1 and HGM 2) were identified within the 500 m regulated area of the Proposed Koppie Mining Project boundary (**Figure 29**). The floodplain wetland received poor scores, indicating that these wetland is heavily transformed systems.

The floodplain wetland systems were assessed in terms of health and found to be categorised as **largely modified (Category D)** (**Table 25 and Figure 27**). The majority of the indigenous vegetation within the development footprint and the surrounding area is transformed with alien invasive vegetation, mining, grazing, cultivation and pollution from informal settlements (**Figure 28).**

Table 25: Summary of PES scores for the HGM Units at Proposed Koppie Mining Project.

Module	HGM Unit 1			HGM Unit 2		
	Impact Score	Category	Trajectory	Impact Score	Category	Trajectory
Hydrology	5,9	D	↓	5,6	D	↓
Geomorphology	5,7	D	↓	5,6	D	↓
Vegetation	4,3	D	↓	4,1	D	↓
Overall Score	**5,30**	**D**	↓	**5,10**	**D**	↓

Improve slightly (↑); Remain stable (→) and deteriorate slightly (↓).

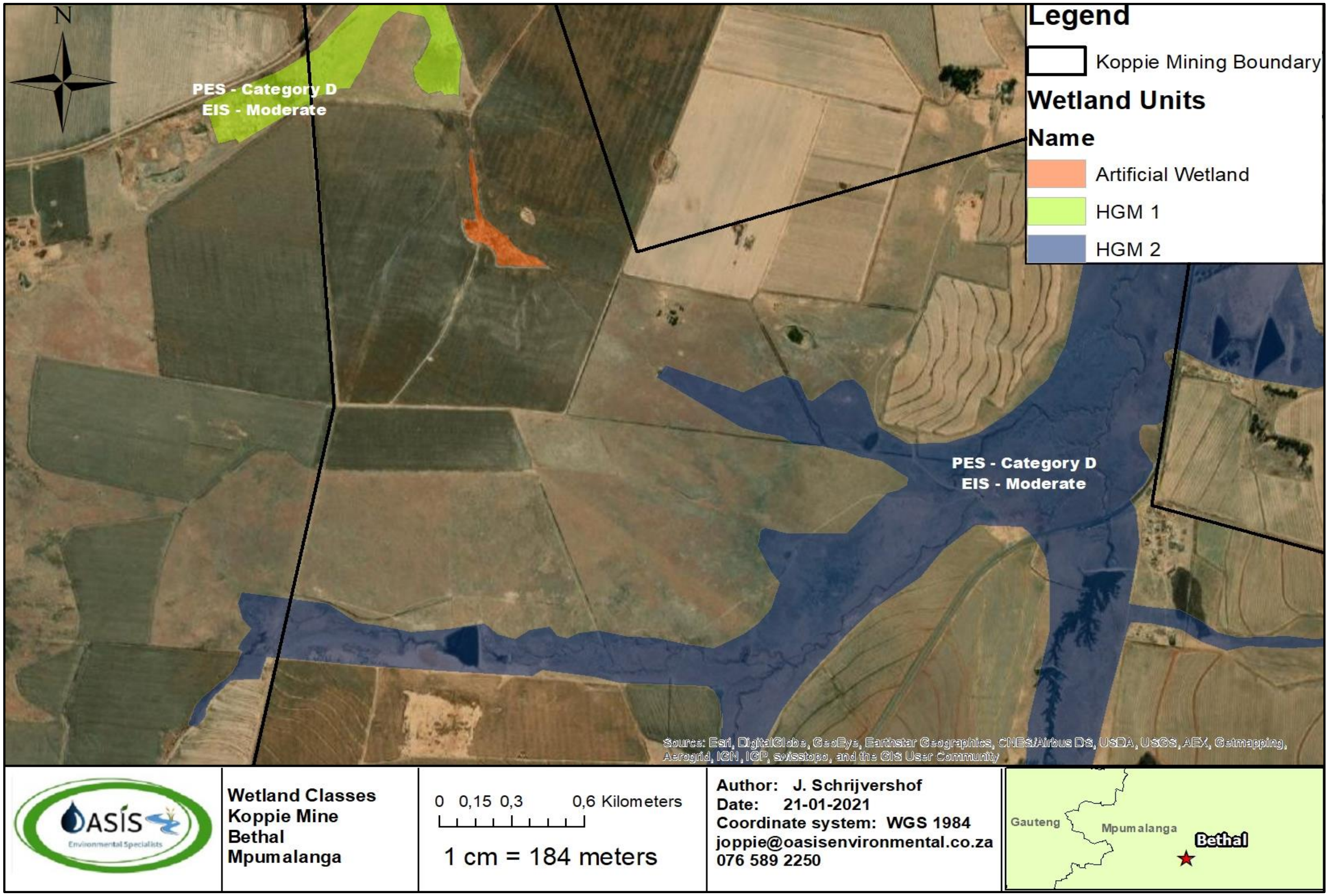


Figure 27: Wetland PES and EIS classes of each HGM Unit delineated.

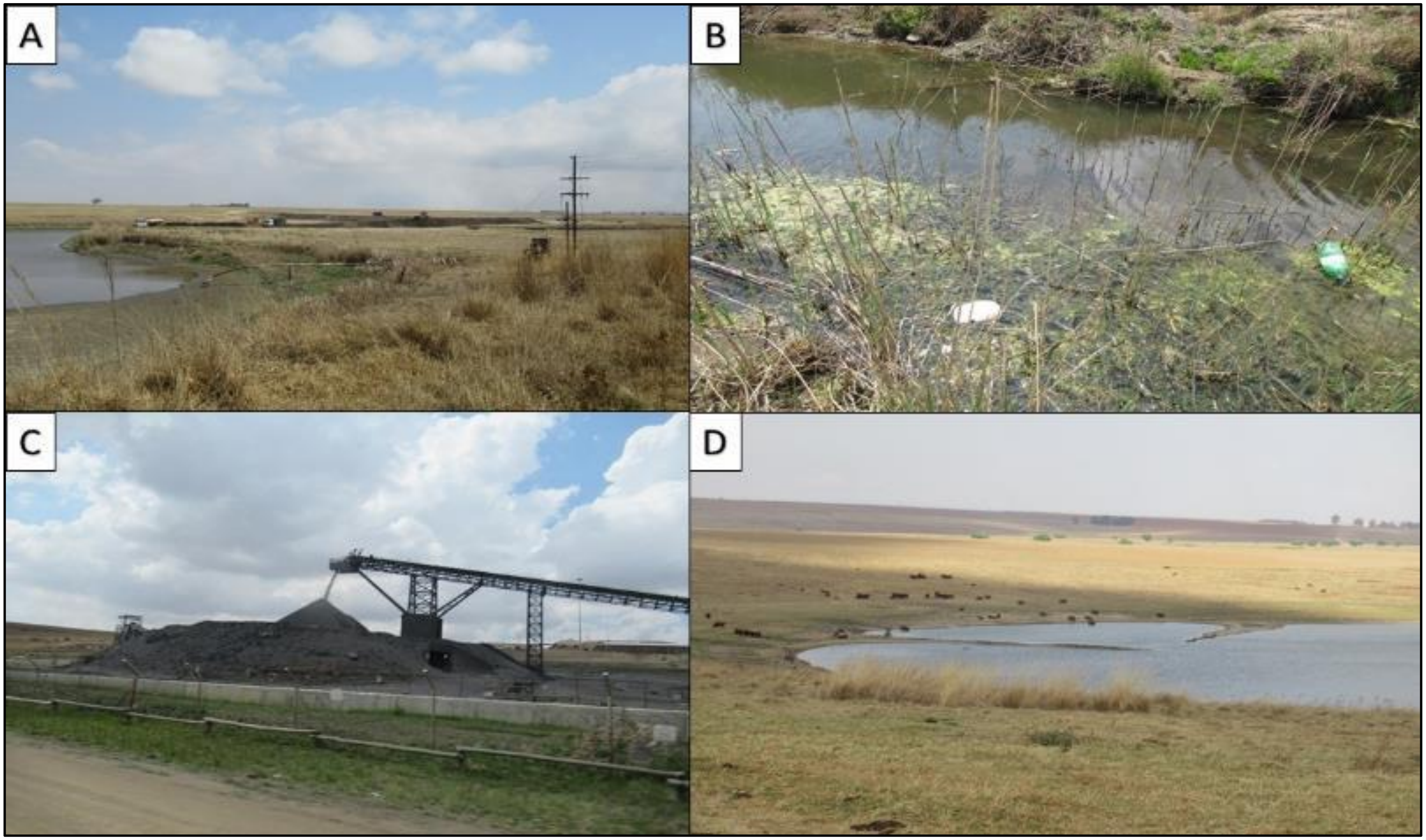


Figure 28: Current impacts identified within the proximity of the Proposed Koppie Mining Project that negatively impact the surrounding wetlands and environment included: (A) Damming of the wetland and river systems (B) Littering within rivers and wetland areas (C) Mining activities in the area (D) Cattle grazing leading to bank trampling of watercourses.

Figure 29: Overall view of the floodplain wetland (HGM 2), where HGM 1 is linked to this system downstream.

4.2 Ecological Assessment

4.2.1 Critical Biodiversity Areas

According to the Critical Biodiversity Areas datasets provided by SANBI (2021), the proposed mining areas overlap with Ecological Support Areas (ESA) and Critical Biodiversity Areas (CBA) as seen in **Figure 30**. These sections were confirmed to be the wetland and grassland areas during the site visit and does overlap with the proposed mining areas and infrastructure

The cultivated land areas are depicted as modified or transformed areas as per SANBI (2021)

4.2.2 Threatened Ecosystems and Protected areas

The proposed mining area is overlaps with Eastern Highveld Grassland vegetation type which is considered to be a threatened ecosystem Mucina and Rutherford, 2006). No national parks or protected areas are in proximity of the Proposed Koppie Mining Project (SANBI, 2021).

4.2.3 Important Bird Areas

The proposed mining operations fall within close proximity (+-7 km) to Important Bird Areas (IBAs), with several pans within the boundary, which could provide nesting areas and foraging habitat for a diversity of avifaunal species. The proposed mining area falls adjacent to the Amersfoort, Bethal and Carolina District (**Figure 31**).

This area is bounded by the main roads between the following towns: Ermelo, Amersfoort, Bethal, Hendrina and Carolina. It consists mostly of flat to undulating farmland between 1,650 and 1,832 m. In a landscape dominated by maize, several remnant patches of moist clay highveld grassland are scattered throughout the district, growing on black vertic clays. The grasslands hold several streams and pans, as well as the Willem-Brummer Dam near Ermelo. Rocky slopes, gullies and ravines favour the development of thicket, dominated by *Leucosidea*, *Buddleja* and *Rhamnus*. In the deeper, fire-protected gullies, secondary forest occasionally develops, with trees of *Euclea*, *Diospyros*, *Myrsine* and *Rhus*. (Birdlife, 2020).

This site holds a large proportion of the global population of Spizocorys fringillaris. The grassland areas also hold *Neotis denhami, Eupodotis senegalensis, Saxicola bifasciata, Monticola explorator* and *Geronticus calvus*. F*alco naumanni, Glareola nordmanni* and *Circus macrourus* (Birdlife, 2020).

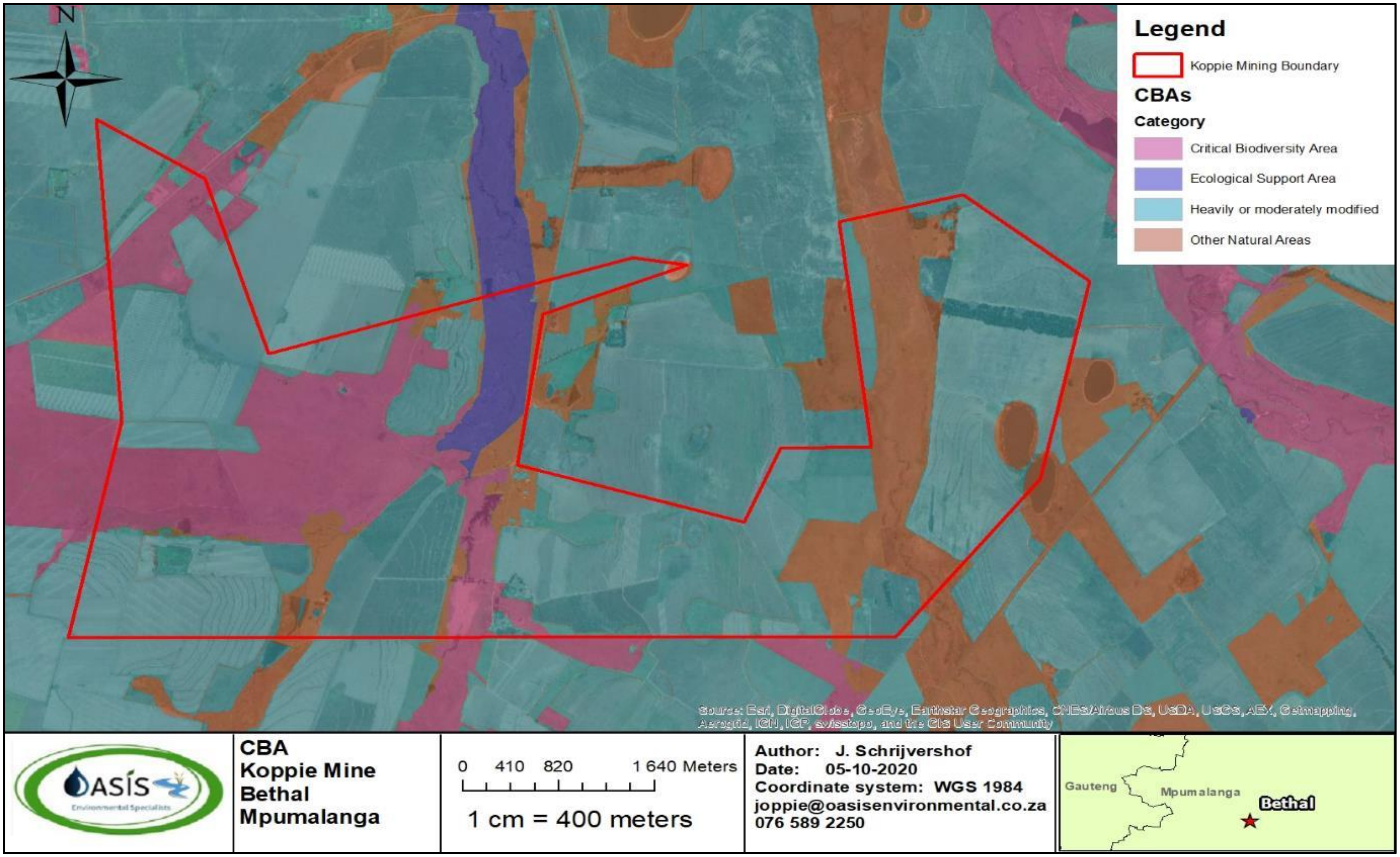


Figure 30: Proposed Koppie Mining Project - Critical Biodiversity Areas map.

