AQUATIC ECOLOGICAL ASSESSMENT AND WETLAND STUDIES AS PART OF THE WATER USE LICENSING PROCESS FOR THE CONSTRUCTION OF A POWERLINE FROM THE CASHAN SUB-STATION TO THE NEW PROPOSED SUB-STATION

Prepared for

SRK Consulting (Pty) Ltd

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SECTION B – Wetland Assessment

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GLOSSARY OF TERMS

Alien vegetation	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally.
Biome	Major regional communities encompassing similar flora and fauna, identifiable at a global scale.
Bioregion	A “composite spatial terrestrial unit defined on the basis of similar biotic and physical features and processes at the regional scale”.
Ecoregion	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region”.
Indigenous vegetation	Vegetation occurring naturally within a defined area.

ACRONYMS

BAR	Basic Assessment Report
CSIR	Council of Scientific and Industrial Research
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EISC	Ecological Importance and Sensitivity Classification
EAP	Environmental Assessment Practitioner
FEPA	Freshwater Ecosystem Priority Areas
DEMC	Desired Ecological Management Class
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
GIS	Geographic Information System
GPS	Global Positioning System
HGM	Hydro-geomorphic
m	Metres
mm	Millimetres
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NPAES	National Protected Area Expansion Strategy
PEMC	Present Ecological Management Class
PES	Present Ecological State
REC	Recommended Ecological Category
SAIAB	South African Institute of Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SAS	Scientific Aquatic Services
subWMA	Sub-Water Management Area
WMA	Water Management Area
WRC	Water Research Commission

1 INTRODUCTION

Scientific Aquatic Services (SAS) was appointed to conduct an aquatic ecological assessment and wetland studies as part of the water use licensing process for the construction of a proposed powerline route from the Cashan sub-station to the new proposed sub-station. Two alternative lines were proposed for this study, one of which being the existing line which may be upgraded (alternative 1). The second alternative is to develop a new line (alternative 2). The alternative powerline 1 is located adjacent to the R560 Road. Alternative line 2 runs approximately parallel, at a distance of approximately 1km from the alternative powerline 1.

A site visit was conducted on the 28th October 2014. During the site visit, wetland areas were delineated and an assessment was conducted in order to define the Present Ecological Status (PES) and Ecological Importance and Sensitivity (EIS) thereof, as well as to determine wetland functionality and service provision in terms of ecological and socio-economic functioning of the systems, in order to guide construction activities within the project footprint and to inform the Water Use Licence Application (WULA) to be submitted for the proposed powerline route.

An impact assessment on the wetland resources of the powerline development was performed to determine the significance of the perceived impacts on the receiving environment. In addition, mitigatory measures were developed which aim to minimise the impacts, followed by an assessment of the significance of the impacts after mitigation, assuming that they are fully implemented.

This report, after consideration and the description of the ecological integrity of the proposed powerline route, must guide the Environmental Assessment Practitioner (EAP), regulatory authorities and developing proponent, by means of the presentation of results and recommendations, as to the ecological viability of the proposed development activities.

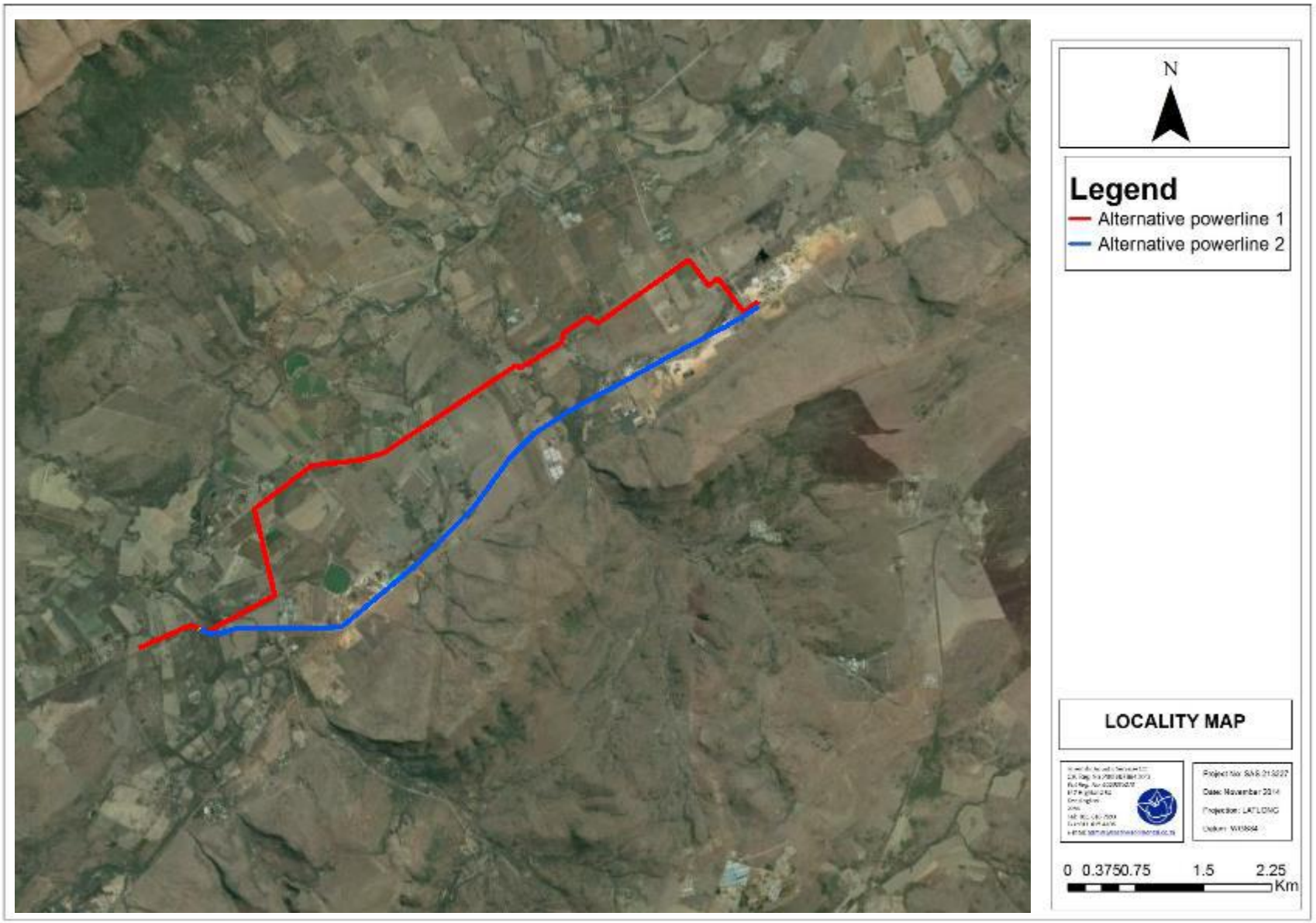

Figure 1: Digital satellite image depicting the location of the proposed powerline route and towers in relation to surrounding areas.

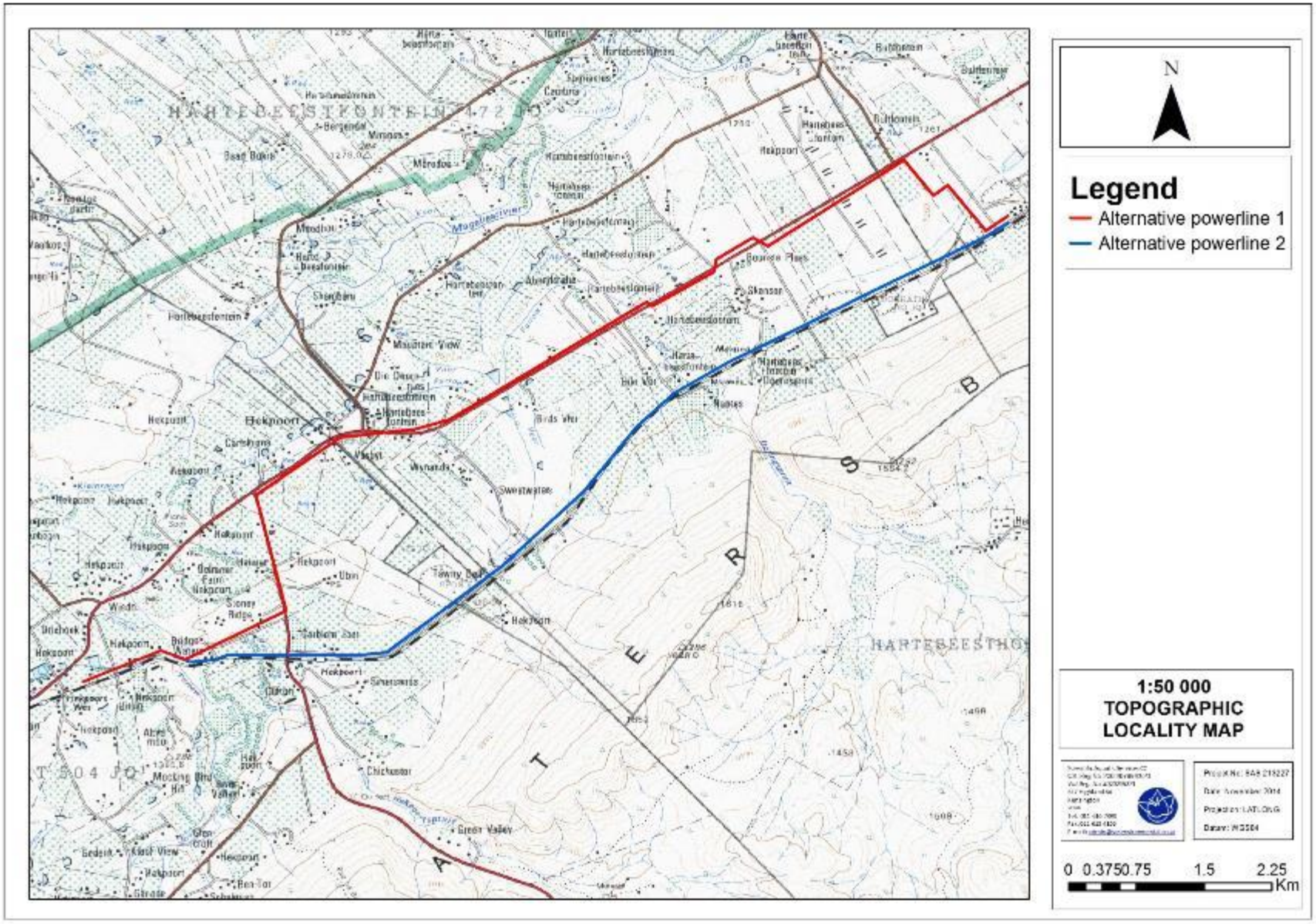

Figure 2: The proposed powerline route depicted on a 1:50 000 topographical map in relation to the surrounding area.

1.1 Scope

Specific outcomes in terms of the wetland and river assessment are as follows:

- Delineation of all wetland and riparian features along the proposed powerline route development according to “DWA (Department of Water Affairs, 2005): A Practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones”;
- Classification of wetland features according the Classification System for Wetlands and other Aquatic Ecosystems in South Africa as defined by Ollis *et al*., 2013;
- Define the wetland services provided by the resources according to the method of Kotze *et al.,* 2009;
- Assess the wetland health according to the resource directed measures guideline as defined by Macfarlane *et al*., (2009) as well as the procedure for the assessment of the Index of Habitat Integrity (IHI) status by Kleynhans (1996), to obtain the Present Ecological State (PES) of the wetland feature and riparian features;
- Determination of the Ecological Importance and Sensitivity (EIS);
- Advocate a Recommended Ecological Category (REC) for the features based on the findings of the EIS assessment;
- Determine the environmental impacts of the proposed development on the wetland and river resources that would be intersected by the proposed powerline route; and
- Define mitigatory measures to minimise impacts should the proposed development proceed.

1.2 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The wetland assessment is confined to the proposed powerline route footprint and does not include the neighbouring and adjacent properties, which were only considered as part of the desktop assessment;
- The wetland delineation as presented in this report is regarded as a best estimate of the wetland boundary based on the site conditions present at the time of assessment. Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. If more accurate assessments are required the wetland will need to be surveyed and pegged according to surveying principles;
- Wetlands and terrestrial zones create transitional areas where an ecotone is formed as vegetation species change from terrestrial to wetland species. Within this transition zone

some variation of opinion on the wetland boundary may occur, however if the DWA 2005 method is followed, all assessors should get largely similar results; and

- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. It is, however, expected that the proposed powerline route has been accurately assessed and considered, based on the field observations undertaken.

