Wetland and Riparian Delineation and Assessment

Sibanye-Stillwater K4 Shaft PCD and GN704 Infrastructure

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INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

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

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This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

1. BACKGROUND INFORMATION

WCS Scientific (Pty.) Ltd. was appointed by Alta van Dyk Environmental Consultants to undertake the specialist wetland assessment study and impact assessment required for the proposed construction and operation of the K4 PCD and GN704 Infrastructures at Sibanye-Stillwater's Marikana Mine, east of Rustenburg in the North-West Province.

Sibanye-Stillwater is the owner of the K4 Shaft that forms part of the Marikana Operations located near Marikana town, North-West Province. The Marikana Operations is divided into two entities consisting of Western Platinum (Pty) Ltd and Eastern Platinum (Pty) Ltd. The K4 Shaft falls under Western Platinum (Pty) Ltd.

The shaft was placed under care and maintenance for a period of 6 years but has been ramped up to be fully operational in the year 2024. The current waste rock dump on the property of the shaft was established and initiated by the previous owner. Sibanye-Stillwater is planning to extend the Life of Mine (LOM) with approximately 30 years and the existing waste rock dump will be used to place the waste rock. The size of the waste rock dump will not exceed the approved footprint as authorised in the Western Platinum Limited – Environmental Management Programme (WPL EMPR).

Additional infrastructure that needs to be implemented includes the construction of:

- A V-drain around the current waste rock dump. The V-drain is considered as catchment berms on either side of the waste rock dump, which is located on a ridge.
- A Pollution Control Dam (PCD) that will be lined and completed with a recovery sump for the recycling of stormwater runoff for the mining operations.
- A pipeline from the K4 Shaft to the PCD.
- An emergency spillway to manage PCD overflow.

The study area for the wetland and riparian assessment study will include the above described infrastructure areas and a 500 metre buffer of such (regulated area as per GN509) to ensure that any wetlands or watercourses falling within the regulated area are identified and assessed. Figure 1 shows the extent of the study area.

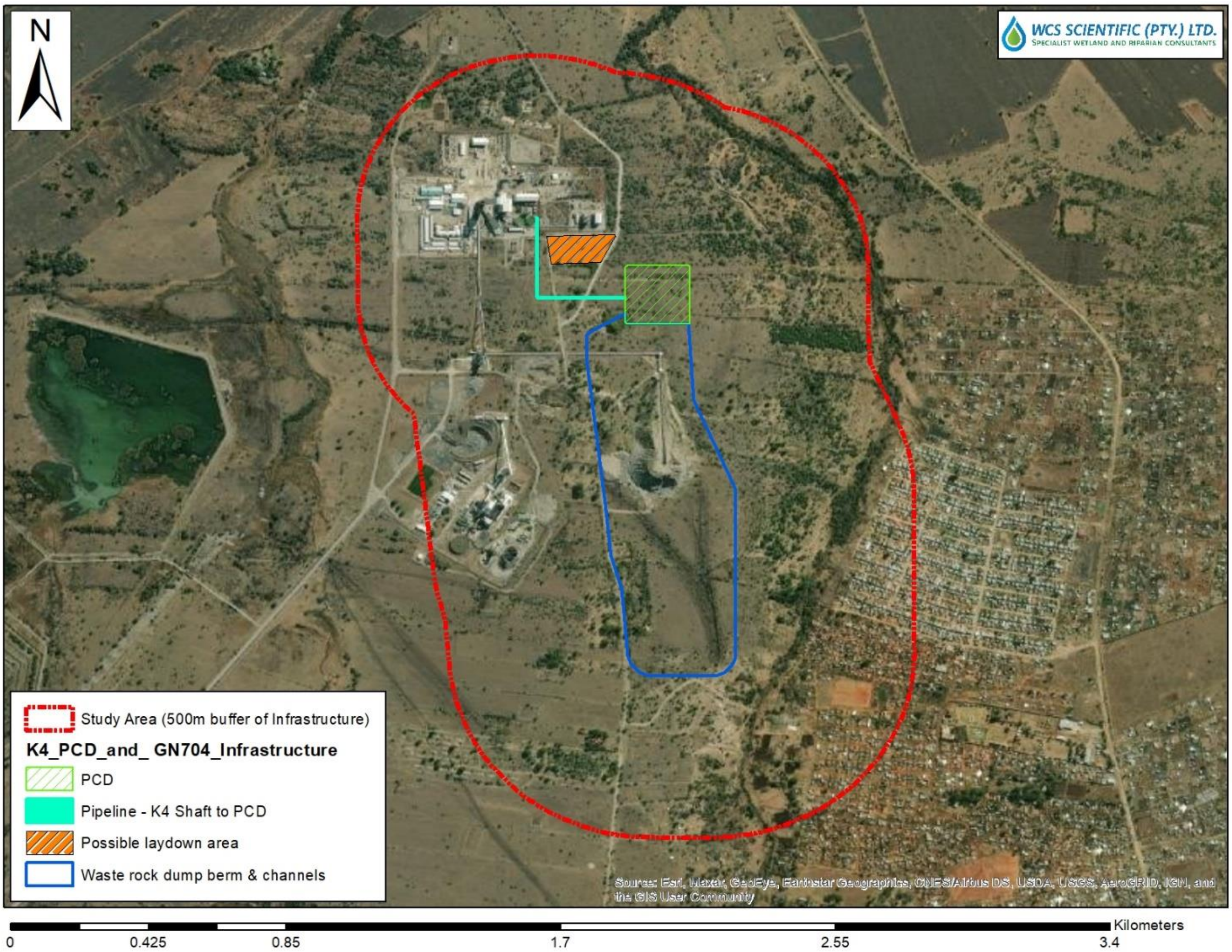

Figure 1. Extent of the study area for the purposes of the wetland and watercourse assessment (500m buffer of the proposed infrastructures).

The aim of the study is to identify and delineate wetlands and riparian habitats within a 500m radius of the proposed infrastructures, to assess affected watercourses in terms of their current condition, to identify and assess likely impacts resulting from the construction and operation of the proposed infrastructures, and to provide detailed recommendations on possible mitigation and management measures within the framework of the mitigation hierarchy to ensure minimisation of the impact to wetlands, riparian habitats and/or watercourses.

The terms of reference for the current study were therefore defined as follows:

- Collation and review of available watercourse data for the study area from published sources as well as previous riparian and wetland assessment studies (as available).
- Field survey to verify the extent of watercourse habitat in close proximity of the proposed infrastructures. Use will be made of the delineation methodology detailed in the DWAF (2005) wetland and riparian delineation guidelines to identify and delineate wetland and riparian habitat.
- Compilation of a site-specific wetland and riparian baseline description sourced from existing wetland and riparian data and the site survey.

- Identification and assessment of risks (including population of the GN5009 Water Use Risk Assessment Matrix);
- Identification and assessment of impacts as part of an impact assessment;
- Development of suitable mitigation and management measures to avoid, minimize and mitigate impacts to the wetland and riparian environments; and
- Compilation of a specialist wetland and riparian assessment report.

2. SPECIALIST REPORT REQUIREMENTS

This report has been compiled to comply with the requirements for specialist technical reports as detailed in Government Notice 267 (24 March 2017) which details regulations and procedural requirements for water use license applications and appeals. The section below details the requirements in table format and references the relevant sections of this report where the required information can be located.

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3. DETAILS OF SPECIALIST

3.1 Details of the Specialist Who Prepared the Report

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3.2 Expertise of the Specialist

3.2.1 Qualifications of the Specialist

Shavaughn Davis holds the following degrees:

- B.Sc. from UPE (2003) – Zoology, Botany.
- B.Sc. (Hons) from NMMU (2004) in Zoology.
- M.Sc. from NMMU (2006) in Zoology.

Shavaughn Davis holds a Professional Registration with SACNASP since 2016 – 115025. She is registered in two fields:

- Ecological Science
- Zoological Science

3.2.2 Past Experience of the Specialist

Shavaughn Davis, Wetland Ecologist and Zoologist, holds a Research M.Sc. (Zoology) degree from the Nelson Mandela Metropolitan University, Port Elizabeth, South Africa, and in 2010 completed the Advanced Wetland Delineation Course offered by the University of Pretoria, South Africa. Shavaughn first started working for Wetland Consulting Services in 2007, for a year, before moving to the Okavango Delta in Botswana to work as a research assistant on the Okavango Buffalo Research Project. She re-joined Wetland Consulting Services in 2010 and has since gained experience conducting wetland delineation and assessment studies as part of scoping assessments, environmental impact assessments, and reserve determination studies for a diversity of projects ranging from urban and linear infrastructure developments to coal and platinum group mining projects. In addition to her work as a wetland specialist, she is a qualified zoologist and has undertaken numerous faunal surveys, both as part of wetland ecology assessments, and as part of larger biodiversity assessments for both urban and mining projects across Gauteng and Mpumalanga. Shavaughn is a Registered Natural Scientist (SACNASP) (Zoological & Ecological Science) and is a member of the South African Wetland Society.

3.2.3 CV of the Specialist

A summarised CV of the Specialist is attached as APPENDIX A to this report.

4. DECLARATION OF INDEPENDENCE

I, Shavaughn Davis from WCS Scientific (Pty) Ltd**,** as the appointed specialist hereby declare/affirm the correctness of the information provided as part of this report, and that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- am aware that it is an offence in terms of Regulation 48 to provide incorrect or misleading information and that a person convicted of such an offence is liable to the penalties as contemplated in section 49B(2) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signature of the specialist

WCS Scientific (Pty.) Ltd

Name of company

30/06/2023

Date

5. SCOPE, PURPOSE, APPROACH AND METHODOLOGY

5.1 Scope and Purpose

This purpose of this report is to provide a detailed summary of the current conditions of the wetlands and/or riparian habitats within the project study area from an ecological perspective, focussing on the following key considerations:

- Presence and extent of wetlands and watercourses.
- Wetland type (hydro-geomorphic classification).
- Functional importance of wetlands.
- Present ecological status of the wetlands and riparian habitats.
- Ecological importance and sensitivity of the wetlands on site.

Using the baseline information collected as part of this study (and previous studies), the next step is to identify and assess likely impacts of the proposed activities on the wetlands and watercourses, and to provide detailed recommendations on the mitigation and management measures required, within the framework of the mitigation hierarchy, to ensure the avoidance and minimisation of the impact to watercourses.

5.2 Approach, Methodology and Actions Performed

The baseline information (wetland and riparian delineation, typing, PES, IS) for wetlands and other watercourse types within the vicinity of the proposed infrastructure location was sourced from the recently completed wetland study that formed part of the "Sensitive Landscapes Project" undertaken for Sibanye-Stillwater by WCSS in 2022. This baseline information was supplemented by a site visit undertaken in May 2023 to assess the proposed project area in detail and confirm the previously delineated watercourse boundaries. In light of this approach, the methodologies detailed in Sections 5.2.1 to 5.2.5 below are those applied as part of the wetland assessment for the Sibanye-Stillwater Sensitive Landscapes Project that was carried out by WCSS in 2022. The specific report that details the findings for the area within which the proposed infrastructure is located is as follows:

- WCSS. 2022. SA Platinum Operations Ecologically Sensitive Areas Delineation – Wetlands: Sibanye-Stillwater Marikana (Big) Operations. Project Reference Number: S2022_047.

5.2.1 Wetland and Riparian Identification and Delineation

The National Water Act, Act 36 of 1998, defines wetlands, watercourses and riparian habitat as follows:

<u>Wetlands:</u>

"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."

<u>Riparian Habitat:</u>

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

Watercourse:

"(a) a river or spring;

(b) a natural channel in which water flows regularly or intermittently;

(c) a wetland, lake or dam into which, or from which, water flows; and

(d) 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;"

Use was made of 1:50 000 topographic maps, 1:10 000 black and white orthophotos and geo-referenced Google Earth images to generate digital base maps of the study area using ArcGIS 10.2. A desktop delineation of suspected wetlands and riparian zones was undertaken by identifying rivers and wetness signatures from the digital base maps. All identified areas suspected of being wetlands or riparian zones were then further investigated in the field.

Riparian zones were delineated according to the delineation procedure as set out by the "*A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas*" document, as published by DWAF (2005). Riparian zones were identified and delineated based on the following indicators as described by DWAF (2005):

- The outer edge of the macro-channel bank (topography);
- Vegetation; and
- Presence of alluvial soils and deposited material.

