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WETLAND AND BIODIVERSITY ASESSMENT FOR THE PROPOSED VLAKLAAGTE COLLIERY NEAR KRIEL, MPUMALANGA

SEPTEMBER 2020

DOCUMENT CONTROL		
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- 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;
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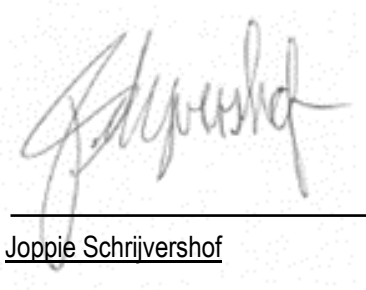

Joppie Schrijvershof

Executive summary

This report summarises the wetland and biodiversity assessment findings for the proposed Vlaklaagte Colliery Coal Mining Operations on Portion 45 of the farm Vlaklaagte 45 IS, near Kriel located in the Mpumalanga Province. The field survey was undertaken on the 11th of August 2020 to ensure environmental compliance. The proposed Vlaklaagte Colliery is located in the B11B sub-quaternary catchment area, with the Olifants River south to the operating colliery.

The scope of work entailed determining the Present Ecological Status (PES) for the wetland systems associated with the proposed Vlaklaagte Colliery. In order to make this determination, the following components were assessed:

- 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 the proposed Vlaklaagte Colliery 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 Vlaklaagte Colliery 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 current mine 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 following findings summarises the key aspects of the wetland assessment conducted for the proposed Vlaklaagte Colliery:

- The proposed Vlaklaagte Colliery falls within the quaternary drainage region B11B which is part of the Olifants Water Management Area. Land cover is dominated by agricultural practices in the form of subsistence farming and coal mining activities.
- Hydrophytic plant species were dominated by *Typha Capensis and Imperata cylindrica*.
- Hydric soils included wet sandy and sandy clay soils with mottles present in the wetland areas.
- From the NFEPA database, valley bottom wetlands were identified within 500 m of the project boundary.
- During the field survey wetlands were delineated and confirmed to be seep wetlands descending to the Olifants River, within the regulated area for the Vlaklaagte Colliery boundary.
- A small pan system was delineated north west from the proposed site.
- The pan wetland system (HGM 1) was assessed in terms of health and was found to be categorised as **seriously modified (Category E)**. Modifications to the systems and the resultant effect on the health of the wetlands is predominantly related to the extensive cultivation and extensive alien invasive vegetation and erosion.
- The seepage wetland (HGM 2) between the proposed project and Olifants River was rated as **Largely Modified (Category D).**
- The seepage wetland east (HGM 3) of the proposed project was rated as **Moderately Modified (Category C)** as result of less disturbances compared to the other two wetland units in proximity to the projects area.
- The Ecological Sensitivity and Importance (EIS) of these wetlands were recorded as **low to moderate** as a result of the alteration of natural resources and the maintenance of biodiversity that many of these wetlands provide and the Ecological Services as **intermediate**.
- Extensive crop farming have had a negative impact on the basal cover of vegetation within the catchments associated with the pan wetland. This results in a negative impact on the wetlands ability to maintain biodiversity.

The following findings summarises the key aspects of the biodiversity assessment conducted for the proposed Vlaklaagte Colliery:

- The proposed Vlaklaagte Colliery property boundaries falls within the Eastern Highveld Grassland vegetation type.
- No plant species of conservation concern were identified during the site visit.
- Common species observed within grassland habitat includes *Eragrostis curvula, Seriphium plumosum, Eragrostis chloromelas, Helichrysum nudifolium, Tagetes minuta, Bidens pilosa, Hermannia transvaalensis, Dicoma zeyheri, Eragrostis gummiflua* and *Hyparrhenia tamba.*
- Beyond the reaches of the grasslands is extensive gumtree and black wattle invasion. *Seriphium species* encroached certain sections of the grassland areas.
- Mammal species that were identified onsite included the African porcupine (*Hystrix africaeaustralis*), yellow mongoose (*Cynictis penicillata*) and ground squirrel (*Xerus spp*.). All these mammal species are listed as least concern by the IUCN red list.
- Bird species included spotted thick-knee (*Burhinus capensis*), Helmeted guineafowl (*Numida meleagris*) Egyptian

goose (*Alopochen aegyptiaca*). Other species included Laughing dove (*Spilopelia senegalensis*), Southern red bishop (*Euplectes orix*) and Southern masked weaver (*Ploceus velatus*).

- No red listed faunal or floral species were observed during the site visit.
- From an ecological perspective these wetlands permanent zones can be regarded as a **highly sensitive area** as it is a nesting and foraging area for a diversity of avifauna. The cultivated areas can be regarded as **low sensitive** areas, where the remainder of the grasslands and outer edge of wetland areas as **moderate sensitive**.
- According to the Critical Biodiversity Areas datasets provided by SANBI (2019), the majority of the mining area falls within a transformed landscape.
- The mining operations does not fall within close proximity to any Important Bird Areas (IBAs).
- Although no protected (vulnerable, endangered and critically endangered) species are thought to occur within the area, it is most likely that they would occur within protected areas within close proximity of the study area, but have been fenced off from the transformed areas.
- No red listed faunal or floral species were observed during the site visit. All expected faunal species are listed in **Appendix A** for QDS 2629AB.

The risk assessment on the wetland areas for the current mining operations were rated as an overall **moderate risk with mitigation** and as a **high risk without mitigation**. Identified impacts pertaining to erosion, sedimentation, water quality and quantity alterations and the continued spread of alien invasive species. The proposed Vlaklaagte Colliery already lies within a heavily transformed landscape and if mitigation measures are being implemented appropriately, the possible impacts could be reduced to **moderate** for the operational phase as the wetland areas drain into the Olifants River System eventually.

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 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.

It must be noted that during the time of the assessment recent fires limited the identification of the grassland vegetation and wetland vegetation within the study area.

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LIST OF ABBREVIATIONS AND ACCRONYMS

BGIS:	Biodiversity Geographic Information System
DEM:	Digital Elevation Model
DWAF:	Department of Water Affairs and Forestry
DWS:	Department of Water Affairs and Sanitation
EA:	Environmental Authorisation
EIS:	Ecological Importance and Sensitivity
EMPr:	Environmental Management Program
GIS:	Geographic Information System
HGM:	Hydrogeomorphic
NFEPA:	National Freshwater Priority Area
NWA:	National Water Act (Act no 36 of 1998)
PES:	Present Ecological Status
QDS:	Quarter Degree Square
SANBI:	South African National Biodiversity Institute
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 the wetland and biodiversity assessment for the proposed Vlaklaagte Colliery Coal Mining Operations on Portion 45 of the farm Vlaklaagte 45 IS, near Kriel located in the Mpumalanga Province (**Figure 1**).

The study site lies northeast of the town of Kriel. The R544 runs west of the study site with the Olifants River to the South. The proposed site is approximately 5 ha in extent and the layout of the proposed mining infrastructure is illustrated in **Figure 2**.

The development area falls within the quarter degree square 2629AB. The site is currently surrounded by existing agricultural activities and coal mining operations.

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 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 Vlaklaagte 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 Vlaklaagte mining boundary 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.

1.3.2 Ecological Assessment

The scope of work entailed to the biodiversity assessment following:

- The scope of work entailed to the Ecological Desktop 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:

- It must be noted that during the time of the assessment recent fires limited the identification of the grassland vegetation and wetland vegetation within the study area;
- 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.

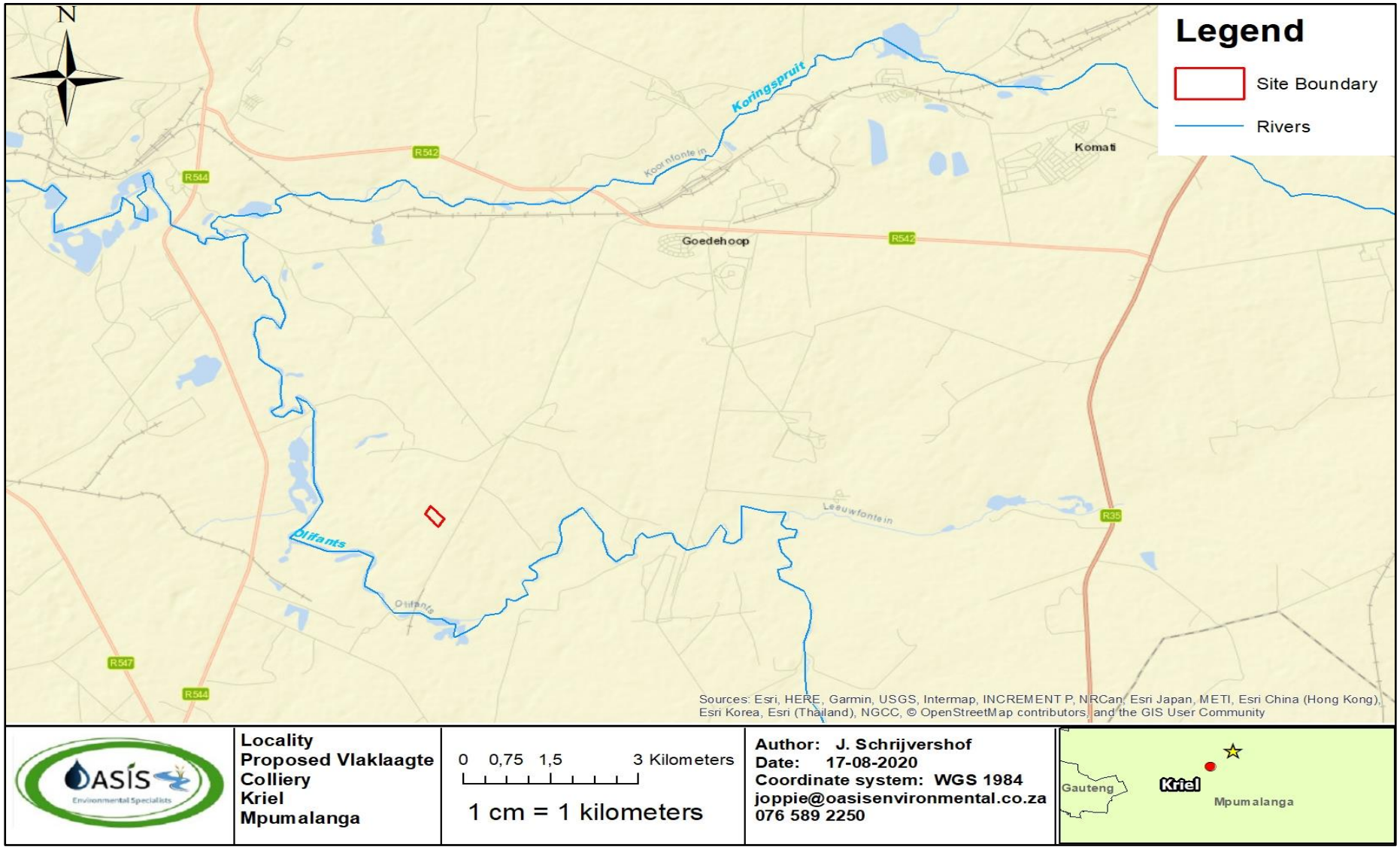

Figure 1: Locality of the proposed Vlaklaagte Coal Mining operations.