1.3 Indemnity and Terms of Use of 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 SAS CC and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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1.4 Legislative requirements

National Water Act (NWA)

In terms of the NWA, the following is applicable:

- The water act recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved;

- No activity may therefore take place within a watercourse, unless it is authorised by the DWA;
- The General Authorisation, specifically addressing the water uses defined under Section 21 (c) & (i) of the NWA, as published in the Government Gazette No. 32805, dated 18 December 2009, Regulations No. 1199, "Replacement of General Authorisation in terms of Section 39 of the NWA, 1998 (Act 36 of 1998), provides a set of requirements which is an authorisation to which a water user must comply. If the water user cannot comply or the water use related activities exceed the conditions or exclusions of the General Authorisation then a water use licence application is required; and
- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWA in terms of Section 21 (c & i).

National Environmental Management Act

The National Environmental Management Act (NEMA) (Act 107 of 1998) as amended and the associated Regulations (No R. 544 and No R. 545), states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact.

2 METHOD OF ASSESSMENT

2.1 Desktop Study

Prior to the commencement of the field assessment, a background study, including a literature review, was conducted in order to determine the ecoregion of the larger aquatic system in close proximity of the proposed powerline route. Aspects considered as part of the literature review are discussed in the sections that follow.

2.2 Ecoregion

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the proposed powerline route is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment to guide the assessment.

The database was consulted for the quaternary catchment of concern in order to define the EIS, PEMC and DEMC. The findings are based on a study undertaken by Kleynhans (1999) as part of

"A procedure for the determination of the ecological reserve for the purpose of the national water balance model for South African rivers".

2.3 National Freshwater Ecosystems Priority Areas (NFEPA)

The NFEPA project is a multi-partner project between the Council of Scientific and Industrial Research (CSIR), Water Research Commission (WRC), South African National Biodiversity Institute (SANBI), DWA, South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). The project responds to the reported degradation of freshwater ecosystem condition and associated biodiversity, both globally and in South Africa. It uses systematic conservation planning to provide strategic spatial priorities of conserving South Africa's freshwater biodiversity, within the context of equitable social and economic development.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. Freshwater ecosystems provide a valuable natural resource, with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges that are practical (managing vast areas of land to maintain connectivity between freshwater ecosystems), socio-economic (competition between stakeholders for utilisation) and institutional (building appropriate governance and co-management mechanisms).

The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present along the proposed powerline route.

2.4 Classification System for Wetlands and other Aquatic Ecosystems in South Africa

All wetland or riparian features encountered along the proposed powerline route were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems, hereafter referred to as the "classification system" (Ollis *et al*., 2013). A summary of Levels 1 to 4 of the classification system are presented in Table 1 and 2, below.

Table 1: Classification structure for Inland Systems, up to Level 3.

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

Table 2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

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

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

2.4.1 Level 1: Inland systems

From the classification system, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[1] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had an historical connection to the ocean, which in some cases may have been relatively recent.

2.4.2 Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that has been included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland (figure below). DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

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

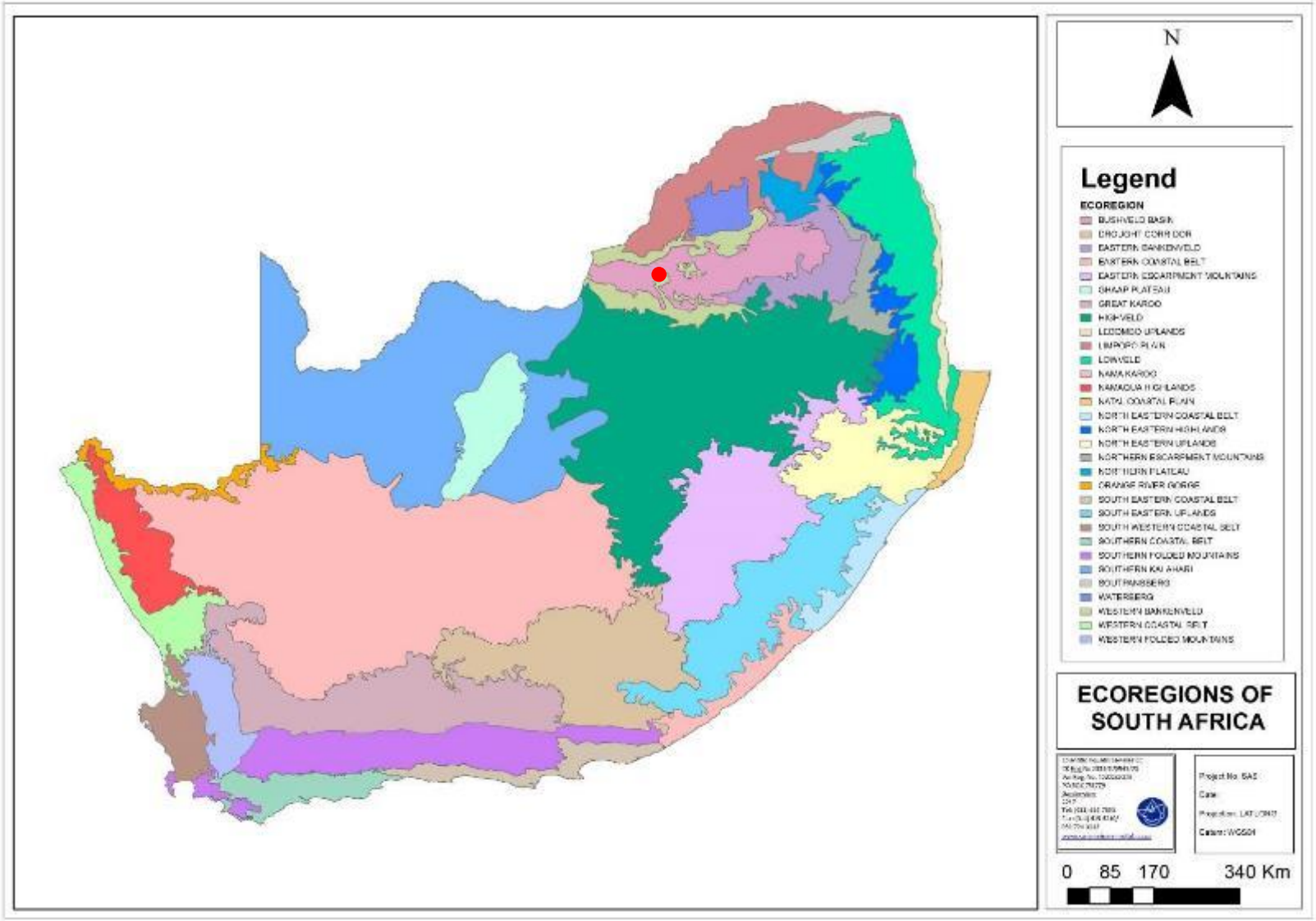

Figure 3: Map of Level 1 Ecoregions of South Africa, with the approximate position of the proposed powerline route indicated in red.

2.4.3 Level 3: Landscape Setting

At Level 3 of the proposed classification System, for Inland Systems, a distinction is made between four Landscape Units (Table 1) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

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

2.4.4 Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table 2), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- **River:** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water;
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it;
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it;
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank;
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates;
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat;

- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the classification system to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al*., 2008), WET-IHI (DWAF, 2007) and WET-EcoServices (Kotze *et al*., 2009).

2.5 Wetland Function Assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[2] The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al* (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

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

[2] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999

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

Table 3: Classes for determining the likely extent to which a benefit is being supplied.

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

2.6 Index of Habitat Integrity (IHI)

To assess the PES of the riparian features, the IHI for South African floodplain and channelled valley bottom wetland types (Department of Water Affairs and Forestry Resource Quality Services, 2007) was used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (table below), and provide a score of the PES of the habitat integrity of the wetland or riparian system being examined.

Table 4: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

Ecological Category	PES % Score	Description
A	90-100%	Unmodified, natural.
B	80-90%	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	60-80%	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	40-60%	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred. 20-40% Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
E	20-40%	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.

Ecological Category	PES % Score	Description
F	0-20%	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible.

2.7 Riparian Vegetation Response Assessment Index (VEGRAI)

The VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results[3]. Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Table 5: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. 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

2.8 WET-Health Assessment

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever changing landscape. The primary purpose of this assessment is to evaluate the ecophysical health of wetlands, and in so doing promote their conservation and wise management.

[3] Kleynhans et al, 2007

2.8.1 Level of Evaluation

Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; or
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

2.8.2 Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

2.8.3 Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems in Section 2.5.

2.8.4 Quantification of Present State of a Wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial *extent* of impact of individual activities and then separately assessing the *intensity* of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores and Present State categories are provided in Table 66.

Table 6: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	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
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
Serious	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
Critical	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

2.8.5 Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (Table 77).

Table 7: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

2.8.6 Overall Health of the Wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provides a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

2.9 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health and the IHI as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland/river features or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 8 below.

Table 8: Descriptions of the EIS Categories.

EIS Category	Range of Mean	Recommended Ecological Management Class[4]
Very high Wetlands/rivers that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands/rivers that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands/rivers that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands/rivers that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

[4] Ed's note: Author to confirm exact wording for version 1.1

2.10 Recommended Ecological Category

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure." [5]

The REC (Table 9) was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above), followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

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

Table 9: Description of REC classes.

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

2.11 Wetland and Riparian Delineation

For the purposes of this investigation, a wetland and a riparian habitat are defined in the national water Act (1998) as stated below:

- A wetland is a land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.
- Riparian habitat is defined as including the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

The wetland zone delineation took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas"

[5] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999*

published by the DWA in February 2005. The foundation of the method is based on the fact that wetlands have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils; and
- The presence of alluvial soils in stream systems.

By observing the evidence of these features in the form of indicators, wetland zones and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWA, 2005).

Wetland zones can be divided into three zones (DWA, 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

Riparian zones have noticeable stream banks as well as an active channel which constitute of alluvial soils and isolated areas of bedrock in some areas. In addition, distinctive change in vegetation abundance as well as diversity is usually noted in the riparian zone when compared to the surrounding terrestrial zones. Where applicable the edge of the riparian zone was delineated.

3 IMPACT ASSESSMENT

The anticipated impacts associated with the proposed project have been assessed according to SRK's standardised impact assessment methodology which is presented below. This methodology has been utilised for the assessment of environmental impacts where the consequence (severity of impact, spatial scope of impact and duration of impact) and likelihood (frequency of activity and frequency of impact) have been considered in parallel to provide an impact rating and hence an interpretation in terms of the level of environmental management required for each impact.

The first stage of any impact assessment is the identification of potential environmental activities[6], aspects[7] and impacts which may occur during the commencement and implementation of a project. This is supported by the identification of receptors[8] and resources[9], which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. Environmental impacts[10] (social and biophysical) are then identified based on the potential interaction between the aspects and the receptors/resources.

The significance (degree to which the impact may cause irreplaceable loss of resources) of the impact is then assessed by rating each variable numerically according to defined criteria as outlined in Table 1010. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity[11], spatial scope[12] and duration[13] of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity[14] and the frequency of the impact[15] together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix table as shown in Table 1111.

This matrix thus provides a rating on a scale of 1 to 150 (low, medium low, medium high or high) based on the consequence and likelihood of an environmental impact occurring.

Natural and existing mitigation measures, including built-in engineering designs, are included in the pre-mitigation assessment of significance. Measures such as demolishing of infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

[6]An ***activity*** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or pieces of infrastructure that are possessed by an organisation.
[7]An ***environmental aspect*** is an 'element of an organisations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an impact.
[8]***Receptors*** comprise, but are not limited to people or man-made structures.
[9]***Resources*** include components of the biophysical environment.
[10]***Environmental impacts*** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. Receptors can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as aquifers, flora and palaeontology. In the case where the impact is on human health or well-being, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
[11]***Severity*** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
[12]***Spatial scope*** refers to the geographical scale of the impact.
[13]***Duration*** refers to the length of time over which the stressor will cause a change in the resource or receptor.
[14]***Frequency of activity*** refers to how often the proposed activity will take place.
[15]***Frequency of impact*** refers to the frequency with which a stressor (aspect) will impact on the receptor.