Wetlands were identified and delineated according to the delineation procedure as set out DWAF (2005) and Kotze & Marneweck (1999). Using this procedure, wetlands were identified and delineated using the Terrain Unit Indicator, the Soil Form Indicator, the Soil Wetness Indicator and the Vegetation Indicator.

For the purposes of delineating the actual wetland boundaries use is made of indirect indicators of prolonged saturation, namely wetland plants (hydrophytes) and wetland soils (hydromorphic soils), with particular emphasis usually on hydromorphic soils. It is important to note that under normal conditions hydromorphic soils must display signs of wetness (mottling and gleying) within the first 50cm of the soil surface for an area to be classified as a wetland (DWAF, 2005). Within the study area however, the nature of the clay soils, which display soil wetness indicators only indistinctly if at all, required that greater reliance be placed on vegetation indicators.

5.2.2 Watercourse Classification

The aquatic ecosystems delineated were classified using the classification system detailed in Ollis, Snaddon, Job and Mbona (2013). This classification system has a six-tiered structure, with the first four levels distinguishing between different types of aquatic ecosystems on the basis of 'primary discriminators', which are criteria that consistently differentiate between the specified categories at a particular level (Figure 2). The tiered structure progresses from 'Systems' (Marine vs. Estuarine vs. Inland) at the broadest spatial scale (Level 1), through to HGM Units (Level 4) as the core units of classification (Ollis *et al*., 2013). 'Secondary discriminators' are applied at Level 5 to classify the tidal/hydrological regime of an HGM Unit, and 'Descriptors' at Level 6 to categorise a range of biophysical attributes. Certain categories within the classification system can be split on the basis of additional criteria; in these cases, the relevant tier is divided into sub-levels that are labelled with sequential letters of the alphabet (e.g. Level 3A and 3B; Level 4A to 4C, etc.). The aquatic ecosystems within the study area were classified to Level 4a (See Table 1).

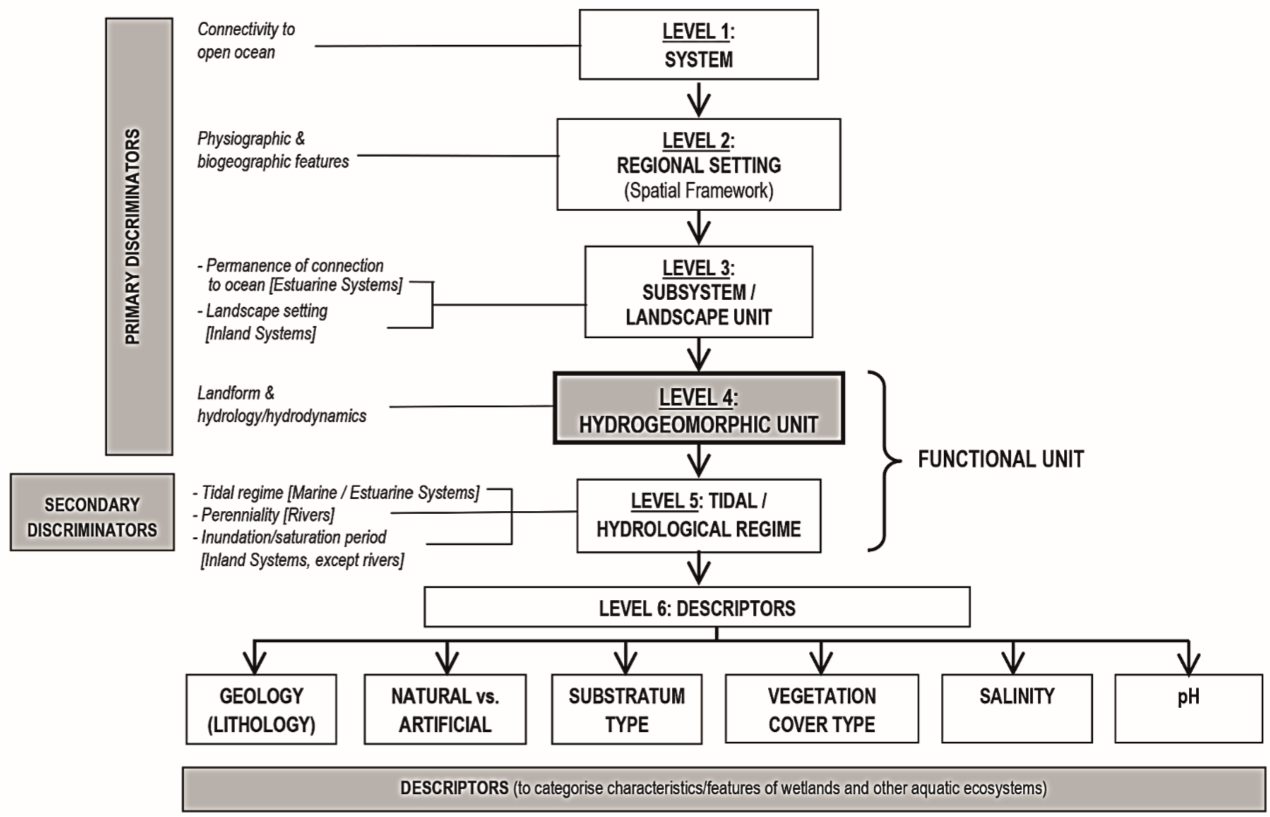

Figure 2: Conceptual overview of the classification system for wetlands and other aquatic ecosystems, taken from Ollis *et al.* (2015).

Table 1: Hydrogeomorphic (HGM) Units for Inland Systems, showing the primary HGM Types at Level 4A and the subcategories at Levels 4B to 4C (Taken from Ollis *et al.* (2013)).

LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM Type	**Longitudinal zonation/landform/outflow drainage**	**Landform/inflow drainage**
A	**B**	**C**
River	Mountain Headwater Stream	Active Channel
		Riparian Zone
	Mountain Stream	Active Channel
		Riparian Zone
	Transitional	Active Channel
		Riparian Zone
	Upper Foothills	Active Channel
		Riparian Zone
	Lower Foothills	Active Channel
		Riparian Zone
	Lowland River	Active Channel
		Riparian Zone
	Rejuvenated Bedrock Fall	Active Channel
		Riparian Zone
	Rejuvenated Foothills	Active Channel
		Riparian Zone
	Upland Floodplain	Active Channel
		Riparian Zone
Floodplain Wetland	Floodplain Depression	n/a
	Floodplain Flat	n/a
Channelled Valley-Bottom Wetland	n/a	n/a
Unchannelled Valley-Bottom Wetland	n/a	n/a
Depression	Exorheic	With Channelled Inflow
		Without Channelled Inflow
	Endorheic	With Channelled Inflow
		Without Channelled Inflow
	Dammed	With Channelled Inflow
		Without Channelled Inflow
Seep	With Channelled Outflow	n/a
	Without Channelled Outflow	n/a
Wetland Flat	n/a	n/a

5.2.3 Wetland Present Ecological State (PES) Assessment

A tool for assessing the PES of wetlands was first developed in 1999 (DWAF, 1999a). More recently WET-Health was developed (Macfarlane, Kotze, Ellery, Walters, Koopman, Goodman, and Goge, 2007), and recently updated (Macfarlane, Ollis and Kotze, 2020). WET-Health uses indicators based on hydrology, geomorphology, water quality and vegetation for assessing the PES of wetland systems, with these indicators inferred from landcover within a wetland, its 200m buffer, and its catchment. Given the size of the greater study area covered by the *Sensitive Landscapes Project* and the number of wetland units included within the greater study area, a Level 1A assessment was undertaken. However, to improve accuracy and detail, the Level 1A methodology was modified to incorporate a number of aspects from the Level 1B approach:

- Mapping of individual wetland catchments for each assessment unit.
- Targeted updating of the National Landcover 2020 dataset to reflect current landuse more accurately.

For the purpose of this assessment, landcover data from the National Landcover 2020 dataset was used to inform landuse within the wetlands, the 200m buffer and the wetland catchments.

Wetland catchments were determined using a catchment modelling approach in QGIS (as per the method described in Van der Kwast and Menke (2022) for larger catchments, and manually digitised using 5m contours as available from the 1:50 000 topographical datasets for smaller catchments.

The PES of artificial wetlands formed or induced as a result of human activities was not determined, as the PES methodology is designed to assess the current integrity of a natural wetland compared to its reference condition. Artificial wetlands have no reference condition and therefore should not be assessed using this method.

Table 2. Rating scale used for the PES assessment.

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	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 - 10	F

A number of important considerations and limitations apply to the PES assessment methodology utilised:

- The current extent of wetland habitat on site was mapped and used as input data for the PES assessment, and not the historical or original extent. This is relevant to wetland systems that have for example been affected by mining and where wetland habitat has been permanently lost to mining or associated infrastructures. Although the mining impact occurred within wetland habitat, given that the PES assessment was undertaken using the current extent of wetland habitat, the mining impact will be assessed as occurring within the wetland buffer rather than within the actual wetland. This may result in overestimating the health and PES of the wetland.
- Wetland systems have been mapped and typed based on their current characteristics. A number of wetland systems receive significant water inputs from artificial sources (e.g. discharges or seepage from Tailings Storage Facilities) and it is uncertain whether or not these systems would have supported wetland habitat under natural (pre-disturbance) conditions, or alternatively would have been rivers or drainage lines. As no historical aerial imagery of these systems pre-dating mining disturbances was available during this study, it is not possible to state without some uncertainty as to whether or not these systems would naturally have been classed as wetlands. The PES assessment methodology was also applied to these wetlands.
- The PES assessment methodology is based on landcover/disturbance units within the wetland, its buffer, and its catchment. Impacts to wetlands that are not associated with a specific landcover class, such as point source discharges of water (e.g., from Waste Water Treatment Works) or flow reduction due to groundwater drawdown, are typically underestimated or excluded from the Level 1A and B assessments. In such cases the PES scores were manually downgraded based on specialist observation and opinion.
- The Level 1A assessment is limited to 19 pre-defined landcover classes. All landcover units mapped had to be allocated to these pre-defined landcover classes.
- The impact intensity scores ascribed to the various landcover classes were used in the assessment as captured in the Level 1A assessment spreadsheets and not changed.
- For landcover within the catchments of wetlands, use was made of the National Landcover 2020 dataset. As this data is already several years old, some changes in landcover may have taken place on site which are not reflected in this assessment. This has been partially addressed through targeted updating of landuse, but some inaccuracies are unavoidable.
- It is also noted that the National Landcover dataset overestimates the extent of natural vegetation on site, with, for example, extensive areas of degraded or historically transformed areas still classed as natural, rather than semi-natural; this results in elevating the PES scores. To correct against this misrepresentation, all areas marked as "*natural grassland*", "*open woodland*" and "*contiguous (indigenous) forest*" were considered as semi-natural in the PES assessment. This was supported by observations from the terrestrial ecologist forming part of the *Sensitive Landscapes Project* team, which revealed very limited remaining primary (natural) vegetation on site (Duncan McKenzie, *pers. comm*.). Areas that remained classified as "Natural" were limited to the Magaliesberg range, where disturbance is assumed to be more limited, and areas highlighted by the terrestrial ecologist as being representative of natural habitat, i.e.: Norite koppies, hills and ridges (D. McKenzie, pers. Comm.).

5.2.4 Wetland Importance and Sensitivity Assessment

A wetland importance and sensitivity (IS) assessment was conducted for each wetland system assessed. This was done in order to provide an indication of the conservation value and sensitivity of the wetlands. For the purpose of this study, the Rountree *et al.* (2013) assessment criteria were used. The scale used to rate the various components of wetland IS is provided in **Table 3** below.

As was the case for the PES of artificial wetlands, the IS of artificial wetlands was also excluded from this study.

Table 3. Rating scale used for the IS assessment.