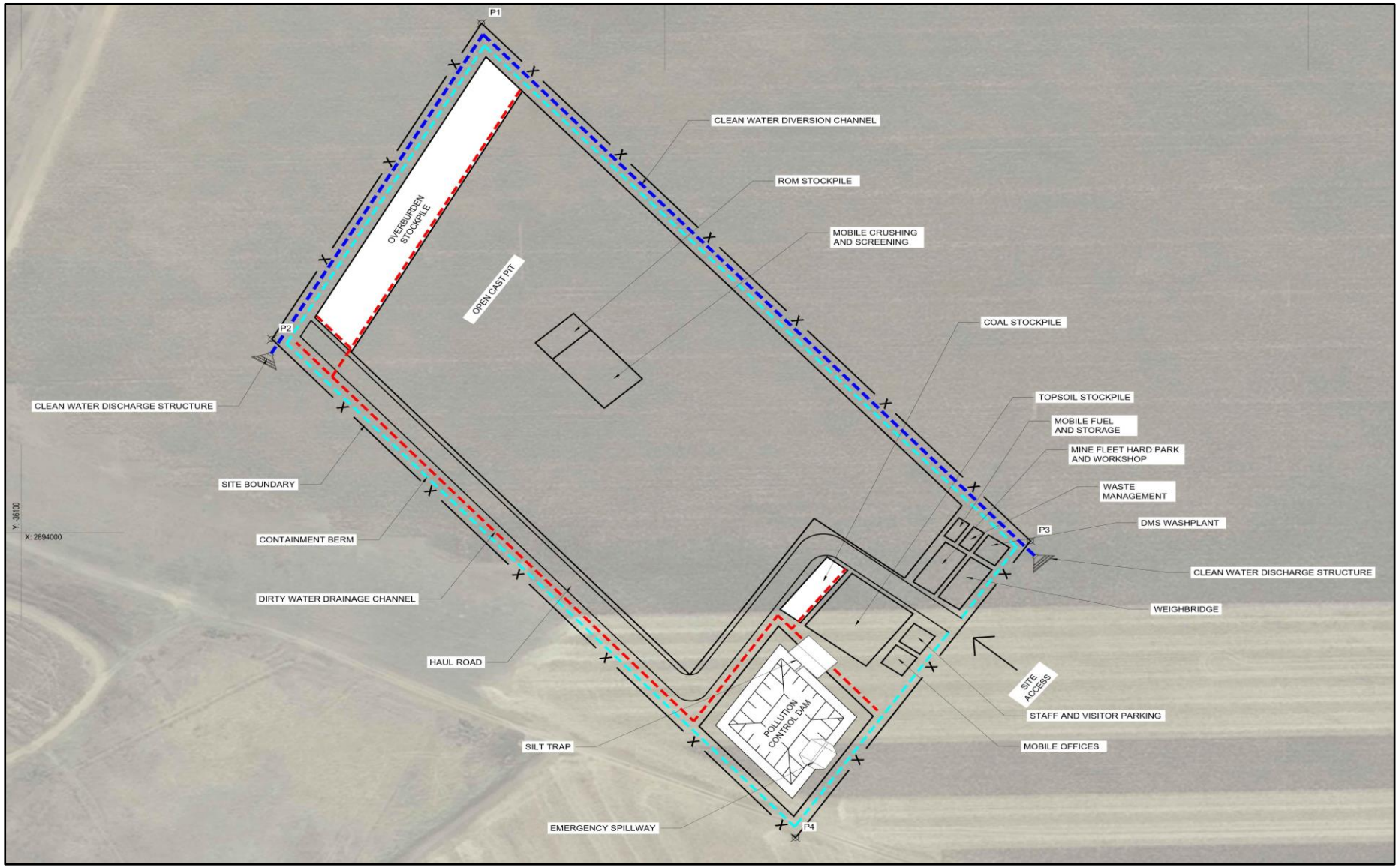

Figure 2: Proposed layout of the newly proposed Vlaklaagte Colliery as provided by Eco Elementum (2020).

2 METHODOLOGY

2.1 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."*

2.1.1 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 1** was utilised to inform the delineation.

Table 1: 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.

2.1.2 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 3**). 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.

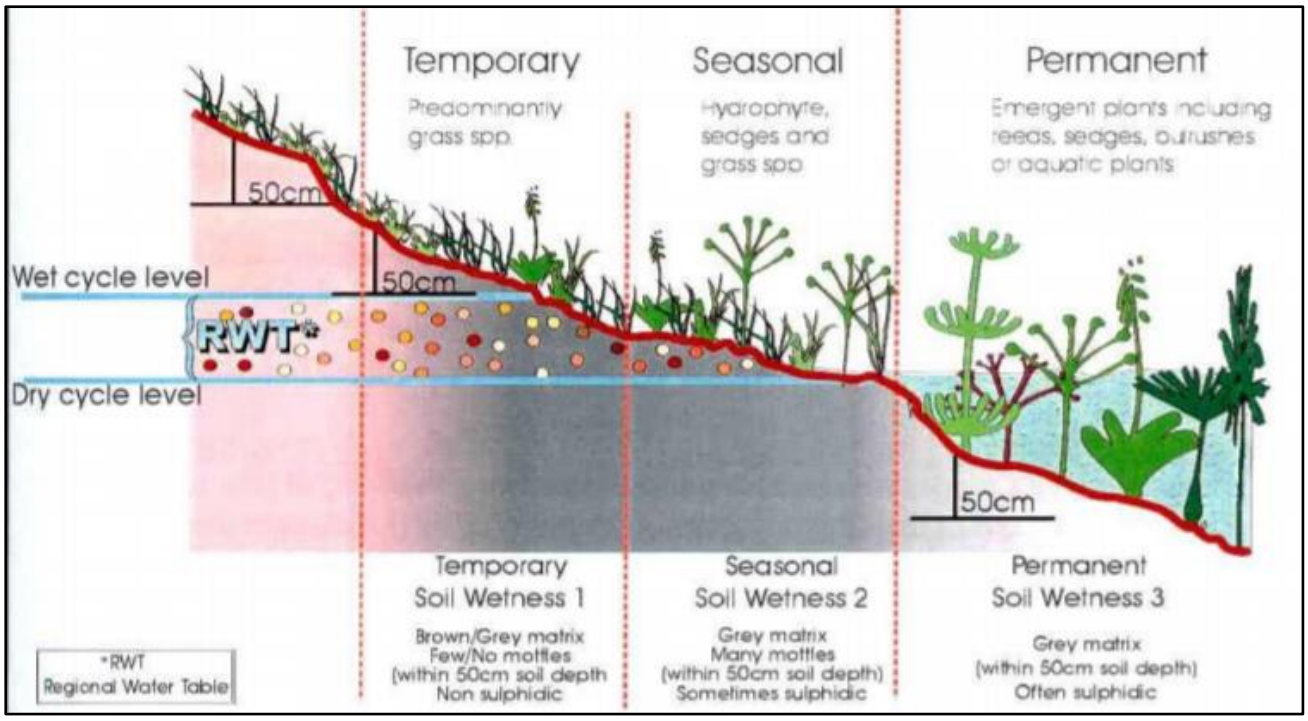

Figure 3: Different zones of wetness found in wetlands, indicating how the soil wetness and vegetation indicators change (DWAF, 2005).

2.1.3 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 2**).

Table 2: 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 3**).

Table 3: 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 4**.

Table 4: 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 4**), 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.

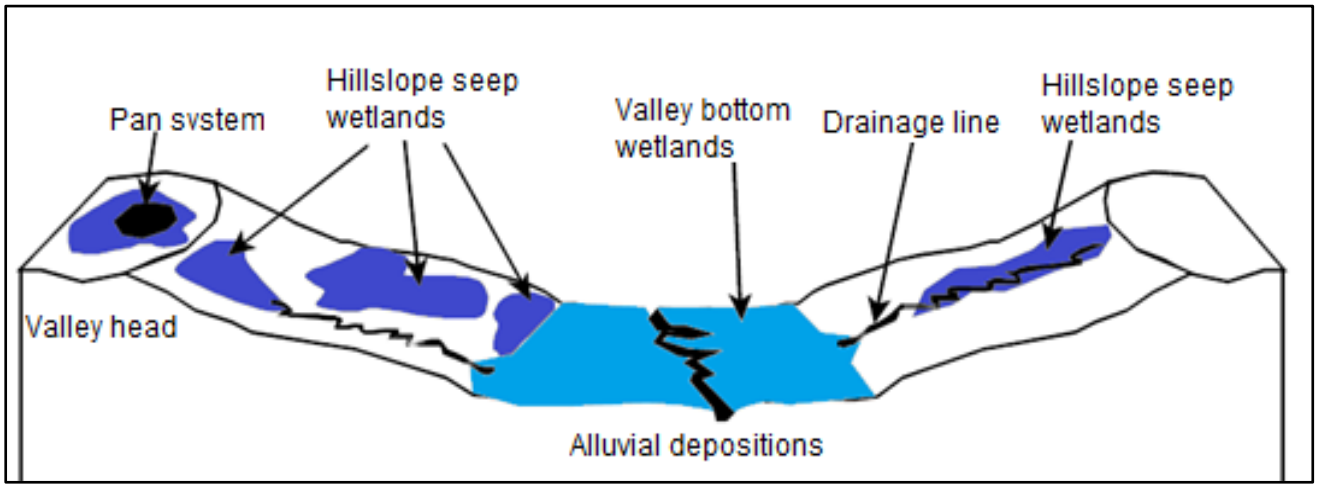

Figure 4: Diagrammatic representation of common wetland systems identified in Southern Africa (based on Kotze *et al*., 2008).

2.2 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 5**).

Table 5: 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.

2.3 Ecological 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 species list (**Appendix A**) for the 2629AB Quarter Degree Square (QDS) within which the study area is situated. 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;
- SANBI Biodiversity GIS tool; and
- Important Bird and Biodiversity Areas (IBAs) (Birdlife South Africa, 2016).

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.

2.3.1 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.

2.3.2 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).

2.3.3 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).

2.3.4 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).

2.3.5 Important Bird Areas

Important Bird Areas are areas that are important for the long-term survival of threatened, restricted avian species (Birdlife South Africa, 2016). 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.

2.3.6 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.

2.3.7 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.

2.3.8 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.

2.3.9 Faunal Assessment

2.3.9.1 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.

2.3.9.2 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.

2.4 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 6**.

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 6: Significance scoring used for each potential impact.

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

3.1 Quaternary catchment and land cover

The study area falls in the B11 tertiary drainage region of the Olifants River catchment (**Figure 5**). Within this tertiary region the Vlaklaagte Colliery falls within the boundary of the B11B quaternary drainage region.

This catchment area's **Present Ecological State (PES) is considered as a Category C (moderately modified) and high Ecological Importance and Sensitivity (EIS)**. The Department of Water Affairs conducted a comprehensive survey in 2012 of the Olifants Catchment and divided it into different Integrated Units of Analysis (IUA), the IUA applicable to the assessment area (catchment B11B), is the Upper Olifants Catchment unit (unit II). This unit can be seen as highly important in terms of ecological sensitivity and is characterised by the following impacts (DWA. 2012):

- Deteriorating water quality as a result of mining and industry;
- High impact from introduced fish species (*Cyprinus carpio* and *Micropterus salmoides*);
- Riparian zones and bank conditions are heavily affected by agricultural activities;
- Flow modifications as a result of impoundments; and
- Bed modification as a result of sedimentation.

The wetlands and rivers within the study site draining toward the north and eventually feeds into the Olifants River which drains into Witbank Dam to the northwest of the study site.

The reference data available is illustrated in **Table 7** below.

Table 7: Sub-Quaternary reach desktop data (DWS, 2016).

SQR		B11B-1327
Category	Name	Olifants
	Ecoregion	Highveld
	Length (km)	36
	Ecological Importance	High
	Ecological Sensitivity	High
	Present Ecological Status	Moderately modified
	Class	**C**

Current land use in the Olifants water management area is characterised by patches of rain fed cultivation and extensive coal mining (DWS, 2016) (**Figure 6**).

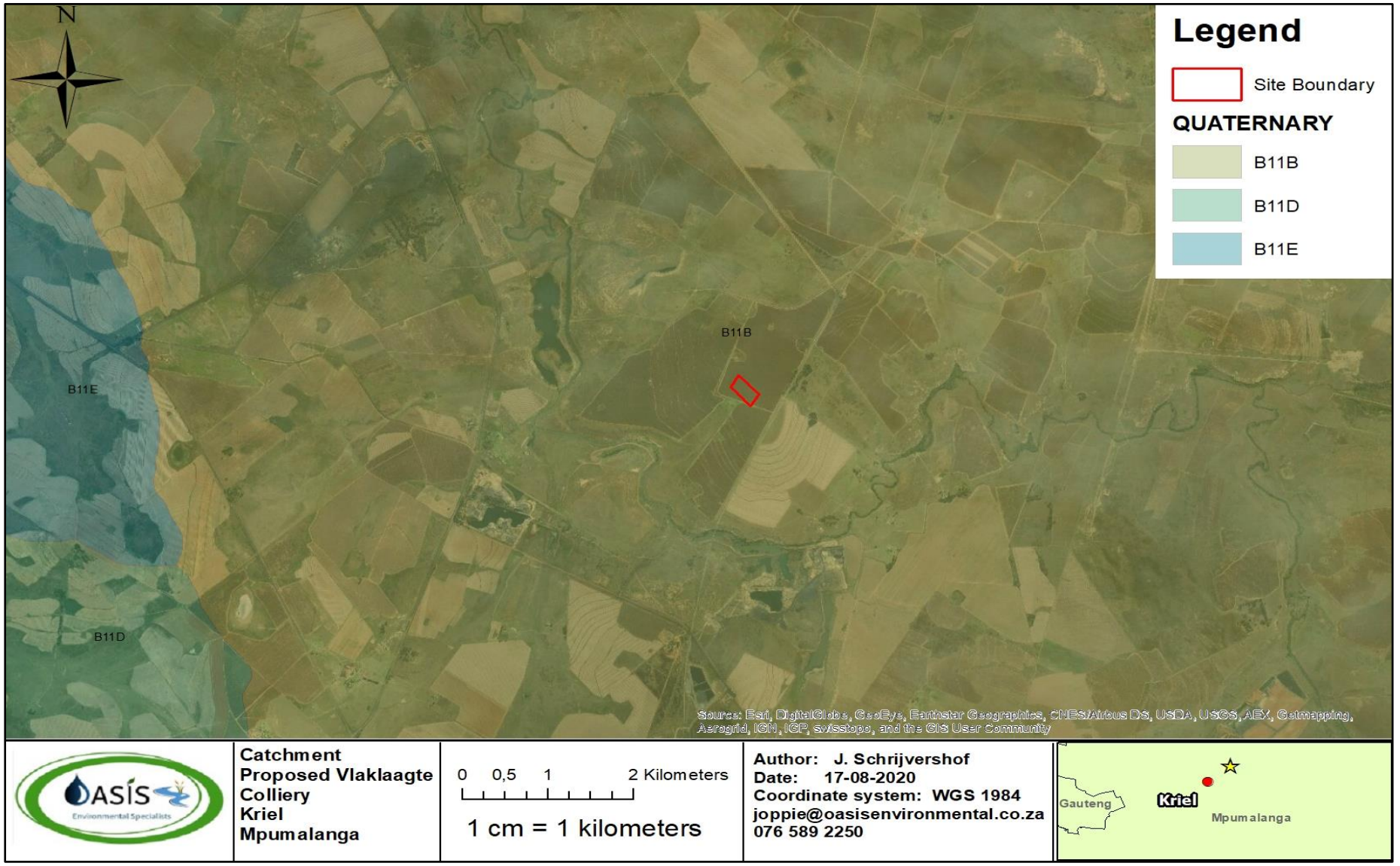

Figure 5: Quaternary Catchment map for the proposed Vlaklaagte Colliery.