Table 10: Criteria for Assessing Significance of Impacts

SEVERITY OF IMPACT	RATING
Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful	5

SPATIAL SCOPE (EXTEND) OF IMPACT	RATING
Activity specific	1
Mine specific (within the mine boundary)	2
Local area (within 5 km of the mine boundary)	3
Regional (Greater Rustenburg area)	4
National	5

DURATION OF IMPACT	RATING
One day to one month	1
One month to one year	2
One year to ten years	3
Life of operation	4
Post closure / permanent	5

CONSEQUENCE

FREQUENCY OF ACTIVITY / DURATION OF ASPECT	RATING
Annually or less / low	1
6 monthly / temporary	2
Monthly / infrequent	3
Weekly / life of operation / regularly / likely	4
Daily / permanent / high	5

FREQUENCY OF IMPACT	RATING
Almost never / almost impossible	1
Very seldom / highly unlikely	2
Infrequent / unlikely / seldom	3
Often / regularly / likely / possible	4
Daily / highly likely / definitely	5

LIKELIHOOD/ PROBABILITY

Table 11: Interpretation of Impact Rating

Consequence

Likelihood														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
3	6	9	12	15	18	21	24	27	30	33	36	39	42	45
4	8	12	16	20	24	28	32	36	40	44	48	52	56	60
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
6	12	18	24	30	36	42	48	54	60	66	72	78	84	90
7	14	21	28	35	42	49	56	63	70	77	84	91	98	105
8	16	24	32	40	48	56	64	72	80	88	96	104	112	120
9	18	27	36	45	54	63	72	81	90	99	108	117	126	135
10	20	30	40	50	60	70	80	90	100	110	120	130	140	150

	High	76 to 150	Improve current management
	Medium High	40 to 75	Maintain current management
	Medium Low	26 to 39	
	Low	1 to 25	No management required

SIGNIFICANCE = CONSEQUENCE x LIKELIHOOD

3.1 Mitigation Measure Development

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

- *Mitigation* and *performance improvement measures* and actions that address the risks and impacts[16] are identified and described in as much detail as possible.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation.
- Desired outcomes are defined, and have been developed in such a way as to be *measurable events with performance indicators, targets and acceptable criteria* that can be tracked over *defined periods*, with estimates of the *resources* (including human resource and training requirements) *and responsibilities for implementation.*

3.2 Recommendations

Recommendations were developed to address and mitigate potential impacts on the wetland ecology associated with the development related to the features identified. These recommendations also include specific management measures applicable to individual Wetland

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

Management Units as well as general management measures which apply to the aquatic ecosystem as a whole.

4 GENERAL IMPORTANCE OF THE PROPOSED POWERLINE ROUTE

4.1 Ecoregions

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the proposed powerline route is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment to guide the assessment.

The proposed powerline route falls within the Western Bankenveld Ecoregion and within the A21F quaternary catchment (Figure 4).

Table 12: Summary of the ecological status of quaternary catchment A21F based on Kleynhans 1999.

Catchment	Resource	EIS	PESC	DEMC
A21F	Magalies River	Moderate	CLASS B	CLASS C: Moderately Sensitive Systems

The points below summarise the impacts on the aquatic resources in A21F quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been significantly affected by med modification.
- Significant flow modifications have taken place.
- Significant impacts have occurred as a result of introduced instream biota such as *Oncorhynchys mykiss and Cyprinus carpio.*
- Impact due to inundation is significant.
- Riparian zones and stream bank conditions are considered to be highly impacted on due to cultivated land in the area and exotics.
- An impact on the aquatic community, due to altered water quality, is deemed to affect the catchment significantly.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions of riverine systems in the A21F catchment:

- Moderate diversity of habitat types.

- Little importance in terms of conservation.
- Significant sensitivity to flow requirements especially effecting *Chiloglanis pretoriae* and *Amphilius uranoscopus.*
- Little importance in terms of migration of aquatic species.
- Insignificant in terms of rare and endemic species conservation.
- The ecology of the riverine resources is not considered to be sensitive to changes in water quality.
- Significant importance as a source of refugia for aquatic species.
- The catchment is considered to be sensitive to water flow changes.
- The catchment has a significant importance in term of species richness in the area.

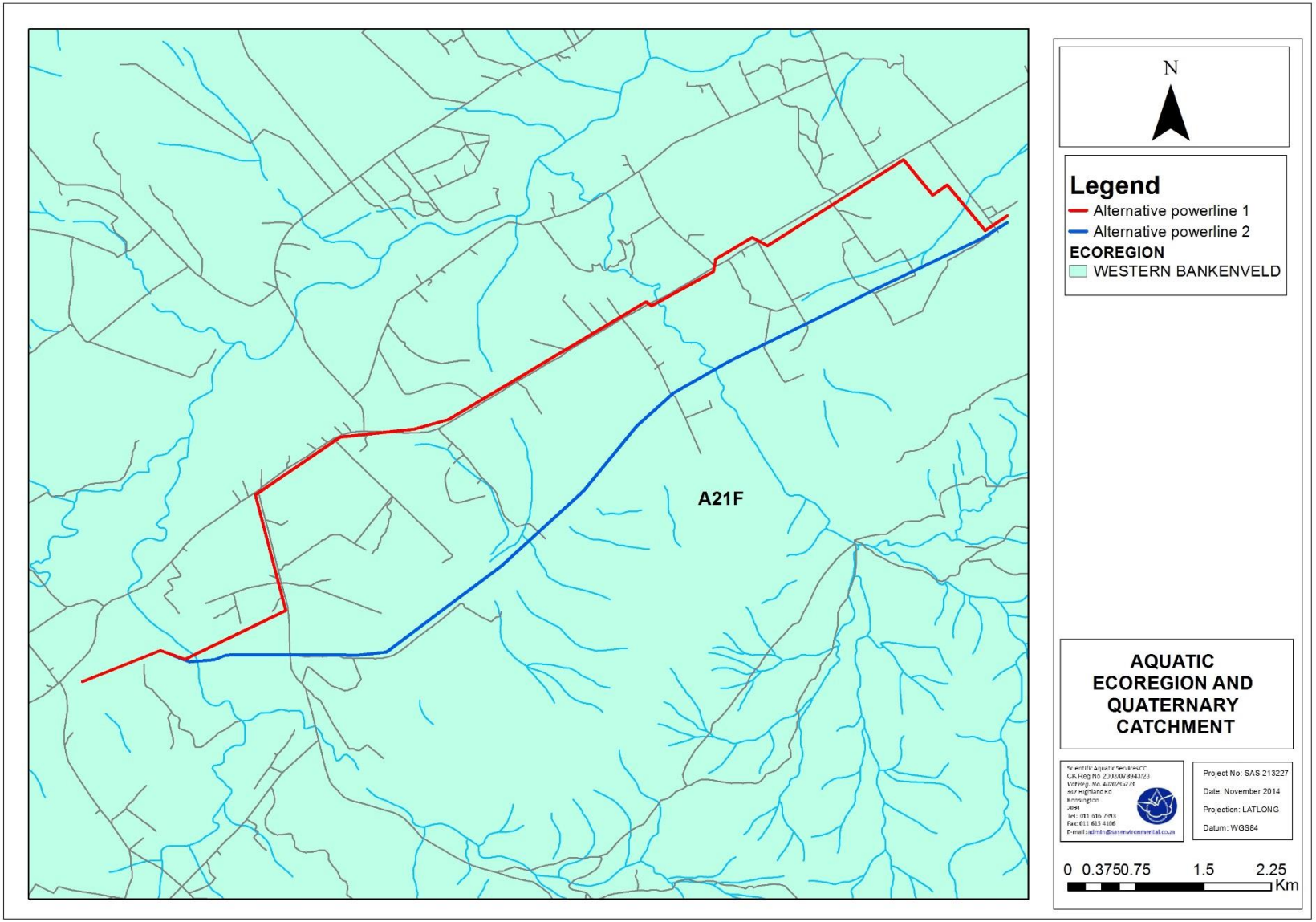

Figure 4: The Aquatic Ecoregion and quaternary catchment associated with the proposed powerline route.

4.2 Importance According to the Gauteng Conservation Plan (V3) and North West Province C Plan

The Gauteng Conservation Plan 2014 (C-plan version 3.3) focuses on the mapping of biodiversity priority areas within Gauteng, compiled by the Gauteng Department of Agricultural and Rural Development (GDARD). Therefore, the C-Plan 3.3 was consulted in order to determine site-specific issues and areas considered sensitive.

The following features are indicated for the study area:

- The proposed powerline is located within an Ecological Support Area (ESA) as well as the Critical Biodiversity Area (CBA) as indicated in Figure 5;

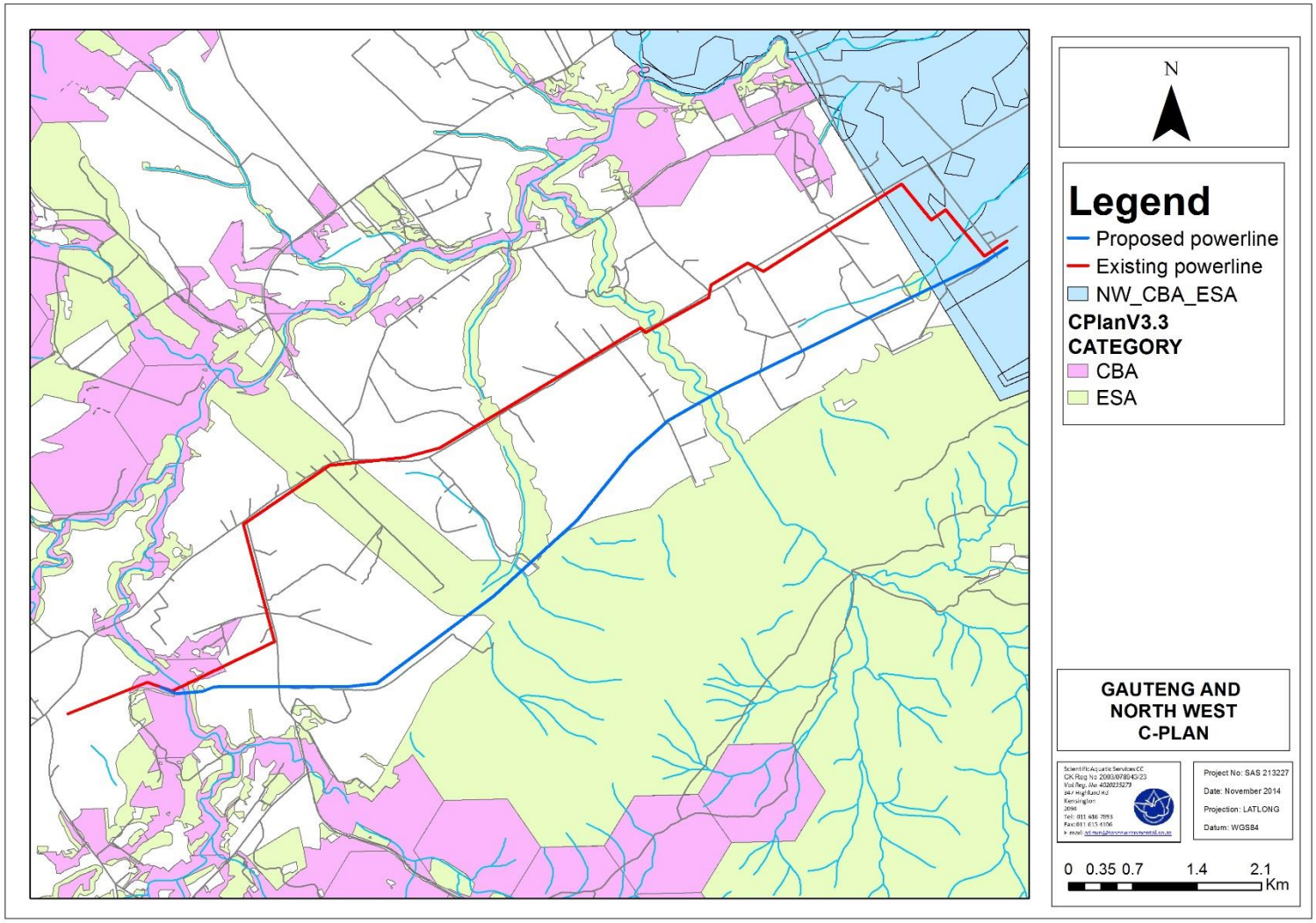

Figure 5: Ecological Support Areas and Critical Biodiversity Areas associated with the proposed powerline route, according to the North West and the Gauteng C-Plan.

4.3 National Freshwater Ecosystem Priority Areas (NFEPA) (2011)

The NFEPA database was consulted with regards to areas in close proximity to or traversed by the proposed powerline route that may be of ecological importance. Aspects applicable to the proposed powerline route are discussed below:

- The proposed powerline route falls within the Crocodile (West) and Marico Water Management Area (WMA). Each Water Management Area is divided into several SubWater Management Areas (subWMA) and the subWMA indicated is the Upper Crocodile;
- According to the NFEPA database, both natural and artificial wetlands are present within close proximity to the proposed powerline route, and some are of these wetlands are intersected by the powerline development;
- The proposed powerline route traverses two rivers (Figure 6) namely:
    - Magalies River, classified as a PES Class C (moderately modified); and
    - Klein River, classified as a PES Class C (moderately modified).
    - None of the rivers were recognised as flagship rivers;
    - The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors;
    - The subWMA is not considered important in terms of translocation and relocation zones for fish; and
    - The subWMA is not listed as a fish Freshwater Ecosystem Priority Area (FEPA).