Wetland Importance and Sensitivity Categories	Range of IS score
Very high: Wetlands that are considered ecologically important and sensitive on a **national or even international** level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1

5.2.5 Wetland Functional Assessment

A functional assessment of the different wetland types identified on site was undertaken using the level 2 assessment as described in "Wet-EcoServices" (Kotze, Macfarlane and Edwards, 2021). This method provides a scoring system for establishing wetland ecosystem services. It enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions. Given the large number of wetlands delineated (>100), it was not practical to undertake a full level two assessment of every wetland unit, and given that the wetlands occur across a relatively uniform landscape with similar land uses and users, the outcomes of the functional assessments would be repetitive for wetlands of the same type. Therefore, functional assessments were undertaken for representative systems of each type within areas of similar topography, geology, vegetation and landuse. This will provide an indication of the current functionality of different wetland types in areas with similar environmental characteristics.

5.2.6 River Present Ecological State (PES) Assessment

The Index of Habitat Integrity (IHI) was used to determine habitat condition. This approach is based on the assessment of physical habitat disturbance (Kleynhans, 1996) and classifies the Present Ecological State of instream and riparian habitat integrity according to the Present Ecological State categories given in **Table 4**, ranging from pristine/undisturbed to critically modified. The following disturbances were considered:

- Water abstraction,

- Flow modification,
- Bed modification,
- Channel modification,
- Inundation,
- Water quality,
- Exotic macrophytes,
- Solid waste disposal,
- Indigenous vegetation removal,
- Exotic vegetation encroachment and
- Bank erosion.

Table 4: Habitat Integrity Assessment Classes

Class	Description	Score (% of total)
A	Unmodified	100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-99
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions have occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions are extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

5.2.7 Buffer Determination

An appropriate buffer for the delineated watercourse, taking into consideration the physical and biotic features of the watercourse, and the nature of the proposed development, was calculated using the excel-based "*Tools for Buffer Zone Determination*" developed as part of the "Buffer Zone Guidelines for Rivers, Wetlands and Estuaries" (MacFarlane and Bredin, 2017).

5.2.8 Impact Assessment

The impact assessment methodology used was provided by Alta van Dyk Environmental Consultants and is detailed here. To ensure uniformity, the assessment of potential impacts was addressed in a standard manner so that a wide range of impacts were comparable. For this reason, a clearly defined rating scale was utilised to assess the impacts on wetlands and rivers associated with the proposed development. Each impact identified was assessed in terms of several components, such as magnitude, duration, extent, irreplaceability of the resource, reversibility of the impact, and probability. To enable a scientific approach to the determination of the impact significance (importance), a numerical value was linked to each rating scale (Table 5). The sum of the numerical values define the significance, as detailed in Table 6

Table 5. Evaluation criteria for the assessment of potential impacts.

Evaluation Component	Rating	Scale	Description / criteria
MAGNITUDE of negative impact (at the indicated spatial scale)	10	Very high	Bio-physical and/or social functions and/or processes might be *severely* altered.
	8	High	Bio-physical and/or social functions and/or processes might be *considerably* altered.
	6	Medium	Bio-physical and/or social functions and/or processes might be *notably* altered.
	4	Low	Bio-physical and/or social functions and/or processes might be *slightly* altered.
	2	Very low	Bio-physical and/or social functions and/or processes might be *negligibly* altered.
	0	Zero	Bio-physical and/or social functions and/or processes will remain *unaltered.*
MAGNITUDE of POSITIVE IMPACT (at the indicated spatial scale)	10	Very high	Positive: Bio-physical and/or social functions and/or processes might be *substantially* enhanced.
	8	High	**Positive**: Bio-physical and/or social functions and/or processes might be *considerably* enhanced.
	6	Medium	**Positive**: Bio-physical and/or social functions and/or processes might be *notably* enhanced.
	4	Low	**Positive**: Bio-physical and/or social functions and/or processes might be *slightly* enhanced.
	2	Very low	**Positive**: Bio-physical and/or social functions and/or processes might be *negligibly* enhanced.
	0	Zero	**Positive**: Bio-physical and/or social functions and/or processes will remain *unaltered.*
DURATION	5	Permanent	**Impact in perpetuity. –**
	4	Long term	Impact ceases after operational phase/life of the activity > 60 years.
	3	Medium term	Impact might occur during the operational phase/life of the activity – 60 years.
	2	Short term	Impact might occur during the construction phase - < 3 years.
	1	Immediate	**Instant impact.**
EXTENT (or spatial scale/influence of impact)	5	International	**Beyond the National boundaries.**
	4	National	Beyond provincial boundaries, but within National boundaries.
	3	Regional	Beyond 5 km of the mine area and within the provincial boundaries.
	2	Local	Within a 5 km radius of the mine area.
	1	Site-specific	**On site or within 100 meters of the site boundaries.**
	0	None	**Zero extent.**
IRREPLACEABLE loss of resources	5	Definite	**Definite** loss of irreplaceable resources.
	4	High potential	**High** potential for loss of irreplaceable resources.
	3	Moderate potential	**Moderate** potential for loss of irreplaceable resources.
	2	Low potential	**Low** potential for loss of irreplaceable resources.
	1	Very low potential	**Very low** potential for loss of irreplaceable resources.
	0	None	**Zero potential.**
REVERSIBILITY of impact	5	Irreversible	Impact **cannot** be reversed.
	4	Low irreversibility	**Low** potential that impact might be reversed.
	3	Moderate reversibility	**Moderate** potential that impact might be reversed.
	2	High reversibility	**High** potential that impact might be reversed.
	1	Reversible	Impact **will be** reversible.
	0	No impact	No impact.
PROBABILITY (of occurrence)	5	Definite	>95% chance of the potential impact occurring.
	4	High probability	75% - 95% chance of the potential impact occurring.
	3	Medium probability	25% - 75% chance of the potential impact occurring
	2	Low probability	5% - 25% chance of the potential impact occurring.
	1	Improbable	<5% chance of the potential impact occurring.
	0	No probability	**Zero probability.**
Evaluation Component	**Rating scale and description / criteria**		
CUMULATIVE impacts	**High**: The activity is one of several similar past, present or future activities in the same geographical area, and might contribute to a very significant combined impact on the natural, cultural, and/or socio-economic resources of local, regional or national concern. ***Medium****:* The activity is one of a few similar past, present or future activities in the same geographical area, and might have a combined impact of moderate significance on the natural, cultural, and/or socio-economic resources of local, regional or national concern. ***Low****:* The activity is localised and might have a negligible cumulative impact. ***None****:* No cumulative impact on the environment.		

Table 6. Environmental significance categories.

Significance Score	Environmental Significance	Description / criteria
125 – 150	Very high (VH)	An impact of very high significance will mean that the project cannot proceed, and that impacts are irreversible, regardless of available mitigation options.
100 – 124	High (H)	An impact of high significance which could influence a decision about whether or not to proceed with the proposed project, regardless of available mitigation options.
75 – 99	Medium-high (MH)	If left unmanaged, an impact of medium-high significance could influence a decision about whether or not to proceed with a proposed project. Mitigation options should be relooked at.
40 – 74	Medium (M)	If left unmanaged, an impact of moderate significance could influence a decision about whether or not to proceed with a proposed project.
<40	Low (L)	An impact of low is likely to contribute to positive decisions about whether or not to proceed with the project. It will have little real effect and is unlikely to have an influence on project design or alternative motivation.
+	Positive impact (+)	A positive impact is likely to result in a positive consequence/effect and is likely to contribute to positive decisions about whether or not to proceed with the project.

5.2.9 Water Use Risk Assessment

A risk assessment was undertaken using the methodology and spreadsheet developed as part of the amendment GA for section 21 (c) and (i) water uses which was published in the Government Gazette (No 40229 Pg 105 Notice 509) on 26 August 2016. This methodology has been formally adopted by the authorities (DWS) and provides a useful outline for assessing the risk to water resources in terms of Section 21 (c) and (i) water uses. The rating scale for this risk assessment is provided in Table 7 and Table 8. A low risk class must be obtained for all activities to be considered for a GA.

Table 7. Impact rating scales used for the GN509 Water Use Risk Assessment.

RISK ASSESSMENT KEY (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment

Negative Rating

TABLE 1- SEVERITY

How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat) ?

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the	

TABLE 2 – SPATIAL SCALE

How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighboring areas (downstream within quaternary catchment)	3
National (impacting beyond seconday catchment or provinces)	4
Global (impacting beyond SA boundary)	5

TABLE 3 – DURATION

How long does the aspect impact on the resource quality?

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
PES and EIS (sensitivity) must be considered.	

TABLE 4 – FREQUENCY OF THE ACTIVITY

How often do you do the specific activity?

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

TABLE 5 – FREQUENCY OF THE INCIDENT/IMPACT

How often does the activity impact on the resource quality?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

TABLE 6 – LEGAL ISSUES

How is the activity governed by legislation?

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

TABLE 7 – DETECTION

How quickly/easily can the impacts/risks of the activity be observed on the resource quality, people and property?

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table 8. Risk rating scale utilised (as per amendment GA for section 21 (c) and (i) water uses which was published in the Government Gazette (No 40229 Pg. 105 Notice 509) on 26 August 2017).

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. Wetlands are excluded.
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.

6. ASSUMPTIONS, UNCERTAINTIES AND KNOWLEDGE GAPS

6.1 Assumptions

- This report has been prepared for the particular purpose outlined in Sections 1 and 5 above and no responsibility is accepted for the use of this report, in whole or in part, in any other context or for any other purpose.
- Wetland and river boundaries reflect the ecological boundary where the interaction between water and plants influences the soils, but more importantly the plant communities. The depth to the water table where this begins to influence plant communities is approximately 50 centimetres. This boundary, based on plant species composition, can vary depending on antecedent rainfall conditions, and can introduce a degree of variability in the wetland boundary between years and/or sampling period. The wetlands systems have been mapped from the most recent aerial imagery available at a scale of between 1:2500 and 1:5000 wherever possible and where the imagery is of sufficient resolution for this purpose. Due to the extent of the area and the mapping scale used, the actual extent of the boundaries of these systems may be underestimated or overestimated in places. This may range from metres to tens of metres but generally is regarded as being of sufficient accuracy for the purposes of this study. While an attempt was made to map all wetlands within the study area, it is likely that some small and/or isolated wetlands may have been missed and not mapped.
- The soils across the study area are dominated by vertic clays. As these soils typically have a high pH and base saturation, Iron redox morphology is not readily expressed, with the result that high chroma mottles cannot be used for the identification of wetlands (van der Waals, 2019, WRC Report 2461/3/18). Therefore, vegetation indicators played a primary role in determining the wetland boundaries. However, the temporary to seasonal zones of a number of the valley bottom wetlands were cultivated or transformed on site, precluding or limiting the use of vegetation indicators in determining wetland boundaries in these areas and thus reducing the confidence of the delineation accuracy in those areas where cultivation (past and present) extends into the wetlands or where the natural vegetation has been significantly disturbed or removed.
- Reference conditions are unknown. This limits the confidence with which the present ecological category (PES) is assigned.

- The impact assessment was based on the project description and proposed development and activity descriptions as detailed and illustrated in this report.

7. CURRENT ENVIRONMENTAL CONDITIONS

7.1 Regional Characteristics

7.1.1 Study Area

The project study area was defined as the described infrastructure areas and a 500 metre buffer of such (regulated area as per GN509) to ensure that any wetlands or watercourses falling within the regulated area are identified and assessed, as illustrated in Figure 3 and 4. The study area is located to the north of the N4 highway, east of Rustenburg and to the west of the settlement of Marikana in the North-West Province. The project study area covers approximately 298 hectares.