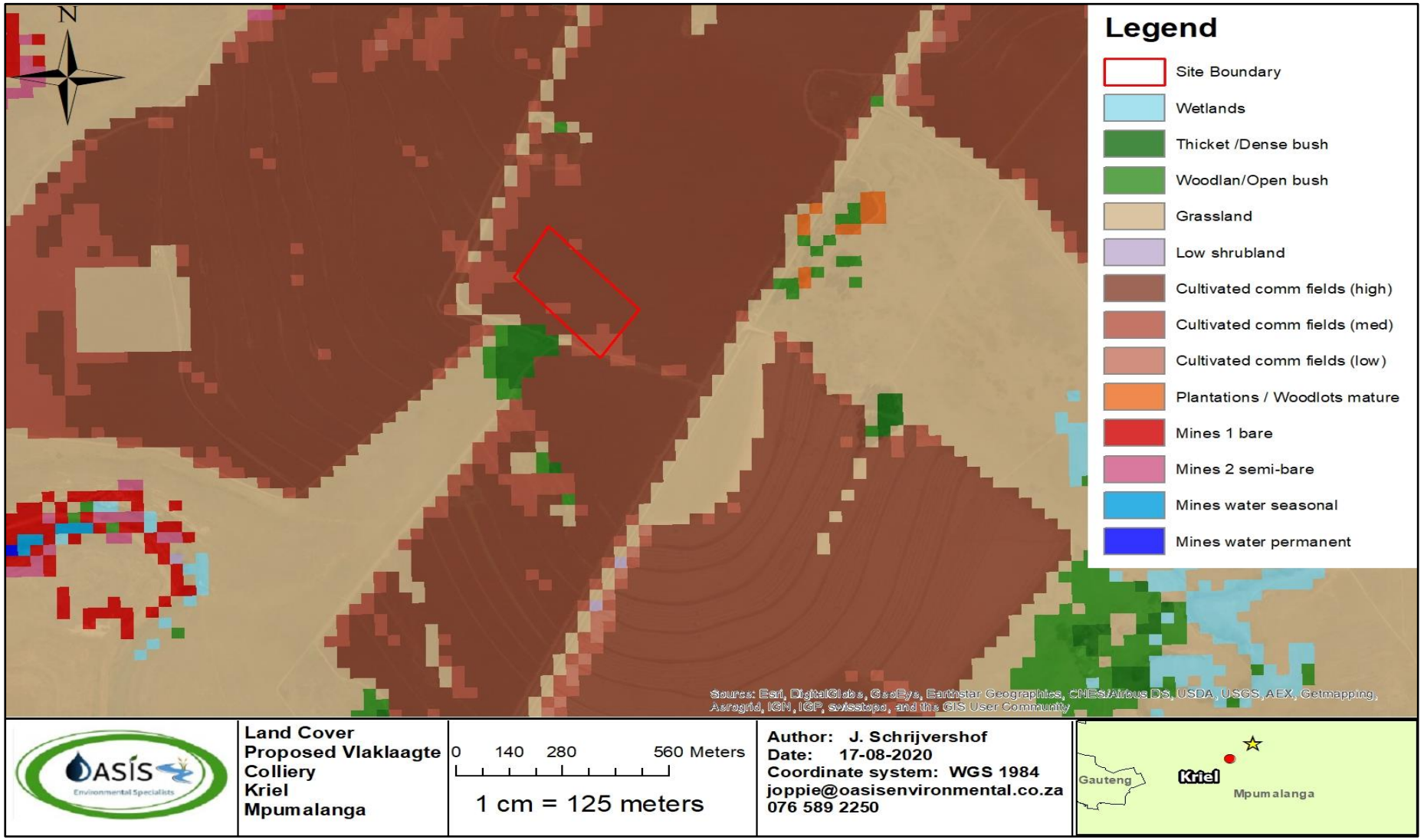

Figure 6: Land cover map for the proposed Vlaklaagte Colliery.

3.2 Ecological Desktop Assessment

3.2.1 Vegetation

The proposed Vlaklaagte Colliery is situated within the **Eastern Highveld Grassland** (Mucina & Rutherford, 2006). The Eastern Highveld Grassland (**Figure 7**) is dominated by Highveld grasses (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya*) 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, Protea. welwitschii* and *Englerophytum magalismontanum*). The conservation status for the area is endangered and some 44% of the land has been transformed primarily by cultivation, plantations, mines, urbanisation and building of dams. A conservation target of 24% has been set for the Eastern Highveld Grassland (Mucina & Rutherford 2006).

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 (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).

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).

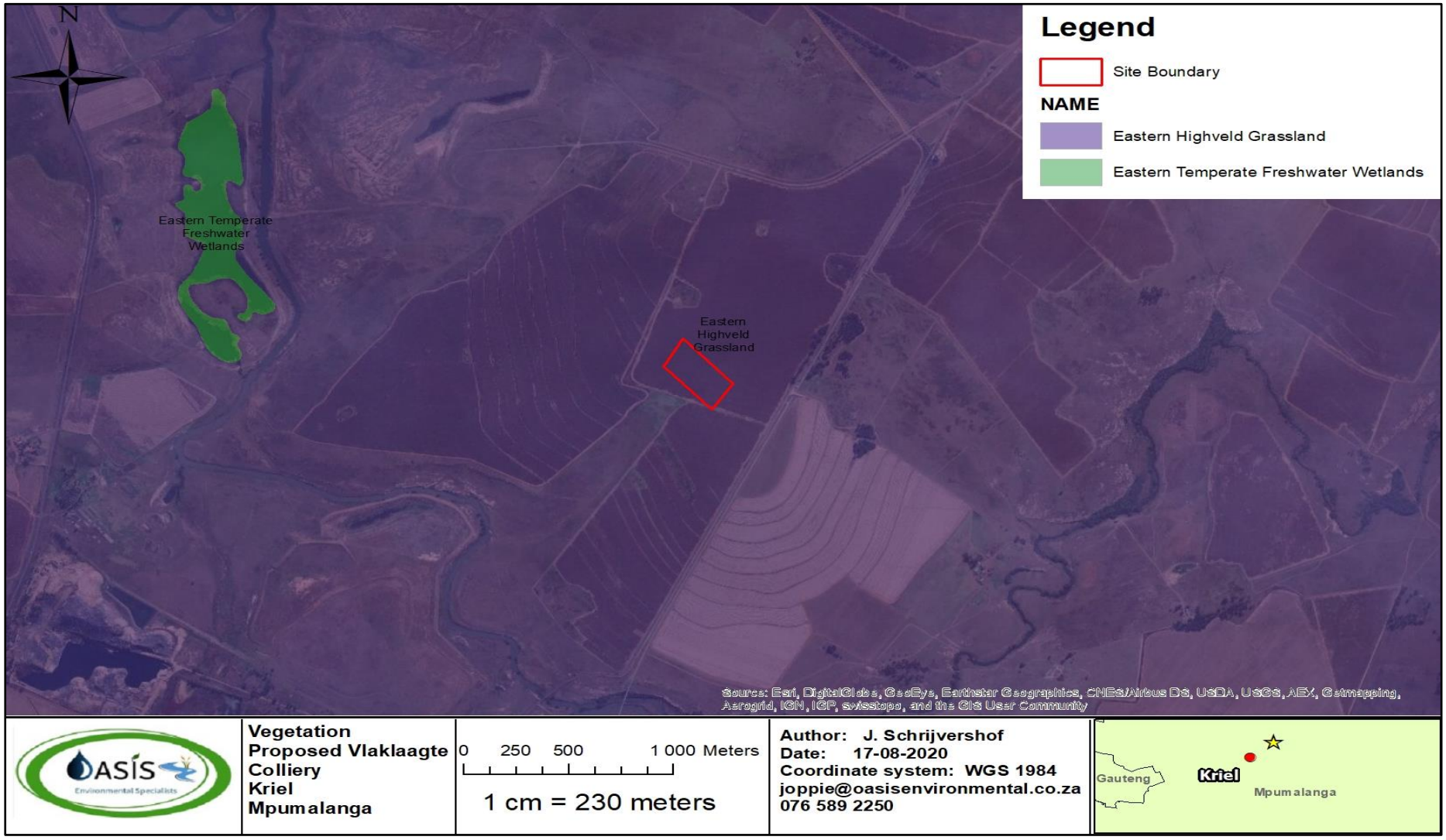

Figure 7: Vegetation map for the proposed Vlaklaagte Colliery.

4 RESULTS

4.1 Desktop Assessment

Examination of the National Freshwater Ecosystem Priority Areas (NFEPA) database were undertaken for the proposed Vlaklaagte Colliery. 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.

Valley bottom NFEPA wetlands were identified within 500 m of the mining area during the desktop assessment (**Figure 8**).

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.

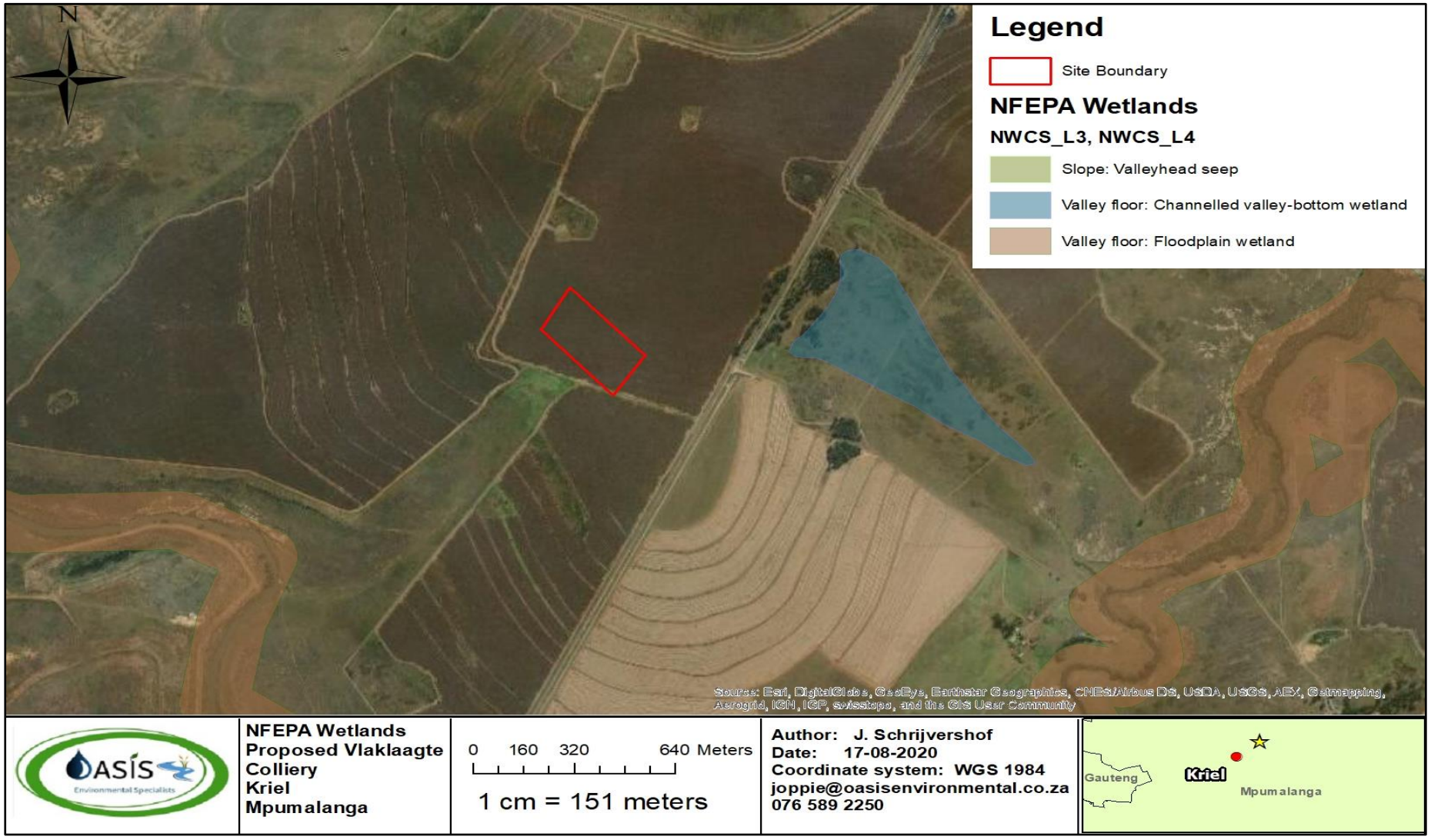

Figure 8: Proposed Vlaklaagte Colliery - NFEPA Wetland map.