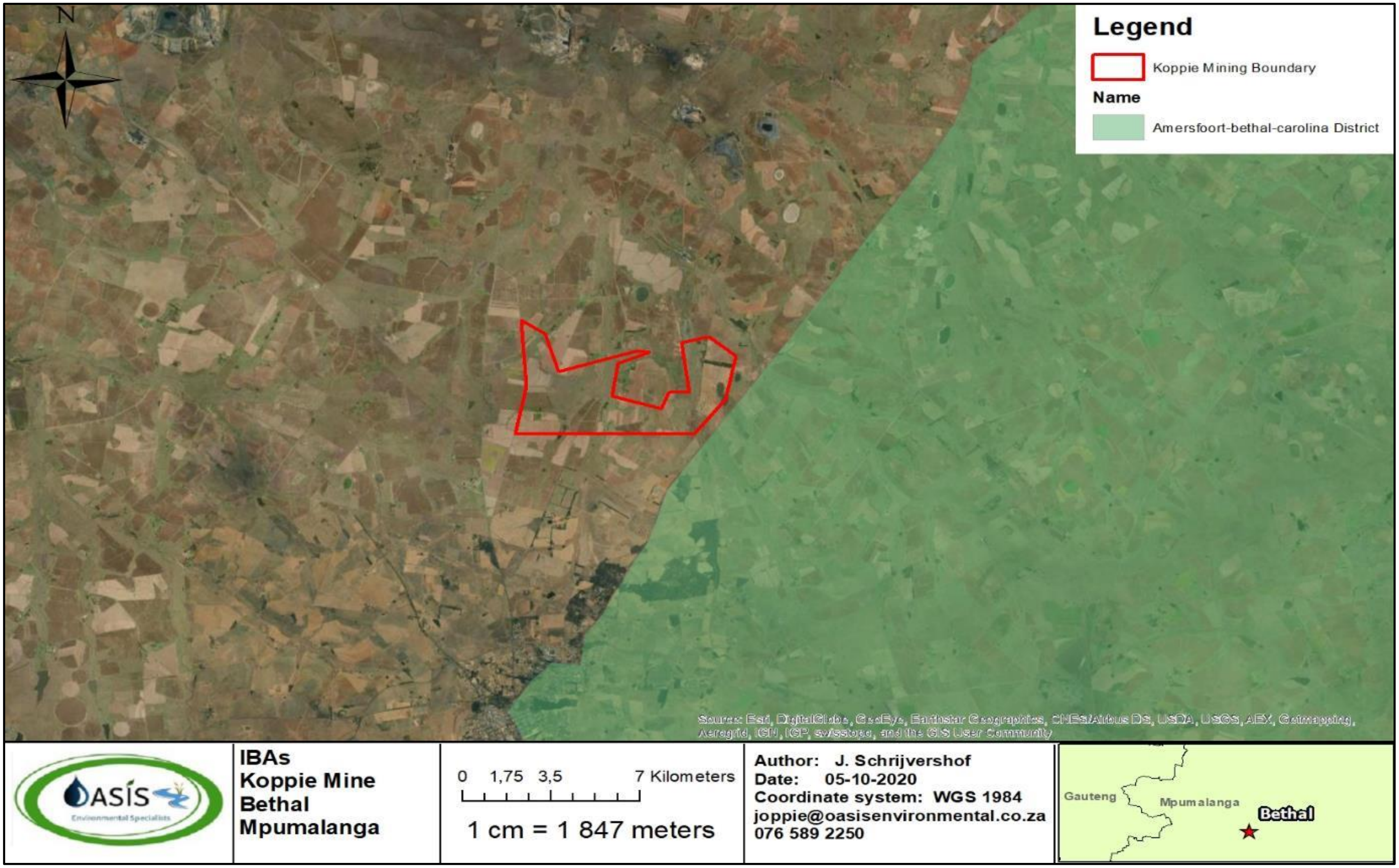


Figure 31: Proposed Koppie Mining Project - Important Bird Areas map.

4.2.4 Vegetation

The majority of the study site consisted of alien invasive vegetation and very little indigenous vegetation, however vegetation that might be associated with that area is listed in **Appendix B** depicted from SANBI's POSA list (SANBI, 2021). Species of conservation concern includes *Nerine gracilis,* listed as Vulnerable, where *Gladiolus robertsoniae* and *Kniphofia typhoides* are listed as Near Threatened. Information on plant species recorded in that area was extracted from the POSA list, indicate that 253 plant species have been thought to occur in the area queried of which 239 are endemic species are known to occur within the area queried. None of the species were found to possibly occur on site that have medicinal uses. (**Table 26**).

Table 26: Floral species summary for the area queried around the proposed Proposed Koppie Mining Project (SANBI, 2021).

Number of Families	Number of species	Endemic species	Exotic species	IUCN Red Listed Species
54	253	239	14	3

Due to the heavily transformed state of the proposed project sites, due to intensive crop cultivation, it is highly unlikely that any IUCN red listed species occur within the project footprint.

Commonly observed grasses (dominant species) within the area of investigation comprised of *Imperata cylindrical* (Cogon grass), *Arundinella nepalensis* (River Grass), *Hyparrhenia hirta* (Thatching grass), *Melines repens* (Natal red top), *Eragrostis gummiflua* (Gum Grass), not favoured by cattle, was dominant and additional *Eragrostis* species were prevalent, including: *Eragrostis curvula* (Lovegrass), *Eragrostis racemose* (Narrow Heart Love Grass) and *Eragrostis chloromelas* (Curly Leaf), *Themeda triandra* (Red Grass) and *Pogonarthria squarrosa* (Herringboe grass) (**Figure 32**). *Seriphium spp.* were found encroaching the grassland areas.

Crinum bulbispermum (River Lily), found within the riparian and wetland areas in this vegetation unit, is provincially protected (according to Mpumalanga Nature Conservation Act, 1998 (Act No. 10 of 1998): Schedule 11).

Figure 32: Proposed Koppie Mining Project - Vegetation habitats identified included: (A) Riparian Vegetation along stream and wetlands, these can be considered highly sensitive (B) Eragrostis-dominated Grasslands, which can be considered moderately sensitive; (C) Transformed land by cultivation and agriculture can be considered low sensitive.

4.2.5 Alien Invasive Vegetation

National Environmental Management: Biodiversity Act (No. 10 of 2004) categories for invasive species according to Section 21 are as follows:

- Category 1a: Species requiring compulsory control;
- Category 1b: Invasive species controlled by an invasive species management programme;
- Category 2: Invasive species controlled by area, and;
- Category 3: Invasive species controlled by activity.

Certain species have different alien invasive categories for different provinces in South Africa, where **Table 27** lists the alien species identified on site as well as their respective alien categories. The dominant plant species identified was alien invasive *Datura stramonium*, Eucalyptus *tereticornis* and Grey poplar tree *(Populus canescens*,).

Table 27: Alien Invasive Plants identified surrounding the mining area.

Species Name	Common Name	Category
Black locust tree	*Robinia pseudoacacia*	1b
Black Wattle	*Acacia mearnsii*	2
Common thorn apple	*Datura stramonium*	1b
Forest red gum	*Eucalyptus tereticornis*	1b
Fountain grass	*Pennisetum setaceum*	1b
Grey poplar tree	*Populus canescens,*	2
Horseweed	*Erigeron bonariensis*	-
Khaki Weed	*Tagetes minuta*	-
Pale smartweed	*Persicaria lapathifolia*	-
Patula pine	*Pinus patula*	2
Sisal hemp	*Agave sisilana*	2
Spiny cocklebur	*Xanthium spinosum*	1b
Syranga	*Melia azedarach*	1b
Tall Verbena	*Verbena bonariensis*	1b
Weeping willow	*Salix babylonica*	-
Wild tomato/Dense thorned bitter apple	*Solanum sisymbriifolium*	1b

4.2.6 **Fauna**

Mammal species that were identified onsite included the yellow mongoose (*Cynictis penicillata*) and ground squirrel (*Xerus spp*.). Spine from the Cape Porcupine (*Hystrix africaeaustralis*) were found within the agricultural land (**Figure 34**).

Bird species identified during the site survey included Fan-tailed widowbird (*Euplectes axillaris*); Southern red bishop (*Euplectes orix*); Southern masked weaver (*Ploceus velatus*); Blacksmith lapwing (*Vanellus armatus*), Hadeda ibis (*Bostrychia hagedash*), Laughing dove (*Spilopelia senegalensis*), Pin-tailed whydah *(Vidua macroura*); Helmeted guineafowl (*Numida meleagris*), Cliff Swallows (*Petrochelidon pyrrhonota*) and Indian myna (*Acridotheres tristis*). Other species include which were observed in a pan included Domestic Goose (*Anser anser subsp. Domesticus*), Grey Heron (*Ardea cinerea*), Cattle Egret (*Bubulcus ibis*), White Stork (*Ciconia ciconia*), Great Egret (*Egretta alba*), Red-knobbed Coot (*Fulica cristata*), Black-winged Stilt (*Himantopus himantopus*), Spur-winged Goose (*Plectropterus gambensis*) and Glossy Ibis (*Plegadis falcinellus*)

Red listed faunal species of Lesser Flamingo (*Phoeniconaias minor*) were observed in one pan area in proximity to the mine boundary during the site visit (26°19'22.57"S; 29°30'56.08"E), The Lesser Flamingo is listed as Near Threatened by the IUCN red list (**Figure 33**).

From the Desktop findings the Southern African Hedgehog (*Atelerix frontalis*), Serval (*Leptailurus serval*), Brown Hyena (*Hyaena brunnea*) and Lesser Flamingo (*Phoenicopterus minor*) which is listed Near Threatened are found within these areas. The Southern Bald Ibis (*Geronticus calvus*) and Secretarybird (*Sagittarius serpentarius*) which is listed by IUCN as Vulnerable might occur in this area according to the data from Virtual Museum (2021), although very unlikely. The fauna expected to occur within that area is listed in **Appendix A**.

Riparian vegetation along stream and wetlands can be considered highly sensitive areas serves as a breeding and foraging habitat for avifauna and aquatic fauna. Grasslands can be considered moderately sensitive as they have been disturbed by surrounding impacts of agriculture and mining. Transformed land by mining and agriculture can be considered low sensitive and covers the majority of the area. These areas are illustrated in **Figure 35 and Figure 36**.

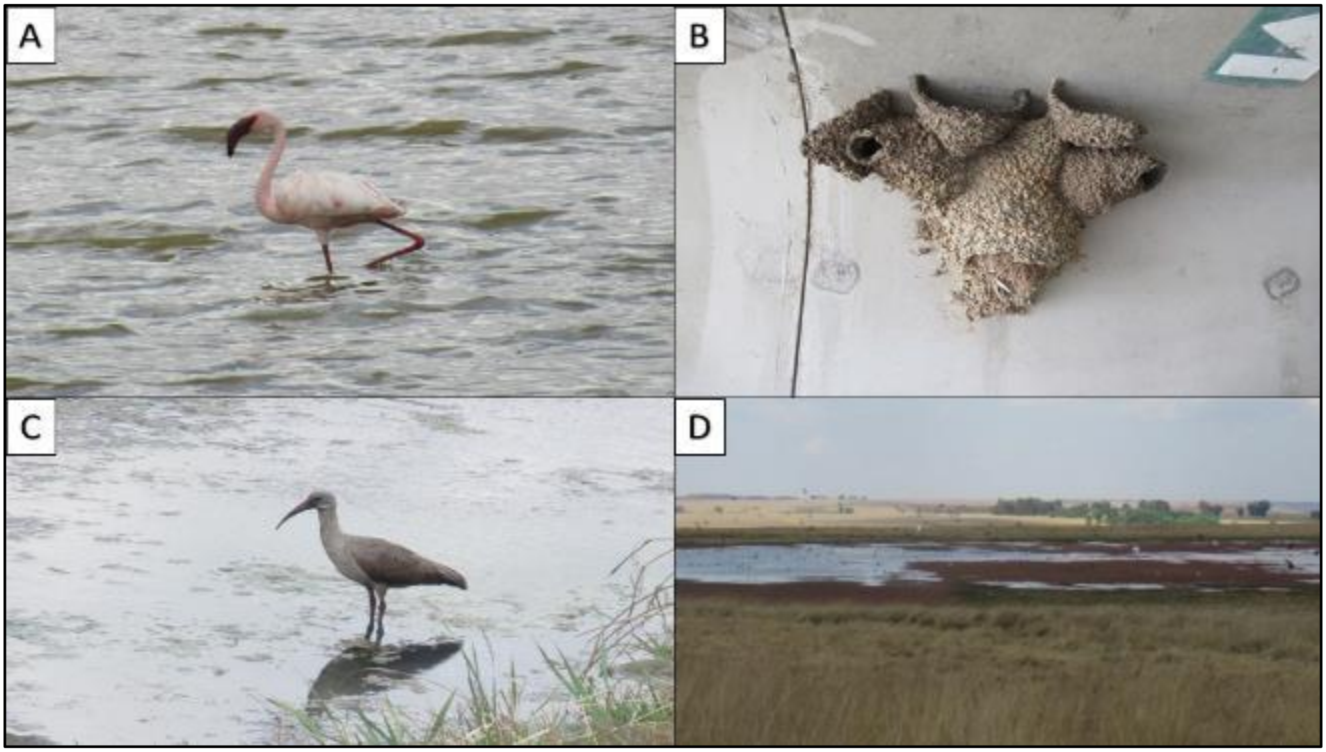


Figure 33: Proposed Koppie Mining Project - Birds identified included: (A) Lesser Flamingo (*Phoeniconaias minor*); (B) Nesting areas with Cliff Swallows (*Petrochelidon pyrrhonota*); (C) Hadeda ibis (*Bostrychia hagedash*) and (D) A pan outside the mine property with several ibis, egret and duck species.