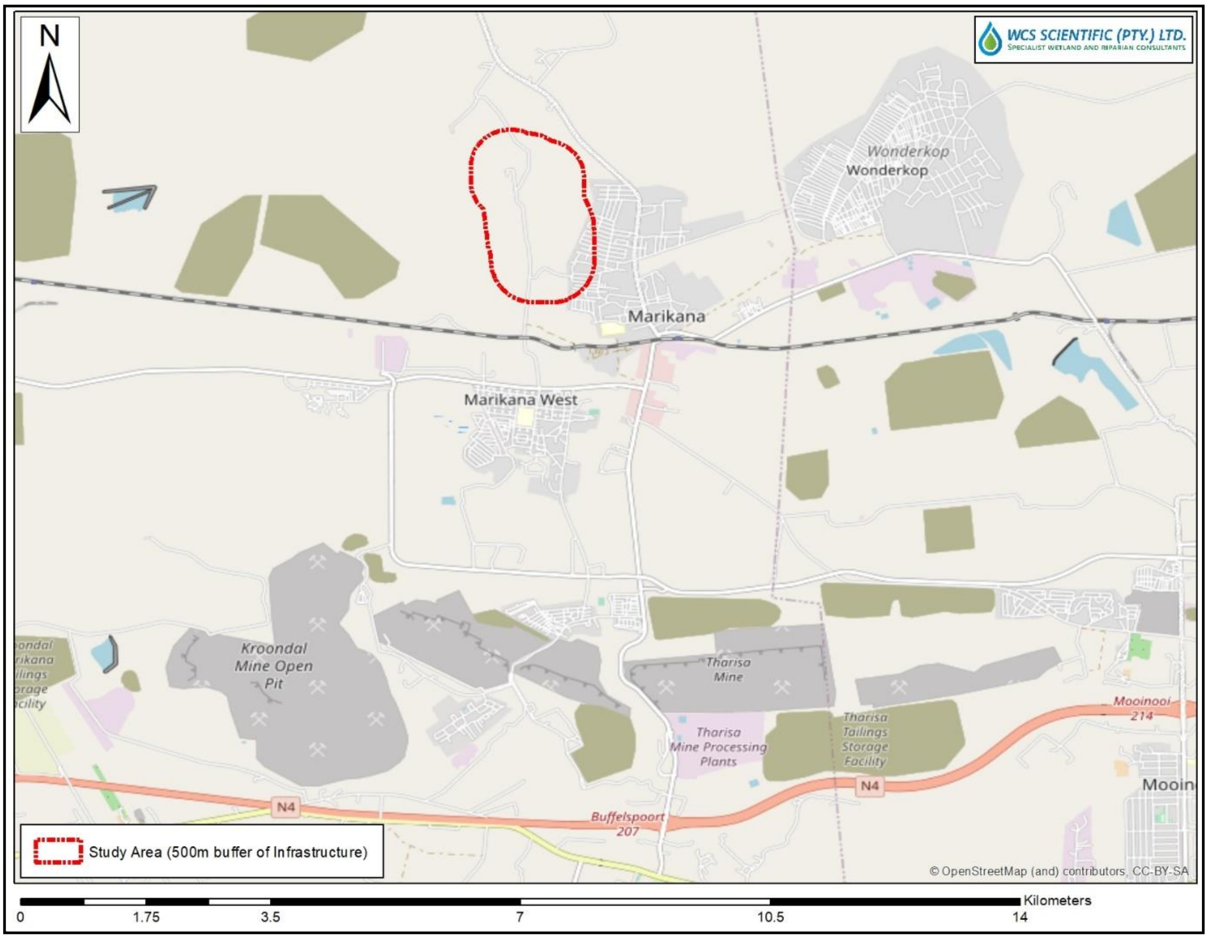

Figure 3. Map showing the regional location of the project study area (500m regulated area of the proposed infrastructures).

Figure 4. Map showing the project study area and proposed infrastructures overlain on recent aerial imagery.

7.1.2 Catchments

The study area is located within Primary Catchment A and within quaternary catchment A21K. Catchment A21K is drained by the Sterkstroom and Gwathle River, which drain into the Crocodile River to the north. Information regarding mean annual rainfall, runoff and evaporation potential per applicable quaternary catchment is provided in the table below. Figure 5 indicates the position of the study area in relation to the affected quaternary catchment.

Table 9. Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment (WR2012 data, as extracted from the WET-Health Version 2 excel spreadsheet).

Quaternary Catchment	Catchment Surface Area (ha)	Mean Annual Precipitation (MAP) in mm	Mean Annual Run-off (MAR) in mm	MAR as percentage of MAP	Potential Evaporation (PE)	MAP:PE
A21K	864	651	27.4	4.2%	1 744	0.4

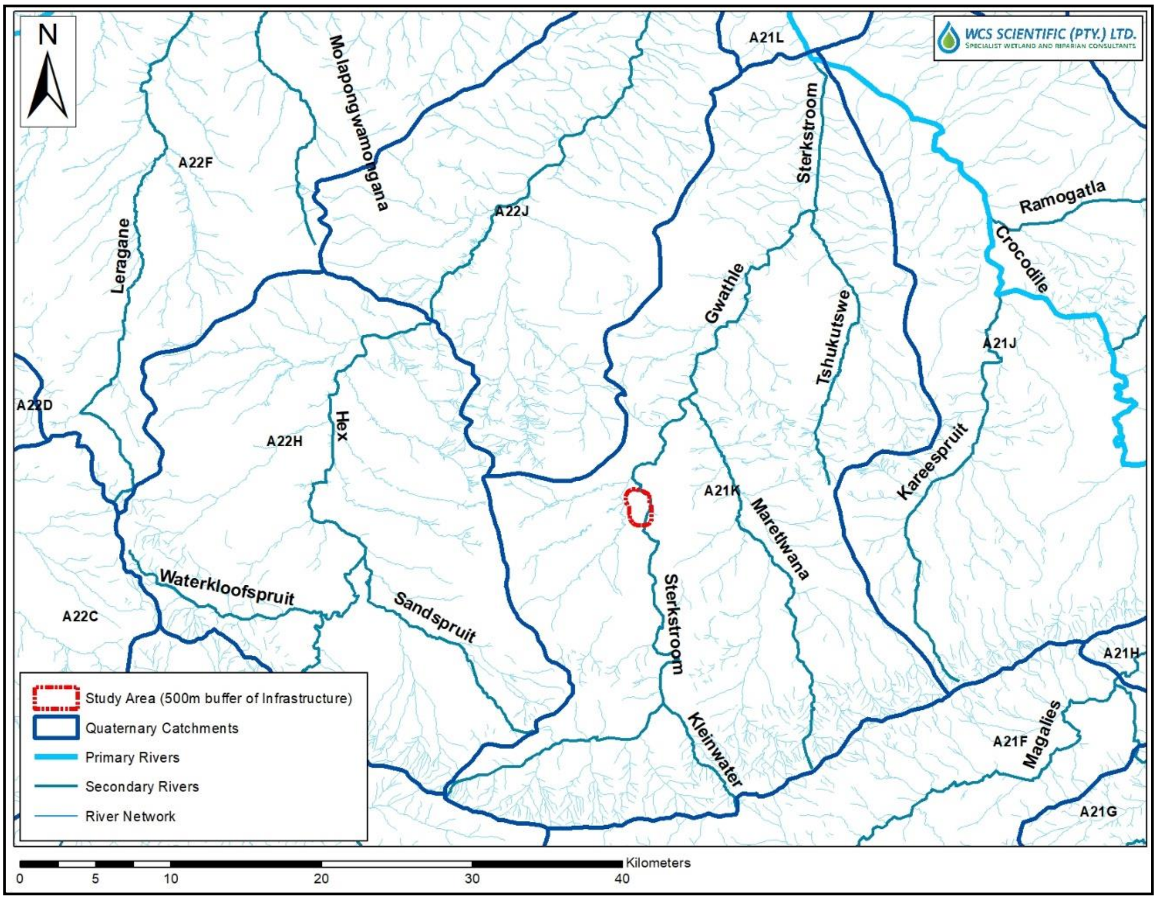

Figure 5. Map showing the study area in relation to the quaternary catchments.

7.1.3 Vegetation

The vegetation across the study area is classified as Marikana Thornveld (SVcb 6), which forms a subset of the Central Bushveld Bioregion within the Savanna Biome (Mucina & Rutherford, 2006). Marikana Thornveld occurs in the North-West and Gauteng Provinces on plains from the Rustenburg area in the west, through Marikana and Brits to the Pretoria area in the east. According to Mucina & Rutherford (2006), Marikana Thornveld is considered Endangered as the conservation target for this vegetation type is 19%, yet less than 1% is statutorily conserved. Marikana Thornveld is highly impacted with at least 48% transformed, primarily due to cultivation and urban or built-up areas. However, according to the published National List of Ecosystems that are Threatened and in Need of Protection (GN1002 of GG34809, NEMBA 2004), Marikana Thornveld is listed as Vulnerable and falls within Criterion A1 which represents ecosystems which have suffered an irreversible loss of natural habitat.

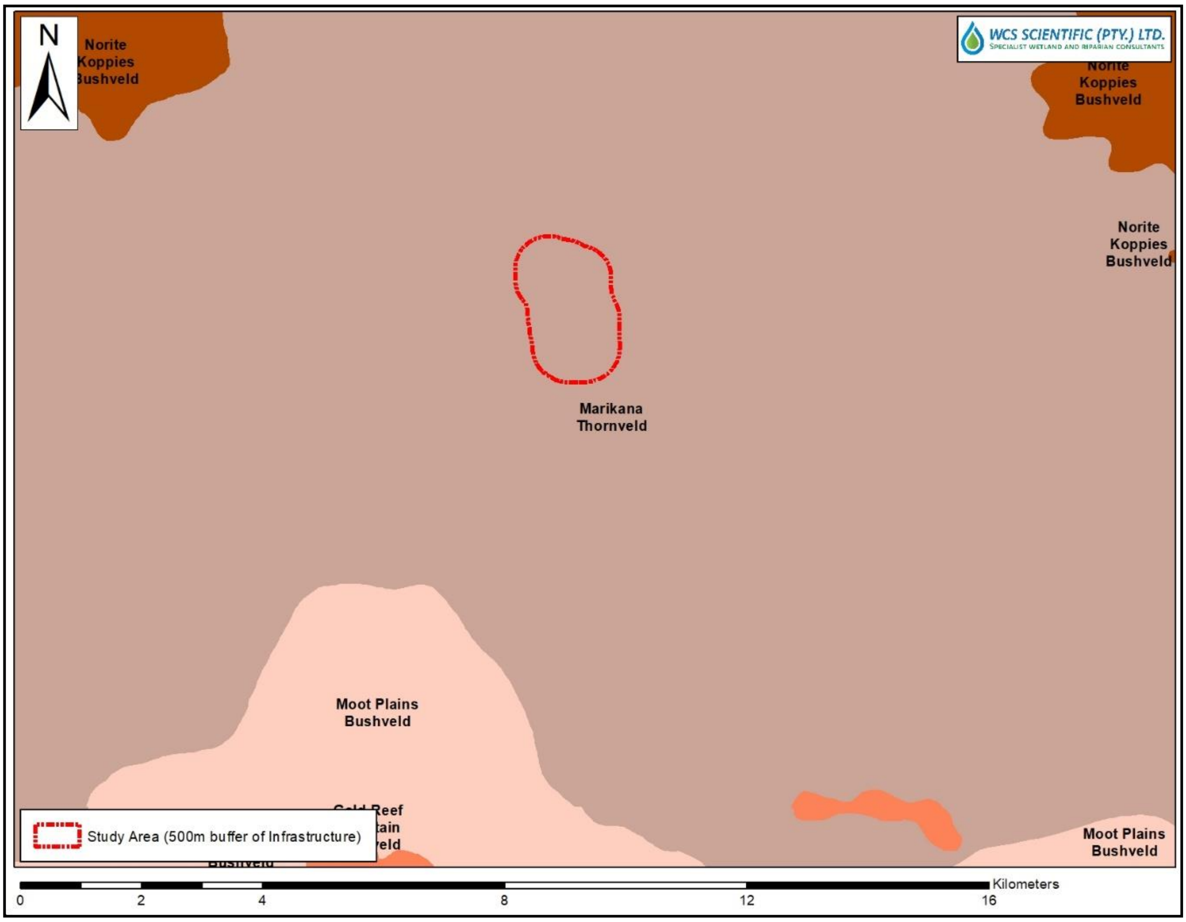

Figure 6. Map showing the vegetation types of the study area.

The 2018 National Wetland Map (Van Deventer *et al*., 2018) compiled as part of the 2018 National Biodiversity Assessment (2018 NBA) determined the Ecosystem Threat Status (ETS) and Ecosystem Protection Level (EPL) for all wetland ecosystem types in South Africa. According to the National Wetland Map, no wetland ecosystem types occur within the study area.