4.2 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 1534 m to 1605 m above sea level. A Digital Elevation Model (DEM) of the aerial photography of the site revealed depression in landscape south-east and south-west of the mining boundary associated with drainage into the Olifants River (**Figure 9**).

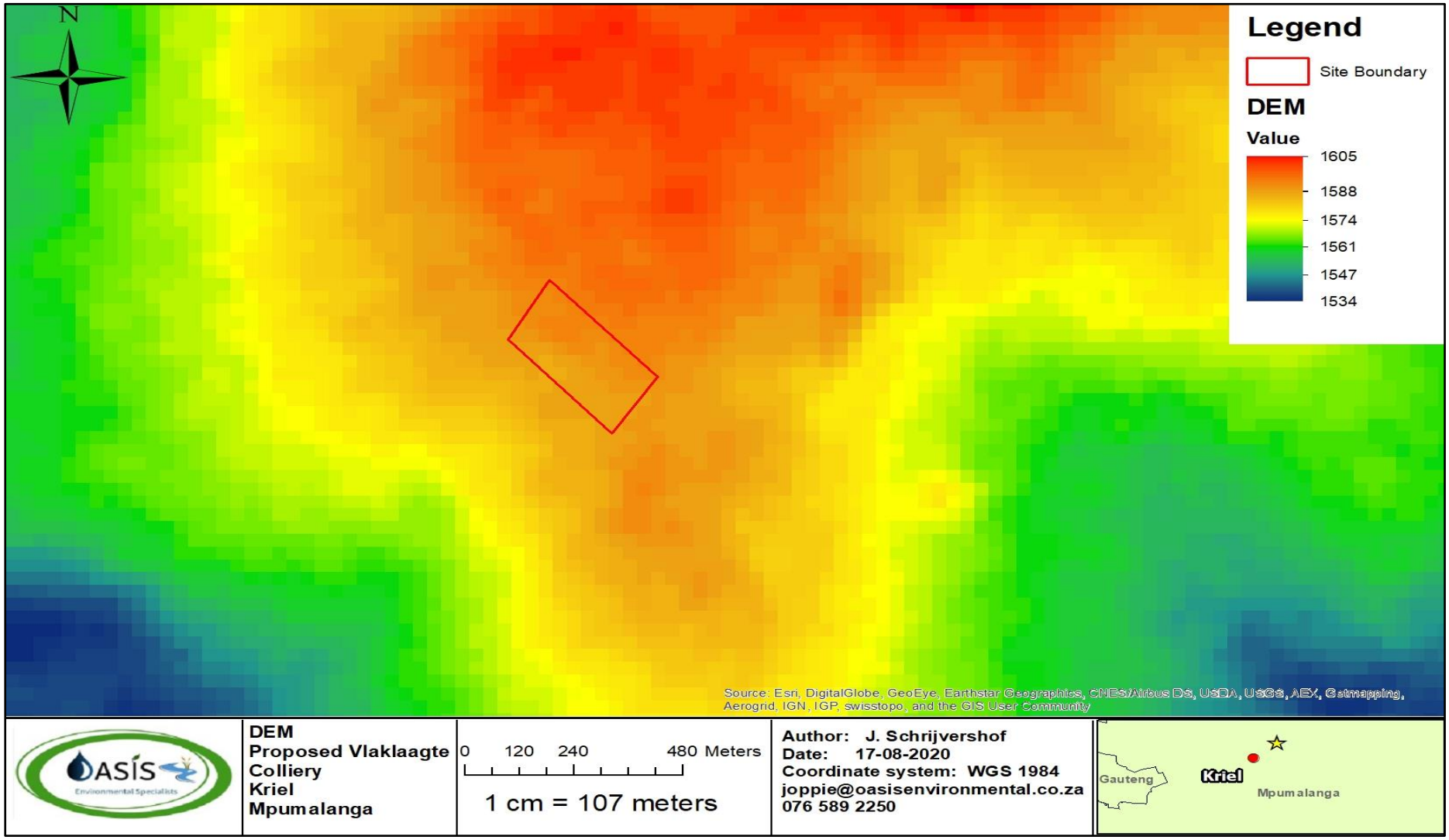

Figure 9: Proposed Vlaklaagte Colliery - Digital Elevation Model map.

4.3 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 wetland seasonal and permanent zones were classified as a Katspruit soil form (**Figure 10**). Wet sandy Wasbank soils were associated with the seepage wetland areas (**Figure 11**).

Terrestrial soils sampled were dominated by Clovelly outside of the wetland areas (**Figure 12**). Soil properties identified on site are shown below (**Table 8**).

Table 8: Information used to inform the wetland delineation for the wetlands identified within 500 m of the proposed Vlaklaagte boundary.

Soil Form and Horizons		Soil	Zone of wetness	Observations
Hydric Soil				
Katspruit	Orthic A	Sandy Clay	Permanent zones	Gleyed matrix, sandy-clay soil identified closer to the Olifants River. Mottling present within these soils within depths of 0.25 m
	Unspecified with signs of wetness			
Wasbank	Orthic A	Sandy	Depression seasonal zones with seep wetlands	Bleached, sandy albic horizon that is limited in depth by hard plinthite. Signs of mottling were already present at soil depths of 0.25 m and mottling increase with depth of the profile. The albic horizon was moist and there was an increase in wetness with soil depth.
Terrestrial Soil				
Clovelly	Orthic A	Sandy	None	Yellow structureless soil with no signs of saturation observed. No mottling was observed in the profiles examined
	Hard Rock			
	Yellow Apedal			

Figure 10: Hydric soils included sandy clay soils with mottling associated with the permanent zones in the wetland areas.

Figure 11: Hydric soils included Wasbank wet sandy soils associated with the seepage wetland areas.

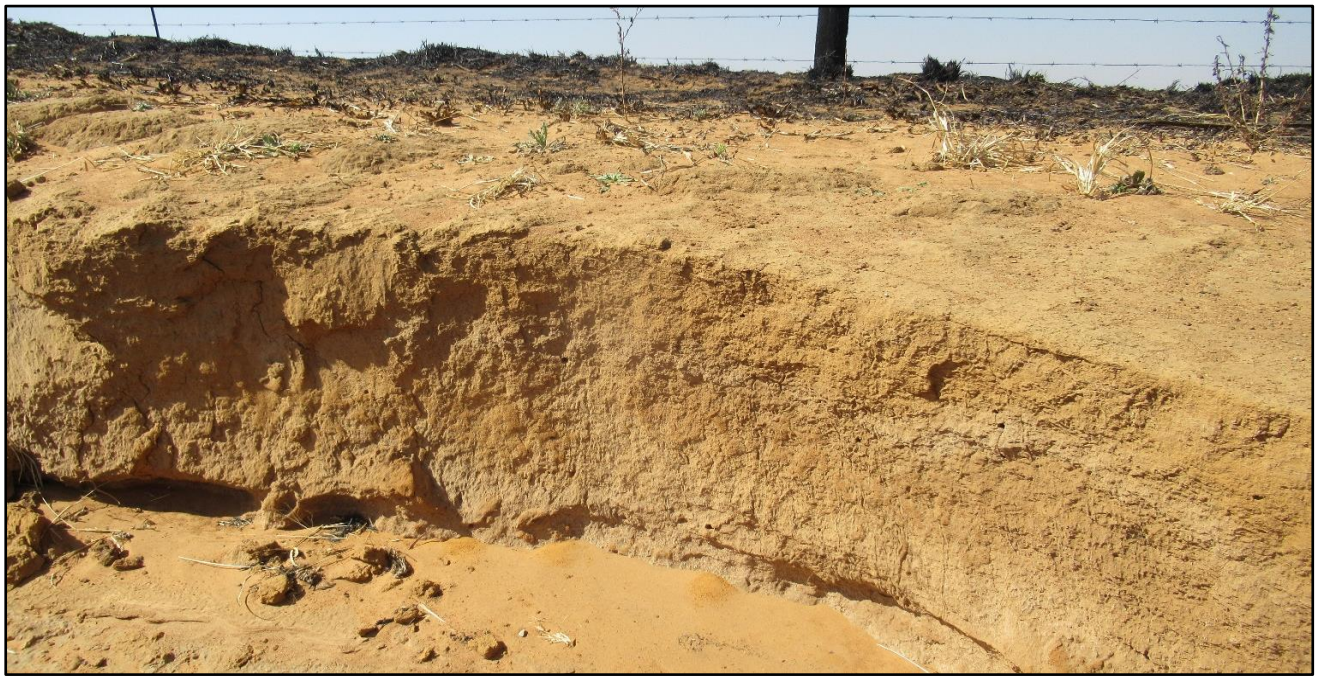

Figure 12: Clovelly soils were identified and dominant outside of the wetland system within the grasslands.

4.4 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). Minor 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.

Hydrophytic wetland vegetation *Typha capensis and Imperata cylindrica* were dominant in the wetland areas (**Figure 12**).

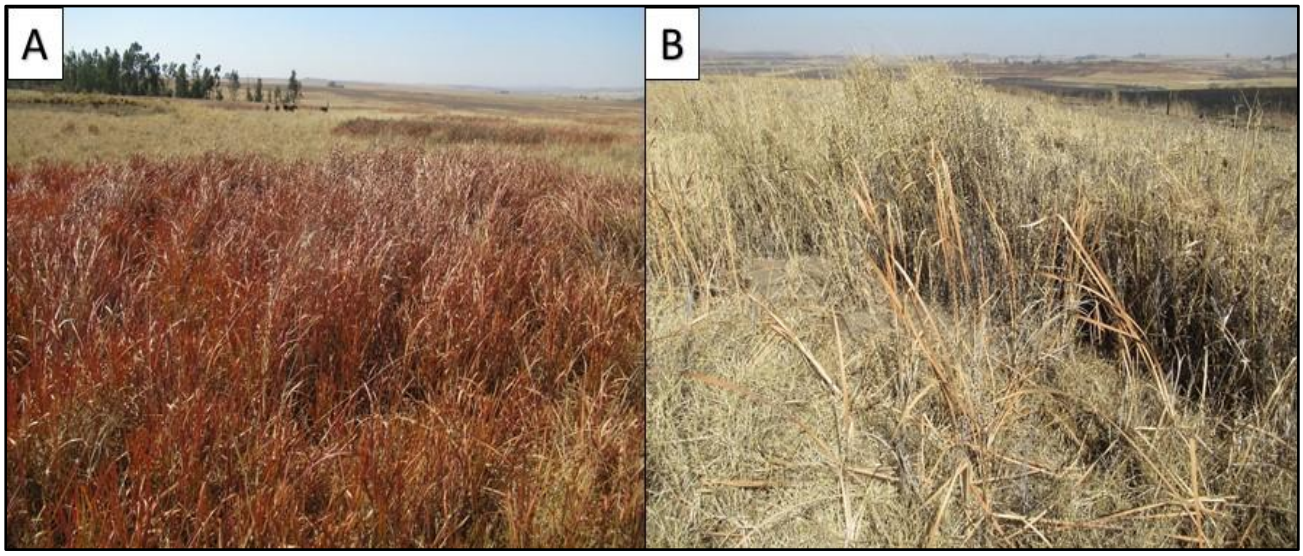

Figure 13: Vegetation identified with the wetland systems included (A) *Imperata cylindrica* and (B) *Typha capensis*

4.5 Wetland Delineation

Any wetlands identified on the site were categorised according to the National Wetland Classification System for South Africa (Ollis *et al*., 2013). The wetland area was classified as a hydrogeomorphic (HGM) unit. 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 Seepage wetland systems (HGM 2 and HGM 3) and one Pan wetland (HGM 1) were identified within the study boundary (**Figure 14**). Seepage wetlands are characterised by their association with topographic positions that either cause groundwater to discharge to the land surface or rain derived water to seep down-slope as subsurface interflow. Water movement through the seep is primarily attributed to interflow, with diffuse overland flow often being significant during and after rainfall events (Kotze *et al.*, 2008; Ollis *et al*., 2013).