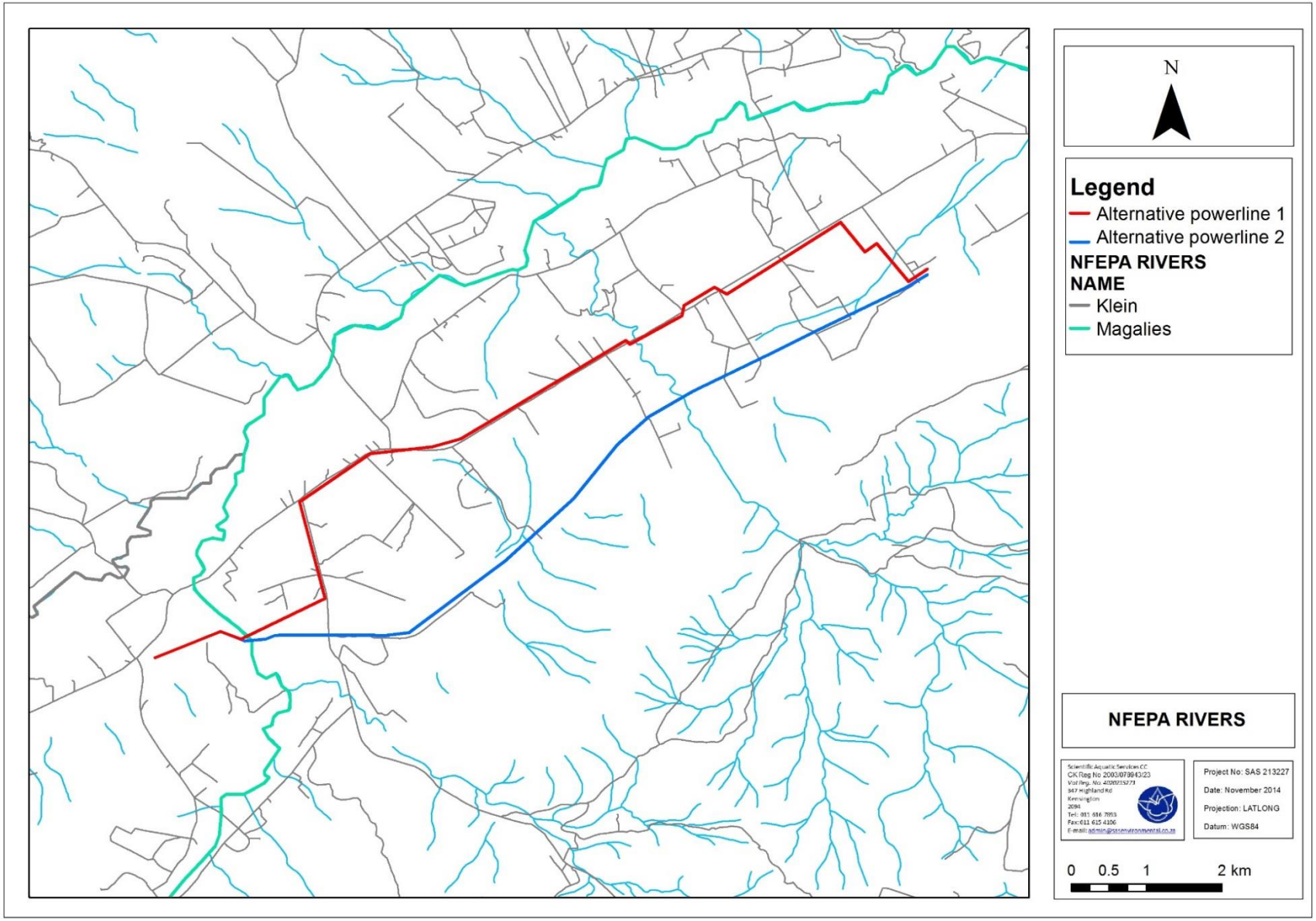

Figure 6: Rivers indicated by the NFEPA database associated with the proposed powerline route.

4.4 National Protected Area Expansion Strategy (NPAES, 2010)

The goal of National Protected Area Expansion Strategy (NPAES) is to achieve cost effective protected area expansion for ecological sustainability and adaptation to climate change. The NPAES sets targets for protected area expansion, provides maps of the most important areas for protected area expansion, and makes recommendations on mechanisms for protected area expansion. It deals with land-based and marine protected areas across all of South Africa's territory (SANBI BGIS).

According to the NPAES database the alternative powerline 2 is located 100m north of the Cradle of Humankind World Heritage Site as presented in Figure 7 below.

4.5 Biome and Bioregion

Biomes are broad ecological units that represent major life zones extending over large natural areas (Rutherford, 1997). The proposed powerline route falls within the Savanna biome. Biomes are further divided into bioregions, which are spatial terrestrial units possessing similar biotic and physical features, and processes at a regional scale. The proposed powerline route is situated within the Central Bushveld Bioregion (Mucina & Rutherford, 2006).

4.6 Vegetation type and Landscape Characteristics

While biomes and bioregions are valuable as they describe broad ecological patterns, they provide limited information on the actual species that are expected to be found in an area. Knowing which vegetation type an area belongs to provides an indication of the floral composition that would be found if the assessment site was in a pristine condition, which can then be compared to the observed floral list and so give an accurate and timely description of the ecological integrity of the assessment site. When the proposed development is superimposed on the vegetation types of the surrounding area it is clear that the proposed development falls within the Central Sandy Bushveld and Zeerust Thornveld vegetation type (Mucina & Rutherford, 2006).

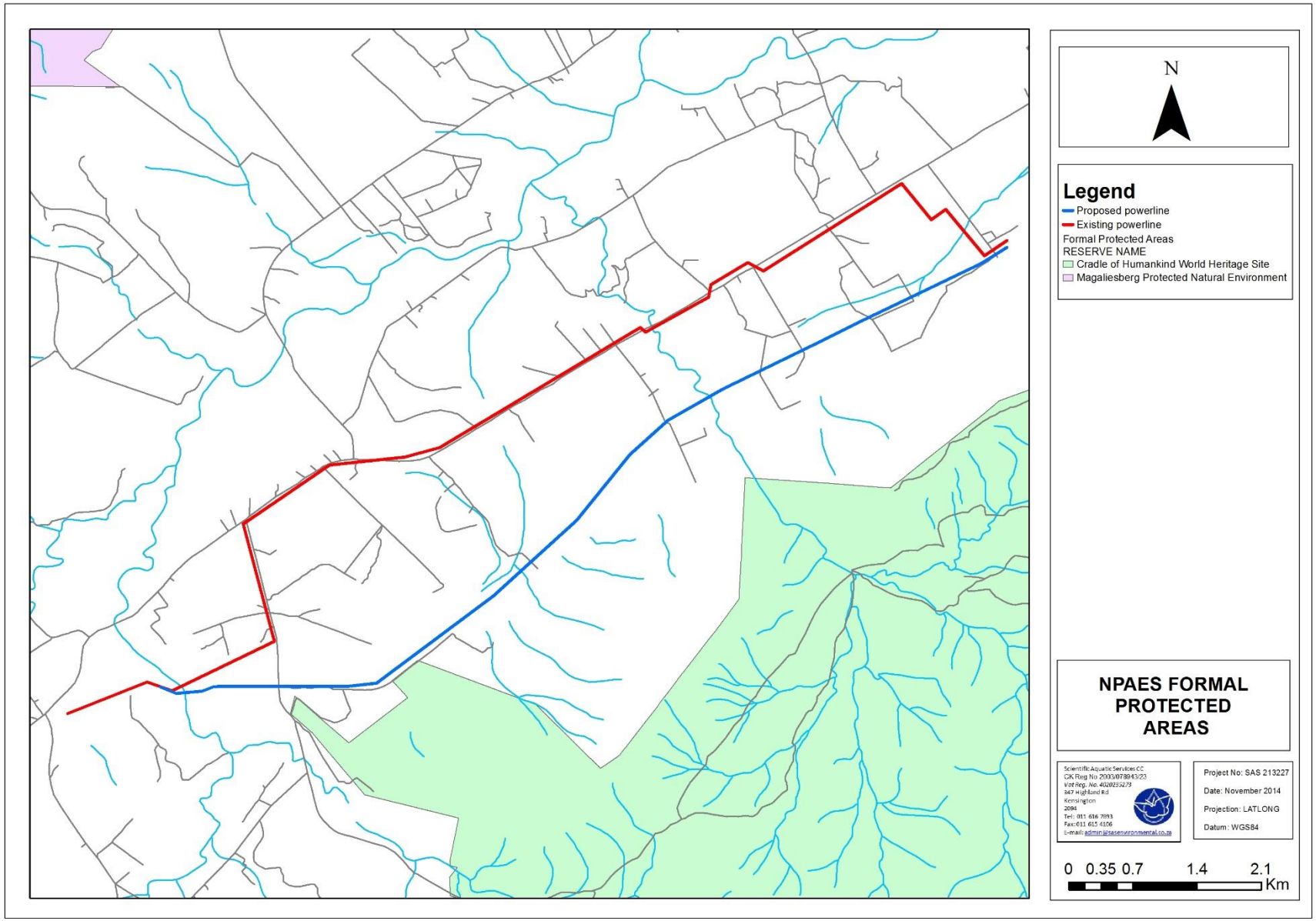

Figure 7: The NPAES database indicating the formally protected area in the vicinity of the proposed powerline route.

5 RESULTS: WETLAND ASSESSMENT

5.1 Wetland and Riparian System Characterisation

The wetland and river features identified during the site visit can be divided into four Hydrogeomorphic Units (HGM units) namely rivers, artificial dams considered as depressions for the purposes of this study, unchannelled valley bottom wetlands and artificial channels representative of channelled valley bottom wetlands.

The approximate location of the features is shown in Figures 8-10 below.

Table 13: Characterisation of the wetland and river features intersected by the proposed powerline route, according to the Classification System (Ollis *et al*., 2013).

Feature	Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit HGM Type
River 1	**Inland:** An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	**Ecoregion:** The powerline development falls within the Western Bankenveld Ecoregion. **NFEPA WetVeg Group:** Central Bushveld Group 5 (Vulnerable)	**Valley floor:** The typically gently sloping, lowest surface of a valley	**River:** A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water
River 2	**Inland:** An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	**Ecoregion:** The powerline development falls within the Western Bankenveld Ecoregion. **NFEPA WetVeg Group:** Central Bushveld Group 5 (Vulnerable) and Central Bushveld Group 1(Critically Endangered)	**Valley floor:** The typically gently sloping, lowest surface of a valley	**River:** A linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water
Unchannelled valley bottom	**Inland:** An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	**Ecoregion:** The powerline development falls within the Western Bankenveld Ecoregion. **NFEPA WetVeg Group:** Central Bushveld Group 5 (Vulnerable) and Central Bushveld Group 1(Critically Endangered)	**Valley floor:** The typically gently sloping, lowest surface of a valley	**Unchannelled valley bottom:** A valley bottom wetland without a river channel running through it.