7.1.4 Freshwater Ecosystem Priority Areas

The Atlas of Freshwater Ecosystem Priority Areas (FEPA) in South Africa (Nel *et al*, 2011) which represents the culmination of the National Freshwater Ecosystem Priority Areas project (NFEPA), a partnership between SANBI, CSIR, WRC, DEA, DWA, WWF, SAIAB and SANParks, provides a series of maps detailing strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. FEPA's were identified through a systematic biodiversity planning approach that incorporated a range of biodiversity aspects such as ecoregion, current condition of habitat, presence of threatened vegetation, fish, frogs and birds, and importance in terms of maintaining downstream habitat.

According to the NFEPA database, no FEPA wetlands or rivers occur within the study area. However, the Sterkstroom River, which flows along the eastern edge of the study area, is categorised as a Phase 2 FEPA which were "identified in moderately modified rivers (C ecological category), only in cases where it was not possible to meet biodiversity targets for river ecosystems in rivers that were still in good condition (A or B ecological category). The river condition of these Phase 2 FEPAs should not be degraded further, as they may in future be considered for rehabilitation once FEPAs in good condition (A or B ecological category) are considered fully rehabilitated and well managed" (Driver *et al*., 2011).

7.1.5 Provincial Conservation Plans

The North-West Province's Biodiversity Sector Plan (BSP) database is split into terrestrial and aquatic layers which indicate Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) from both an aquatic and terrestrial perspective. CBAs are terrestrial and aquatic areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. Failure to maintain these areas as such would result in the biodiversity targets for the province not being met. ESAs are terrestrial and aquatic areas that are not essential for meeting biodiversity representation targets (thresholds), but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and/or in delivering ecosystem services that support socio-economic development, such as water provision, flood mitigation or carbon sequestration (READ, 2015).

Priority rivers and catchments, as identified as part of the NFEPA project, have, for the most part, been incorporated into the aquatic CBAs and ESAs (READ, 2015). Figure 7 shows the categorisation of different areas according to the aquatic component of the BSP. The watercourse crossing through the study area (the Sterkstroom River) is indicated as being a combination of CBA1 and CBA2, with smaller patches along the margins classified as ESA1 and ESA2. Figure 8 shows the categorisation of different areas according to the terrestrial component of the BSP, and in this case a large proportion of the remaining open areas within the study area are listed as CBA2's, and the remainder of the area outside of mine facilities and urban footprints as ESA2.

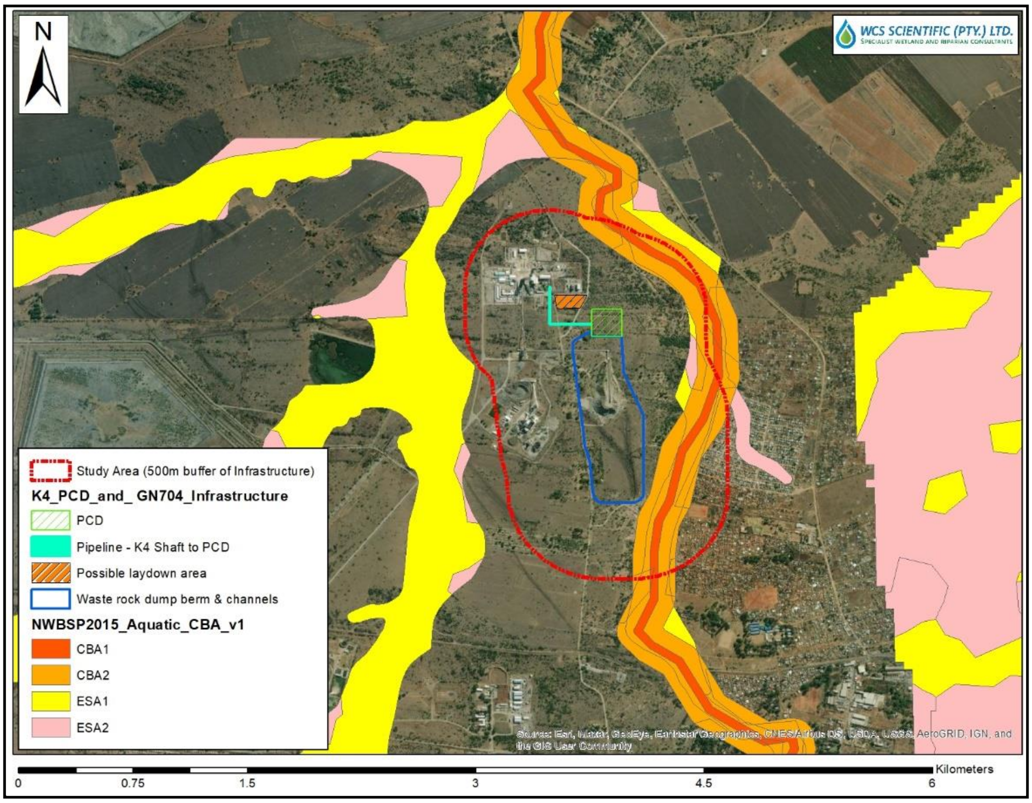

Figure 7. Conservation Importance of the study area according to the current North-West Province Biodiversity Sector Plan's Aquatic Layer.

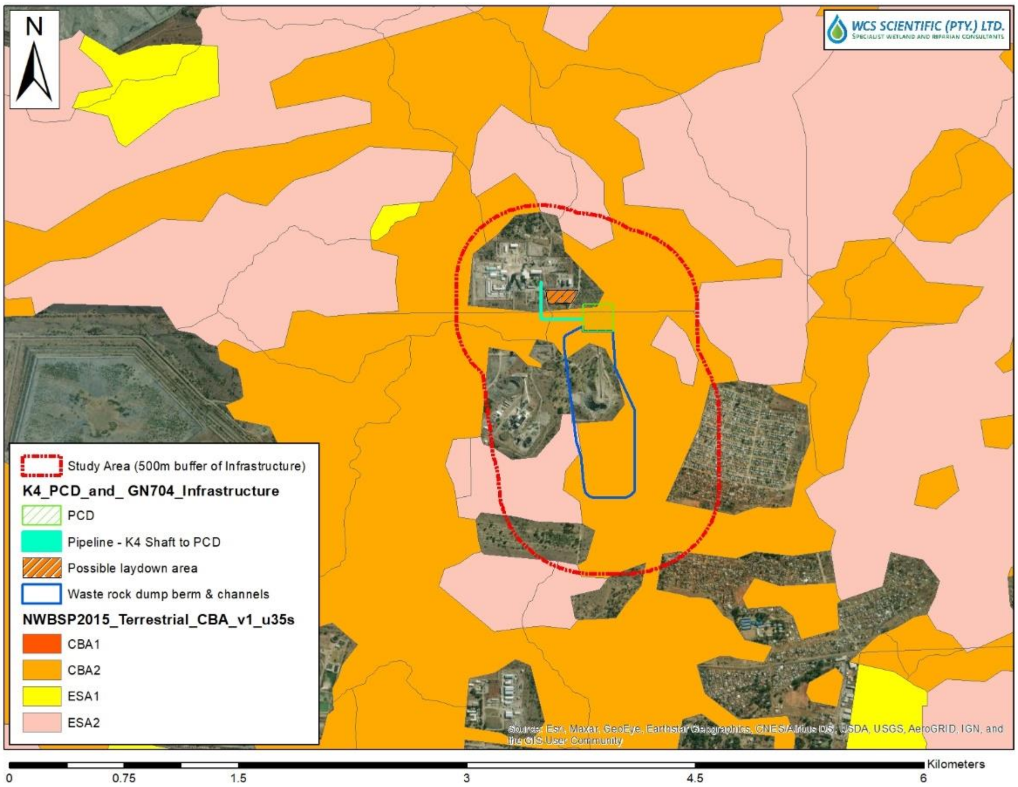

Figure 8. Conservation Importance of the study area according to the current North-West Province Biodiversity Sector Plan's Terrestrial Layer.

7.2 Site Specific Assessment

A survey of the wetlands and other watercourses relevant to this project was undertaken in April 2022 as part of the Sensitive Landscapes Project completed for Sibanye-Stillwater to determine the extent of wetlands and/or watercourses within Sibanye-Stillwater's Rustenburg operations and to collect data to inform the baseline assessments. The timing of the field surveys during the summer season was considered important to maximise use of vegetation indicators in identifying and delineating wetlands. A follow-up site survey of the study area specific to this project was undertaken in May 2023 to verify the watercourse boundaries at a finer scale and assess the proposed infrastructure footprint.

7.2.1 Wetland and Riparian Delineation & Typing

Within the study area a single aquatic ecosystem type was identified and delineated, namely riparian habitat associated with the Sterkstroom River. No wetland habitat was found to occur within the study area, though a valley bottom wetland flows to the west, and outside, of the study area. The delineated riparian habitat within the study area is illustrated in Figure 9 and described below.

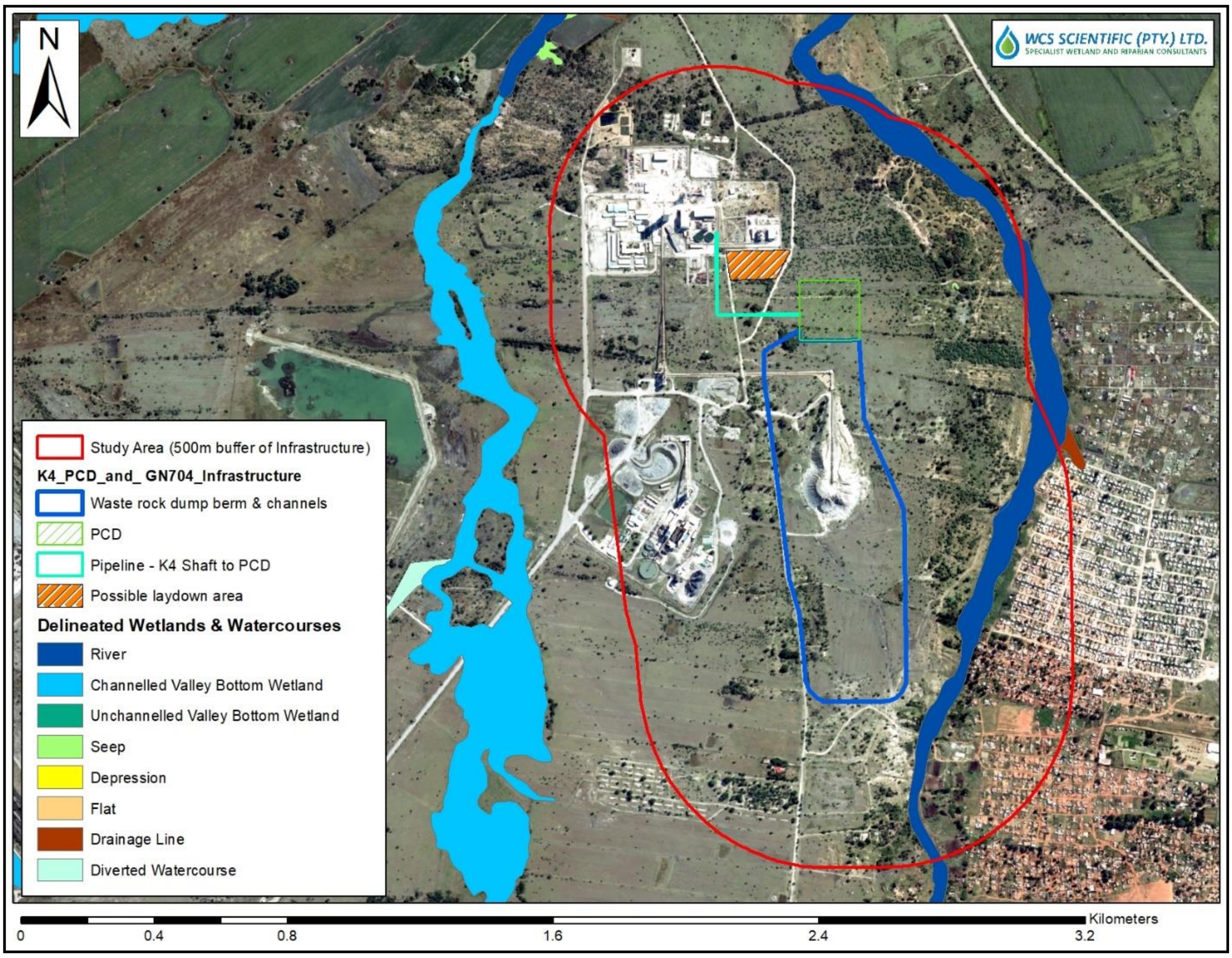

Figure 9. Map of the delineated and classified riparian habitat within the study area.