Figure 34: Proposed Koppie Mining Project – Unknown animal droppings and spines from an Cape Porcupine (*Hystrix africaeaustralis*)

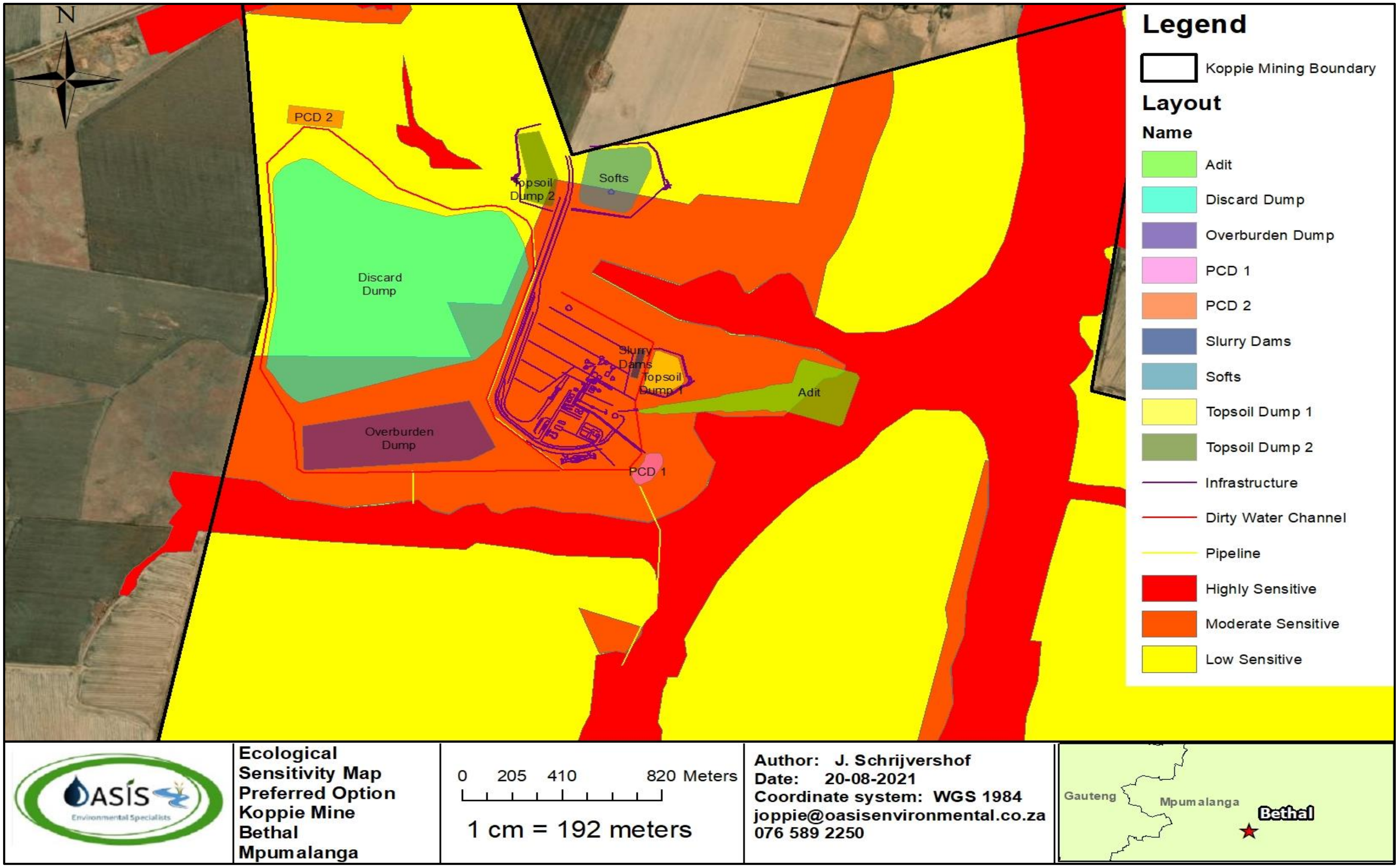


Figure 35: Proposed Koppie Mining Project - Sensitivity map for the Preferred Option.

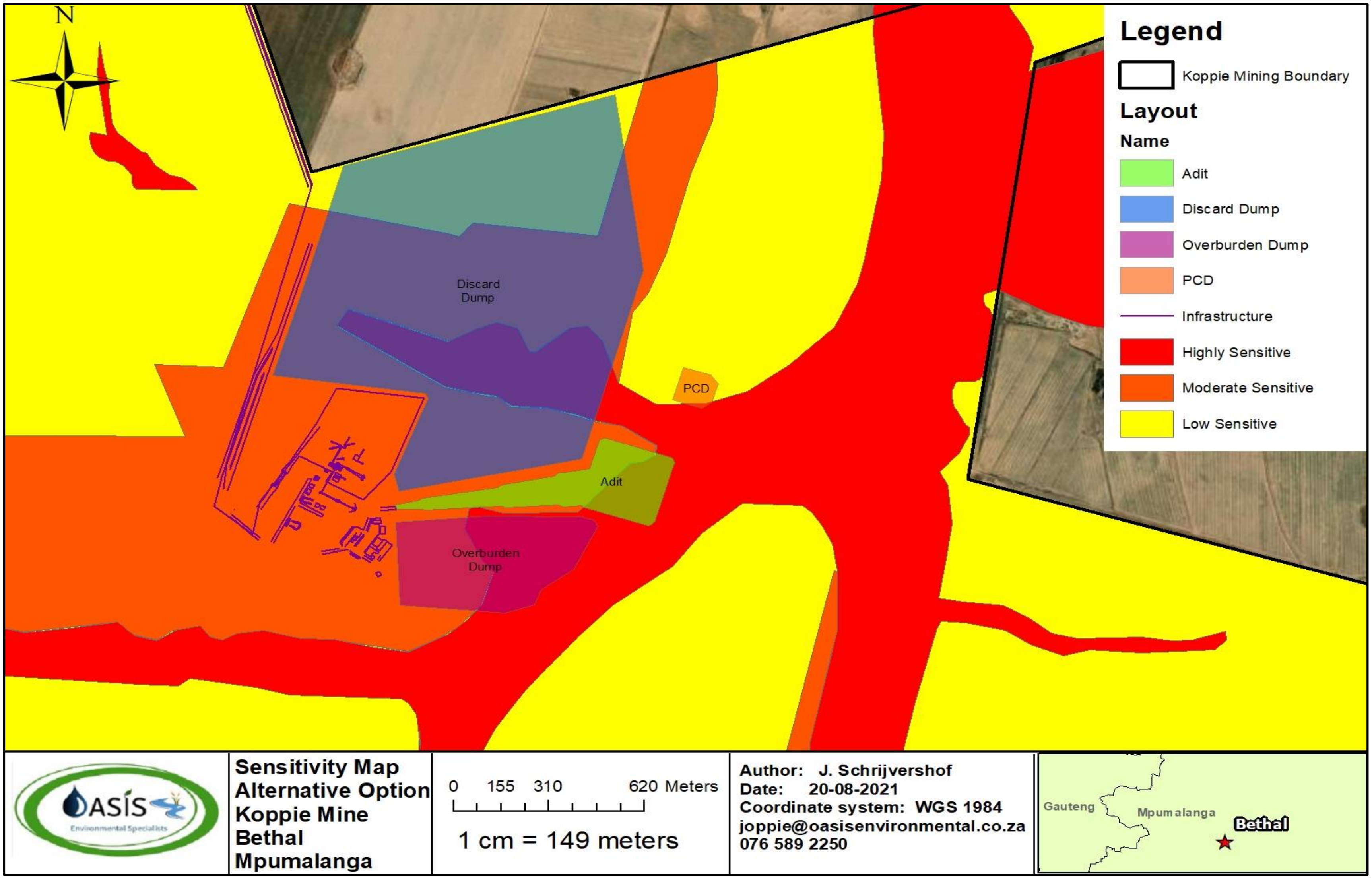


Figure 36: Proposed Koppie Mining Project - Sensitivity map for the Alternative Option.

5 RISK ASSESSMENT OF DELINEATED WETLANDS

The risk assessment focussed on the impacts associated with the Proposed Koppie Mining Project as mentioned above.

Vegetation clearing will occur and this will lead to increased turbidity and sedimentation in the watercourses as well as altered flow patterns. The machinery used has a risk of hydrocarbon spills into watercourses.

There are impacts on the flow patterns to the stream as well as possibly increased nutrient levels from the waste materials entering the water course.

This report highlights the findings for a one site survey, limiting the confidence for the risk assessment for the Preferred Option and the Alternative Option **without mitigation in Table 28 and Table 29 and with mitigation in Table 30 and Table 31 respectively.**

The proposed mining infrastructure of coal will include the following for the Preferred Option:

- Access / haul roads;
- Washing plant;
- Workshops;
- Offices;
- Weighbridge;
- Two slurry dams;
- Two Pollution Control Dams;
- Stormwater management facilities;
- Boreholes;
- Powerlines;
- Substation;
- Sewage management systems;
- Conveyor belt systems;
- Two Topsoil Dumps;
- Dirty water channels
- Adit;
- Ventilation Shafts;
- Discard Dump;

- Overburden Dump; and
- Two pipelines leading to the existing dams.

The proposed mining infrastructure of coal will include the following for the Alternative Option:

- Access / haul roads;
- Washing plant;
- Workshops;
- Offices;
- Weighbridge;
- One Pollution Control Dam;
- Stormwater management facilities;
- Boreholes;
- Powerlines;
- Substation;
- Sewage management systems;
- Conveyor belt systems;
- Adit;
- Ventilation Shafts;
- Discard Dump; and
- Overburden Dump.

Operational Phase

Increased sedimentation may occur as a result from the runoff from stockpiles. This has the potential to change habitat structure within the receiving environment and this will in turn result in changes in ecosystem function. Changes in habitat structure due to sedimentation would result in changes in the species composition.

Water quality impairment has the potential to change ecosystem function, change community structure as species sensitive to water quality impairment are eliminated and tolerant species increase in number, this results in a loss of biodiversity of sensitive species in other words the sensitive species disappear first when water quality alterations take place.

Invasive alien plants have far reaching detrimental effects on native biota and has been widely accepted as being a leading cause of biodiversity loss. They typically have rapid reproductive turnover and are able to outcompete native species for environmental resources, alter soil stability, and promote erosion, change litter accumulation and soil properties. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flow thereby potentially increasing sediment inputs and altering natural hydrology of receiving watercourses. These impacts negatively affect areas that are largely natural (with low existing weed levels) greater than for areas already characterised by dense infestations of alien plants with low indigenous plant diversity (Macfarlane *et al*., 2014).

5.1.1 **Sedimentation and soil erosion**

Soil erosion will result in the deposition of sediment into the wetland system; posing a risk to the downstream catchment geomorphological/functional integrity. Subsequent impacts that are likely to result are: a loss of instream flow including aquatic refugia and flow dependent taxa; sedimentation of the watercourse that will be destructive to many faunal species affecting their habitat; breeding and feeding cycles.

Some of the key biological effects related to the deposition of sediment and suspension of fine sediment within the watercourses includes:

- Habitat alteration downstream of crossing points due to increased sediment deposition (degradation of coarse riverbed habitats by the infilling of interstitial spaces and the reduction of inter-granular flow for example);
- Reductions in photosynthetic activity and primary production caused by sediments impeding light penetration;
- Reduced density and diversity in benthic invertebrate communities as a result of habitat degradation, blanketing of fish spawning sites and the establishment of more tolerant taxa or exotic species; and
- Changes to the behaviour and feeding ability of fish at low levels of suspended sediments, while physiological damage and mortality can occur at very high concentrations of suspended sediment resulting in clogging of fish gills, interference in embryogenesis and larval development of amphibians and mortality of filter-feeding macro-invertebrates.

During the operational phase rainfall is likely to filter through stockpiles and dumps. This water is likely to accumulate particles and pollutants that will pose a risk to the surrounding water courses. Sediment that washes from the dumps and stockpiles during periods of rainfall will also contribute to increased sedimentation in the aquatic environment.

Erosion and sedimentation impacts are linked to alterations in hydrological regimes as a result of increased storm water floodpeaks associated with increased impermeable surfaces and the concentration of flows. Increases in peak discharge may significantly increase stream power, increasing the risk of erosion (localised scouring and incision) and resultant sedimentation of watercourses. Local site factors such as soil erodibility, vegetation cover, gradient of local slopes and regional rainfall/runoff intensity will affect the probability and intensity of erosion impacts (Macfarlane *et al*., 2014). Typical results of erosion & sedimentation on water resources may include:

- Locally increased channel slopes;
- Loss of in-stream biotope diversity due to scouring or blanketing of sites with sediment;
- Localised scouring at stormwater discharge points into watercourses;
- Headcut migration upstream and subsequent deepening of channels (where base level lowering has occurred);
- Lowering of the local water table and subsequent desiccation of adjacent to the river and riparian areas;
- Relatively higher channel banks that may exceed critical height resulting in bank failure/collapse;
- Addition of sediment to the water column (increased turbidity) affecting suitability for aquatic organisms; and
- Deposition of large masses of sediment downstream causing localised channel braiding, instability of the river banks and alterations in water distribution.

5.1.2 **Pollution of water resources and soil**

Changes to the water quality will result in changes to the ecosystem structure and function as well as a potential loss of biodiversity. Water quality pollution leads to modification of the species composition where sensitive species are lost and organisms tolerant to environmental changes dominate the community structure. Any substances entering and polluting watercourses will directly impact downstream ecology through surface runoff during rainfall events, or subsurface water movement, particularly during the wetter summer months.

Contaminants such as hydrocarbons, solids, pathogens and hazardous materials may enter watercourses (examples include petrol/diesel, oil/grease, paint, cement/concrete and other hazardous substances). These contaminants negatively affect aquatic ecosystems including sensitive or intolerant species of flora and fauna. Where significant changes in water quality occur, this will ultimately result in a shift in aquatic species composition, favouring more tolerant species, and potentially resulting in the localised exclusion of sensitive species. Water quality monitoring must be implemented to ensure sustainable management of water sources within that area. Sudden drastic changes in water quality can also have chronic effects on aquatic biota leading to localised extinctions. Deterioration in water quality will also affect its suitability for human domestic/agricultural use and have far reaching impacts for local communities who may rely on rivers as water supply (Macfarlane *et al*., 2014).