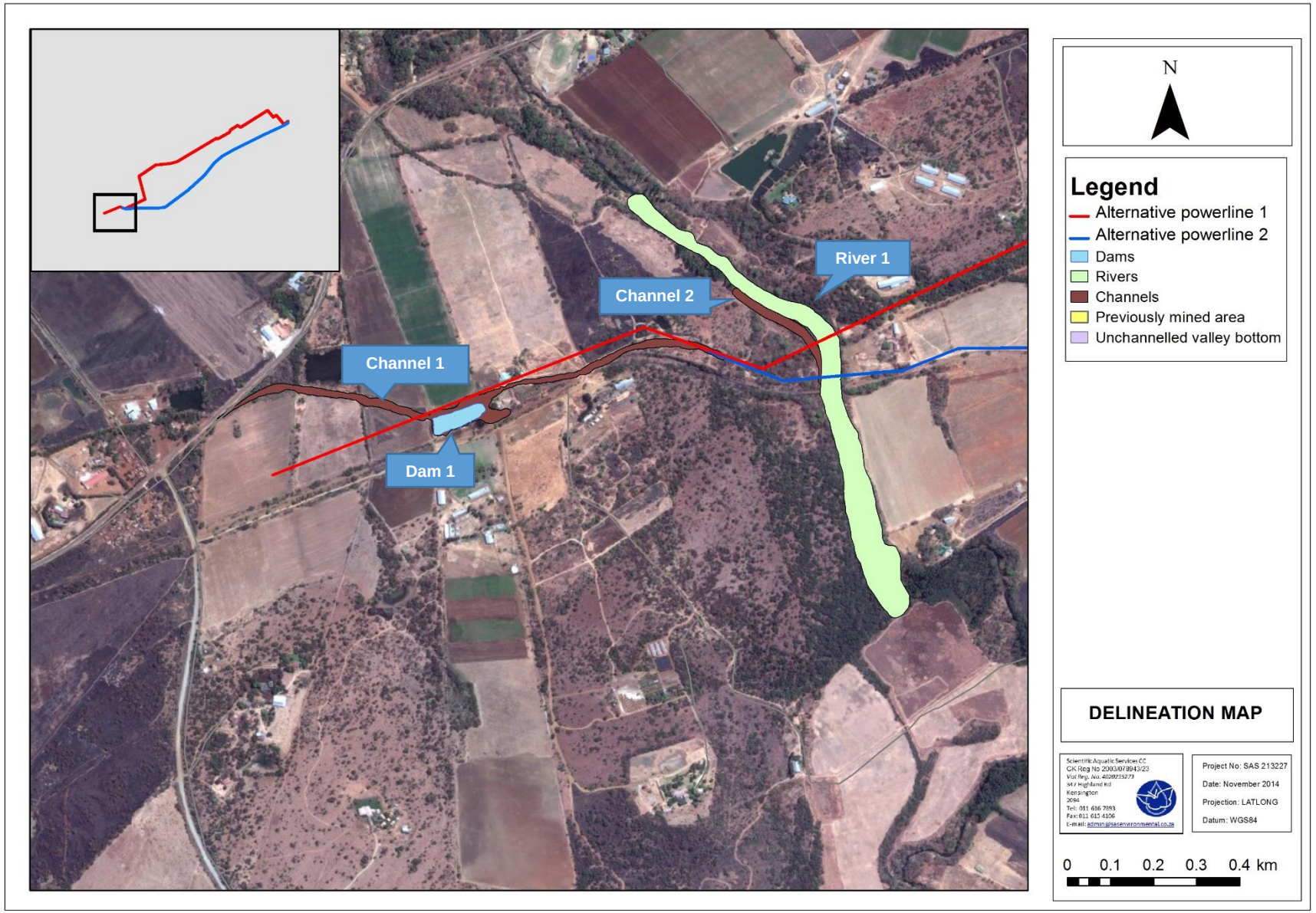

Figure 8: Location of wetlands and river features identified in close proximity of the proposed powerline route

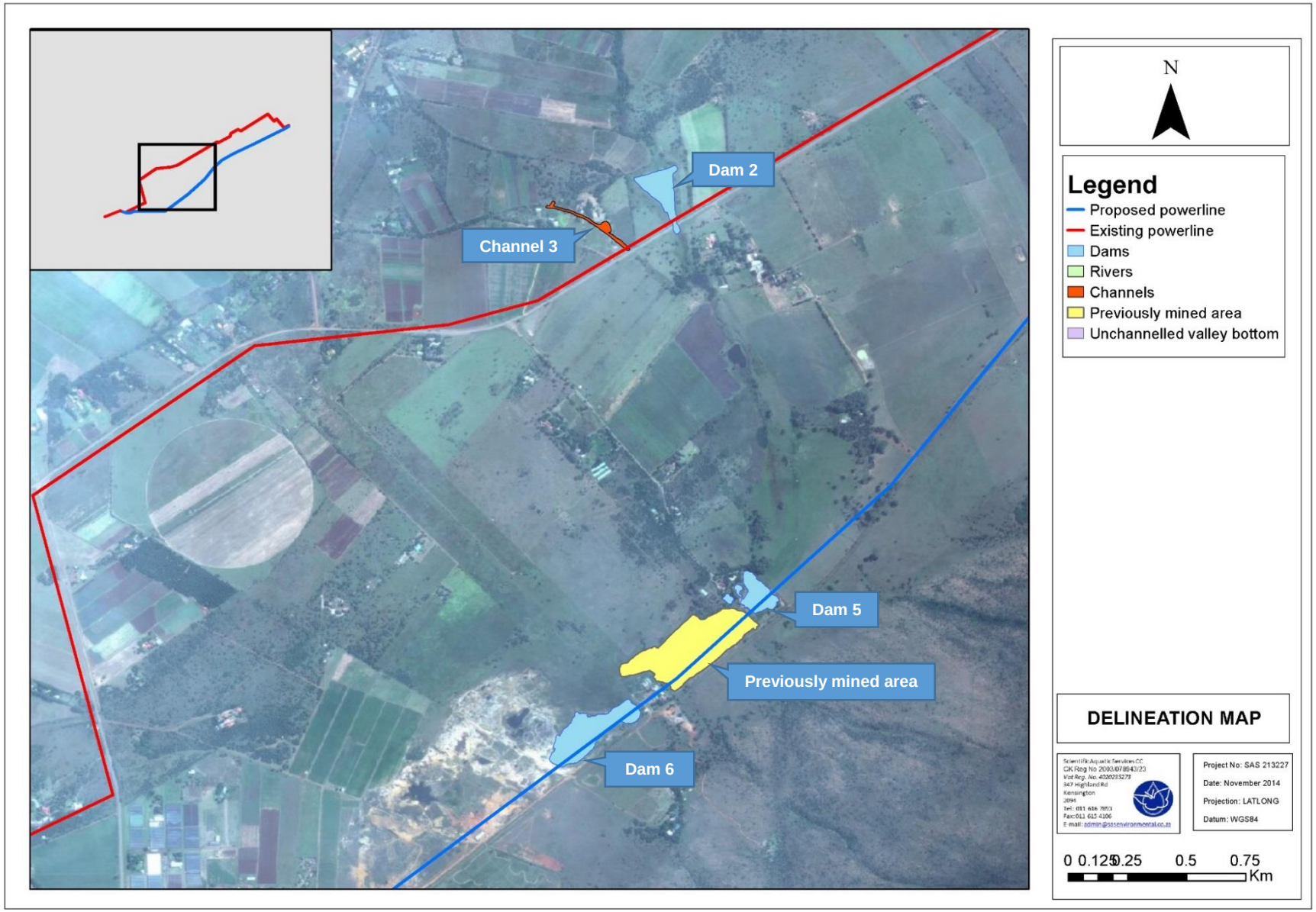

Figure 9: Location of wetlands and river features identified in close proximity of the proposed powerline route.

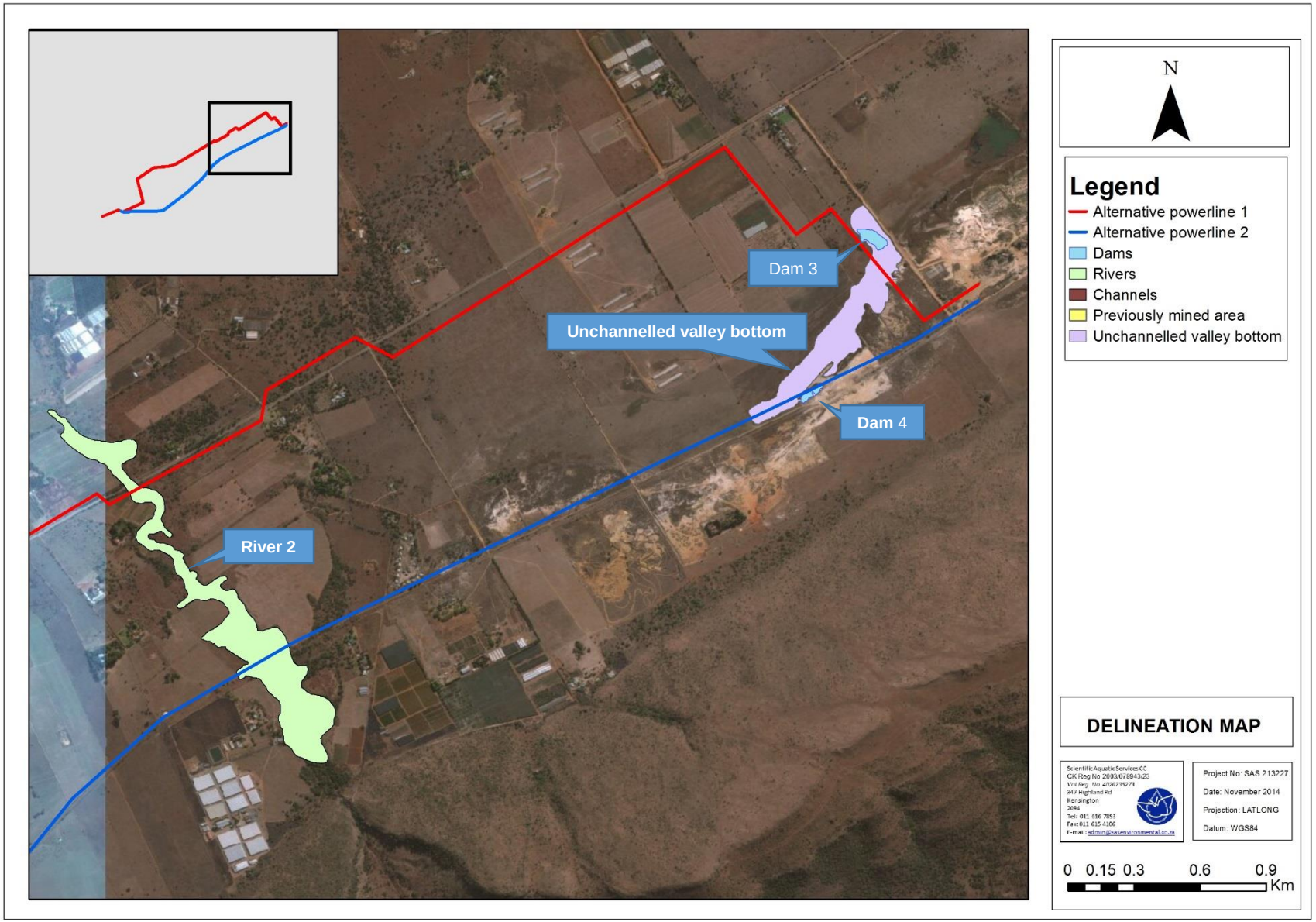

Figure 10: Location of wetlands and river features identified in close proximity of the proposed powerline route.

NATURAL FEATURES

For the purposes of this study only the naturally occurring features were assessed. These features include one unchannelled valley bottom wetland, River 1 and River 2.

Unchannelled valley bottom wetland

The unchannelled valley bottom wetland was situated on the eastern portion of the proposed powerline route and had two impoundments, one of which was located upstream whereas the other was located downstream. *Imperata cylindrica* as illustrated in Figure 11 below.

Figure 11: *Imperata cylindrica* observed within the unchannelled valley bottom wetland.

River 1 and River 2

Both rivers had low vegetation cover, however there was limited erosion observed mainly as a result of livestock grazing and trampling within certain areas.

River 1

River 2

Figure 12: Representative photographs of the rivers identified.

ARTIFICIAL FEATURES

Dams

Most of the dams observed during site visit were created due to excavations and soil dumping as a result of historical mining activities. Therefore these features did not form part of the assessment since they are artificial. There was a pump observed where dam 1 was located, therefore it was definitely being used for irrigation purposes. Dam 2 might have been anthropogenically formed for irrigation purposes, however from what was observed on site, water was being pumped into the dam instead of being abstracted. Where Dam 5 is located seems to have been a channelled valley bottom wetland previously and was transformed into a leisure park. The figures below illustrates all artificial dams observed during site visit.

Dam 1

Dam 2

Dam 3

Dam 4

Dam 5

Figure 13: Representative photographs of the dams identified in field.

Previously mined area

There was a previously mined area observed on site. The area was mainly dominated by Eucalyptus tree spp as well as wetland species such as *Canna indica, Zantedeschia aethiopia, Imperata cylindrica* and *Typha capensis*. The figure below is the representation of the area and vegetation observed.

Figure 14: Representative photographs of the previously mined are.

Artificial channels

Three artificial channels were observed and may have been formed to intercept water for irrigation purposes. None of the channels displayed wetland characteristics as defined by DWA 2005, therefore they were not considered as natural wetlands. The figures below represents the channels observed.

Channel 1

Channel 2

Channel 3

Figure 15: Representative photographs of the channels identified in field

5.2 Wetland Function Assessment

The ecosystem function and service provision assessment of each wetland and river feature were assessed utilising the WET-Ecoservices (Kotze *et al.* 2009) method as previously described. The results of the assessment are tabulated below and presented in the radar plot in Figure 16.

Table 14: Functions and service provision for the HGM units identified.