Pan wetlands serve as small (deflationary) depressions which are circular or oval in shape; usually found on the crest positions in the landscape. The topographic catchment area can usually be well-defined (i.e. a small catchment area following the surrounding watershed). Although often apparently endorheic (inward draining), many pans are “leaky” in the sense that they are hydrologically connected to other wetland or river systems through subsurface diffuse flow paths (Rountree *et al*., 2007).

A description of the wetland types is given in **Table 9**.

Table 9: Wetland hydrogeomorphic (HGM) types (Kotze *et al.*, 2008).

HGM Unit	Description	Source of water maintaining the	
		Surface	Subsurface
Seep 	Slopes on hillsides, which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from subsurface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
Depression/Pans 	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream.	*/***	*/***

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

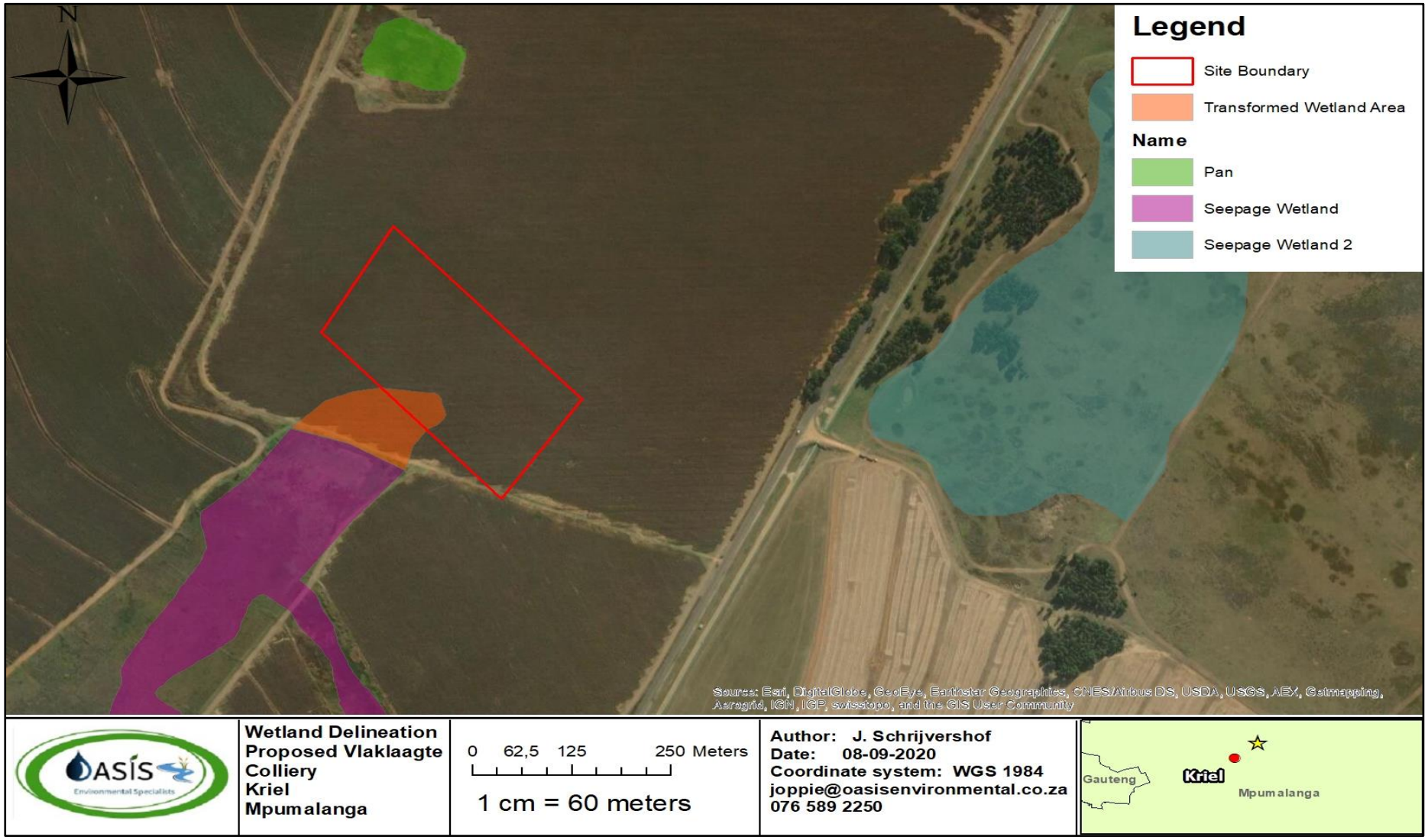

Figure 14: Proposed Vlaklaagte Colliery - Wetland delineation map.

4.6 Wetland Functional and Health Assessment

4.6.1 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 Sensitivity and Importance (EIS) of the wetlands has generally been recorded as low to moderate and the Ecological Services as intermediate (**Table 10** and **Table 11**). Although no red-data species were identified during the site investigation, the majority of channelled valley bottom systems usually, provide habitat for a number of floral and faunal species.

Table 10: Summary of the Ecological Importance and Sensitivity of the wetland systems associated with the proposed Vlaklaagte Colliery.

ECOLOGICAL IMPORTANCE AND SENSITIVITY:		
Ecological Importance	Score (0-4)	*Confidence (1-5)*
Biodiversity support	**1,43**	*4,00*
Presence of Red Data species	**1,20**	*4,00*
Populations of unique species	**1,40**	*4,00*
Migration/breeding/feeding sites	**1,70**	*4,00*
Landscape scale	**1,68**	*3,80*
Protection status of the wetland	**1,80**	*4,00*
Protection status of the vegetation type	**1,50**	*3,00*
Regional context of the ecological integrity	**1,90**	*4,00*
Size and rareity 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	**1,83**	***3,60***
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**2,00**	***2,00***
DIRECT HUMAN BENEFITS	**1,67**	***3,00***
Overall	**1,83**	**2,87**

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

Table 11: Summary of the Ecological Services of the three wetland systems in proximity of the proposed Vlaklaagte Colliery.

Condensed summary sheet	HGM 1		HGM 2		HGM 3	
	Overall score	Confidence rating	Overall score	Confidence rating	Overall score	Confidence rating
Flood attenuation	4,0	4.0	2,6	3	1,6	4.0
Streamflow regulation	2,0	3	1,9	3	1,0	4
Sediment trapping	2,0	3	2,3	3	2,0	4
Phospahte trapping	2,0	3	1,0	2	1,0	3
Nitrate removal	1,0	2	1,0	2	1,0	3
Toxicant removal	0,5	3	1,0	3	1,0	3
Erosion control	0,7	4	0,5	4	0,2	4
Carbon storage	1,9	3	1,5	3	1,2	3
Maintenance of biodiversity	0,5	2	0,5	2	0,1	4
Water supply for human use	0,3	2	0,5	3	0,3	3
Natural resources	0,5	3	1,0	3	1,2	3
Cultivated foods	4,0	3	2,6	3	1,5	3
Cultural significance	0,5	3	0,1	3	0,1	3
Tourism and recreation	0,1	3	0,1	3	0,1	3
Education and research	0,1	3	0,1	3	0,1	3
Threats	1,2	3	3,0	3	1,5	3
Opportunities	0,2	3	0,5	3	0,2	3
Overall	**1,3**	**2,9**	**1,2**	**2,9**	**0,8**	**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

4.7 Wetland Health and PES

According to the functional assessment flood attenuation; sediment trapping; erosion control; the maintenance of biodiversity; and the provision of natural resources are the predominant attributes provided by these wetlands to the surrounding landscapes.

The pan wetland system (HGM 1) was assessed in terms of health and was found to be categorised as **seriously modified (Category E)** (**Table 12**). Modifications to the systems and the resultant effect on the health of the wetlands is predominantly related to the extensive cultivation and extensive alien invasive vegetation and erosion (**Figure 15**). The seepage wetland (HGM 2) between the proposed project and Olifants River was rated as **Largely Modified (Category D)** (**Figure 17**).

The seepage wetland east (HGM 3) of the proposed project was rated as **Moderately Modified (Category C)** as result of less disturbances compared to the other two wetland units in proximity to the projects area (**Figure 19**).

Table 12: Summary of PES scores for the HGM Units within proximity of the proposed Vlaklaagte Colliery.

Module	HGM Unit 1			HGM Unit 2			HGM Unit 3		
	Impact Score	Category	Trajectory	Impact Score	Category	Trajectory	Impact Score	Category	Trajectory
Hydrology	6,2	E	↓	5,2	D	↓	3,9	C	↓
Geomorphology	6,6	E	↓	5,7	D	↓	4,5	D	↓
Vegetation	6,3	E	↓	4,3	D	↓	3,3	C	↓
Overall Score	**6,37**	**E**	↓	**5,07**	**D**	↓	**3,90**	**C**	↓

Extensive crop farming have had a negative impact on the basal cover of vegetation within the catchments associated with the pan wetland (**Figure 16**). This results in a negative impact on the wetlands ability to maintain biodiversity.

Despite the modified nature of the seep wetlands they still provide a number of functions to the larger landscape, particularly with regard to flood attenuation; sediment trapping; erosion control; the maintenance of biodiversity; and the provision of natural resources (**Figure 18 and Figure 20**).

Figure 15: Overall view for the valley bottom wetland (HGM 1) within 500 m of the proposed Vlaklaagte project boundary.

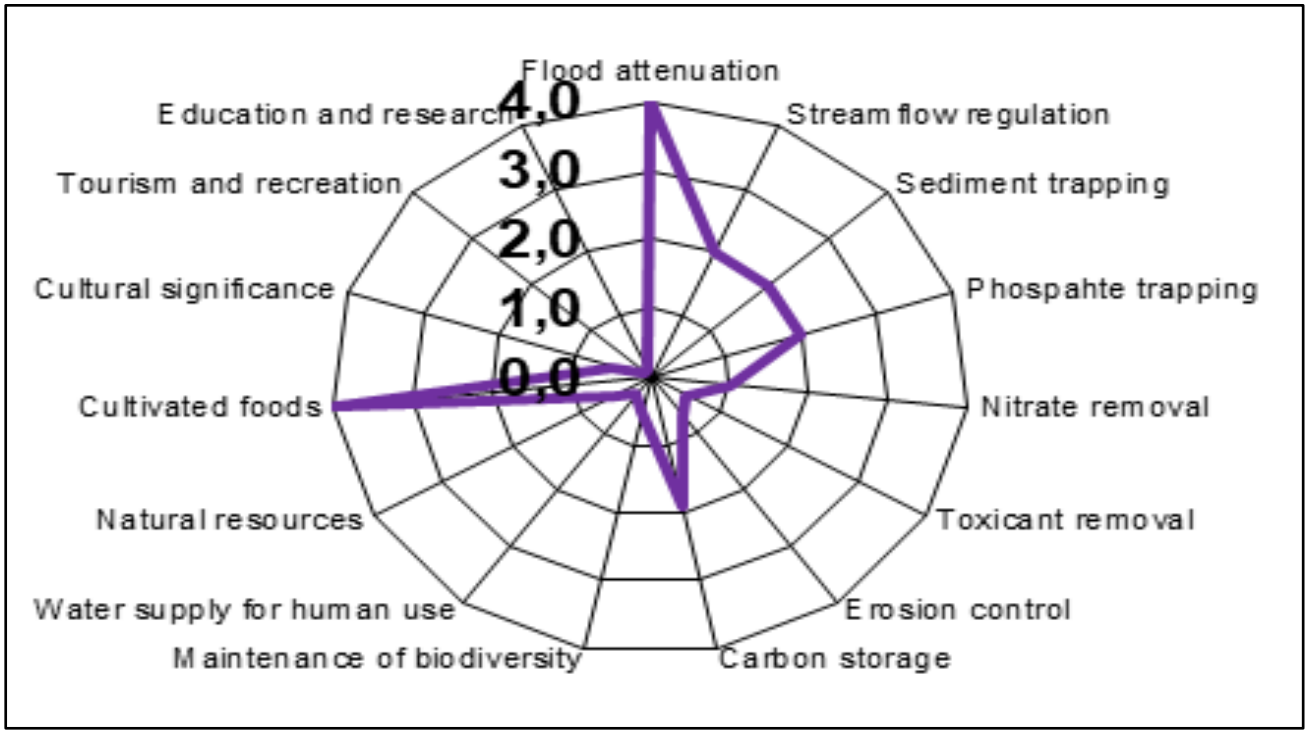

Figure 16: WET-Eco Services results for HGM 1.

Figure 17: Overall view for the valley bottom wetland (HGM 2) within 500 m of the proposed Vlaklaagte project boundary.