5.1.3 Alien Invasive Species

There are several alien invasive plant species currently present within the proposed mining areas. Any ground disturbance provides an opportunity for alien invasive plant species to spread and for new species to establish themselves in the areas. Alien invader plant species pose an ecological threat as they alter habitat structure, lower biodiversity (both number and "quality" of species), change nutrient cycling and productivity, and modify food webs (Zedler & Kercher, 2004). Such changes on the ecology of the riparian habitat have/will have a detrimental impact on its ability to maintain both floral and faunal biodiversity. Invasive alien plant species, particularly woody species, have much increased water usage compared with indigenous vegetation. Many alien invasive plant species are particularly found in riparian ecosystems and their invasion results in the destruction of indigenous species; increased inflammable biomass (high fire intensity); erosion; clogging of waterways such as small streams and drainage channels causing decreased river flows and incision of river beds and banks. This results in an overall impact on the hydrological functioning of the system.

Physical alteration of cross-sectional and longitudinal profiles of rivers may also result from bulk earthworks associated with the plants for example, altering natural water flow and sediment dynamics within rivers, having a knock-on effect on habitat and ecosystem dynamics. These impacts can stimulate erosion, as well as potential sedimentation of downstream habitats and a change to water regimes of adjoining riverine and riparian habitat. Areas that are mainly natural/intact would be most affected by these impacts (Macfarlane *et al*., 2014).

5.1.4 **Mitigation**

The Proposed Koppie Mining Project will have negative effects on the environment. The following mitigation measures may reduce the severity of impacts:

- Design and implementation of a suitable stormwater system;
- Rehabilitation of the disturbed areas;
- Limiting instream sedimentation;
- Minimising pollutants entering the watercourse;
- Implement a programme for the clearing/eradication of alien species including long term control of such species;
- A 110 m buffer implemented for the wetland system;
- Water quality monitoring must take place every month during operational phases; and
- Biomonitoring must take place bi-annually during hi flow and low flow season.

Sedimentation and soil erosion

Mitigation options

- Alien vegetation must be cleared prior to clearing/stripping new areas, to ensure alien vegetation is not spread to other areas.
- A topsoil stripping and stockpiling guideline must be completed to ensure rehabilitation success.
- Attenuation of stormwater from any establishment and its associated infrastructure is important to control the velocity of runoff towards the wetland systems. Attenuation structures must be placed between the development and associated infrastructure and the river.
- Attenuation measures must include, but are not limited to - the use of sand bags, erosion control blankets, and silt fences.
- Long term attenuation measures, such as attenuation/infiltration trenches, swales must be established to control stormwater from hardened surfaces so as to Sustainable Urban Drainage Systems (SUDS): All storm water runoff from the site must be supplemented by an appropriate road drainage system that must include open, grass-lined channels/swales rather than simply relying on underground piped systems or concrete V-drains. SUDS will encourage infiltration across the site, provide for the filtration and removal of pollutants and provide for some degree of flow attenuation by reducing the energy and velocity of storm water flows through increased roughness when compared with pipes and concrete V-drains.
- Do not allow surface water or stormwater to be concentrated, or to flow down cut or fill slopes without erosion protection measures being in place.

- Vegetation clearing must be undertaken as and when necessary in phases.
- Materials such as metals, chemicals cement and sand for the plant and plant infrastructure, other than sourced from the approved quarries/pits, must be sourced from a licensed commercial source.
- Any topsoil removed from the project footprint must be stockpiled separately from subsoil material and be stored suitably for use in rehabilitation activities.
- Install sediment barriers (silt catchers and Reno mattresses) along any drainage areas to prevent the migration of silt.
- All demarcated sensitive zones outside of the mine area are strictly off limits during any mining activity.
- Exposed soils must be rehabilitated as soon as practically possible to limit the risk of erosion. Erosion control measures must be employed where required.
- Stabilise, re-shape and rehabilitate disturbed areas as soon as practically possible (within 3 weeks of disturbance) with indigenous wetland and riparian vegetation. Such rehabilitation should be informed by a suitable replanting and re-vegetation programme, sand bags, silt fencing, etc. A mix of rapidly germinating indigenous vegetation must be used.
- Riparian vegetation bordering on drainage lines, wetlands and rivers will be considered environmentally sensitive and impacts on these habitats should be avoided.
- If erosion has taken place, rehabilitation will commence as soon as possible.
- All roads need to be maintained and any erosion ditches forming along the road filled and compacted.
- Berms/ earthen walls should be vegetated in order to avoid erosion and sedimentation.
- Runoff water from the waste dumps, stockpiles and contaminated stormwater will be channelled into newly pollution control dams to avoid effects on the wetland system. The water in these pollution control dams will be reused during the mining operations.
- Demarcated and bunded stockpiles and waste dumps will also be placed in areas where groundwater and surface water pollution can be avoided.
- The runoff will be routinely monitored for acidity and salinity as an early warning for potential increases in salinity or acidic drainage water.

Pollution of water resources and soil

Mitigation options

- Demarcate wetland areas to avoid unauthorised access.
- No washing of any equipment in close proximity to a watercourse is permitted.
- No releases of any substances that could be toxic to fauna or faunal habitats within the channels or any watercourses is permitted.
- Spillages of fuels, oils and other potentially harmful chemicals must be cleaned up immediately and contaminants properly drained and disposed of using proper solid/hazardous waste facilities (not to be disposed of within the natural environment). Any contaminated soil must be removed and the affected area rehabilitated immediately.
- Portable toilets must be placed on impervious level surfaces that are lipped to prevent spillage. The general consensus is that they should be within 30 m to 50 m of a work face
- Cut-off trenches must be constructed to prevent any harmful substances from entering the wetland area.
- Education of workers is key to establishing good pollution prevention practices. Training programs must provide information on material handling and spill prevention and response, to better prepare employees in case of an emergency.
- Signs should also be placed at appropriate locations to remind workers of good housekeeping practices including litter and pollution control.
- The proper storage and handling of hazardous substances (hydrocarbons and chemicals) needs to been ensured. All employees handling fuels and other hazardous materials are to be properly trained. Storage containers must be regularly inspected so as to prevent leaks.
- Ensure that any rubbish/litter is cleared once a month as to minimise litter near the wetland areas. These will need to be cleaned out in accordance with a regular maintenance programme.
- Industry Best Practise Guidelines and Standards needs to be implemented in terms of tailings storage design. Built-in engineering designs such as drainage systems and decanting pools are recognised as mitigation measures.
- Water quality will be monthly monitored with the site activities. This includes sites upstream and downstream.
- Ensure pollution sources are isolated through clean and dirty water separation and monitor this throughout the lifespan of the Koppie Coal Mine.
- All contractors and employees should undergo induction which is to include a component of environmental awareness

Alien Invasive Species

Mitigation Options

- An alien invasive management programme must be incorporated into an Environmental Management Programme.
- Ongoing alien plant control must be undertaken, particularly in the disturbed areas as these areas will quickly be colonised by invasive alien species, especially in the riparian zone, which is particularly sensitive to AIP infestation.
- Herbicides must be carefully applied, in order to prevent any chemicals from entering the river. Spraying of herbicides within or near to the wetland areas is strictly forbidden.
- Re-instate indigenous vegetation (grasses and indigenous trees) in disturbed areas.

Table 28: Significance ratings matrix for the impacts without mitigation measures being implemented for the Proposed Koppie Mining Project's Preferred Option.

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level
1	Construction phase	**Proposed Koppie Mining Project Preferred Option**	Altering of stream banks Work Revetments New access routes Site clearing Placement of stockpiles Use of heavy machinery	Flow alterations due to erosion and sedimentation	3	2	2	2	2,25	3	2	7,25	3	3	5	3	14	101,5	M	80
2	Construction phase	**Proposed Koppie Mining Project Preferred Option**	Use of heavy machinery using oils and fuels during site clearing Accidental spillages of chemicals, cements, oils, etc.	Pollution of watercourse	2	3	2	3	2,5	3	2	7,5	3	3	5	3	14	105	M	80
3	Construction phase	**Proposed Koppie Mining Project Preferred Option**	New access route Use of heavy machinery Placement of stockpiles Bank trampling leading to erosion	Spread of alien vegetation	2	2	3	2	2,25	3	2	7,25	3	3	5	2	13	94,25	M	80
4	Operational phase	**Proposed Koppie Mining Project Preferred Option**	Increased traffic Use of heavy machinery Runoff from dumps and stockpiles Bank Erosion	Flow alterations due to erosion and sedimentation	3	2	3	3	2,75	4	4	10,75	5	5	5	4	19	204,3	H	80
5	Operational phase	**Proposed Koppie Mining Project Preferred Option**	Increased traffic leading to potential accidential spills of hydrocarbon materials Hazardous materials entering the watercourses Increased road runoff during rainfall events	Pollution of watercourse	3	4	3	4	3,5	4	4	11,5	5	5	5	4	19	218,5	H	80
6	Operational phase	**Proposed Koppie Mining Project Preferred Option**	Increased runoff from hardened surfaces Increased traffic	Spread of alien vegetation	3	2	3	2	2,5	4	4	10,5	4	4	5	4	17	178,5	H	70

Table 29: Significance ratings matrix for the impacts without mitigation measures being implemented for the Proposed Koppie Mining Project's Alternative Option.

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level
1	Construction phase	**Proposed Koppie Mining Project Alternative Option**	Altering of stream banks Work Revetments New access routes Site clearing Placement of stockpiles Use of heavy machinery	Flow alterations due to erosion and sedimentation	3	2	2	2	2,25	3	3	8,25	3	3	5	3	14	115,5	M	80
2	Construction phase	**Proposed Koppie Mining Project Alternative Option**	Use of heavy machinery using oils and fuels during site clearing Accidental spillages of chemicals, cements, oils, etc.	Pollution of watercourse	2	3	2	3	2,5	3	3	8,5	3	3	5	3	14	119	M	80
3	Construction phase	**Proposed Koppie Mining Project Alternative Option**	New access route Use of heavy machinery Placement of stockpiles Bank trampling leading to erosion	Spread of alien vegetation	2	2	3	2	2,25	3	3	8,25	3	3	5	2	13	107,3	M	80
4	Operational phase	**Proposed Koppie Mining Project Alternative Option**	Increased traffic Use of heavy machinery Runoff from dumps and stockpiles Bank Erosion	Flow alterations due to erosion and sedimentation	4	3	3	4	3,5	4	4	11,5	5	5	5	4	19	218,5	H	80
5	Operational phase	**Proposed Koppie Mining Project Alternative Option**	Increased traffic leading to potential accidential spills of hydrocarbon materials Hazardous materials entering the watercourses Increased road runoff during rainfall events	Pollution of watercourse	3	5	3	5	4	4	4	12	5	5	5	4	19	228	H	80
6	Operational phase	**Proposed Koppie Mining Project Alternative Option**	Increased runoff from hardened surfaces Increased traffic	Spread of alien vegetation	3	3	4	3	3,25	4	4	11,25	4	4	5	4	17	191,3	H	70

Table 30: Significance ratings matrix for the impacts with mitigation measures being implemented for the Proposed Koppie Mining Project's Preferred Option.

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level
1	Construction phase	**Proposed Koppie Mining Project Preferred Option**	Altering of stream banks Work Revetments New access routes Site clearing Placement of stockpiles Use of heavy machinery	Flow alterations due to erosion and sedimentation	2	1	1	1	1,25	3	2	6,25	3	3	5	3	14	87,5	M	80
2	Construction phase	**Proposed Koppie Mining Project Preferred Option**	Use of heavy machinery using oils and fuels during site clearing Accidental spillages of chemicals, cements, oils, etc.	Pollution of watercourse	1	2	1	2	1,5	3	2	6,5	3	3	5	3	14	91	M	80
3	Construction phase	**Proposed Koppie Mining Project Preferred Option**	New access route Use of heavy machinery Placement of stockpiles Bank trampling leading to erosion	Spread of alien vegetation	1	1	2	2	1,5	3	2	6,5	3	3	5	2	13	84,5	M	80
4	Operational phase	**Proposed Koppie Mining Project Preferred Option**	Increased traffic Use of heavy machinery Runoff from dumps and stockpiles Bank Erosion	Flow alterations due to erosion and sedimentation	3	2	2	1	2	4	3	9	5	5	5	3	18	162	M	80
5	Operational phase	**Proposed Koppie Mining Project Preferred Option**	Increased traffic leading to potential accidential spills of hydrocarbon materials Hazardous materials entering the watercourses Increased road runoff during rainfall events	Pollution of watercourse	3	4	3	3	3,25	4	3	10,25	5	5	5	3	18	184,5	H	80
6	Operational phase	**Proposed Koppie Mining Project Preferred Option**	Increased runoff from hardened surfaces Increased traffic	Spread of alien vegetation	2	2	3	2	2,25	4	3	9,25	4	4	5	4	17	157,3	M	70

Table 31: Significance ratings matrix for the impacts with mitigation measures being implemented for the Proposed Koppie Mining Project's Alternative Option.

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level
1	Construction phase	**Proposed Koppie Mining Project Alternative Option**	Altering of stream banks Work Revetments New access routes Site clearing Placement of stockpiles Use of heavy machinery	Flow alterations due to erosion and sedimentation	2	2	1	1	1,5	3	2	6,5	3	3	5	3	14	91	M	80
2	Construction phase	**Proposed Koppie Mining Project Alternative Option**	Use of heavy machinery using oils and fuels during site clearing Accidental spillages of chemicals, cements, oils, etc.	Pollution of watercourse	1	2	1	3	1,75	3	2	6,75	3	3	5	3	14	94,5	M	80
3	Construction phase	**Proposed Koppie Mining Project Alternative Option**	New access route Use of heavy machinery Placement of stockpiles Bank trampling leading to erosion	Spread of alien vegetation	1	1	2	2	1,5	3	2	6,5	3	3	5	2	13	84,5	M	80
4	Operational phase	**Proposed Koppie Mining Project Alternative Option**	Increased traffic Use of heavy machinery Runoff from dumps and stockpiles Bank Erosion	Flow alterations due to erosion and sedimentation	3	2	2	2	2,25	4	3	9,25	5	5	5	4	19	175,8	H	80
5	Operational phase	**Proposed Koppie Mining Project Alternative Option**	Increased traffic leading to potential accidential spills of hydrocarbon materials Hazardous materials entering the watercourses Increased road runoff during rainfall events	Pollution of watercourse	3	4	3	4	3,5	4	3	10,5	5	5	5	4	19	199,5	H	80
6	Operational phase	**Proposed Koppie Mining Project Alternative Option**	Increased runoff from hardened surfaces Increased traffic	Spread of alien vegetation	3	2	4	3	3	4	3	10	4	4	5	4	17	170	H	70

5.2 Wetland Buffer

The wetland assessed within the Proposed Koppie Mining Project boundary, namely the floodplain wetlands and pans associated covers a great area and the buffer calculated for the wetland study should be implemented and adhered to by mine management.