Ecosystem services	River 1	River 2	Unchannelled valley bottom
Flood attenuation	1	1,6	1,4
Streamflow regulation	1,4	1,2	1,4
Sediment trapping	1,8	1,4	1,6
Phosphate assimilation	1,4	1	2,4
Nitrate assimilation	1,1	1	2,1
Toxicant assimilation	1,6	1,1	2,6
Erosion control	1,7	2	2,7
Carbon Storage	2	1,7	1,3
Biodiversity maintenance	1,3	1,1	1
Water Supply	0,8	0,5	0,8
Harvestable resources	0	0	0,2
Cultural value	0	0	0
Cultivated foods	0	0	0
Tourism and recreation	0	0	0
Education and research	0	0	0
SUM	**14,1**	**12,6**	**17,5**
Average score	**0,9**	**0,8**	**1,2**

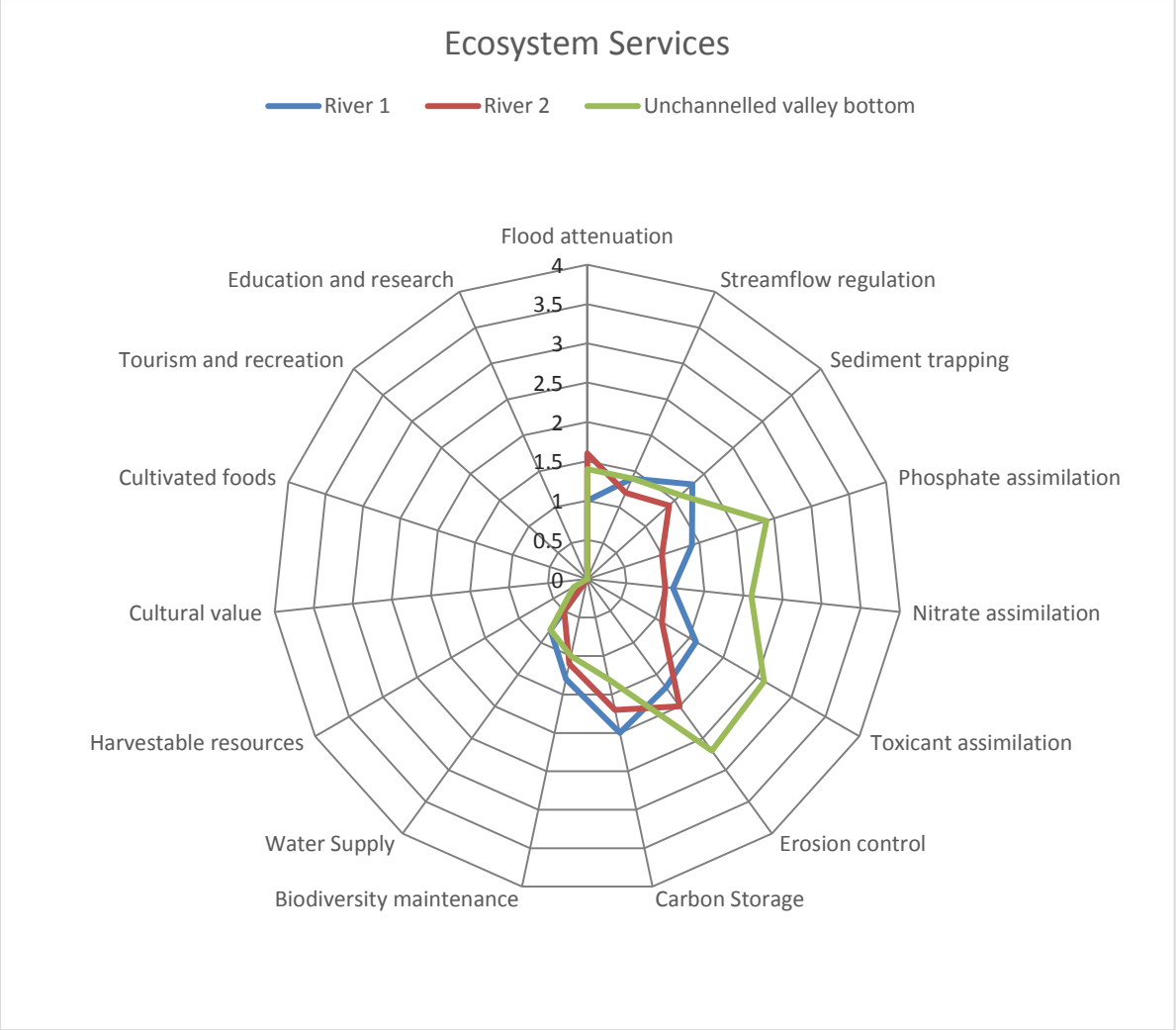

Figure 16: Radar plot of services provided by the of the HGM units identified in field

The features had no importance in terms of direct services provision (harvestable resources, cultural value, cultivated foods, tourism and recreation as well as education and research), this is due to the location and inaccessibility of the features.

River 1

The feature obtained an average score of 0.9 which implies that the feature is able to provide ecological services and functioning at a moderately low level.

The riparian vegetation was low at the time of the assessment. This affected the ability of the feature to trap sediments and slow down the flow of water in the riparian zone. Although the vegetation and surface roughness was low, the feature was not significantly eroded, and this can

be due to the low runoff intensity of the soil. Sediment deposited within the feature was from the horse stable adjacent the feature as well as a few agricultural activities downstream.

The fence across the river as well as a bridge that collapsed inside the river channel caused an obstruction to water flow, and resulted in an intermediate score for biodiversity maintenance. The feature has moderately low importance for flood attenuation.

River 2

The feature obtained an average score of 0.8 which implies that the feature is able to provide ecological services and functioning at a moderately low level.

The upper portion of the feature was dry as compared to the lower portion which had a permanent zone. In addition there was evidence of livestock trampling observed within the feature, which has led to the reduction of vegetation cover. Due to land use activities such as mining and agriculture, water quality is expected to be low. The feature obtained a moderately score for biodiversity maintenance, and this is mainly due to the low vegetation cover within the feature as well as obstructive infrastructure noted such as roads, fences and powerlines.

Although the feature is intermediately channelled upstream, water is still able to overtop the banks. However, the downstream portion was extremely incised and wide making it impossible for water to overtop the banks, hence there was no evidence of wetland conditions.

For phosphate assimilation, nitrate assimilation, and toxicant assimilation, the feature obtained a moderately low score, due to the low vegetation cover.

Unchannelled Valley Bottom

The feature obtained an average score of 1.2 which implies that the feature is able to provide ecological services and functioning at a moderately low level. The feature has high vegetation cover which plays an important role in trapping sediments and toxicants, hence the moderately high score for water quality enhancement services. Agricultural activities, historical mining activities as well as current mining activity surrounding the feature, contributes to sediment and toxicant deposition, however due to the presence of dams on the upper and the lower portions of the feature, not much sediment was observed within the wetland.

Regardless of the high vegetation cover and overall good ecological condition of the wetland, the feature obtained a moderately low biodiversity maintenance score, mainly as a result of the low indigenous vegetation cover extent around the wetland zone as well as the modification of the sediment regime, hydrological regime and water quality regime.

The feature has intermediate importance in terms of sediment trapping, stream flow regulation and flood attenuation, this can be attributed to the diffuse nature of the feature as well as vegetation cover.

5.3 WET-Health Assessment

Due to the limited time available on site to assess the wetland features, a Level 1 WET-Health assessment was applied to the unchannelled valley bottom wetland to assess its integrity. Three modules were assessed, namely hydrology, geomorphology and vegetation. The results of this assessment are summarised in the table below.

Table 15: Summary of results of the WET-Health Assessment.

Feature	Hydrology		Geomorphology		Vegetation		Overall PES Category
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	
Unchannelled Valley Bottom	D	↓	B	↓	C	↓	C

Unchannelled Valley Bottom

The feature obtained a score that falls within category C (moderately modified) which implies that moderate change in ecosystem processes and loss of natural habitat has taken place but the natural habitat remains predominantly intact. The hydrology of the feature has been largely modified by the creation of the two dams both upstream and downstream of the feature, as well as the presence of the road adjacent the feature which increases water input. All these activities will alter the natural hydrological regime as well as vegetation structure overtime In addition, agricultural activities and mining activities neighbouring the feature contributes to sediment deposition which further modifies the geomorphology. The vegetation of this feature was modified by vegetation clearing during the creation of the dams, however indigenous vegetation is still persistent and abundant in a large portion of the wetland.

5.4 Index of habitat integrity (IHI)

The protocol "Index of Habitat Integrity (IHI) for South African floodplain and channelled valley bottom wetland types" (Department of Water Affairs and Forestry Resource Quality Services, 2007) was used to assess the rivers observed on site.

Table 16: The overall PES score for the rivers.

Wetland	Hydrology	Geomorphology	Water Quality	Vegetation	Overall Score	PES Category
River 1	C	C	C	C	1.5	C
River 2	C/D	C	D	C	1.6	C

River 1

The river obtained an overall score that indicates that the feature falls within the PES Category C (moderately modified), this implies that there has been loss and change of natural habitat and biota, but the basic ecosystem functions are still predominantly unchanged.

The geomorphology of the feature has been moderately modified by the creation of a drain that is located on the west, parallel to the feature. In addition there was a bare area with a horse stable adjacent the feature which contributed to sediment deposition within the feature.

The hydrology of the feature has been modified by the presence of a concrete bridge that collapsed. The obstruction altered the normal velocities and flow patterns within the feature. Although the vegetation cover within this feature was low, the expected water quality was moderately modified due to sediment deposition into the river.

River 2

The river obtained an overall score that indicates that the feature falls within the PES Category C which is moderately modified. There was channel widening observed upstream of the feature, and this was due to minor bank erosion observed. This activity led to the moderate modification of the geomorphology of the feature. In addition, livestock trampling and grazing resulted in the alteration of the geomorphology as well as low vegetation cover. Due to the presence of a tar road and a bridge, there was increased water input downstream of this feature, and with sediment from the cultivated land water quality could be low.

5.5 Riparian Vegetation Response Assessment Index (VEGRAI)

Table 17: The overall VEGRAI score rivers.

Feature	VEGRAI %	VEGRAI EC	Marginal Weighted Rating	Non-Marginal Weighted Rating
River1	62.9	C	26.9	35.9
River 2	71.3	C	23.9	47.4

The scores attained for the VEGRAI assessment indicates that both features fall within Ecological Category C. The assessments indicates that the riparian vegetation has been moderately modified, and loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged. The non-woody component has undergone a higher degree of transformation in both the marginal and non-marginal zones. The main cause of vegetation modification is the presence of agricultural fields as well as invasion of alien species such as *Melia azedarach* and *Asparagus laricinus*

5.6 Ecological Importance and Sensitivity (EIS)

The EIS was applied to all features in order to ascertain the levels of ecological importance and sensitivity associated with each crossing, and to inform in part the REC. The results of this assessment are presented below.

Table 18: The EIS score for the features that will be intercepted by the proposed powerline route.

Determinant	River 1		River 2		Channelled Valley Bottom	
	Score	Confidence	Score	Confidence	Score	Confidence
PRIMARY DETERMINANTS						
1. Rare & Endangered Species	0	3	0	3	0	3
2. Populations of Unique Species	2	3	2	3	3	3
3. Species/taxon Richness	1	3	1	3	2	3
4. Diversity of Habitat Types or Features	1	3	1	3	2	3
5. Migration route/breeding and feeding site for wetland species	0	3	1	3	1	3
6. PES as determined by WET Health /IHI assessment	2	4	2	4	2	4
7. Importance in terms of function and service provision	2	4	2	4	2	4
MODIFYING DETERMINANTS						
8. Protected Status according to NFEPA Wetveg	2	4	2	4	2	4
9. Ecological Integrity	2	3	2	3	3	3
TOTAL	12		13		17	
MEAN	1.3		1.4		1.9	
OVERALL EIS	**C**		**C**		**C**	

As can be seen from these results, all features obtained scores that falls within EIS category C (moderate), which implies that the features are considered to be ecologically important and sensitive on a provincial or local scale. However, the biodiversity of these features is not usually sensitive to flow and habitat modifications.

5.7 Recommended Ecological Category (REC)

The REC for the wetland and river systems that would be intercepted by the proposed powerline route was determined, taking into consideration the results of the eco services and function, WET-Health and/or IHI assessments as well as the EIS assessments. All features assessed undergone moderate levels of transformation, overall they are considered to provide ecoservices at a moderately low level. Therefore, a REC Category C was assigned to all the features assessed in order to ensure the maintenance of present levels of ecological services and functioning of the wetland and rivers are retained. None of the wetland and rivers should be permitted to deteriorate any further.