"*River—a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit*." (Ollis *et al.*, 2013).

Rivers are linear features, that carry concentrated flow of water within a channel. Rivers often support riparian habitat adjacent to the active channel, which differs in vegetation composition and structure from adjacent terrestrial vegetation, however, many riparian areas are well drained and would not be defined as wetlands (according to the South African National Water Act), especially in the upper reaches of rivers (Ollis *et al.* 2013).

Riparian habitat delineated is associated with the Sterkstroom river which flows towards the north along the eastern boundary of the study area. This river has clearly defined bed and banks, well-defined riparian vegetation outside of the active channel, consisting of indigenous, woody, riparian species such as *Combretum erythrophyllum*, *Celtis africana, Gymnosporia buxifolia, Searsia lancea*, and *Vachellia karroo*. Within, and along the margins of the active channel, hydrophytic plant species such as *Phragmites australis, Cyperus sexangularis, Paspalum urvillei,* and *Schoenoplectus brachyceras* were noted. Several alien, invasive species have colonised the riparian habitat, including *Populus canescens*, *Arundo donax*, *Eucalyptus* sp., *Lantana camara*, *Dicanthium aristatum, Morus alba, Phytolacca dioica, Salix babylonica*, and *Verbena brasiliensis*.
Photographs illustrating the riparian and instream habitat associated with the Sterkstroom River in the vicinity of the project area, as well as downstream are provided in Figure 10.

Aside from the natural watercourse identified and delineated within the study area, a number of areas within the study area were noted to be currently supporting hydrophytic plant species (usually indicative of wetland habitat) as a result of artificial impoundment of water. This included flow impoundment between roads and berms, within old infrastructure footprints, and within excavations. Due to the limited permeability of the vertic soils typical of the area, any impediments to surface runoff of catchment flows can result in the accumulation of water, which then supports the establishment of hydrophytic plants.

Figure 10. Photographs of the Sterkstroom River and associated riparian habitat within the vicinity of the study area and downstream.

7.2.2 Riparian Habitat Present Ecological State (PES)

The Sterkstroom River is located within a landscape, and a catchment, that has become modified as a result of urban development, and significant mining and mining-related activities. Landuse in the river's catchment is dominated by mining-related activities and surface infrastructure, limited formal and informal settlements, and even more limited cultivation. Extensive open land remains between mine surface infrastructures but is considered to be semi-natural.

The Sterkstroom River is impounded upstream in the large Buffelspoort Dam and several smaller dams. Flow impoundment such as this, as well as abstraction from these dams, reduces flow volumes to the downstream reach, and alters seasonal flow fluctuations. Numerous road crossings over the river result in confinement of flows and can be associated with channel modification, bank erosion and indigenous vegetation removal. The river runs through several settlements, agricultural areas, and mines, all of which are expected to affect water quality, through discharges, and are also associated with indigenous vegetation removal and can act as a source of exotic vegetation. A number of alien, invasive plant species were identified within the riparian habitat of the Sterkstroom River, as mentioned in the previous section. *In situ* water quality taken at the time of the May 2023 site visit (bank full flow) returned a pH value of 6.78, Electrical Conductivity of 106 µS/cm, total dissolved solids of 53ppm, and temperature of 16.6^{o}C, suggesting relatively good water quality.

The above impacts and various landuses within the catchment have resulted in the present ecological state of the river on site departing significantly from the assumed reference condition or un-impacted state. This is reflected in the result of the PES assessment which classes the river (including both the instream and riparian habitat) as being moderately modified (IHIA Class of “C”).

Aquatic biomonitoring of the Sterkstroom River undertaken in 2022 as part of Sibanye-Stillwater’s aquatic biomonitoring programme (The Biodiversity Company, 2022) found the reach of the Sterkstroom River crossing through the study area to be moderately modified (overall PES category of “C”) based on several assessed aquatic components, including riparian habitat, the macroinvertebrate assemblage and the ichthyofaunal assemblage. This agrees with the findings of the current PES results, which also found the Sterkstroom River to be moderately modified. The Biodiversity Company (2022) stated in reference to the ecological condition of the section of Sterkstroom River included in their aquatic biomonitoring assessment that “*despite the level of modification, the watercourse is intact and functioning well, offering a host of ecosystem services which includes a diverse biotic assemblage with a low portion of sensitive biota recorded*.”

Table 10. Results of the Index of Habitat Integrity (IHI) Assessment conducted for the Sterkstroom River in the vicinity of the study area.

Instream	**Impact Score**
Water Abstraction	6
Flow Modification	10
Bed Modification	8
Channel Modification	10
Water Quality	10
Inundation	2
Exotic Macrophytes	2
Exotic Fauna	3
Rubbish Dumping	4
Instream Habitat Integrity Score	**73**
Integrity Class	**C**
Riparian	**Impact Score**
Vegetation Removal	10
Exotic Vegetation	5
Bank Erosion	6
Channel Modification	10
Water Abstraction	5
Inundation	2
Flow Modification	8
Water Quality	12
Riparian Zone Habitat Integrity Score	**63**
Integrity Class	**C**

Figure 11. Map showing the results of the PES assessment.

7.2.3 Riparian Habitat Buffer Determination

Water resource buffer zones have been shown to perform a wide range of functions, and have therefore been adopted as a standard measure to protect water resources and associated biodiversity (Macfarlane & Bredin, 2017a). Some of these key functions include:

- Maintaining basic aquatic processes.
- Reducing impacts on water resources from upstream activities and adjoining land uses.
- Providing habitat for aquatic and semi-aquatic species.
- Providing habitat for terrestrial species.
- A range of ancillary societal benefits.

However, though buffer zones can potentially provide some, or all, of the above mentioned functions, not all water resource related problems can be addressed simply by applying a buffer zone, and they should ideally be implemented with a range of complementary mitigation and management measures (Macfarlane & Bredin, 2017a). Notable impacts or threats to water resources that cannot necessarily be addressed through the application of a buffer zone alone include:

- Point-source discharges (such as sewage outflows),
- Hydrological changes caused by stream flow reduction, and

- Groundwater contamination or use

The results of the buffer determination are detailed in Table 11 and Figure 12. Based on the characteristics of the Sterkstroom River in the study area, the proposed development activity, and taking into consideration the likely impacts and mitigation measures that can be applied, a final aquatic impact buffer requirement of 25m from the outer edge of the delineated riparian habitat was determined. Application of the buffer zone, and exclusion of project activities from within the buffer zone, should be seen as part of a suite of mitigation and management tools required to minimise impact to the aquatic environment as a result of proposed development. Therefore, enforcement of the buffer zone does not exempt the user from effectively and fully applying other recommended mitigation and management measures considered necessary to protect the river and riparian habitat from impact, as per Section 8 below.

Table 11. Selected input data to the aquatic impact buffer determination and the buffer requirement outcome.

Final aquatic impact buffer requirements	
Level of assessment	Site-based
River type	Upper Foothills
Present Ecological State	C
Ecological importance & sensitivity	High
Management objective	Maintain
Proposed development/activity	Mining - Plant and plant waste from mining operations - moderate risk activities
Construction Phase	25 meters
Operational Phase	25 meters
Final aquatic impact buffer requirement	**25 meters**

Figure 12. Delineated riparian habitat and the determined aquatic impact buffer.

8. IMPACT AND RISK ASSESSMENTS

8.1 Project Description

Sibanye-Stillwater is the owner of the K4 Shaft that forms part of the Marikana Operations located near Marikana town, North-West Province. The Marikana Operations is divided into two entities consisting of Western Platinum (Pty) Ltd and Eastern Platinum (Pty) Ltd. The K4 Shaft falls under Western Platinum (Pty) Ltd.

The shaft was placed under care and maintenance for a period of 6 years but has been ramped up to be fully operational in the year 2024. The current waste rock dump on the property of the shaft was established and initiated by the previous owner. Sibanye-Stillwater is planning to extend the Life of Mine (LOM) with approximately 30 years and the existing waste rock dump will be used to place the waste rock. The size of the waste rock dump will not exceed the approved footprint as authorised in the Western Platinum Limited – Environmental Management Programme (WPL EMPR).

Additional infrastructure that needs to be implemented include the construction of:

- A V-drain around the current waste rock dump. The V-drain is considered as catchment berms on either side of the waste rock dump, which is located on a ridge.
- A Pollution Control Dam (PCD) that will be lined and completed with a recovery sump for the recycling of stormwater runoff for the mining operations.
- A pipeline from the K4 Shaft to the PCD.
- An emergency spillway to manage the overflow.

Waste rock dump, berm and channels

The total final waste rock dump footprint area will be 203 830 m^2 and ***this footprint has already been authorised in the WPL EMPR***. The berm will be 1353 meters in length and 10,83 meters wide.

Catchment = 203830 m^2
Berm length West = 550 m,
Berm Length East = 600 m.
Average width = 10.83 m

Pollution control dam (PCD)

The PCD will have a capacity of 35 203 m^2 and will have a maximum height of 3 m from the floor of the dam. The V-drain will discharge via 2 legs into the PCD. The trapezoidal channels will have a max flow of 6452 l/s from the East leg (a 1:100 year storm estimate flow is 2500 l/s/ leg)

Pipelines

The pipeline will be installed to transfer water from the PCD to the K4 Shaft for re-use. The pipeline will be 500m in length with a total pump capacity of 60m^3/hour. The pipeline will be an HDPE line, sized to empty the dam for a 1:20 year ARI over 14 days continuous operation.

Laydown Area

The construction laydown area is expected to fall within an existing disturbance footprint outside of the riparian habitat and 100m regulated area.

No detailed, recent floodlines were available for the Sterkstroom River at the time of this study, therefore, according to GN509, the regulated area for riparian habitat is 100m from the outer edge of the delineated riparian habitat. The location and approximate extent of the operational footprint of the infrastructure in relation to the delineated riparian habitat, the 25m aquatic impact buffer, and the 100m regulated area of the riparian habitat, is illustrated in Figure 13.

It is important to note that, as the total final waste rock dump footprint has already been authorised, this impact and risk assessment will not assess the potential impacts to the river resulting from the waste rock dump itself, as it is assumed that those impacts have been adequately considered as part of the existing authorisation. ***This impact assessment will only focus on potential impacts arising from construction and operation of the berms and channels, PCD, pipeline, and construction laydown area.***

Figure 13. Proposed infrastructure footprint, 100m regulated area, and 25m aquatic impact buffer in relation to the delineated riparian habitat.

8.2 Description of Potential Impacts

Likely impacts are identified based on an evaluation of the project description (Section 8.1 above) in relation to the riparian habitat identified on site and within the regulated area of the proposed project activities.

Based on the provided project information, it is expected that the proposed project will not infringe directly on the river or associated riparian habitat. All permanent infrastructure will remain approximately a minimum of 95m from delineated riparian habitat associated with the Sterkstroom river.

Expected indirect impacts are as follows:

8.2.1 Increased risk of erosion of catchment soils and sediment transport into the riparian habitat

Clearing of vegetation and disturbance of soils within the catchment of the river will expose the bare soils to an increased risk of erosion. Any erosion of catchment soils that does occur will provide a potential sediment source to the adjacent river and riparian habitat should storm events lead to surface runoff during any phase of the project. Increased sediment within the river can lead to burial of riparian and instream vegetation and soils and increased turbidity in the water column, all of which would result in a deterioration of the riparian and instream habitat. Material stockpiles or constructed berms (if composed of easily erodible materials) could also act as sediment sources. However, the proposed infrastructure footprint lies approximately 95m from the edge of riparian habitat, making it unlikely that mobilised sediment in surface runoff would reach the river. However, additional mitigation measures are proposed in Section 8.5 to further reduce the likelihood of any impacts.

8.2.2 Deterioration of water quality

During both the construction and operation phase, as activities are taking place adjacent to the riparian habitat, there is a possibility that water quality can be impaired. Impairment may occur as a consequence of any sediment transported into the river resulting in an increase in turbidity. Water quality may also be impaired because of accidental spillages and the intentional washing and rinsing of equipment. It is likely that hydrocarbons will be stored and used on site, as well as other potential pollutants, such as cement. Construction activities could lead to an impact on water quality through leaks and spillages from machinery and materials used on site, entering the river.