The buffer tool aims to provide a method for determining appropriate buffer-widths for developments associated with wetlands, rivers or estuaries. This method takes into account a number of different factors in determining the buffer width including the impact on water resources, climatic factors and the sensitivity of the water resource

The calculated results indicate that a 110 m buffer is appropriate for the protection of the ecosystem services provided by the wetland systems (**Figure 37 and Figure 38**). Any activity must occur outside of the recommended 110 m buffer zone.

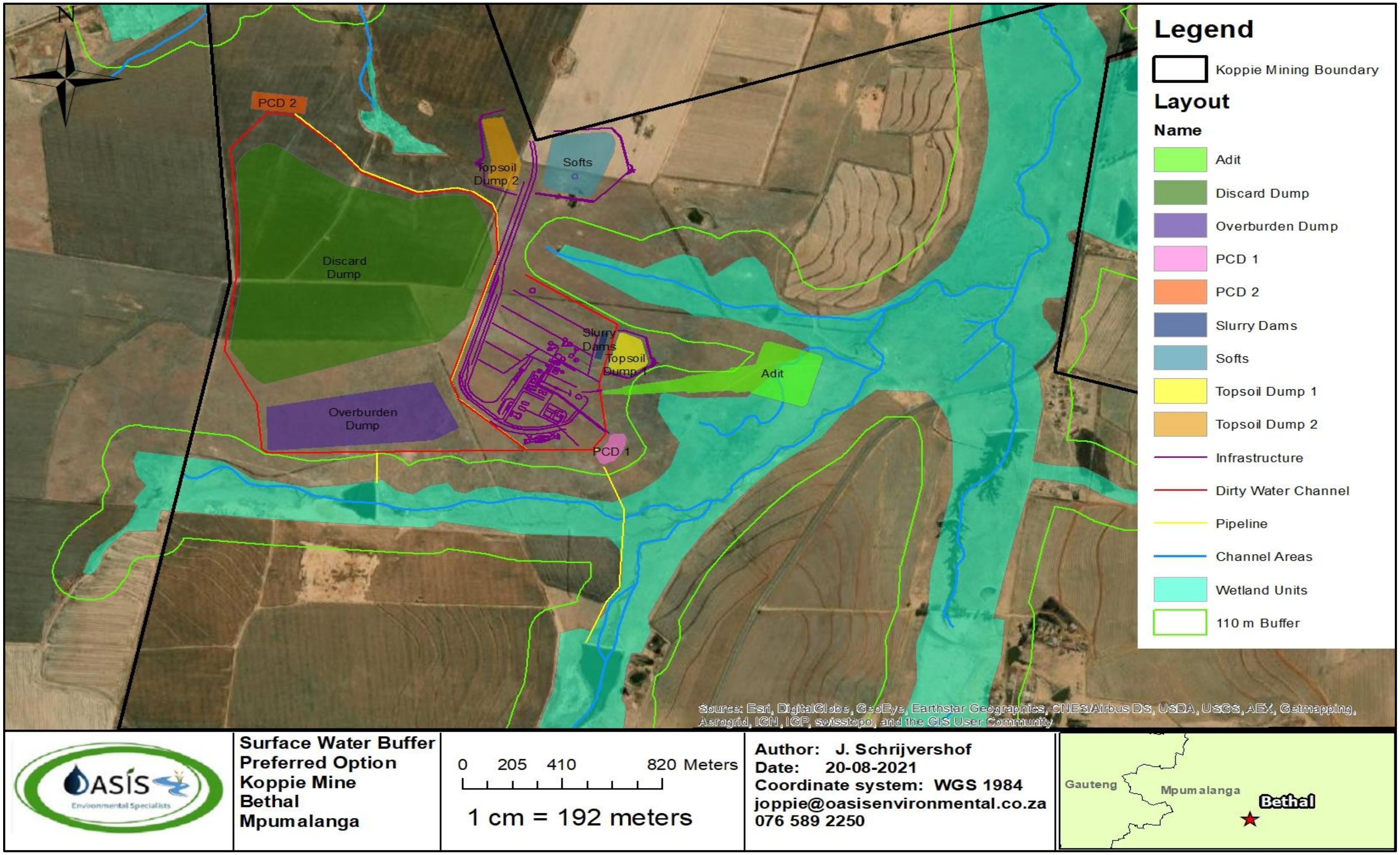


Figure 37: Proposed Koppie Mining Project - 110 m Wetland Buffer map for the Preferred Option.

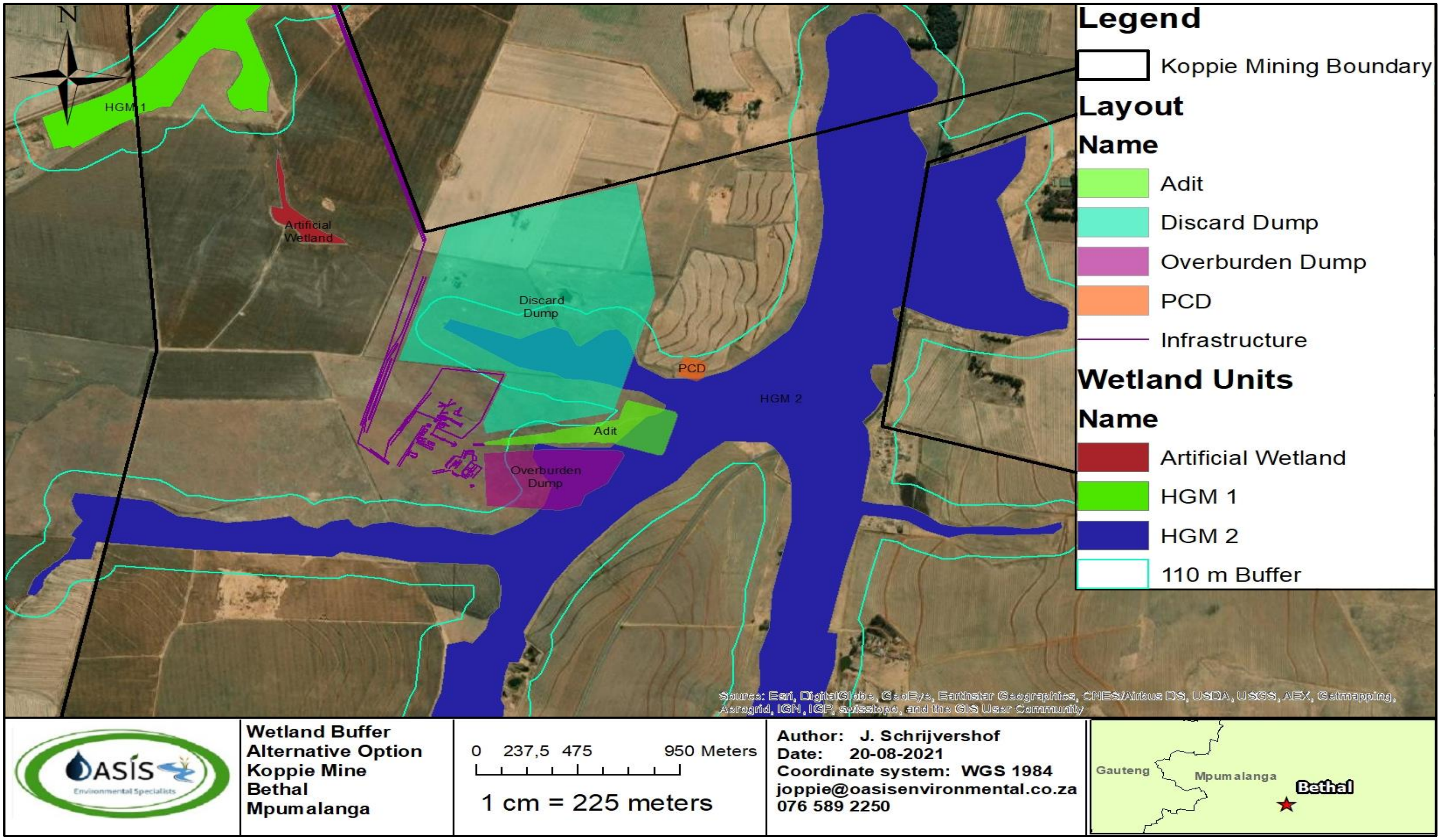


Figure 38: Proposed Koppie Mining Project - 110 m Wetland Buffer map for the Alternative Option.

6 IMPACTS ON BIODIVERSITY

Any development activity in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of this phase of the study was to identify and assess the significance of the potential impacts caused by the Proposed Koppie Mining Project operation.

A number of potential impacts relating to the loss of indigenous vegetation, floral habitat and ecological structure, loss of floral diversity and ecological integrity, proliferation of alien invasive species, loss of plant species of conservation concern, loss of faunal habitat, direct faunal impacts and disturbance to fauna are predicted to occur as a result of the mine operation.

Mitigation actions and scores are listed in **Table 32**, which outlines the current operational impacts before and after mitigation.

6.1.1 **Loss of Species of Conservation Concern**

No red listed faunal or floral species were identified in the study area, but some of the species numbers may deplete over time. All endemic species and species of concern have specific habitat requirements and the impacts of the mine operation might have effects on these species.

6.1.2 **Loss of indigenous vegetation, floral and faunal habitat and ecological structure of water resources and soil**

The mine operation might impact on foraging, breeding and roosting ecology of faunal species. Loss of vegetation generally affects nutrient cycles, removes the organic litter layer and results in habitat fragmentation and destruction of wildlife corridors. Cumulative impacts might include a decrease in floral habitat and ecological structure will lead to the proliferation of alien invasive species.

6.1.3 **Alien Invasive Species**

Alien invasive plant species will quickly encroach into disturbed areas. Alien plant species generally out-compete indigenous plant species for water, light, space and nutrients as they are adaptable to changing conditions and are able to easily invade a wide range of ecological niches (Bromilow, 2010). Alien invader plant species pose an ecological threat as they alter habitat structure, lower biodiversity (both number and “quality” of species), change nutrient cycling and productivity, and modify food webs (Zedler, 2004). This negatively affects the ability of the disturbed area to maintain indigenous floral biodiversity.

Table 32: Scoring of each impact with and without mitigation measures for Proposed Koppie Mining Project for the operational phase.

Impacts associated with the operational phase of the activities										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation		
Operational Phase										
Loss of Species of Conservation Concern	2	1	4	3	2	1	4	2	**20 (LOW)**	**6 (LOW)**
Loss of indigenous vegetation, floral and faunal habitat and ecological structure of water resources and soil	2	1	4	3	2	1	4	2	**20 (LOW)**	**6 (LOW)**
Alien Invasive Species	3	2	5	3	3	2	4	2	**36 (MODERATE)**	**14 (LOW)**

6.1.4 **Mitigation**

- Avoidance of wetland areas as far as possible (110 m buffer), these areas are regarded as highly sensitive areas.
- Search and rescue for reptiles and other vulnerable species, before areas are cleared;
- Environmental induction for all staff and contractors on-site.
- Any disturbed areas should be rehabilitated in line with the rehabilitation guidelines, this includes the clearing of alien vegetation, following the guidelines of a suitable alien invasive plant management plan.
- The site must be regularly monitored for re-growth of alien invasive species, and any new seedlings etc. eradicated using methods appropriate for the particular species, whether mechanical, chemical or biological.
- Protect as much indigenous vegetation as possible.
- An alien invasive management programme must be incorporated into an Environmental Management Programme.
- Ongoing alien plant control must be undertaken in the disturbed areas as these areas will quickly be colonised by invasive alien species, especially in the riparian zone, which is particularly sensitive to AIP infestation.
- Herbicides must be carefully applied, in order to prevent any chemicals from entering the river. Spraying of herbicides within or near to the wetland areas is strictly forbidden.
- Re-instate indigenous vegetation (grasses and indigenous trees) in disturbed areas directly after mining ceases so as to stabilise against erosion and sedimentation.

7 REHABILTATION PLAN

The directive mine manager and Environmental Control Officer (ECO) from the Proposed Koppie Mining Project is responsible and will play a major role in ensuring that this rehabilitation plan and mine closure is effectively managed and implemented. This plan is environmental legally binding and must be implemented to fulfil the requirements of relevant legislations and recommendations.

Canyon Coal will be responsible for the appointment of the ECO, Dam Engineers and relevant specialists to perform rehabilitation and monitoring activities as well as alien vegetation removal and control. The rehabilitation works have to be signed off by a suitably qualified environmental specialists.

The hardened surfaces adjacent to wetland areas will only marginally increase the velocity and volume of stormwater entering the wetland areas. However, one must take into account the steepness of the topography of the surrounding area. Stormwater will increase in velocity substantially before entering the wetland areas at the base of these steep adjacent hills. The root cause of absence of offsite stormwater management must therefore be addressed in order to begin to protect, rehabilitate and manage the wetland systems. The current lack of adequate stormwater control impacting can create erosion in all the wetland and riverine areas. Failure to address this is likely to lead to the complete destruction of the majority of the wetland systems in the future.

Findings from the wetlands assessed that are associated with the causes of degradation can be summarised as relating to three fundamental issues:

- Soil erosion and gully formation, either as a result of a lack of stormwater management in the larger catchment or as a result of local activities including mining, overgrazing and crops in all wetland systems; and
- The dominance of alien invasive plant species in large areas of the wetland systems.

In order to address these impacts a wetland management plan that establishes favourable hydrological conditions in the delineated wetland systems and allows for the regeneration of the functional integrity of the wetlands is needed.

7.1 Soil Erosion and Gully Formation

In an unspoiled wetland, the soil-vegetation interplay is generally in equilibrium with the energy expanded on them by the surface waters that flow through them. Stability is maintained as long as conditions in the catchment remain static and in a good state of conservation (Russel, 2009).

The first step in addressing soil erosion and gully formation in a wetland is therefore to look at the impacts causing this degradation in the wetland's catchment area. It is important to note that a wetland is a mirror of its catchment; a degraded catchment equals a degraded wetland. Overgrazing is one of the two major contributions to soil erosion, the other being a lack of stormwater control; it should be noted that the former is an important contributor to the latter.