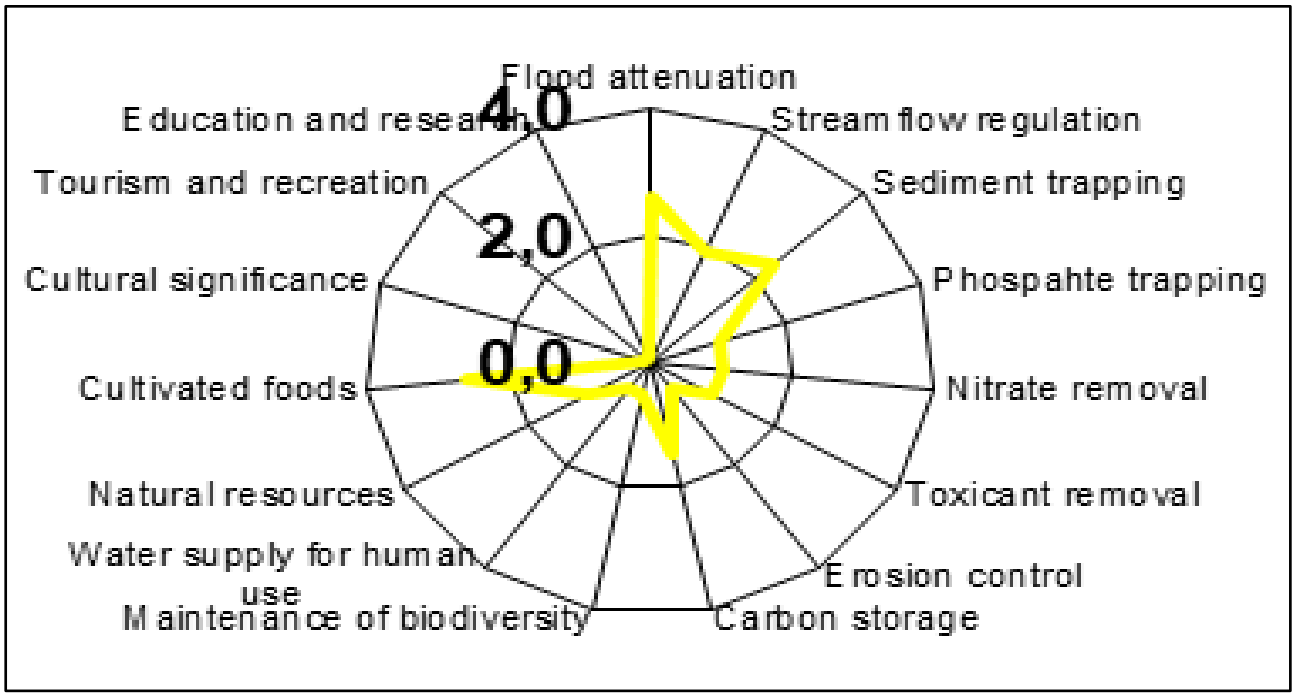

Figure 18: WET-Eco Services results for HGM 2.

Figure 19: Overall view for the valley bottom wetland (HGM 3) within 500 m of the proposed Vlaklaagte project boundary.

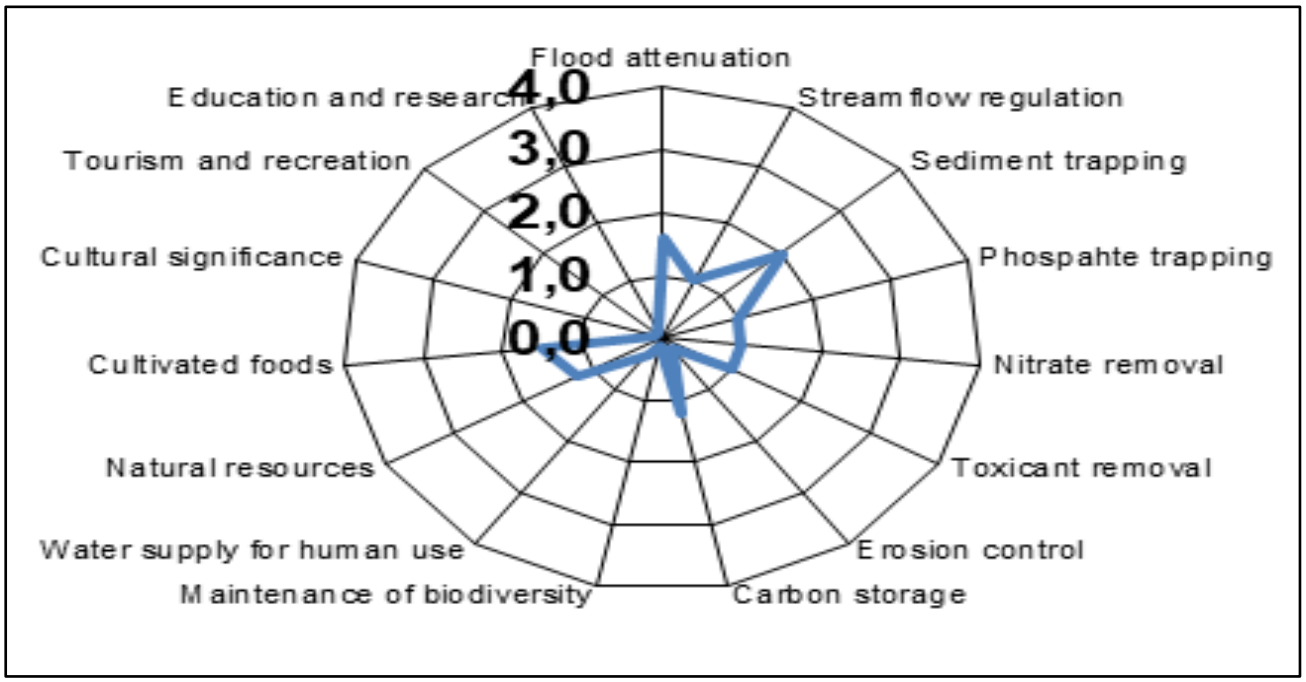

Figure 20: WET-Eco Services results for HGM 3.

4.8 Ecological Assessment

4.8.1 Critical Biodiversity Areas

According to the Critical Biodiversity Areas datasets provided by SANBI (2019), the majority of the application area does not overlap with any CBAs as seen in **Figure 22**. These sections were confirmed to be transformed landscape during the site visit.

4.8.2 Threatened Ecosystems and Protected areas

The mining area does not overlap with any threatened ecosystems and/or protected areas.

4.8.3 Important Bird Areas

The mining area does not occur within close proximity to any Important Bird Areas.

4.8.4 Vegetation

The majority of the study site consisted of alien invasive vegetation and very little indigenous vegetation, however vegetation normally associated with that area is listed in **Appendix B** depicted from Mucina and Rutherford (2006) for the Eastern Highveld Grassland. No red listed floral species were observed during the site visit.

Commonly observed grasses (dominant species) within the area of investigation comprised *Imperata cylindrica* (Cogon grass) *Hyparrhenia hirta* (Thatching grass) associate with the wetland areas. Common species observed within grassland habitat includes *Eragrostis curvula, Seriphium plumosum, Eragrostis chloromelas, Helichrysum nudifolium, Tagetes minuta, Bidens pilosa, Hermannia transvaalensis, Dicoma zeyheri, Eragrostis gummiflua* and *Hyparrhenia tamba* (**Figure 21**). Beyond the reaches of the grasslands is extensive gumtree and black wattle invasion. *Seriphium spp.* encroached certain sections of the grassland areas.

4.8.5 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 13** lists the alien species identified on site as well as their respective alien categories. Majority of the area has been transformed into cultivated land, other species identified are included in **Table 13**.

Table 13: Alien Invasive Plants identified surrounding the mining area.

Species Name	Common Name	Category
Acacia mearnsii	Black Wattle	2
Datura stramonium	Common Thorn Apple	1b
Eucalyptus tereticornis	Forest Red Gum	1b
Tagetes minuta	Khaki Weed	-
Verbena bonariensis	Tall Verbena	1b

4.8.6 Fauna

Mammal species that were identified onsite included the African porcupine (*Hystrix africaeaustralis*) **(Figure 23**), yellow mongoose (*Cynictis penicillata*) and ground squirrel (*Xerus spp*.). All these mammal species are listed as least concern by the IUCN red list.

Bird species included Spotted thick-knee (*Burhinus capensis*) (**Figure 24**), Helmeted guineafowl (*Numida meleagris*) Egyptian goose (*Alopochen aegyptiaca*). Other species included Laughing dove (*Spilopelia senegalensis*), Southern red bishop (*Euplectes orix*) and Southern masked weaver (*Ploceus velatus*).

No red listed faunal species were observed during the site visit.

All wetland areas can be regarded as highly sensitive areas as it provides suitable habitat for faunal species (**Figure 25**). All transformed areas were rated as low sensitive and natural grasslands between the wetland and crop areas has been rated as moderately sensitive.

Figure 21: Vegetation identified included grasslands patches between cultivated lands.

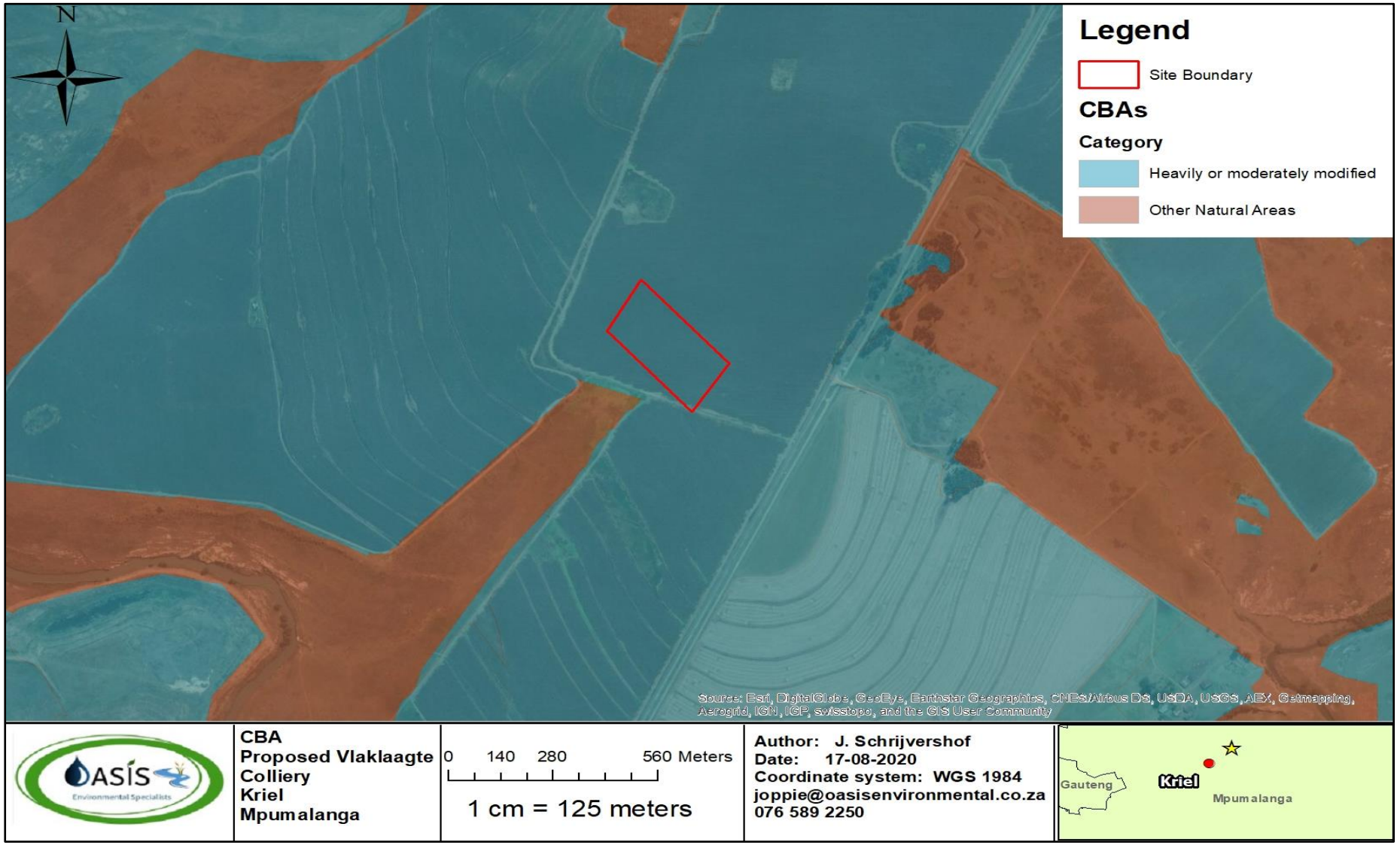

Figure 22: Proposed Vlaklaagte Colliery - Critical Biodiversity Areas map.

Figure 23: Signs of faunal species identified included African porcupine (*Hystrix africaeaustralis*).

Figure 24: Spotted thick-knee (*Burhinus capensis*).

Figure 25: Proposed Vlaklaagte Colliery - Ecological Sensitivity map.

5 RISK ASSESSMENT OF DELINEATED WETLANDS

The risk assessment focussed on the impacts associated with the proposed Vlaklaagte Colliery as mentioned above.

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

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 in **Table 14 without mitigation and Table 15 with mitigation**.