During operation, the channels will intercept and convey potentially polluted flows from the waste rock dump footprint to the lined PCD, from which collected dirty water will be pumped back to K4 shaft for re-use. Only during exceptionally high flow events, when the volume of the PCD is exceeded, will flows collected within the PCD potentially discharge to the environment via the spillway on its eastern edge. As such, the placement of the proposed infrastructures (channel and berm, lined PCD, and pipeline) will effectively reduce the risk of water quality deterioration in the receiving river during normal operating conditions, as a result of the (already authorised and existing) waste rock dump. In the expectedly infrequent event of overflow from the PCD via the spillway towards the Sterkstroom River, or spills or leakages from the pipeline, an impact to water quality in the river can be expected. The nature of this water quality impact is uncertain, but is expected to align with potentially leachable constituents of the waste rock being stored.

8.3 Quantitative Impact Assessment

The results of a quantitative impact assessment undertaken based on the above described project activities and potential impacts is provided in Table 12. Construction-related impacts are expected to be of low overall significance due to the distance of the proposed infrastructures from the river and riparian habitat, and the nature of the construction activities required. During operation, overflow from the PCD during high flow events poses the greatest potential impact to the wetlands, in terms of the discharge of dirty water to the river. As a consequence, potential impacts during the operational phase are of low to moderate significance. However, with application of the provided mitigation measures, the total significance scores of all impacts can be reduced to a greater or lesser degree. Potential impacts during the decommissioning and closure phase have not been explicitly detailed in this report, but are expected to be similar in nature and significance to those anticipated during the construction phase. Mitigation, management, and rehabilitation measures aimed at avoiding or minimising the identified impacts are detailed in Section 8.5.

Table 12. Results of the impact assessment.

DEVELOPMENT PHASE	POTENTIAL ENVIRONMENTAL IMPACT	ACTIVITY	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION								CUMULATIVE	STATUS	RECOMMENDED MITIGATION MEASURES / REMARKS	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION							
			M	D	S	I	R	P	TOTAL	SS				M	D	S	I	R	P	TOTAL	SS
Riparian Habitat																					
Construction	Increased risk of erosion and sedimentation	Construction of the channel, berm and PCD - Vegetation clearing, earthworks	4	2	2	1	2	3	33		LOW	Negative	See Section 8.5 for full list of mitigation/management measures proposed. Dry season construction preferable, or place sediment barriers downslope of bare areas and material stockpiles to limit sediment transport towards the riparian habitat. No vehicle and foot traffic within the delineated riparian habitat or within the buffer, to avoid rut formation and the development of preferential flow pathways. No vegetation and soil disturbance within the riparian habitat or buffer. Avoid creation of concentrated or diverted flow pathways towards the riparian habitat. Revegetate construction footprint post construction to limit sources of sediment. This should include the outer walls of the PCD and channel berms if these will be composed of, or topped with, sediment that can be eroded easily during rainfall events. Completely remove any material or sediment stockpiles at the end of construction.	2	2	1	1	1	2	14	
Construction	Water quality deterioration	Construction of the channel, berm and PCD - use of potentially polluting materials, equipment, increased turbidity.	4	2	2	1	2	3	33		MEDIUM	Negative	See Section 8.3 for full list of mitigation/management measures proposed. Dry season construction preferable, or place sediment barriers downslope of bare areas and material stockpiles to limit sediment transport towards the riparian habitat. No vehicle and foot traffic within the delineated riparian habitat or within the buffer, to avoid rut formation and the development of preferential flow pathways. No vegetation and soil disturbance within the riparian habitat or buffer. No storage of equipment, materials, or machinery within the riparian habitat or buffer. Avoid creation of concentrated or diverted flow pathways towards the riparian habitat. Revegetate construction footprint post construction to limit sources of sediment. This should include the outer walls of the PCD and channel berms if these will be composed of, or topped with, sediment that can be eroded easily during rainfall events. Completely remove any material or sediment stockpiles at the end of construction. Provide appropriate ablutions for construction personal outside of the riparian habitat and buffer. No littering on site.	2	2	1	1	1	2	14	
Operation	Increased risk of erosion and sedimentation	Maintenance of the channel, berm and PCD - Vegetation clearing, earthworks	2	3	1	1	2	2	18		LOW	Negative	See Section 8.3 for full list of mitigation/management measures proposed. Schedule maintenance of the infrastructure (specifically PCD and eastern channel/berm) for the dry season or place sediment barriers downslope of bare areas and material stockpiles to limit sediment transport towards the riparian habitat. No vehicle and foot traffic within the delineated riparian habitat or within the buffer, to avoid rut formation and the development of preferential flow pathways. No vegetation and soil disturbance within the riparian habitat or buffer. Avoid creation of concentrated or diverted flow pathways towards the riparian habitat. Revegetate any disturbance footprint post maintenance to limit sources of sediment. This should include the outer walls of the PCD and channel berms if these will be composed of, or topped with, sediment that can be eroded easily during rainfall events. Completely remove any material or sediment stockpiles at the end of work.	2	3	1	1	1	1	8	
Operation	Water quality deterioration	Functioning of the channel/berm, PCD and pipeline - overflow from the PCD, or accidental seepage, leaks or spills of dirty water from the channel, PCD or pipeline	6	3	3	1	2	4	60		MEDIUM	Negative	See Section 8.3 for full list of mitigation/management measures proposed. The PCD must be lined to effectively prevent seepage of poor quality water to the environment. The capacity of the dam must be maintained, and inputs should not exceed its capacity such that overflow to the environment occurs more frequently than the 1:50 year flood event. Place erosion protection structures below PCD spillway outlet to limit the risk of erosion, slow flows and encourage infiltration. Monitor spillway outlet following heavy rainfall events, following any overtopping events from the PCD, and at the end of the wet season to identify any erosion that may have taken place below the spillway. If erosion is noted, corrective actions to be identified and implemented. Ensure all infrastructures remain in a good state of repair to limit the risk of accidental leaks or spills. Implement monitoring plan for the channels/berm, PCD and pipeline to identify issues and apply corrective measures. A detailed spill management and rehabilitation plan (as part of the Standard Operating Procedure – SOP) must be compiled by a suitably qualified specialist or specialist team in advance of the construction and operation phase to deal with possible spill scenarios (from pipelines and PCD). This plan must include a pipe failure response plan and must detail timeframes for response, management and rehabilitation as well as the responsible persons. The SOP's should preferably be signed off by the relevant environmental authorities.	4	3	3	1	1	3	36	

8.4 Water Use Risk Assessment

A water use risk assessment was undertaken as per the methodology included in GN509 of 2016. Of the proposed infrastructures detailed above, only a section of the channel and berm around the water rock dump footprint will extend marginally into the regulated area of the riparian habitat. All other infrastructures, including the PCD and pipeline, will remain wholly outside of the regulated area and are therefore not included in the risk assessment. Therefore, only potential impacts identified in Section 8.2, and as applicable to the channel and berm construction and operation, were included in the risk assessment. Results are provided in Table 13. For an activity to qualify for authorisation under a General Authorisation, all risks must be assessed as being of LOW significance. ***Where risks are of LOW/MODERATE significance (in the range between 56 and 80), activities can be motivated for authorisation under a GA under special circumstances and where adequate mitigation measures are possible.***

An important consideration of the GN509 Water Use Risk Assessment approach, which differs from impact assessment methodologies adopted in EIA processes, is that the GN509 approach considers the full life cycle of the proposed activity (the activity is not spilt into project phases) and the risk is rated under the scenario of all recommended mitigation measures being implemented (no “without mitigation” scenario is assessed). However, for the purpose of this study, the project lifecycle has been split into construction and operational phases, as impacts and risk between the phases differ.

Results obtained indicate that the risks associated with construction, and operation of the channel and berm surrounding the waster rock dump are of LOW significance (scores of up to 47.5). Therefore, as all risks are rated below 55, all these risks fall within the ambit of risks that can be authorised by a General Authorisation (GA), assuming appropriate mitigation and control measures, and taking into account the circumstances of the proposed activity, its location, the watercourses potentially affected and the current local conditions. However, if any other water uses are being applied for, the relevance of a general authorisation falls away, as according to GN509, the General Authorisation does not apply in instances where an application must be made for a water use license for the authorisation of any other water use as defined in section 21 of the Act that may be associated with a new activity.

Name of Company	WCS Scientific (Pty) Ltd
Name of Specialist Consultant	Shavaughn Davis
SACNASP Registration	Pr. Sci. Nat. 115025
Signature of Specialist Consultant	

Table 13. Water Use Risk Assessment as compiled for the proposed project activities – construction and operation of the channel and berm within the regulated area.

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

NAME and REGISTRATION No of SACNASP Professional member: ………SHAVAUGHN DAVIS (Pr. Sci. Nat.) ……. Reg no. ……115025…………………..

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	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND IS OF WATERCOURSE
1	Construction	Construction of the channel and berm outside of riparian habitat, but within the 100m regulated area of a river and riparian habitat	• Removal of vegetation within the infrastructure footprint • Excavation of the channel and berm	• Exposure of bare catchment soils to increased risk of erosion • Water quality impact (hydrocarbon leaks from vehicles, sediment mobilisation, cement/concrete)	1	3	1	2	1.8	1	2	4.8	1	2	5	2	10	47.5	L	High	See Section 8.5 of the report for full control/ mitigation/ rehabilitation measures.	N/A	Affected River: Sterkstroom River and associated riparian habitat. (PES = C)
2	Operation	Maintenance of the channel and berm outside of riparian habitat, but within the 100m regulated area of a river and riparian habitat	• Maintenance of a vehicle track around the channel and berm perimeter • Occasional earthworks to maintain the channel and berm	• Exposure of bare soils to increased risk of erosion • Water quality impact (hydrocarbon leaks from vehicles, sediment mobilisation)	1	2	1	2	1.5	1	2	4.5	2	1	5	2	10	45	L	High	See Section 8.5 of the report for full control/ mitigation/ rehabilitation measures.	N/A	Affected River: Sterkstroom River and associated riparian habitat. (PES = C)

8.5 Mitigation, Management & Rehabilitation

Key mitigation measures are highlighted in Tables 12 of the impact assessment. Key mitigation measures are however again highlighted in this section. Where implementation of any of the recommended mitigation measures is not possible, it might be necessary to revise the impact assessment and Water Use risk assessment accordingly, potentially changing the impact and risk categories of the proposed activity.

Construction Phase

- The PCD must be lined to prevent seepage of dirty water from the dam during normal operating conditions.
- The entire construction footprint (including the infrastructures to be constructed, associated infrastructure area, vehicles, personnel areas, laydown area, and all material storage areas, etc.) must remain completely outside of the riparian habitat and 25m riparian buffer, and should be kept as small as practically possible and should be demarcated with fencing/danger tape to ensure no vehicles, materials, personnel, or infrastructure impact on riparian habitat.
- Dry season construction preferable, or place sediment barriers downslope of bare areas and material stockpiles to limit sediment transport towards the riparian habitat.
- No vehicle and foot traffic within the delineated riparian habitat or within the 25m buffer, to avoid rut formation and the development of preferential flow pathways.
- No vegetation and soil disturbance within the riparian habitat or buffer.
- Avoid creation of concentrated or diverted flow pathways towards the riparian habitat.
- Revegetate construction footprint post construction to limit sources of sediment. This should include the outer walls of the PCD and channel berms if these will be composed of, or topped with, sediment that can be eroded easily during rainfall events.
- No storage of equipment, materials, or machinery within the riparian habitat or buffer.
- A detailed procedure for the handling, storage and disposal of waste must be developed and fully implemented during construction.
- Provide appropriate ablutions for construction personal outside of the riparian habitat and buffer.
- No littering on site.
- The construction footprint should be regularly inspected for waste or littering, and clean-up operations initiated if required.
- Stormwater or any additional flows generated during construction should not be discharged in an uncontrolled manner into the riparian habitat or buffer. Surface flows must be discharged in a low velocity, diffuse manner to ensure no erosion at point of discharge.
- Place erosion protection structures below the PCD spillway outlet to limit the risk of erosion, slow flows and encourage infiltration.
- At the conclusion of construction activities, the following should form part of the site closure and rehabilitation:
  - Surface runoff along access tracks should not lead to erosion towards the watercourse. Where ruts have formed and remain following completion of

construction activities, these should be plugged with regular shallow soil berms to prevent preferential flow paths forming along the vehicle ruts, or ripped and landscaped to the natural soil profile.