The approach to wetland conservation and sustainable use therefore needs to take into account the current pressures and threats facing the wetlands and provide a general recognition, that in order to be effective the strategies for wetland conservation need to include the community that utilises the wetland. The first step in reversing the effects of overgrazing is therefore the removal of livestock from these areas for a predetermined period of time.

A number of governmental and poverty-relief organisations can be utilised to provide education to the surrounding community on the benefits associated with rehabilitating these wetlands and stopping the overgrazing of these areas as well as providing job opportunities in conducting the actual rehabilitation works.

7.2 Watercourse Rehabilitation

7.2.1 Fix any erosion points created

- Any erosion features created need to be stabilised.
- Earthen berms or plugs, rock packs or gabions may be used for the plugging of erosion gullies.
- For earthen structures used to fill erosion points, the soil used needs to be properly compacted.

7.2.2 Reinstate soils and prepare planting area

- Stockpiled soils shall be placed in the reverse order as to which it was removed (i.e. subsoil first followed by topsoil).
- Reinstated soil is not to be compacted too heavily, as this will prevent water saturation and proper plant growth during rehabilitation. Where significant soil compaction has occurred, the soil may need to be ripped in order to reduce the bulk density of the soil such that vegetation can become established at the site.
- Where good topsoil exists, no specific preparation is required.
- An average depth of 30 cm to 50 cm topsoil should be maintained across the disturbed area where possible to provide sufficient depth for rooting of indigenous plants.

7.2.3 Remove any waste products

- All waste products (spoils, hazardous substances and general litter) need to be removed from wetland and riparian areas and disposed of in proper local waste facilities.
- Minimise additional disturbance by limiting the use of heavy vehicles and personnel during clean-up operations.

7.2.4 Reinstate vegetation

- A specialist should be contracted to supervise the rehabilitation of wetland/riparian areas disturbed.
- Vegetation is to be reinstated as soon as weather conditions allow for plant growth.
- A suitable replanting/re-vegetation programme should be implemented. This should comprise a mix of rapidly germinating indigenous species grasses, shrubs and trees naturally occurring in the affected habitat and adapted to stabilizing areas.
- It would be advisable to plant at the onset of the wet season (early spring – August to October) so that watering requirements are minimal.
- Do not use fertilizer, lime, or mulch unless required.
- The three main methods of re-vegetating wetland areas include: seeding, cuttings and the transplanting of whole plants
- Monitor re-vegetation progress and administer alien plant control.
- Recovery of disturbed areas should be assessed by the ECO. Any areas that are not progressing satisfactorily must be identified (e.g. on a map) and action must be taken to actively re-vegetate these areas. If natural recovery is progressing well, no further intervention may be required.
- The use of herbicides in IAP control will require an investigation into the necessity, type to be used, effectiveness and impacts of the agent on aquatic biota.
- Implement alien invasive plant control as stipulated below to ensure that alien plants are actively managed and eradicated from the site, with adequate monitoring and follow-up measures.

7.2.5 Control of Alien Invasive and Problem Plant Species

This must be conducted by a registered pest control operator, specialising in alien invasive plant control. Alien plant invasions cause a decline in species diversity, local extinction of indigenous species and ecological imbalance. Thus, preventing the onset of an alien invasion and management of further spreading is required as they outcompete the indigenous plant species and quickly establish themselves in an area. Therefore, a national strategy has been compiled and identifies four primary categories of programs to address the management of alien invasive plant species and they are as follows:

- **Prevention—**Keep the invasive species out;
- **Early detection and rapid response—**Detect and eradicate invasive species to stop them from spreading;
- **Control and management—**Eliminate or control the problem of invasive species; and
- **Rehabilitation and restoration**—Heal, minimize, or reverse the harmful effects from invasive species.

The occurrence of alien invasive plants not only affect the growth and distribution of natural endemic plants, they also use more water than indigenous plants, some have toxic fruits or leaves which when consumed could be poisonous and lead to fatality. Therefore, alien invasive plant species need to be controlled or removed and the following section contains different methods that could be used to control AIP.

The ultimate aim of an alien invasive species management programme is to eradicate species completely. This is often very difficult as many of the species have seeds that remain viable for a very long time and even after physical removal of plants, the seeds germinate to form new infestations. An alien invasive management programme therefore must be an ongoing practice over many years and should follow the following phases:

A. The initial bulk eradication of alien invasive species by chemical or mechanical means, and in some instances biological control agents. This may also require rehabilitation if large stands of alien invasive species are removed. Local, indigenous species should be planted in the disturbed areas;

B. There should also be immediate follow up and all seedlings should be pulled out and removed. This should be done regularly, although the timeframes will vary from species to species depending on their growth forms and rates; and

C. Finally, areas that appear to be under controlled must continue to be managed and observation of these sites should continue on at least an annual basis. Rehabilitation at sites should also be monitored and action taken immediately if issues occur.

Various control methods are available for control of alien invasive species, including mechanical, chemical and biological control. In most instances, mechanical means are utilised and include physical removal of plants. Research on use of herbicides has been conducted on many species and can be applied in conjunction with mechanical methods. For some species, herbicides have not yet been fully researched and/or herbicides have not been registered and they need to be mechanically controlled.

Biological control of alien invasive species is also an ongoing process and some biological control agents have been released on various alien invasive species and show varying degrees of success. Biological control options need to be carried out with specialist advice from academic or research institutes involved in research of alien invasive species.

Control options utilised must take into account the species being controlled and should take into account the ecosystem in which the control options are being applied. Some of the herbicides registered for control of alien invasive species should not be used in riparian areas, and some should be preferably used over others in areas where natural grass cover occurs. Some herbicides should only be utilised after consultation with a Working for Water technical advisor.

The control options are discussed below as individual actions, but in many cases integrated measures (more than one (1) control measure) are taken for more effective control of alien invasive species. As already mentioned, research with regard to herbicide application and biological control is lacking for certain alien invasive species and these, especially if listed as Category 1 invasive species, need to be managed and mechanical control of these species should be considered as a default control option.

8 MONITORING

The monitoring programme must include sites/locations where biological monitoring has occurred previously, if possible. The sites included in this study will be sufficient to include in future monitoring applications during the high and low flow season. The objectives of the programme would be to monitor the state of the wetland system through the measurement of physical and biological properties. It is the project manager and lead environmental manager/consultant's responsibility to ensure the correct implementation of the monitoring programme.

As of this study the baseline data is established and can be used to compare with in future studies as a means to determine if ecological degradation or improvement has occurred. Key performance indicators would include the improvement of biotic communities associated with the project area. Implement a suitable bi-annual monitoring surveys for the lifetime of the project. The following parameters should be monitored by qualified specialists:

- Monthly water quality monitoring;
- Bi-annual i*n situ* and *ex situ* water quality constituents as per DWS Guidelines;
- Bi-annual biomonitoring (SASS 5 and IHAS); and
- Bi-annual riparian vegetation monitoring.

If modifications to the system occur, a reduced biological diversity will be observed. Proliferation of pollution tolerant species may also be an indication of a deterioration of ecological integrity. If there is further reduction in species diversity further studies should be undertaken which should include water quality analysis as well as the accumulation of pollutants in the sediments, however, if mitigation measures are followed this may be avoided or reduced.

9 CONCLUSION & RECOMMENDATIONS

According to the ecological importance classification and reference data provided by Department Water and Sanitation (2013) for the quaternary catchment, B11A; the Joubertsvleispruit is classified in its present state as a Category D (largely Modified) and the Viskuile River as Category C (moderately Modified). The default ecological management class for the relevant quaternary catchments is considered to be highly sensitive system for the Joubertsvlei and moderate for the Viskuile in terms of ecological importance with both being a highly ecological sensitive. The attainable ecological management class for the systems is a Category B (largely natural). The Viskuile River was assessed which served as a reference site for the study and was the receiving environmental from the Joubertsvleispruit flowing adjacent to the proposed mining areas.

The *in situ* water quality assessment findings were found to be within an **unacceptable** range according to the TWQRs for Aquatic Ecosystems. The pH remained relatively constant throughout the sites and within the neutral range. Temperatures were relatively stable, where electrical conductivity levels were above recommended guideline levels for the Joubertsvleispruit. Dissolved oxygen (DO) levels were below guideline levels at both upstream and downstream sites.

The IHIA results recorded, placed both sites assessed within a **seriously modified state (Category E)**. A category of E indicates that the loss of natural habitat, biota and basic ecosystem functions is extensively transformed from reference conditions. The predominant cause for concern was agriculture, erosion, grazing, damming, alien invasive plants, mining and water pollution.

Hydrophytic riparian vegetation consisted of mainly of *Imperata cylindrica*, *Phragmites australis*, *Typha capensis, Hypoxis spp.* and *Cyperus spp*. Others included *Juncus spp*. and *Crinum bulbispermum* (Orange River Lilly). The findings for the vegetation assessment revealed that riparian habitat of the area was **seriously modified (Category E)**

This SASS5 scores that the downstream site for the Viskuile River and the upstream site for the Joubertsvleispruit was in a **seriously modified (Category E/F) state.** The majority of highly pollution tolerant organisms indicates the pressure from extensive pollution and lack of suitable flow, which may be as a result to water abstraction and upstream impoundments. The upstream site of the Viskuile River was found to be **moderately modified (Category C)** as this point is in close proximity to the water source. The downstream site of the Joubertsvleispruit was dry.

The habitat reaches which were assessed and found to be **inadequate**, where biotopes with limited habitat structures were present. The dominant feature of the invertebrate habitat is the mud and gravel substrate which dominates the streams under study.

The SQR fish data available for that specific reach had seven species of fish expected to occur within that stretch of river according to DWS (2013)). Although two indigenous and one exotic fish species were sample, some were observed to surface at the downstream site.

The adjusted FRAI results indicated that fish community is in a **seriously modified state (Category E)** as a result of up and downstream anthropogenic activities compounded with low flows and poor habitat availability and the presence of alien invasive species.

Several valley bottom and depression NFEPA wetlands were identified within the mining boundary during the desktop assessment.

Hydric soils identified within the site were classified as a sandy clay loam and the Katspruit soil form, where terrestrial soils included Clovelly and Hutton soils.

Wetland riparian vegetation consisted of mainly of *Arundinella nepalensis*, *Phragmites australis*, *Typha capensis*, *Cyperus spp*, *Juncus effesus* and *Crinum bulbispermum*.

Two floodplain wetland systems (HGM 1 and HGM 2) were identified within the 500 m buffer of the Proposed Koppie Mining Project. The floodplain wetland systems were assessed in terms of health and was found to be categorised as **largely modified (Category D)**. The Ecological Services of the wetland has been recorded as intermediate and the sensitivity and importance (EIS) has been recorded as moderate.

The DWS based risk assessment (GN 509) found that the impact on the wetland areas from the Proposed Koppie Mining Project were rated as an overall **moderate impact during construction** and as an overall **high impact during operation for** the Alternative Option. The Preferred Option's an overall risk is considered **moderate impact during construction** and as an overall **moderately-high impact during operation**. This is considering and taking into account that the mitigations measures as provide being implemented appropriately, otherwise the impacts will be significantly higher for both options. Identified impacts pertaining to erosion, sedimentation, water quality and quantity alterations and the continued spread of alien invasive species and the main concern is the placement of the proposed Adit within the wetland areas.

From an ecological perspective these wetlands can be regarded as a **highly sensitive area** as it is a nesting and foraging area for a diversity of avifauna and aquatic life. The grasslands between the wetlands and transformed areas can be regarded as **moderately sensitive**. The remainder of the study area can be regarded as a **low sensitive** area as this represents heavily transformed landscape. A recommended buffer of 110 m is implemented for the protection of the wetlands.

According to the Critical Biodiversity Areas datasets provided by SANBI (2020), the majority of the mining area falls within transformed landscape during the site visit. Wetlands and grassland serves as Ecological Support Areas (ESA) and Critical Biodiversity Areas (CBAs). The Proposed Koppie Mining Project property boundaries falls within the Eastern Highveld Grassland. The mining operations does not fall within the Amersfoort and Carolina Important Bird Area (IBAs).

Information on plant species recorded in that area was extracted from the POSA online database hosted by SANBI (2020), indicate that 253 plant species have been recorded in the area queried of which 239 are endemic species are known to occur within the area queried. None of the species were found to possibly occur on site that have medicinal uses.

Floral species of conservation concern includes *Nerine gracilis,* listed as Vulnerable, where *Gladiolus robertsoniae* and *Kniphofia typhoides* are listed as Near Threatened for that area according to the desktop assessment, however due to the heavily transformed state of the proposed project with intensive crop cultivation, it is highly unlikely that any IUCN red listed species occur within the project footprint. A complete list of expected floral species for the Bethal area is given in Appendix B.

Commonly observed grasses (dominant species) within the area of investigation comprised of *Imperata cylindrical* (Cogon grass), *Arundinella nepalensis* (River Grass), *Hyparrhenia hirta* (Thatching grass), *Melines repens* (Natal red top), *Eragrostis gummiflua* (Gum Grass), not favoured by cattle, was dominant and additional *Eragrostis* species were prevalent, including: *Eragrostis curvula* (Lovegrass)*, Eragrostis racemose* (Narrow Heart Love Grass) and *Eragrostis chloromelas* (Curly Leaf), *Themeda triandra* (Red Grass) and *Pogonarthria squarrosa* (Herringboe grass). *Crinum bulbispermum* (River Lily), which is dominant in this vegetation unit, is provincially protected (according to Mpumalanga Nature Conservation Act, 1998 (Act No. 10 of 1998): Schedule 11). Dominant plant species identified was alien invasive *Eucalyptus tereticornis*, Black Wattle (*Acacia mearnsii*) and Grey poplar tree *(Populus canescens*,).

Mammal species that were identified onsite included the yellow mongoose (*Cynictis penicillata*) and ground squirrel (*Xerus spp*.). Spine from the Cape Porcupine (*Hystrix africaeaustralis*) were found within the agricultural land.