Construction/Establishment Phase

During the construction phase, areas that are targeted for the expanded opencast mining and new access roads, will be cleared of vegetation and the topsoil will be stripped. This will lead to sediments being washed downslope into wetland areas impacting on the biota and hydrodynamics of the wetlands. The increased runoff will increase the erosion potential and sediment carrying capacity of surface waters, especially during a storm event.

Construction/establishment activities associated with bulk earthworks (such as excavations, reshaping, back-filling and compaction) can alter natural patterns of surface runoff reaching water resources downslope/downstream. Excavations may impound and redirect/restrict water, starving downstream water resources. Infilling, compaction and rutting of soils caused by construction/establishment alter the patterns of diffuse surface and sub-surface flows by altering micro-topography and the permeability of soil profiles. Changes in flow patterns will affect hydrological functionality and ecosystem integrity. Increased runoff velocities linked to concentrated flow paths created during construction/establishment will lead to erosion and sedimentation. Should temporary damming and abstraction of water take place, a short-term reduction of flows to downstream habitat will also result in alterations of the sediment balance (Macfarlane *et al*., 2014).

Prior to stripping of vegetation, alien plant species must be identified and removed as per an alien invasive plant management plan. Only after the alien vegetation has been removed and disposed of appropriately can the remaining vegetation be stripped. All trees or bushes taller than 50 cm must be removed first and placed into a separate stockpile (these can be used in the ongoing rehabilitation to reduce erosion risk). After the taller vegetation has been removed, the remaining vegetation in these areas can be stripped with the topsoil (top 30 cm only) and stockpiles as one. This will ensure a healthy seedbank remains within the topsoil layer as well as to provide nutrients and organic matter to keep the soil healthy. The remaining subsoil must be stripped and stockpiles separately

Upgrading and construction/establishment of infrastructure will result in increased sediment runoff and sedimentation. Site preparation and all associated infrastructure will entail blasting, drilling, dewatering, clearing, grubbing, grading and ground preparation as well as the creation of containment facilities that will eliminate some stream reaches and intercept all surface

run-off within the proposed area. Impacts associated with this activity include increased erosion and sediment deposition in the receiving aquatic environment far downstream.

Topsoil and subsoil will be placed into stockpiles which change the natural drainage of the area where they have been placed. The stockpile could compact the soil below it and reduce infiltration and possible sub-surface flows, altering the hydrodynamics. Stockpiles also provide a source of sediment which could be eroded, increasing sediment loads to areas downslope.

Operational Phase

Increased sedimentation may occur as a result from the runoff from the waste rock dump. 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.

Infrastructure construction/establishment/maintenance will introduce unnatural disturbance, enhancing the "edge effect" promoting establishment of disturbance-tolerant species, including further colonisation by alien invasive species in areas adjacent to the work servitude. While this impact is initiated during the construction/establishment phase the impacts will persist into the operational phase. 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 Sedimentation and soil erosion

Soil erosion will result in the deposition of sediment into the wetland and channel 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 (e. as a result of clogging of fish gills, interference in embryogenesis and larval development of amphibians and mortality of filter-feeding macro-invertebrates).

During the operational phase of the plants rainfall is likely to filter through into the waste dump. This water is likely to accumulate particles and pollutants that will pose a risk to the surrounding water courses. Sediment that washes off the waste dump 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.

5.2 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).

5.3 Alien Invasive Species

There are minimal alien invasive plant species currently present within the area. 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).

5.4 Mitigation

The Vlaklaagte Colliery 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 50 m buffer implemented for the wetland system;
- Water quality monitoring must take place every month during operational phases; and
- Wetland monitoring and biomonitoring must take place bi-annually.

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 or 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 dams.

- Ensure pollution sources are isolated through clean and dirty water separation and monitor this throughout the lifespan of the Vlaklaagte.
- 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 14: Significance ratings matrix for the impacts without mitigation measures being implemented for the proposed Vlaklaagte Colliery.

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 Vlaklaagte Colliery**	Stream Diversion Work Revetments New access routes Site clearing for opencast area Placement of cleared topsoil into allocated stockpiles Use of heavy machinery	Flow alterations due to erosion and sedimentation	3	2	3	3	2,75	3	2	7,75	4	4	5	3	16	124	M	70
2	Construction phase	**Proposed Vlaklaagte Colliery**	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	4	4	5	3	16	120	M	70
3	Construction phase	**Proposed Vlaklaagte Colliery**	New access routes Use of heavy machinery Placement of cleared topsoil into allocated stockpiles Bank trampling leading to erosion	Spread of alien vegetation	3	2	3	3	2,75	3	2	7,75	4	4	5	3	16	124	M	70
4	Operational phase	**Proposed Vlaklaagte Colliery**	Increased traffic Use of heavy machinery Bank Erosion	Flow alterations due to erosion and sedimentation	4	2	4	3	3,25	3	3	9,25	5	5	5	4	19	175,8	H	80
5	Operational phase	**Proposed Vlaklaagte Colliery**	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	3	3	9,5	5	5	5	4	19	180,5	H	80
6	Operational phase	**Proposed Vlaklaagte Colliery**	Increased runoff from hardened surfaces Increased traffic	Spread of alien vegetation	3	3	3	3	3	3	3	9	3	3	5	4	15	135	M	70

Table 15: Significance ratings matrix for the impacts with mitigation measures being implemented for the proposed Vlaklaagte Colliery.

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 Vlaklaagte Colliery**	Stream Diversion Work Revetments New access routes Site clearing for opencast area Placement of cleared topsoil into allocated stockpiles Use of heavy machinery	Flow alterations due to erosion and sedimentation	2	2	2	2	2	3	2	7	4	4	5	3	16	112	M	70
2	Construction phase	**Proposed Vlaklaagte Colliery**	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	4	4	5	3	16	104	M	70
3	Construction phase	**Proposed Vlaklaagte Colliery**	New access routes Use of heavy machinery Placement of cleared topsoil into allocated stockpiles Bank trampling leading to erosion	Spread of alien vegetation	2	1	2	2	1,75	3	2	6,75	4	4	5	3	16	108	M	70
4	Operational phase	**Proposed Vlaklaagte Colliery**	Increased traffic Use of heavy machinery Bank Erosion	Flow alterations due to erosion and sedimentation	3	2	3	3	2,75	3	3	8,75	5	5	5	4	19	166,3	M	80
5	Operational phase	**Proposed Vlaklaagte Colliery**	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	3	3	3	3	3	3	9	5	5	5	4	19	171	H	80
6	Operational phase	**Proposed Vlaklaagte Colliery**	Increased runoff from hardened surfaces Increased traffic	Spread of alien vegetation	2	2	2	2	2	3	3	8	3	3	5	4	15	120	M	70

5.5 Wetland Buffer

The wetland assessed within the Vlaklaagte Colliery boundary, namely the channelled valley bottom 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 50 m buffer is appropriate for the protection of the ecosystem services provided by the wetland systems (**Figure 26**). Any activity must occur outside of the recommended 50 m buffer zone.

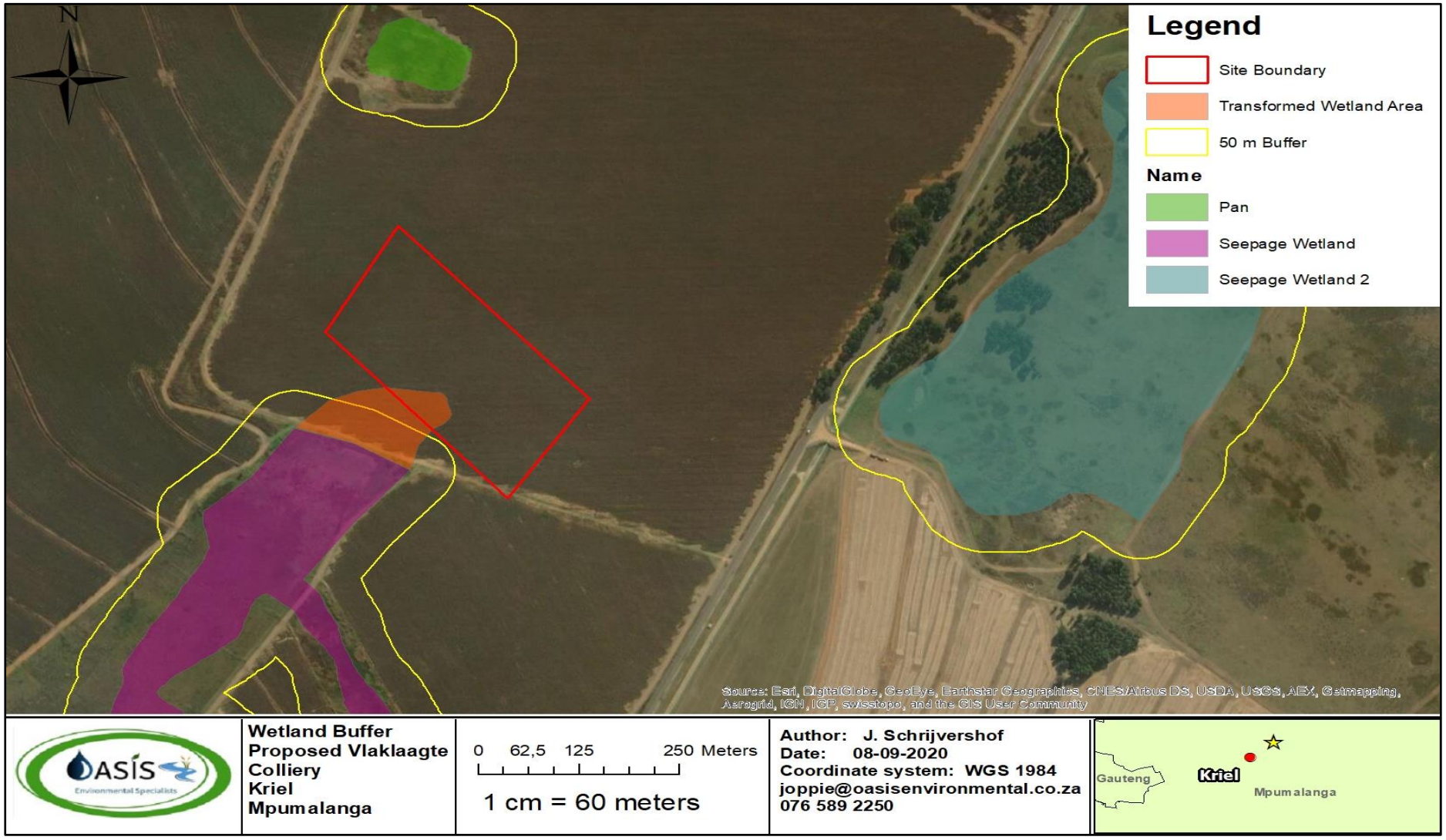

Figure 26: Proposed Vlaklaagte Colliery - 50 m Wetland Buffer map.

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 current mining 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 16**, which outlines the current operational impacts before and after mitigation.

6.1 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.

6.2 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.

6.3 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 16: Scoring of each impact with and without mitigation measures for proposed Vlaklaagte Colliery 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	2	2	**16 (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	2	2	**16 (LOW)**	**6 (LOW)**
Alien Invasive Species	2	1	5	3	2	1	2	2	**18 (LOW)**	**6 (LOW)**

6.4 Mitigation

- Avoidance of the wetland areas as far as possible, 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 CONCLUSION

It must be noted that during the time of the assessment recent fires limited the identification of the grassland vegetation and wetland vegetation within the study area. The proposed Vlaklaagte Colliery falls within the quaternary drainage region B11B which is part of the Olifants Water Management Area. Land cover is dominated by agricultural practices in the form of subsistence farming and coal mining activities. The proposed Vlaklaagte Colliery falls within the Eastern Highveld Grassland vegetation types.

From the NFEPA database, valley bottom wetlands were identified within 500 m of the project boundary. During the field survey these wetlands were confirmed to be seep wetlands descending to the Olifants River, south of the proposed Vlaklaagte Colliery boundary. A small pan system was delineated north west from the proposed site.

The proposed Vlaklaagte Colliery property boundaries falls within the Eastern Highveld Grassland vegetation type. No plant species of conservation concern were identified during the site visit. Riparian plant species were dominated by *Typha Capensis and Imperata cylindrical*. Hydric soils included wet sandy and sandy clay soils with mottles present in the wetland areas.

The pan wetland system (HGM 1) was assessed in terms of health and was found to be categorised as **seriously modified (Category E)**. Modifications to the systems and the resultant effect on the health of the wetlands is predominantly related to the extensive cultivation and extensive alien invasive vegetation and erosion. The seepage wetland (HGM 2) between the proposed project and Olifants River was rated as **Largely Modified (Category D).** The seepage wetland east (HGM 3) of the proposed project was rated as **Moderately Modified (Category C)** as result of less disturbances compared to the other two wetland units in proximity to the projects area.

The Ecological Sensitivity and Importance (EIS) of these wetlands were recorded as **low to moderate** as a result of the alteration of natural resources and the maintenance of biodiversity that many of these wetlands provide and the Ecological Services as **intermediate**.