- On completion of construction, the site should be left clean and free from all debris, liners, stored dirty or contaminated water, hydrocarbons and waste, and all excavations filled appropriately. No hazardous chemicals, cement or carbonaceous materials should remain. All waste should be removed from site and disposed of at an appropriate disposal facility to prevent contamination of the water resource.
- Completely remove any material or sediment stockpiles at the end of construction.
- Any areas remaining bare of vegetation at the end of the construction phase as a result of construction activities must be monitored weekly thereafter, and if not fully revegetated within three months, active revegetation must be pursued under the guidance of a suitably qualified botanist or ecologist.

Operation Phase

- The capacity of the PCD must be maintained, and inputs should not exceed its capacity such that overflow to the environment occurs more frequently than the 1:50 year flood event.
- Ensure all infrastructures remain in a good state of repair to limit the risk of accidental leaks or spills.
- Implement monitoring plan for the channels/berm, PCD and pipeline to identify issues and apply corrective measures.
- Monitor spillway outlet following heavy rainfall events, following any overtopping events from the PCD, and at the end of the wet season to identify any erosion that may have taken place below the spillway. If erosion is noted, corrective actions to be identified and implemented.
- A detailed spill management and rehabilitation plan (as part of the Standard Operating Procedure – SOP) must be compiled by a suitably qualified specialist or specialist team in advance of the construction and operation phase to deal with possible spill scenarios (from pipelines and PCD). This plan must include a pipe failure response plan and must detail timeframes for response, management, and rehabilitation as well as the responsible persons. The SOP's should preferably be signed off by the relevant environmental authorities.
- Schedule regular or expected maintenance of the infrastructure (specifically PCD and eastern channel/berm) for the dry season or place sediment barriers downslope of bare areas and material stockpiles to limit sediment transport towards the riparian habitat.
- All vehicles, machinery, stockpiles, laydown areas required for regular or unexpected maintenance to remain outside of the riparian habitat and 25m buffer zone.
- All waste generated on site must be transported off site and disposed of in an appropriate and authorised waste disposal facility of the mine.
- The 25m riparian buffer must be managed and maintained in its current or better condition to maintain its effectiveness in addressing diffuse impacts.

9. SUMMARY OF FINDINGS

This wetland and riparian study identified riparian habitat in close proximity to the proposed activity and infrastructure footprints, with such activities extending into the 100m regulated area associated with the riparian habitat. No wetland habitat was identified within the 500m of the proposed activity and infrastructure. The Sterkstroom River is currently in a moderately modified condition.

The footprint of the proposed development lies completely outside of all riparian habitat, and only limited, indirect impacts to the river and associated riparian habitat could occur. Both an impact assessment and a water use risk assessment were completed for the proposed activity. The risk assessment indicated a low risk to the river as a result of construction of the channel and berm, which is the only infrastructure extending into the regulated area. The impact assessment indicated low to moderate potential impact to the river and riparian habitat as a consequence of the proposed activities and infrastructures. Although the water use risk assessment returned a low risk rating for 21 (c) and (i) water uses within the regulated area, the proposed project will be applying for water uses in addition to 21 (c) and (i) water uses, therefore, according to GN509, a general authorisation is excluded, and a full water use licence application process must be pursued for all water uses. It is important to keep in mind that during operation, the proposed infrastructures (channel and berm, lined PCD, and pipeline) will be in place to intercept and convey potentially polluted flows from the waste rock dump footprint to the lined PCD, from which collected dirty water will be pumped back to K4 shaft for re-use. Only during exceptionally high flow events, when the volume of the PCD is exceeded, will flows collected within the PCD potentially discharge to the environment via the spillway on its eastern edge. As such, the placement of the proposed infrastructures (channel and berm, lined PCD, and pipeline) will effectively reduce the risk of water quality deterioration in the receiving river during normal operating conditions, as a result of the (already authorised) wate rock dump. Assuming that construction of the proposed infrastructures is undertaken in an environmentally sensitive manner, and all avoidance, mitigation and rehabilitation measures detailed in this report can be, and are, fully applied during the applicable project phases, indirect disturbance of river and riparian habitat can be limited to acceptable levels. As such the proposed project activities should be considered for authorisation.

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APPENDIX A

CV of the Specialist
Shavaughn Davis
Summarised *Curriculum Vitae*

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Academic History:
2006 – M.Sc. Zoology, Nelson Mandela Metropolitan University
2004 – B.Sc. (Hons.) Zoology, Nelson Mandela Metropolitan University
2003 – B.Sc. Zoology and Botany, University of Port Elizabeth (now NMMU)
2000 - Matriculated with a University Exemption from Woodridge College, Port Elizabeth.

Professional Affiliations:
SACNASP: Ecological & Zoological Science (115025)
South African Wetland Society (Reg. number EJGYPMF3)

Additional Training: 2010 - Advanced Wetland Delineation Course, University of Pretoria

Employment record: 2010 - Present day: Wetland Ecologist & Zoologist at Wetland Consulting Services (Pty.) Ltd. & WCS Scientific (Pty) Ltd.

2008: Research Assistant at Okavango Buffalo Research Project, Okavango Delta, Botswana
2007 - 2008: Scientific Consultant at Wetland Consulting Services (Pty.) Ltd.

Previous Research Projects:

1. Davis, S. 2006. Endozoochory in the Subtropical Thicket: comparing effects of species with different digestive systems on seed fate. Unpublished MSc dissertation, Nelson Mandela Metropolitan University. Dissertation supervisor: Prof. G. I. H. Kerley
2. Davis, S. 2004. Diet of Elephants in the Nyati Concession Area, Addo Elephant National Park. Unpublished Honours project, Nelson Mandela Metropolitan University. Project supervisors: Prof. G. I. H. Kerley and M. Landman
3. Davis, S. 2003. Potential for saltmarsh rehabilitation in the Swartkops river estuary. Undergraduate research project, Department of Botany, University of Port Elizabeth (now Nelson Mandela Metropolitan University). Project supervisor: Dr. J. Adams

Conference Presentations:

1. Davis, S. & Kerley, G. I. H. 2006. Seed dispersal by elephants: passage rate and seed germination. Paper presented at 2nd Eastern Cape Elephant Conservation and Management Workshop. September 2006, Port Elizabeth, South Africa.
2. Davis, S., Kerley, G. I. H. & Landman, M. 2005. Dietary shifts of elephants in the Addo Elephant National Park. Paper presented at the Zoological Society of South Africa Conference. July 2005, Grahamstown, South Africa.
3. Davis, S., Kerley, G. I. H. & Landman, M. 2004. Dietary shifts of elephants in the Addo Elephant National Park. Paper presented at the Elephant Managers and Owners Association Conference. September 2004, Pilansburg, South Africa.

Summarised project experience

2018 Consulting Projects

1. Detailed wetland delineation and assessment studies for various Sasol Collieries in the Secunda and Sasolburg areas.
2. Wetland monitoring as part of the Glisa Bio-Monitoring Programme, Mpumalanga Province.
3. Wetland monitoring as part of the Eerstelingsfontein Bio-Monitoring Programme, Mpumalanga Province.
4. Wetland delineation, assessment and application of the DWS risk assessment for activities proposed at the Goedehoop Colliery.
5. Desktop assessment and rehabilitation planning of selected wetlands within the Ekurhuleni Metropolitan Municipality as part of the development of a wetland rehabilitation strategy for the municipality, Gauteng Province.
6. Wetland delineation, baseline assessment and impact assessment for proposed underground mining and surface infrastructure in the Metsimaholo Municipality, Free State Province.

2017 Consulting Projects:

1. Update of the national wetland map – summer rainfall mesic & arid regions – Providing specialist wetland input, training of interns, and evaluation of the updated wetland map.
2. Wetland delineation and assessment for surface infrastructure associated with the New Denmark Colliery, Mpumalanga Province.
3. Wetland and river baseline and impact assessment study for the proposed Burgersfort Road Upgrade, Limpopo Province.
4. Wetland vegetation monitoring and vegetation rehabilitation and management plan as part of the KPSX Wetland Rehabilitation Project Environmental Baseline Monitoring, Mpumalanga Province.
5. Offsite wetland offset strategy within the South32 Mine Closure Areas, Mpumalanga Province.
6. Wetland mitigation strategy for Glencore's Impunzi Mine, Mpumalanga Province.

2016 Consulting Projects:

1. Wetland delineation and assessment for the Anglo American Thermal Coal Setlabotsha Project near Standerton, Mpumalanga Province.
2. Development of a wetland mitigation/offset strategy for the proposed Vlakfontein extension project, Mpumalanga Province.
3. Development of a wetland mitigation/offset strategy for the proposed Khutala Life Extension Project.
4. Wetland baseline monitoring as part of the Exxaro's Belfast Implementation Project, Mpumalanga Province.
5. Wetland delineation, assessment and conceptual rehabilitation plan to address the requirements of a Non-compliance notice issued for a property in Kyalami, Gauteng Province.

2015 Consulting Projects:

1. Wetland delineation and impact assessment for the Algoa Basin Crude Oil Production Project in the Eastern Cape.
2. Wetland mitigation strategy for the proposed Mafube Life Extension Project, Mpumalanga Province.
3. Wetland delineation and assessment of pans and upper catchment wetlands as part of the Elders-Viskuile Wetland Reserve Determination.
4. Wetland delineation and impact assessment for a proposed urban development in Calvinia, Northern Cape.
5. Wetland study as part of a Critical Habitat Biodiversity Assessment of the Nhangonzo Coastal Stream, Mozambique.

2014 Consulting Projects:

1. Wetland delineation of wetlands surrounding proposed drilling locations for Exxaro's Matla Colliery Mine 1, Mpumalanga Province.
2. Wetland delineation and ecological assessment of the property Portion 85 of the Farm Rietvlei 101 IR, Johannesburg, Gauteng Province.
3. Riparian delineation and assessment on Erf 174 Morningside Ext 13, Morningside, Johannesburg.
4. Present ecological state (PES) assessment of pan wetlands as part of the wetland reserve determination within the Arnot Mining Rights Area for Exxaro Mpumalanga Coal.
5. Contributed towards the Wetland Mitigation Strategy for New Largo Opencast Coal Mine, Mpumalanga Province

2013 Consulting Projects:

1. Wetland delineation and ecological assessment of specific wetland systems along the Saaiwaterspruit for Anglo American Thermal Coal as part of the Proposed New Largo Mining Project, Mpumalanaga Province.
2. Wetland delineation, ecological assessment and impact assessment for the proposed Copperleaf Residential Estate, Gauteng Province.
3. Wits Rural Facility specialist baseline wetland and riparian assessment and impact assessment for a proposed facilities expansion, Limpopo Province.
4. Wits Rural Facility specialist baseline faunal assessment and environmental impact assessment for a proposed facilities expansion north of Acornhoek, Limpopo Province.
5. Specialist faunal assessment and environmental impact assessment for the proposed ATCOM Dragline Relocation Project Specialist Assessment, Mpumalanga Province.

2012 Consulting Projects:

1. Wetland delineation, assessment and impact assessment for the proposed development of Fochville Extension 13, North West Province.
2. Specialist faunal assessment as part of the EIA/EMP for a proposed mine located on the banks of the Nyl River floodplain near Mokopane, Limpopo Province.
3. Faunal baseline survey of mammals, avifauna and herpetofauna for the proposed Lustoff opencast mine in the Chrissiesmeer area, Mpumalanga Province.
4. Wetland delineation, impact assessment and compilation of a conceptual wetland rehabilitation plan for the proposed upgrading of roads and stormwater systems in a residential area of Mamelodi, Gauteng Province.
5. Specialist wetland delineation and assessment of identified EWR sites as part of the Wetland Reserve Study for the Extension of the Boschmanskrans Section of the Wolwekrans Colliery, Mpumalanga Province.
6. Wetland delineation and impact assessment for Anglo American Thermal Coal as part of the proposed New Vaal Colliery Life Extension Project, Free State Province.