Bird species identified during the site visit included Fan-tailed widowbird (*Euplectes axillaris*); Southern red bishop (*Euplectes orix*); Southern masked weaver (*Ploceus velatus*); Blacksmith lapwing (*Vanellus armatus*), Hadeda ibis (*Bostrychia hagedash*), Laughing dove (*Spilopelia senegalensis*), Pin-tailed whydah *(Vidua macroura*); Helmeted guineafowl (*Numida meleagris*), Cliff Swallows (*Petrochelidon pyrrhonota*) and Indian myna (*Acridotheres tristis*). Other species include which were observed in a pan included Domestic Goose (*Anser anser subsp. Domesticus*), Grey Heron (*Ardea cinerea*), Cattle Egret (*Bubulcus ibis*), White Stork (*Ciconia ciconia*), Great Egret (*Egretta alba*), Red-knobbed Coot (*Fulica cristata*), Black-winged Stilt (*Himantopus himantopus*), Spur-winged Goose (*Plectropterus gambensis*) and Glossy Ibis (*Plegadis falcinellus*)

Red listed faunal species of Lesser Flamingo (*Phoeniconaias minor*) were observed in one pan area in proximity (+-7km) to the proposed mining areas during the site visit (26°19'22.57"S; 29°30'56.08"E), The Lesser Flamingo is listed as Near Threatened by the IUCN red list

From the Desktop findings the Southern African Hedgehog (*Atelerix frontalis*), Serval (*Leptailurus serval*), Brown Hyena (*Hyaena brunnea*) and Lesser Flamingo (*Phoenicopterus minor*) which is listed Near Threatened are found within these areas. The Southern Bald Ibis (*Geronticus calvus*) and Secretarybird (*Sagittarius serpentarius*) which is listed by IUCN as Vulnerable are also thought to occur within this area. All expected faunal species are listed in **Appendix A** for QDS 2629AD and 2629BC.

A number of potential ecological impacts relating to proliferation of alien invasive species, loss of species of conservation concern, loss of indigenous vegetation, floral and faunal habitat and ecological structure of water resources and soil, loss of floral diversity and ecological integrity. The significance of potential impacts on biodiversity within the area was rated as a **low significance with and low to moderate without mitigation** as the area is already heavily transformed and with the implementation of a suitable rehabilitation and alien invasive plant program, could improve biodiversity in that area in the future.

Provided mitigation measures are to be implemented within an environmental management programme (EMPr) and the significance of any negative impacts reduced. Potential impacts associated with the construction and operational phase include:

- Increased sedimentation;
- Water quality contamination due to runoff;
- Alteration of natural flow regime; and
- Increased utilisation of aquatic resources by local population.

Mitigation measures, aimed at minimising the afore-mentioned impacts, include (but are not limited to):

- Design and implementation of a suitable stormwater system;
- Rehabilitation of the disturbed areas;
- Limiting instream sedimentation;
- Minimising pollutants entering the watercourse;
- Implement a programme for the clearing/eradication of alien species including long term control of such species;
- A 110 m buffer was implemented for the wetland systems;
- Ongoing water quality monitoring must take place every month during operational phases; and
- Biomonitoring where/if flow conditions allow for effective sampling analysis must take place bi-annually to determine any trends in ecology and hydrology.

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GLOSSARY

Catchment: The area where water from atmospheric precipitation becomes concentrated and drains downslope into a river, lake or wetland. The term includes all land surface, streams, rivers and lakes between the source and where the water enters the ocean.

Delineation: Refers to the technique of establishing the boundary of a resource such as a wetland or riparian area.

Invasive alien species: Invasive alien species means any non-indigenous plant or animal species whose establishment and spread outside of its natural range threatens natural ecosystems, habitats or other species or has the potential to threaten ecosystems, habitats or other species.

Mitigate/Mitigation: Mitigating wetland impacts refers to reactive practical actions that minimise or reduce *in situ* wetland impacts. Examples of mitigation include "changes to the scale, design, location, siting, process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites". Mitigation actions can take place anywhere, as long as their effect is to reduce the effect on the site where change in ecological character is likely, or the values of the site are affected by those changes (Ramsar Convention, 2012).

Water course: Means a river or spring; a natural channel in which water flows regularly or intermittently: a wetland, lake or dam into which, or from which, water flows: und 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 (National Water Act, 1998).

APPENDIX A – FAUNAL SPECIES LIST FOR 2629AD AND 2629BC

Insecta			
Coenagrionidae	Africallagma glaucum	Swamp Bluet	Least Concern
Coenagrionidae	Africallagma sapphirinum	Sapphire Bluet	Least Concern
Lycaenidae	Aloeides aranda	Yellow russet	Least Concern (SABCA 2013)
Lycaenidae	Aloeides dentatis maseruna	Maluti toothed russet	Least Concern (SABCA 2013)
Lycaenidae	Aloeides taikosama	Dusky russet	Least Concern (SABCA 2013)
Lycaenidae	Aloeides trimeni trimeni	Brown russet	Least Concern (SABCA 2013)
Lycaenidae	Cacyreus virilis	Mocker bronze	Least Concern (SABCA 2013)
Pieridae	Colias electo electo	African clouded yellow	Least Concern (SABCA 2013)
Nymphalidae	Danaus chrysippus orientis	African plain tiger	Least Concern (SABCA 2013)
Nymphalidae	Junonia hierta cebrene	Yellow pansy	Least Concern (SABCA 2013)
Lestidae	Lestes plagiatus	Highland Spreadwing	Least Concern
Hesperiidae	Metisella meninx	Marsh sylph	Least Concern (SABCA 2013)
Libellulidae	Orthetrum caffrum	Two-striped Skimmer	Least Concern
Coenagrionidae	Pseudagrion citricola	Yellow-faced Sprite	LC
Hesperiidae	Spialia asterodia	Star sandman	Least Concern (SABCA 2013)
Libellulidae	Trithemis dorsalis	Highland Dropwing	Least Concern
Nymphalidae	Vanessa cardui	Painted lady	Least Concern (SABCA 2013)

Arachnida			
Buthidae	Uroplectes formosus	Fair Lesser Thicktail	
Theraphosidae	Brachionopus sp.		
Theraphosidae	Harpactira hamiltoni	Highveld Babbon Spider	
Amphibia			
Bufonidae	Sclerophrys capensis	Raucous Toad	Least Concern
Bufonidae	Sclerophrys gutturalis	Guttural Toad	Least Concern (IUCN, 2016)
Hyperoliidae	Kassina senegalensis	Bubbling Kassina	Least Concern
Hyperoliidae	Semnodactylus wealii	Rattling Frog	Least Concern
Pipidae	Xenopus laevis	Common Platanna	Least Concern
Ptychadenidae	Ptychadena porosissima	Striped Grass Frog	Least Concern
Pyxicephalidae	Amietia delalandii	Delalande's River Frog	Least Concern (2017)
Pyxicephalidae	Amietia fuscigula	Cape River Frog	Least Concern (2017)
Pyxicephalidae	Cacosternum boettgeri	Common Caco	Least Concern (2013)
Pyxicephalidae	Strongylopus fasciatus	Striped Stream Frog	Least Concern
Pyxicephalidae	Tomopterna natalensis	Natal Sand Frog	Least Concern
Reptilia			
Agamidae	Agama aculeata distanti	Distant's Ground Agama	Least Concern (SARCA 2014)
Colubridae	Dasypeltis scabra	Rhombic Egg-eater	Least Concern (SARCA 2014)

Gekkonidae	Pachydactylus vansoni	Van Son's Gecko	Least Concern (SARCA 2014)
Lamprophiidae	Aparallactus capensis	Black-headed Centipede-eater	Least Concern (SARCA 2014)
Lamprophiidae	Psammophylax rhombeatus	Spotted Grass Snake	Least Concern (SARCA 2014)
Lamprophiidae	Duberria lutrix lutrix	South African Slug-eater	Least Concern (SARCA 2014)
Lamprophiidae	Homoroselaps lacteus	Spotted Harlequin Snake	Least Concern (SARCA 2014)
Lamprophiidae	Psammophylax rhombeatus	Spotted Grass Snake	Least Concern (SARCA 2014)
Leptotyphlopidae	Leptotyphlops scutifrons conjunctus	Eastern Thread Snake	
Scincidae	Acontias gracilicauda	Thin-tailed Legless Skink	Least Concern (SARCA 2014)
Scincidae	Trachylepis punctatissima	Speckled Rock Skink	Least Concern (SARCA 2014)
Mamalia			
Bovidae	Alcelaphus buselaphus caama	Red Hartebeest	Least Concern (2008)
Bovidae	Antidorcas marsupialis	Springbok	Least Concern (2016)
Erinaceidae	Atelerix frontalis	Southern African Hedgehog	Near Threatened (2016)
Herpestidae	Atilax paludinosus	Marsh Mongoose	Least Concern (2016)
Canidae	Canis mesomelas	Black-backed Jackal	Least Concern (2016)
Bovidae	Connochaetes gnou	Black Wildebeest	Least Concern (2016)
Herpestidae	Cynictis penicillata	Yellow Mongoose	Least Concern (2016)
Bovidae	Damaliscus pygargus phillipsi	Blesbok	Least Concern (2016)

Equidae	Equus quagga	Plains Zebra	Least Concern (2016)
Felidae	Felis silvestris	Wildcat	Least Concern (2016)
Herpestidae	Herpestes sanguineus	Slender Mongoose	Least Concern (2016)
Hyaenidae	Hyaena brunnea	Brown Hyena	Near Threatened (2015)
Hystricidae	Hystrix africaeaustralis	Cape Porcupine	Least Concern
Mustelidae	Ictonyx striatus	Striped Polecat	Least Concern (2016)
Felidae	Leptailurus serval	Serval	Near Threatened (2016)
Leporidae	Lepus saxatilis	Scrub Hare	Least Concern
Muridae	Otomys sp.	Vlei Rats	
Procaviidae	Procavia capensis	Cape Rock Hyrax	Least Concern (2016)
Bovidae	Raphicerus campestris	Steenbok	Least Concern (2016)
Herpestidae	Suricata suricatta	Meerkat	Least Concern (2016)
Bovidae	Sylvicapra grimmia	Bush Duiker	Least Concern (2016)
Bovidae	Syncerus caffer	African Buffalo	Least Concern (2008)
Canidae	Vulpes chama	Cape Fox	Least Concern (2016)
Sciuridae	Xerus inauris	South African Ground Squirrel	Least Concern
Aves			
Anatidae	Alopochen aegyptiacus	Egyptian Goose	Least Concern
Anatidae	Anas smithii	Cape Shoveler	Least Concern

Anatidae	Anas undulata	Yellow-billed Duck	Least Concern
Anatidae	Anser anser subsp. domesticus	Domestic Goose	Least Concern
Ardeidae	Ardea cinerea	Grey Heron	Least Concern
Ardeidae	Bubulcus ibis	Cattle Egret	Least Concern
Ciconiidae	Ciconia ciconia	White Stork	Least Concern
Ardeidae	Egretta alba	Great Egret	Least Concern
Falconidae	Falco amurensis	Amur (Eastern Red-footed) Falcon (Kestrel)	Least Concern
Rallidae	Fulica cristata	Red-knobbed Coot	Least Concern
Threskiornithidae	Geronticus calvus	Southern Bald (Bald) Ibis	Vulnerable
Recurvirostridae	Himantopus himantopus	Black-winged Stilt	Least Concern
Anatidae	Plectropterus gambensis	Spur-winged Goose	Least Concern
Threskiornithidae	Plegadis falcinellus	Glossy Ibis	Least Concern
Ploceidae	Ploceus velatus	Southern Masked-Weaver	Least Concern
Sagittariidae	Sagittarius serpentarius	Secretarybird	Vulnerable
Phasianidae	Scleroptila levaillantii	Red-winged Francolin	Least Concern
Tytonidae	Tyto alba	Barn Owl	Least Concern
Charadriidae	Vanellus armatus	Blacksmith Lapwing (Plover)	Least Concern
Phoenicopteridae	Phoenicopterus minor	Lesser Flamingo	Near Threatened

Phoenicopteridae	Phoenicopterus roseus	Greater Flamingo	Least Concern

APPENDIX B – FLORAL SPECIES LIST ACCORDING TO SANBIS PLANTS OF SOUTH AFRICA (POSA.

Family	Genus	Species	IUCN	Ecology
Euphorbiaceae	Acalypha	angustata	LC	Indigenous
Euphorbiaceae	Acalypha	caperonioides	DD	Indigenous
Apiaceae	Afrosciadium	magalismontanum	LC	Present
Poaceae	Agrostis	continuata	LC	Indigenous
Poaceae	Agrostis	lachnantha	LC	Indigenous
Poaceae	Agrostis	gigantea		Not indigenous; Naturalised
Poaceae	Agrostis	eriantha	LC	Indigenous
Hyacinthaceae	Albuca	baurii	LC	Present
Asphodelaceae	Aloe	ecklonis	LC	Indigenous
Poaceae	Andropogon	appendiculatus	LC	Indigenous
Poaceae	Andropogon	schirensis	LC	Indigenous
Rubiaceae	Anthospermum	rigidum	LC	Indigenous
Aponogetonaceae	Aponogeton	junceus	LC	Indigenous
Fabaceae	Argyrolobium	harveyanum	LC	Indigenous
Poaceae	Aristida	scabrivalvis	LC	Indigenous
Poaceae	Aristida	junciformis	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Poaceae	Aristida	congesta	LC	Indigenous
Poaceae	Aristida	canescens	LC	Indigenous
Apocynaceae	Asclepias	multicaulis	LC	Indigenous
Apocynaceae	Asclepias	aurea	LC	Indigenous
Apocynaceae	Asclepias	gibba	LC	Indigenous
Apocynaceae	Aspidoglossum	lamellatum	LC	Indigenous
Asteraceae	Berkheya	pinnatifida	LC	Indigenous; Endemic
Asteraceae	Berkheya	zeyheri	LC	Indigenous
Asteraceae	Berkheya	setifera	LC	Indigenous
Poaceae	Brachiaria	serrata	LC	Indigenous
Apocynaceae	Brachystelma	foetidum	LC	Indigenous
Bryaceae	Bryum	cellulare		Indigenous
Orobanchaceae	Buchnera	sp.		
Asphodelaceae	Bulbine	capitata	LC	Indigenous
Poaceae	Catalepis	gracilis	LC	Indigenous
Caryophyllaceae	Cerastium	capense	LC	Indigenous
Verbenaceae	Chascanum	sp.		
Gentianaceae	Chironia	purpurascens	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Agavaceae	Chlorophytum	fasciculatum	LC	Indigenous
Commelinaceae	Commelina	benghalensis	LC	Indigenous
Commelinaceae	Commelina	africana	LC	Indigenous
Convolvulaceae	Convolvulus	arvensis		Not indigenous; Naturalised
Convolvulaceae	Convolvulus	sagittatus	LC	Indigenous
Asteraceae	Conyza	podocephala		Indigenous
Apocynaceae	Cordylogyne	globosa	LC	Indigenous
Amaryllidaceae	Crinum	bulbispermum	LC	Indigenous
Fabaceae	Crotalaria	sphaerocarpa	LC	Indigenous
Cucurbitaceae	Cucumis	myriocarpus	LC	Indigenous
Commelinaceae	Cyanotis	speciosa	LC	Indigenous
Orobanchaceae	Cycnium	tubulosum	LC	Indigenous
Poaceae	Cymbopogon	caesius	LC	Indigenous
Poaceae	Cynodon	hirsutus	LC	Indigenous
Poaceae	Cynodon	dactylon	LC	Indigenous
Boraginaceae	Cynoglossum	hispidum	LC	Indigenous
Boraginaceae	Cynoglossum	austroafricanum	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Cyperaceae	Cyperus	longus	NE	Indigenous
Cyperaceae	Cyperus	esculentus	LC	Indigenous
Cyperaceae	Cyperus	congestus	LC	Indigenous
Cyperaceae	Cyperus	schlechteri	LC	Indigenous
Cyperaceae	Cyperus	rigidifolius	LC	Indigenous
Cyperaceae	Cyperus	obtusiflorus	LC	Indigenous
Cyperaceae	Cyperus	difformis	LC	Indigenous
Solanaceae	Datura	stramonium		Not indigenous; Naturalised
Asteraceae	Denekia	capensis	LC	Indigenous
Scrophulariaceae	Diclis	rotundifolia	LC	Indigenous
Poaceae	Digitaria	ternata	LC	Indigenous
Poaceae	Digitaria	eriantha	LC	Indigenous
Asteraceae	Dimorphotheca	caulescens	LC	Indigenous
Hyacinthaceae	Dipcadi	marlothii	LC	Indigenous
Hyacinthaceae	Dipcadi	viride	LC	Indigenous
Fabaceae	Dolichos	falciformis	LC	Indigenous
Hyacinthaceae	Drimia	elata	DD	Indigenous