Extensive crop farming have had a negative impact on the basal cover of vegetation within the catchments associated with the pan wetland. This results in a negative impact on the wetlands ability to maintain biodiversity.

Common species observed within grassland habitat includes *Eragrostis curvula, Seriphium plumosum, Eragrostis chloromelas, Helichrysum nudifolium, Tagetes minuta, Bidens pilosa, Hermannia transvaalensis, Dicoma zeyheri, Eragrostis gummiflua* and *Hyparrhenia tamba.* Beyond the reaches of the grasslands is extensive gumtree and black wattle invasion. *Seriphium species.* encroached certain sections of the grassland areas.

Mammal species that were identified onsite included the African porcupine (*Hystrix africaeaustralis*), yellow mongoose (*Cynictis penicillata*) and ground squirrel (*Xerus spp*.). All these mammal species are listed as least concern by the IUCN red list.

Bird species included spotted thick-knee (*Burhinus capensis*), Helmeted guineafowl (*Numida meleagris*) Egyptian goose (*Alopochen aegyptiaca*). Other species included Laughing dove (*Spilopelia senegalensis*), Southern red bishop (*Euplectes*

orix) and Southern masked weaver (*Ploceus velatus*). No red listed faunal or floral species were observed during the site visit.

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. The cultivated areas can be regarded as **low sensitive** areas, where the remainder of the grasslands and outer edges of wetland areas as **moderate sensitive**.

According to the Critical Biodiversity Areas datasets provided by SANBI (2019), the majority of the mining area falls within a transformed landscape. The mining operations does not fall within close proximity to any Important Bird Areas (IBAs).

Although no protected (vulnerable, endangered and critically endangered) species are thought to occur within the area, it is most likely that they would occur within protected areas within close proximity of the study area, but have been fenced off from the transformed areas.

No red listed faunal or floral species were observed during the site visit. All expected faunal species are listed in **Appendix A** for QDS 2629AB.

The risk assessment on the wetland areas for the current mining operations were rated as an overall **moderate risk with mitigation** and as a **high risk without mitigation**. Identified impacts pertaining to erosion, sedimentation, water quality and quantity alterations and the continued spread of alien invasive species. The proposed Vlaklaagte Colliery already lies within a heavily transformed landscape and if mitigation measures are being implemented appropriately, the possible impacts could be reduced to **moderate** for the operational phase as the wetland areas drain into the Olifants River System eventually.

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 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.

i. Potential impacts associated with the operational phase include:

- Increased sedimentation and water quality impairment due to runoff from waste dumps;
- Water quality contamination due to runoff or seepage from any tailings storage facility;
- Alteration of natural flow regime due to discharge of pit water;
- Increased utilisation of aquatic resources by local population; and
- Habitat loss associated with the stream diversion.

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 50 m buffer was implemented for the wetland systems;
- Ongoing water quality monitoring must take place every month during operational phases; and
- Wetland monitoring 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 2629AB

Insecta			
Hesperiidae	*Metisella meninx*	Marsh sylph	Least Concern (SABCA 2013)
Lycaenidae	*Zizeeria knysna knysna*	African grass blue	Least Concern (SABCA 2013)
Nymphalidae	*Junonia hierta cebrene*	Yellow pansy	Least Concern (SABCA 2013)
Nymphalidae	*Telchinia rahira rahira*	Marsh telchinia	Least Concern (SABCA 2013)
Nymphalidae	*Vanessa cardui*	Painted lady	Least Concern (SABCA 2013)
Pieridae	*Eurema brigitta brigitta*	Broad-bordered grass yellow	Least Concern (SABCA 2013)
Coenagrionidae	*Africallagma glaucum*	Swamp Bluet	LC
Coenagrionidae	*Pseudagrion citricola*	Yellow-faced Sprite	LC
Libellulidae	*Pantala flavescens*	Wandering Glider	LC
Platycnemididae	*Elattoneura glauca*	Common Threadtail	LC
Amphibia			
Bufonidae	*Schismaderma carens*	Red 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
Phrynobatrachidae	*Phrynobatrachus natalensis*	Snoring Puddle Frog	Least Concern (IUCN, 2013)
Pipidae	*Xenopus laevis*	Common Platanna	Least Concern
Pyxicephalidae	*Amietia delalandii*	Delalande's River Frog	Least Concern (2017)
Pyxicephalidae	*Cacosternum boettgeri*	Common Caco	Least Concern (2013)
Pyxicephalidae	*Strongylopus fasciatus*	Striped Stream Frog	Least Concern
Colubridae	*Crotaphopeltis hotamboeia*	Red-lipped Snake	Least Concern (SARCA 2014)
Elapidae	*Naja mossambica*	Mozambique Spitting Cobra	Least Concern (SARCA 2014)
Gekkonidae	*Pachydactylus affinis*	Transvaal Gecko	Least Concern (SARCA 2014)
Lamprophiidae	*Boaedon capensis*	Brown House Snake	Least Concern (SARCA 2014)
Lamprophiidae	*Lycodonomorphus inornatus*	Olive House Snake	Least Concern (SARCA 2014)
Lamprophiidae	*Lycodonomorphus rufulus*	Brown Water Snake	Least Concern (SARCA 2014)
Lamprophiidae	*Lycophidion capense capense*	Cape Wolf Snake	Least Concern (SARCA 2014)
Lamprophiidae	*Psammophylax rhombeatus*	Spotted Grass Snake	Least Concern (SARCA 2014)
Leptotyphlopidae	*Leptotyphlops sp.*		
Leptotyphlopidae	*Leptotyphlops scutifrons conjunctus*	Eastern Thread Snake	
Scincidae	*Trachylepis punctatissima*	Speckled Rock Skink	Least Concern (SARCA 2014)

Typhlopidae	*Afrotyphlops bibronii*	Bibron's Blind Snake	Least Concern (SARCA 2014)
Viperidae	*Causus rhombeatus*	Rhombic Night Adder	Least Concern (SARCA 2014)
Mamalia			
Felidae	*Felis nigripes*	Black-footed Cat	Vulnerable (2016)
Felidae	*Leptailurus serval*	Serval	Near Threatened (2016)
Muridae	*Gerbilliscus brantsii*	Highveld Gerbil	Least Concern (2016)
Muridae	*Mastomys coucha*	Southern African Mastomys	Least Concern (2016)
Muridae	*Mus (Nannomys) minutoides*	Southern African Pygmy Mouse	Least Concern
Muridae	*Otomys auratus*	Southern African Vlei Rat	Near Threatened (2016)
Muridae	*Rhabdomys pumilio*	Xeric Four-striped Grass Rat	Least Concern (2016)
Mustelidae	*Hydrictis maculicollis*	Spotted-necked Otter	Least Concern (IUCN 2008)
Nesomyidae	*Dendromus mystacalis*	Chestnut African Climbing Mouse	Least Concern (2016)
Soricidae	*FAMILY Soricidae*	Unidentified Soricidae (Shrew)	
Soricidae	*Crocidura mariquensis*	Swamp Musk Shrew	Near Threatened (2016)
Soricidae	*Myosorex varius*	Forest Shrew	Least Concern (2016)
Aves			
Accipitridae	*Lophaetus occipitalis*	Long-crested Eagle	LC
Alaudidae	*Mirafra africana*	Rufous-naped Lark	LC
Anatidae	*Anas undulata*	Yellow-billed Duck	LC
Anhingidae	*Anhinga rufa*	African Darter	LC
Charadriidae	*Vanellus armatus*	Blacksmith Lapwing (Plover)	LC
Columbidae	*Columba guinea*	Speckled (Rock) Pigeon	LC
Columbidae	*Streptopelia capicola*	Cape Turtle (Ring-necked) Dove	LC
Columbidae	*Streptopelia semitorquata*	Red-eyed Dove	LC
Laridae	*Larus cirrocephalus*	Grey-headed Gull	LC
Motacillidae	*Macronyx capensis*	Cape (Orange-throated) Longclaw	LC
Muscicapidae	*Saxicola torquata*	African (Common) Stonechat	LC
Numididae	*Numida meleagris*	Helmeted Guineafowl	LC
Phalacrocoracidae	*Phalacrocorax africanus*	Reed (Long-tailed) Cormorant	LC
Phoenicopteridae	*Phoenicopterus roseus*	Greater Flamingo	Global: LC; BLSA: NT
Ploceidae	*Euplectes orix*	Southern Red (Red) Bishop	LC

Ploceidae	*Ploceus velatus*	Southern Masked-Weaver	LC

APPENDIX B – FLORAL SPECIES LIST ACCORDING TO MUCINA AND RUTHERFORD (2006) EASTERN HIGHVELD GRASSLAND.

Family	Form	*Taxon*
Acanthaceae	Herbs	*Justicia anagalloides*
Amaryllidaceae	Geophytic Herbs	*Haemanthus humilis subsp. hirsutus*
Asphodelaceae	Succulent Herb	*Aloe ecklonis*
Asteraceae	Herbs	*Berkheya setifera*
Asteraceae	Herbs	*Dicoma anomala*
Asteraceae	Herbs	*Euryops gilfillanii*
Asteraceae	Herbs	*Euryops transvaalensis subsp. setilobus*
Asteraceae	Herbs	*Haplocarpha scaposa*
Asteraceae	Herbs	*Helichrysum aureonitens*
Asteraceae	Herbs	*Helichrysum caespititium*
Asteraceae	Herbs	*Helichrysum callicomum*
Asteraceae	Herbs	*Helichrysum oreophilum*
Asteraceae	Herbs	*Helichrysum rugulosum*
Asteraceae	Herbs	*Senecio coronatus*
Asteraceae	Herbs	*Vernonia oligocephala*
Asteraceae	Low Shrubs	*Stoebe plumosa*
Campanulaceae	Herbs	*Wahlenbergia undulata*
Convolvulaceae	Herbs	*Ipomoea crassipes*
Euphorbiaceae	Herbs	*Acalypha angustata*

Family	Form	*Taxon*
Fabaceae	Herbs	*Chamaecrista mimosoides*
Geraniaceae	Herbs	*Pelargonium luridum*
Hyacinthaceae	Geophytic Herbs	*Ledebouria ovatifolia*
Hypoxidaceae	Geophytic Herbs	*Hypoxis rigidula var. pilosissima*
Iridaceae	Geophytic Herbs	*Gladiolus crassifolius*
Poaceae	Graminoids	*Alloteropsis semialata subsp. eckloniana*
Poaceae	Graminoids	*Andropogon appendiculatus*
Poaceae	Graminoids	*Andropogon schirensis*
Poaceae	Graminoids	*Aristida aequiglumis*
Poaceae	Graminoids	*Aristida congesta*
Poaceae	Graminoids	*Aristida junciformis subsp. galpinii*
Poaceae	Graminoids	*Bewsia biflora*
Poaceae	Graminoids	*Brachiaria serrata*
Poaceae	Graminoids	*Ctenium concinnum*
Poaceae	Graminoids	*Cynodon dactylon*
Poaceae	Graminoids	*Digitaria monodactyla*
Poaceae	Graminoids	*Digitaria tricholaenoides*
Poaceae	Graminoids	*Diheteropogon amplectens*
Poaceae	Graminoids	*Elionurus muticus*
Poaceae	Graminoids	*Eragrostis capensis*

Family	Form	*Taxon*
Poaceae	Graminoids	*Eragrostis chloromelas*
Poaceae	Graminoids	*Eragrostis curvula*
Poaceae	Graminoids	*Eragrostis gummiflua*
Poaceae	Graminoids	*Eragrostis patentissima*
Poaceae	Graminoids	*Eragrostis plana*
Poaceae	Graminoids	*Eragrostis racemosa*
Poaceae	Graminoids	*Eragrostis sclerantha*
Poaceae	Graminoids	*Harpochloa falx*
Poaceae	Graminoids	*Heteropogon contortus*
Poaceae	Graminoids	*Loudetia simplex*
Poaceae	Graminoids	*Microchloa caffra*
Poaceae	Graminoids	*Monocymbium ceresiiforme*
Poaceae	Graminoids	*Panicum natalense*
Poaceae	Graminoids	*Rendlia altera*
Poaceae	Graminoids	*Schizachyrium sanguineum*
Poaceae	Graminoids	*Setaria nigrirostris*
Poaceae	Graminoids	*Setaria sphacelata*
Poaceae	Graminoids	*Sporobolus africanus*
Poaceae	Graminoids	*Sporobolus pectinatus*
Poaceae	Graminoids	*Themeda triandra*

Family	Form	*Taxon*
Poaceae	Graminoids	*Trachypogon spicatus*
Poaceae	Graminoids	*Tristachya leucothrix*
Poaceae	Graminoids	*Tristachya rehmannii*
Poaceae	Graminoids	*Urelytrum agropyroides*
Rubiaceae	Herbs	*Pentanisia prunelloides subsp. latifolia*
Rubiaceae	Low Shrubs	*Anthospermum rigidum subsp. pumilum*
Scrophulariaceae	Herbs	*Selago densiflora*