5.8 Wetland and Riparian Area Delineation and Sensitivity Mapping

During the assessment, the following indicators were used to ascertain the boundaries of the temporary zones of the wetland and river features:

- Terrain units were used to determine in which parts of the landscape the wetland features are most likely to occur. The features occur within a valley floor landscape unit;
- Vegetation was used to identify the wetland boundary through the identification of the distribution of both facultative and obligate wetland vegetation associated with soils that are frequently saturated;
- Saturated soils were not present in all wetland features, however, it was noted and taken into consideration in areas where it was observed;

Any activities proposed within the wetland or river boundaries, including rehabilitation, must be authorised by the DWA in terms of Section 21 (c) & (i) of the National Water Act (Act 36 of 1998). The mitigation measures as provided, if implemented in conjunction with the mitigatory measures outlined in Section 9.1, are considered sufficient to maintain the PES and to achieve the REC determined following the assessment.

The wetland and river delineation and associated 32m buffer zone are conceptually presented in Figures 17-19 below.

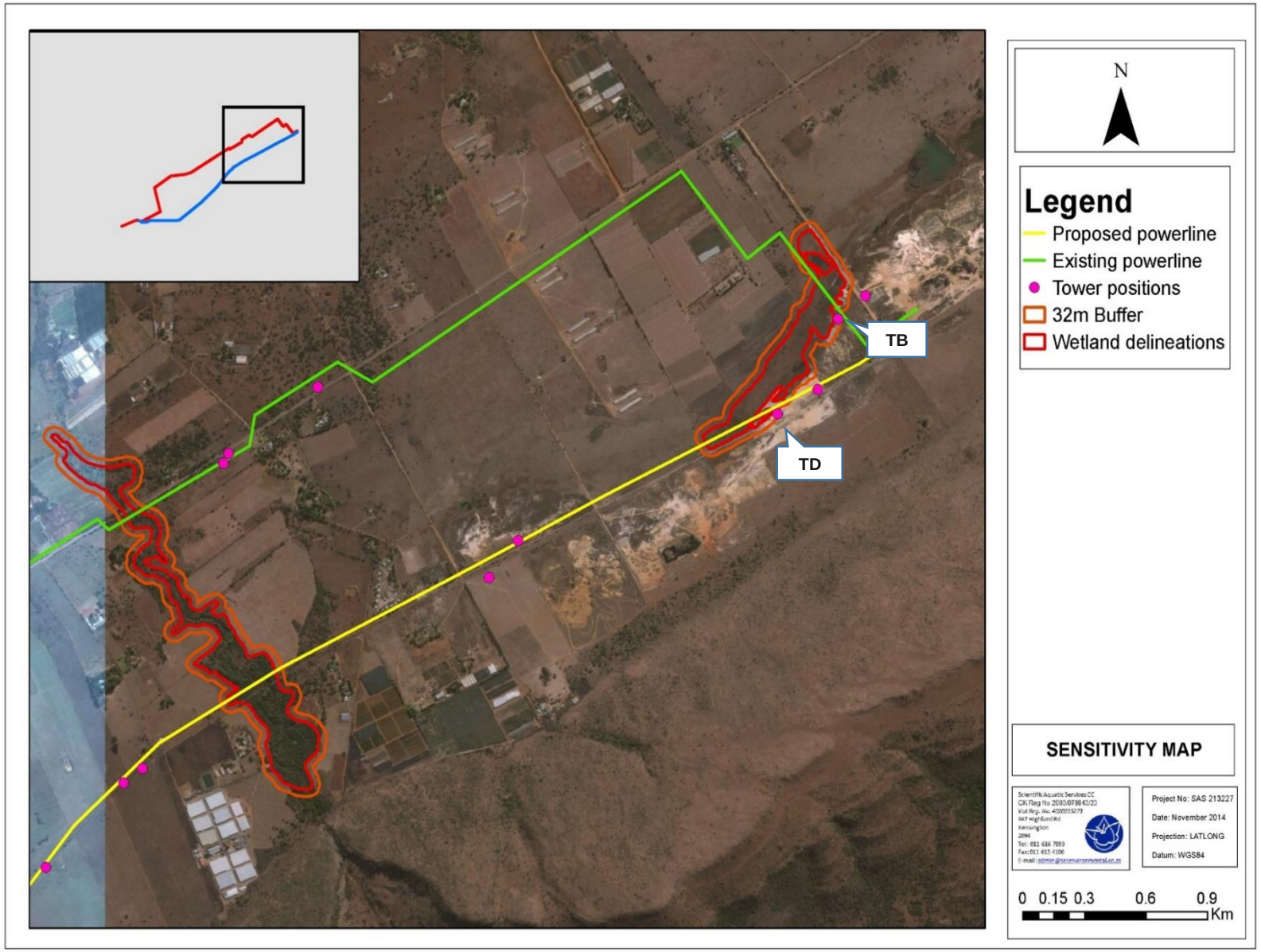

Figure 17: Wetland delineations with associated buffer zones.

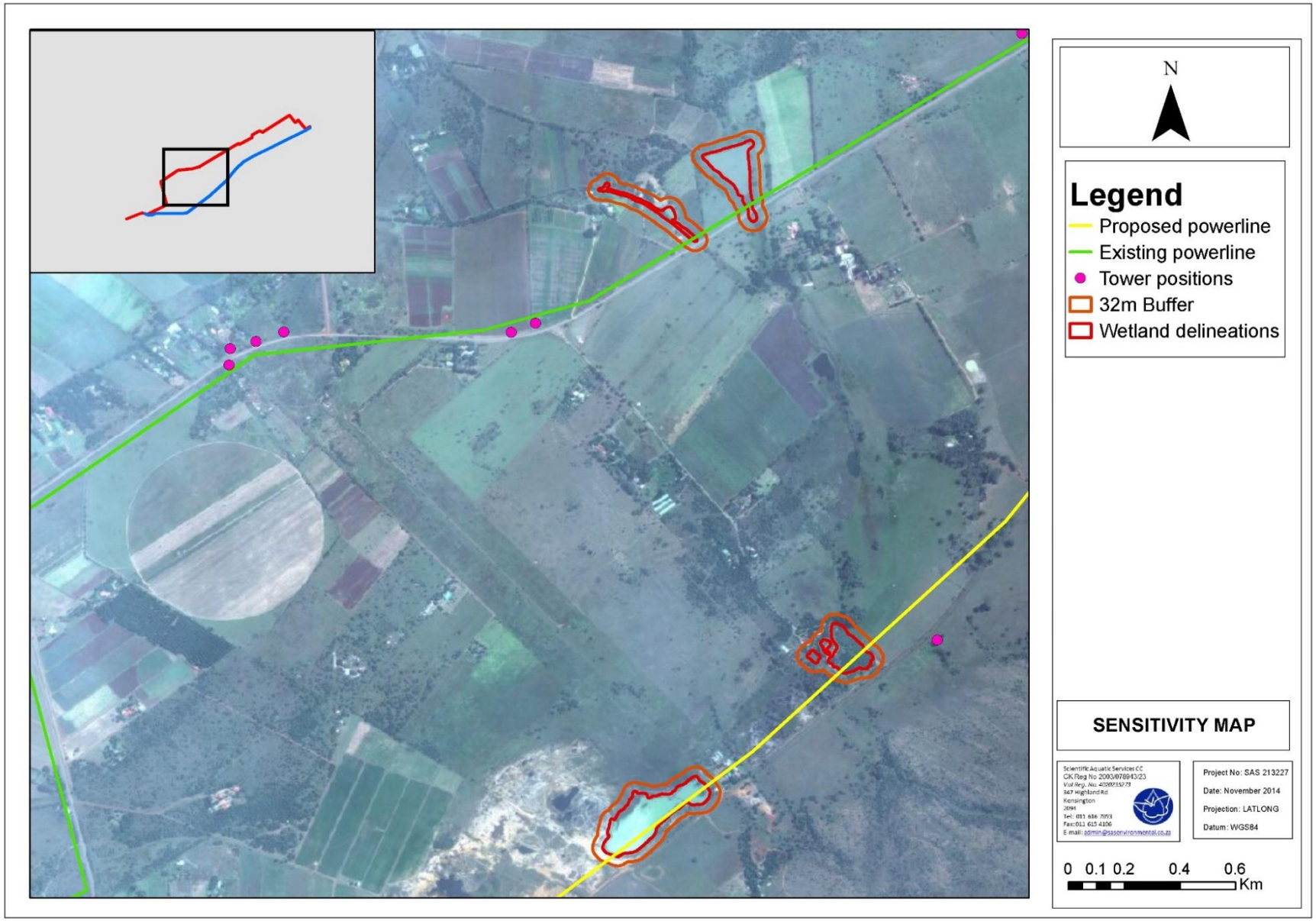

Figure 18: Wetland delineations with associated buffer zones.

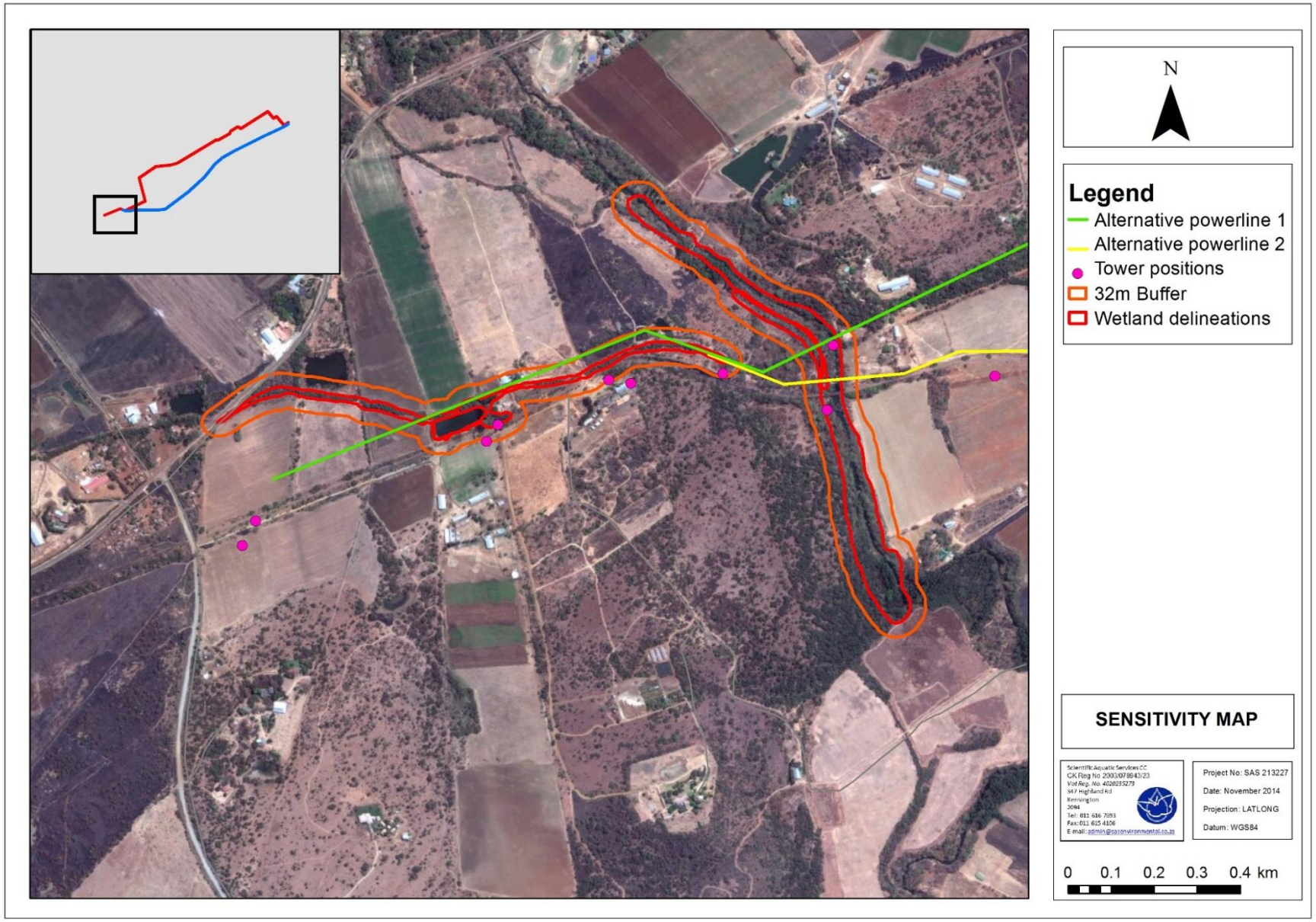

Figure 19: Wetland delineations with associated buffer zones.

6 TOWER SPECIFIC MITIGATIONS

The tables below presents the impacts that the construction phase might have on the wetland features, as well as mitigation measures that should be implemented in order to maintain the PES of the wetland features within which the towers are located or within the associated buffer zones.