Family	Genus	Species	IUCN	Ecology
Dryopteridaceae	Dryopteris	athamantica	LC	Indigenous
Acanthaceae	Dyschoriste	burchellii	LC	Indigenous
Poaceae	Elionurus	muticus	LC	Indigenous
Hypoxidaceae	Empodium	elongatum	LC	Indigenous
Poaceae	Eragrostis	tef	NE	Not indigenous; Naturalised
Poaceae	Eragrostis	curvula	LC	Indigenous
Poaceae	Eragrostis	obtusa	LC	Indigenous
Poaceae	Eragrostis	chloromelas	LC	Indigenous
Poaceae	Eragrostis	racemosa	LC	Indigenous
Poaceae	Eragrostis	remotiflora	LC	Indigenous; Endemic
Poaceae	Eragrostis	sclerantha	LC	Indigenous
Poaceae	Eragrostis	capensis	LC	Indigenous
Poaceae	Eragrostis	planiculmis	LC	Indigenous
Asteraceae	Erigeron	bonariensis		Not indigenous
Fabaceae	Eriosema	salignum	LC	Indigenous
Fabaceae	Eriosema	sp.		
Fabaceae	Eriosema	simulans	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Brassicaceae	Erucastrum	austroafricanum	LC	Indigenous
Fabaceae	Erythrina	zeyheri	LC	Indigenous
Hyacinthaceae	Eucomis	autumnalis	NE	Indigenous
Orchidaceae	Eulophia	ovalis	LC	Present
Euphorbiaceae	Euphorbia	striata	LC	Indigenous
Euphorbiaceae	Euphorbia	inaequilatera	LC	Indigenous
Gentianaceae	Exochaenium	grande	LC	
Convolvulaceae	Falkia	oblonga	LC	Indigenous
Asteraceae	Felicia	muricata	LC	Indigenous
Poaceae	Fingerhuthia	sesleriiformis	LC	Indigenous
Cyperaceae	Fuirena	coerulescens	LC	Indigenous
Rubiaceae	Galium	capense	LC	Indigenous
Asteraceae	Gazania	sp.		
Asteraceae	Gazania	krebsiana	LC	Indigenous
Asteraceae	Geigeria	aspera	LC	Indigenous
Geraniaceae	Geranium	multisectum	LC	Indigenous
Asteraceae	Gerbera	ambigua	LC	Indigenous
Iridaceae	Gladiolus	longicollis	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Iridaceae	Gladiolus	sericeovillosus	LC	Indigenous
Iridaceae	Gladiolus	elliotii	LC	Indigenous
Iridaceae	Gladiolus	robertsoniae	NT	Indigenous
Asteraceae	Gnaphalium	filagopsis	LC	Indigenous
Thymelaeaceae	Gnidia	gymnostachya	LC	Indigenous
Scrophulariaceae	Gomphostigma	virgatum	LC	Indigenous
Amaranthaceae	Gomphrena	celosioides		Not indigenous; Naturalised
Orchidaceae	Habenaria	clavata	LC	Indigenous
Orchidaceae	Habenaria	epipactidea	LC	Indigenous
Asteraceae	Haplocarpha	scaposa	LC	Indigenous
Poaceae	Harpochloa	falx	LC	Indigenous
Scrophulariaceae	Hebenstretia	rehmannii	LC	Indigenous; Endemic
Asteraceae	Helichrysum	aureonitens	LC	Indigenous
Asteraceae	Helichrysum	oreophilum	LC	Indigenous
Asteraceae	Helichrysum	rugulosum	LC	Indigenous
Asteraceae	Helichrysum	nudifolium	LC	Present
Asteraceae	Helichrysum	nudifolium	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Asteraceae	Helichrysum	adenocarpum	LC	Indigenous
Malvaceae	Hermannia	sp.		
Malvaceae	Hermannia	cordata	LC	Indigenous; Endemic
Caryophyllaceae	Herniaria	erckertii	LC	Present
Iridaceae	Hesperantha	longicollis	LC	Indigenous
Poaceae	Heteropogon	contortus	LC	Indigenous
Malvaceae	Hibiscus	trionum		Not indigenous; Naturalised
Malvaceae	Hibiscus	aethiopicus	LC	Indigenous
Malvaceae	Hibiscus	microcarpus	LC	Indigenous
Asteraceae	Hilliardiella	elaeagnoides		
Asteraceae	Hilliardiella	aristata	LC	Present
Poaceae	Hyparrhenia	hirta	LC	Indigenous
Hypoxidaceae	Hypoxis	multiceps	LC	Indigenous
Hypoxidaceae	Hypoxis	hemerocallidea	LC	Indigenous
Hypoxidaceae	Hypoxis	rigidula	LC	Indigenous
Hypoxidaceae	Hypoxis	argentea	LC	Indigenous
Fabaceae	Indigofera	longibarbata	LC	Indigenous

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Fabaceae	Indigofera	hilaris	LC	Indigenous
Fabaceae	Indigofera	dimidiata	LC	Indigenous
Fabaceae	Indigofera	evansiana	LC	Indigenous
Fabaceae	Indigofera	hedyantha	LC	Indigenous
Convolvulaceae	Ipomoea	ommanneyi	LC	Indigenous
Convolvulaceae	Ipomoea	crassipes	LC	Indigenous
Cyperaceae	Isolepis	setacea	LC	Indigenous
Scrophulariaceae	Jamesbrittenia	sp.		
Juncaceae	Juncus	exsertus	LC	Present
Juncaceae	Juncus	oxycarpus	LC	Indigenous
Asphodelaceae	Kniphofia	typhoides	NT	Indigenous; Endemic
Poaceae	Koeleria	capensis	LC	Indigenous
Rubiaceae	Kohautia	caespitosa	LC	Indigenous
Rubiaceae	Kohautia	amatymbica	LC	Indigenous
Cyperaceae	Kyllinga	pulchella	LC	Indigenous
Thymelaeaceae	Lasiosiphon	kraussianus		
Hyacinthaceae	Ledebouria	ovatifolia		Indigenous
Poaceae	Leersia	hexandra	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Brassicaceae	Lepidium	transvaalense	LC	Indigenous
Fabaceae	Lessertia	frutescens	LC	Indigenous
Scrophulariaceae	Limosella	maior	LC	Indigenous
Plantaginaceae	Linaria	vulgaris	NE	Not indigenous; Naturalised
Linderniaceae	Linderniella	nana		
Fabaceae	Listia	heterophylla	LC	Indigenous
Lobeliaceae	Lobelia	sonderiana	LC	Present
Poaceae	Loudetia	simplex	LC	Indigenous
Fabaceae	Melolobium	alpinum	LC	Indigenous
Phrymaceae	Mimulus	gracilis	LC	Indigenous
Lobeliaceae	Monopsis	decipiens	LC	Indigenous
Geraniaceae	Monsonia	brevirostrata	LC	Indigenous
Iridaceae	Moraea	pallida	LC	Indigenous
Scrophulariaceae	Nemesia	fruticans	LC	Indigenous
Amaryllidaceae	Nerine	angustifolia	LC	Indigenous
Amaryllidaceae	Nerine	gracilis	VU	Indigenous; Endemic
Asteraceae	Nidorella	anomala	LC	Indigenous; Endemic

Family	Genus	Species	IUCN	Ecology
Asteraceae	Nidorella	resedifolia	LC	Indigenous
Onagraceae	Oenothera	tetraptera		Not indigenous; Naturalised
Hyacinthaceae	Ornithogalum	flexuosum	LC	Present
Orchidaceae	Orthochilus	foliosus	LC	Present
Asteraceae	Osteospermum	scariosum	NE	Present
Oxalidaceae	Oxalis	obliquifolia	LC	Indigenous
Poaceae	Panicum	schinzii	LC	Indigenous
Fabaceae	Pearsonia	sessilifolia	LC	Indigenous
Geraniaceae	Pelargonium	luridum	LC	Indigenous
Poaceae	Pennisetum	thunbergii	LC	Indigenous
Rubiaceae	Pentanisia	angustifolia	LC	Indigenous
Rubiaceae	Pentanisia	prunelloides	LC	Indigenous
Polygonaceae	Persicaria	lapathifolia		Not indigenous; Naturalised
Poaceae	Pogonarthria	squarrosa	LC	Indigenous
Polygalaceae	Polygala	transvaalensis	LC	Indigenous
Polygalaceae	Polygala	africana	LC	Indigenous
Polygalaceae	Polygala	gracilenta	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Polygalaceae	Polygala	transvaalensis		Present
Polygalaceae	Polygala	albida	LC	Indigenous
Pontederiaceae	Pontederia	cordata		
Asteraceae	Pseudognaphalium	luteoalbum	LC	Not indigenous; Naturalised
Cyperaceae	Pycreus	chrysanthus	LC	Indigenous
Ranunculaceae	Ranunculus	multifidus	LC	Indigenous
Apocynaceae	Raphionacme	hirsuta	LC	Indigenous
Poaceae	Rendlia	altera	LC	Indigenous
Fabaceae	Rhynchosia	adenodes	LC	Indigenous
Fabaceae	Rhynchosia	reptabunda	LC	Indigenous
Ricciaceae	Riccia	cavernosa		Indigenous
Ricciaceae	Riccia	crystallina		Indigenous
Ricciaceae	Riccia	stricta		Indigenous
Brassicaceae	Rorippa	fluviatilis	LC	Indigenous
Polygonaceae	Rumex	acetosella		Not indigenous; Naturalised
Polygonaceae	Rumex	lanceolatus	LC	Indigenous
Lamiaceae	Salvia	runcinata	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Rosaceae	Sanguisorba	minor		Not indigenous; Naturalised
Dipsacaceae	Scabiosa	columbaria	LC	Indigenous
Asteraceae	Schistostephium	crataegifolium	LC	Indigenous
Hyacinthaceae	Schizocarphus	nervosus	LC	Present
Asteraceae	Schkuhria	pinnata		Not indigenous; Naturalised
Cyperaceae	Schoenoplectus	decipiens	LC	Indigenous
Cyperaceae	Scirpoides	burkei	LC	Indigenous
Anacardiaceae	Searsia	dentata	LC	Present
Anacardiaceae	Searsia	discolor	LC	Present
Gentianaceae	Sebaea	leiostyla	LC	Indigenous
Scrophulariaceae	Selago	densiflora	LC	Indigenous
Asteraceae	Senecio	affinis	LC	Indigenous
Asteraceae	Senecio	sp.		
Asteraceae	Senecio	laevigatus	LC	Indigenous; Endemic
Asteraceae	Senecio	othonniflorus	LC	Indigenous
Asteraceae	Senecio	erubescens	NE	Indigenous; Endemic
Asteraceae	Senecio	bupleuroides	LC	Indigenous

Family	Genus	Species	IUCN	Ecology
Asteraceae	Senecio	subcoriaceus	LC	Indigenous
Poaceae	Setaria	pumila	LC	Indigenous
Poaceae	Setaria	nigrirostris	LC	Indigenous
Caryophyllaceae	Silene	burchellii		Present
Caryophyllaceae	Silene	undulata		Indigenous
Solanaceae	Solanum	lichtensteinii	LC	Indigenous
Solanaceae	Solanum	campylacanthum		Indigenous
Orobanchaceae	Sopubia	cana	LC	Indigenous
Poaceae	Sporobolus	fimbriatus	LC	Indigenous
Orobanchaceae	Striga	bilabiata	LC	Indigenous
Santalaceae	Thesium	scirpioides	LC	Indigenous
Santalaceae	Thesium	asterias	LC	Indigenous
Asteraceae	Tolpis	capensis	LC	Indigenous
Asphodelaceae	Trachyandra	saltii	LC	Indigenous
Poaceae	Trachypogon	spicatus	LC	Indigenous
Poaceae	Tragus	racemosus	LC	Indigenous
Zygophyllaceae	Tribulus	terrestris	LC	Indigenous
Fabaceae	Trifolium	africanum	NE	Indigenous

Family	Genus	Species	IUCN	Ecology
Alliaceae	Tulbaghia	acutiloba	LC	Indigenous; Endemic
Poaceae	Urochloa	panicoides	LC	Indigenous
Asteraceae	Ursinia	nana	LC	Indigenous
Lentibulariaceae	Utricularia	prehensilis	LC	Indigenous
Valerianaceae	Valeriana	capensis	LC	Indigenous
Fabaceae	Vigna	luteola	LC	Indigenous
Fabaceae	Vigna	oblongifolia	LC	Indigenous
Campanulaceae	Wahlenbergia	undulata	LC	Indigenous
Scrophulariaceae	Zaluzianskya	spathacea	LC	Indigenous
Rhamnaceae	Ziziphus	zeyheriana	LC	Indigenous
Fabaceae	Zornia	capensis	LC	Indigenous