Table 19: Tower specific impacts and mitigations for the proposed powerline route

Wetland type	Tower number	System Modifiers	Construction impacts on resources	Mitigation Measures
Channel/Dam	**T2**	• Alien invasion. • Impoundment. • Agricultural activities. • Road traversing the wetland. • Increased runoff.	• Directly affected.	• Move tower either 70m east or 45m south to stay outside the wetland and buffer zone. • Keep vegetation clearing and excavations to a minimum extend. • Control and remove alien species. • Control runoff and erosion to minimize sedimentation. • Access must be limited to a single existing road instead of creating a new road.
Channel	**T3**	• Road traversing the wetland. • Infrastructure. • Soil compaction due to road formation. • Increased runoff.	• Sedimentation. • Erosion. • Runoff. • Alien invasion.	• Move tower 15m south to stay outside the buffer zone • Control runoff and erosion to minimize sedimentation. • Control and remove alien species. • Keep vegetation clearing and excavations to a minimum extent.
Channel	**T4**	• Roads traversing the wetland. • Infrastructure. • Soil compaction due to road formation. • Increased runoff.	• Sedimentation. • Erosion. • Runoff. • Alien invasion.	• Move tower 30m south so that it stays across the road and outside the buffer zone. • Stabilize channel edges. • Control and minimize erosion. • Control alien invasion. • Keep vegetation clearing and excavations to a minimum extent.
River	**T5**	• Alien invasion • Agricultural activities. • Road traversing the wetland.	• Directly affected.	• Move tower 60m east so that it stays outside the wetland and buffer zone. • Control runoff and erosion. • Remove and control alien plants. • Stabilize river banks. • Keep vegetation clearing and excavations to a minimum extent.

Table 20: Tower specific impacts and mitigations for the proposed powerline route

Unchannelled valley bottom	**TB**	• Current mining activities. • Sedimentation. • Agricultural activities. • Livestock trampling and grazing.	• Sedimentation as a result of runoff from the construction area. • Erosion.	• Move 20m east to stay outside the buffer zone. • Control runoff and erosion to minimize sedimentation.
Unhannelled valley bottom/pan	**TD**	• Historical mining activities. • Sedimentation. • Agricultural activities.	• Sedimentation as a result of runoff from the construction area. • Erosion.	• Move 20m east to stay outside the buffer zone. • Control runoff and erosion to minimize sedimentation.
River	**TN**	• Alien invasion. • Agricultural activities.	• Directly affected.	• Move tower 60m west so that it stays outside the wetland and buffer zone. • Control runoff and erosion. • Remove and control alien plants. • Stabilize river banks. • Keep vegetation clearing and excavations to a minimum extent.
Channel	**TO**	• Road traversing the wetland. • Infrastructure. • Soil compaction due to road formation. • Increased runoff.	• Sedimentation. • Erosion. • Runoff. • Alien invasion.	• Control runoff and erosion to minimize sedimentation. • Control and remove alien species. • Keep vegetation clearing and excavations to a minimum extent.
Channel/Dam	**TP**	• Alien invasion. • Impoundment. • Agricultural activities. • Road traversing the wetland. • Increased runoff.	• Sedimentation. • Erosion. • Runoff. • Alien invasion.	• Keep vegetation clearing and excavations to a minimum extend. • Control and remove alien species. • Control runoff and erosion to minimize sedimentation. • Access must be limited to a single existing road instead of creating a new road.

7 IMPACT ASSESSMENT

An impact assessment was undertaken on all aspects of wetland and aquatic ecology deemed likely to be affected by the development. The sections below present the results of the findings per identified risk/impact for various wetland types including:

- Rivers;
- Unchannelled valley bottom wetland and
- Dams and channels/drains.

The potential impacts on the wetlands and rivers were assessed taking into consideration the fact that the layout of the proposed powerline route will result in placing towers within some of the features identified in field. Therefore, realignment is recommended where possible, in order to avoid constructing towers within wetland areas and rivers, thus minimising the potential impacts on these areas.

7.1 Impact Analyses

The impact tables below serve to summarise the significance of perceived impacts on the wetland and river ecology of the features that would be traversed by the proposed power line. The tables present the impact assessment according to the method described in Section 3 of this report, and also indicate the mitigation measures required to minimise the impacts. In addition, an assessment of the significance of the perceived impacts is presented, taking into consideration the available mitigating measures assuming that they are fully implemented.

7.1.1 General management and good housekeeping practices

The following essential mitigation measures are considered to be standard best practice measures applicable to a development of this nature, and must be implemented during all phases of the development activities, in conjunction with those stipulated in the individual tables in the following sections, which define the mitigatory measures specific to the minimisation of impacts on wetland and river resources that would be traversed by the development.

Development footprint

- It is recommended that the sensitivity maps be considered during all phases of the development and with special mention of the planning of infrastructure to aid in the conservation of resources traversed by the powerline route where possible;

- All development footprint areas should remain as small as possible and should not encroach onto surrounding areas beyond the powerline route footprint. It must be ensured that the wetland and riparian features beyond the footprint of the powerline are off-limits to construction vehicles and personnel;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Planning of temporary roads and access routes should avoid natural areas and be restricted to existing tarred and gravel roads where possible;
- Appropriate sanitary facilities must be provided for the life of the construction and all waste removed to an appropriate waste facility;
- All hazardous chemicals should be stored in designated area which are not located near wetland features;
- No fires should be permitted in or near the construction area; and
- Ensure that an adequate number of litter bins are provided and ensure the proper disposal of waste and spills.

Vehicle access

- It must be ensured that all hazardous storage containers and storage areas comply with the relevant South African Bureau of Standards (SABS) standards to prevent leakage. All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Wetland habitat and riparian habitat

- Ensure that as far as possible infrastructure is placed outside of wetland areas and riparian habitat as well as their respective buffer zones;

Soils

- Sheet runoff from access roads should be slowed down by the strategic placement of berms;
- As far as possible, all construction activities should occur in the low flow season, during the drier winter months; and
- Monitor all areas within the development footprint for erosion and incision, during site clearing in the operational phase and throughout the construction phase.

Rehabilitation

- All alien vegetation in the construction footprint areas as well as immediate vicinity should be removed upon completion of construction. Alien vegetation control should take place for a minimum period of two growing seasons after construction is completed.

7.2 Rivers

7.2.1 Impact 1: impacts on river recharge, inundation and instream flow

Impacts on wetland recharge and instream flow can be significant and has the potential to affect the biodiversity and functioning of the riverine systems. Specific issues can be streamflow diversion leading to inundation of upstream areas and impacts on biota with specific requirements for instream flow.

Aspects and activities register

Pre-Construction	Construction	Operational
Poor planning with regards to the placement of infrastructure within riparian areas that could result in change of the hydrological regime	Site clearing and the removal of vegetation leading to increased runoff	Indiscriminate driving of vehicles within the riparian area
	Earthworks in the vicinity of the riparian areas leading to altered stream flow and recharge patterns	Increased water runoff into the rivers due to unvegetated areas overlooked after construction
	Construction within rivers resulting in streamflow discontinuation which leads to drying of downstream areas	
	Draining rivers/streams leading to inundation of adjacent areas	
	Streamflow diversion resulting in inundation of upstream areas	

7.2.2 Impact 2: impacts due to sedimentation, canalisation and erosion

Impacts due to sedimentation can be significant and have the potential to affect the biodiversity and functioning of riverine systems. Specific issues can be impacts on taxa requiring a rocky substrate clear of sediment and taxa requiring fast clear flowing water free of suspended solids. With disturbance of the soils associated with the project, there is a risk of sedimentation of the river systems being crossed.

Impacts due to canalisation and erosion can be significant and has the potential to affect the hydrological functioning and biodiversity of the riverine systems. Disturbances caused by vegetation clearing and soil disturbance are the key activities which could lead to this impact.

With the crossing of riverine features during construction phase, there is a risk that the excavations could lead to altered drainage patterns and the removal of vegetation and the disturbance of the soil could lead to erosion and incision of the stream banks.

Aspects and activities register

Pre-Construction	Construction	Operational
Poor planning with regards to the placement of infrastructure within wetlands that could result in change of the sediment regime	Site clearing and the removal of vegetation leading to erosion which alters the geomorphology of the riparian areas	Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management
	Excavations and creation of canals along the river banks, thus altering the meandering nature of the river	Contamination of water as a result of waste dumping
	Destabilization of river banks due to vegetation clearing	
	Sediment deposition and stream bed scouring	
	Trampling and indiscriminate driving in the riparian areas leading to soil compaction	

7.2.3 Impact 3: impacts on ecological and sociocultural service provision

There is a possibility for construction activities to affect the socio-cultural service provision in these areas. Specific issues can be loss of instream biota and impacts due to alien vegetation encroachment and other physical alteration such as inundation and erosion and incision. The removal of vegetation may lead to loss of provision of services such as sediment trapping, phosphate assimilation and nitrate assimilation. Alteration of the hydrology such as excavations will impact on benefits such as streamflow regulation.

Aspects and activities register

Pre-Construction	Construction	Operational
Inappropriate design of the powerline leading to loss of function and ability to provide services	Site clearing and further removal of riparian vegetation resulting in loss of flood attenuation capabilities	Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management
	Waste dumping within river, leading to the deterioration of the water quality	
	Inability to support biodiversity as a result of changes to water quality, increased sedimentation and alteration of natural hydrological regimes	
	Alteration of the natural hydrological regime, impacting on streamflow regulation capabilities	
	Loss of phosphate, nitrate and toxicant removal abilities as a result of vegetation clearing and incised river banks	

7.2.4 Impact 4: impacts on instream habitat

Impacts on instream habitat can be significant and have the potential to affect the biodiversity and functioning of the system. Specific risks occur to taxa with highly specific habitat requirements, especially those requiring cobble substrates clear of sediment taxa requiring cover from bankside vegetation.

Sedimentation can lead to loss of habitat within deeper pools which could impact aquatic species which require refuge pools during the dry season. Disturbances caused by vegetation clearing and soil disturbance are the key activities which could lead to this impact. Furthermore, this would lead to reductions of species diversity in these riverine systems.

Aspects and activities register

Pre-Construction	Construction	Operational
Inappropriate planning and design leading to overall loss of instream habitat	Site clearing leading to the modification of the riparian habitat	Ongoing disturbance of soils during maintenance activities
Increased anthropogenic activity within riparian areas	Construction of access roads traversing rivers resulting in the modification of the river channel	Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management
	Loss of vegetation resulting in a loss of breeding and foraging habitat and overall biodiversity	Continuous introduction and proliferation of alien plant species and further transformation of natural habitat
	Dumping waste and construction material instream leading to alien plant species proliferation	

7.2.5 Impact 5: impacts on refugia for aquatic species

Sedimentation can lead to a loss of habitat within deeper pools which could impact aquatic species which require refuge pools during the dry season. Disturbances caused by vegetation clearing and soil disturbance are the key activities which could lead to this impact.

There is a risk that sedimentation of the drainage features may take place, which in turn, could lead to the loss of refuge pools in the rivers.

Aspects and activities register

Pre-Construction	Construction	Operational
Inappropriate planning leading to overall loss of aquatic species	Site clearing leading to the removal of indigenous wetland vegetation	Ongoing disturbance of refugia for aquatic species during general maintenance activities
Inappropriate design of infrastructure leading to changes to instream habitat	Loss of refuge pools due to sedimentation	Contamination of water during maintenance activities
	Limited mobility of aquatic species due to the disturbance of corridors	
	Loss of vegetation resulting in a loss of breeding and foraging habitat for aquatic species	

7.3 Unchannelled valley bottom wetland

7.3.1 Impact 1: impacts on wetland recharge, inundation and streamflow

Activities and aspects register

Impacts on wetland recharge and instream flow can be significant and has the potential to affect the biodiversity and functioning of the system. Specific issues can be encroachment of terrestrial species and impacts on biota with a specific requirement for instream flow. During excavations, runoff from the road reserve may become confined in the trenches and areas of disturbed soils leading to reduced wetland recharge.

During construction site clearing, the removal of vegetation may result in an increase in runoff from disturbed areas and an increase in the erosion and incision of the wetland. In addition, flow patterns might be altered and result in the severity of floods downstream.

Pre-Construction	Construction	Operational
Poor planning with regards to the placement of infrastructure within the riparian and wetland areas that could result in change of the hydrological regime	Site clearing and the removal of vegetation leading to increased runoff	Indiscriminate driving of vehicles within the wetlands leading soil compaction, which results in increased runoff
	Earthworks in the vicinity of the wetland leading to increased runoff and altered runoff patterns	Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management
	Reconstruction within wetland altering stream and base flow patterns and water velocities	Increased water runoff into the rivers due to unvegetated areas overlooked after construction

7.3.2 Impact 2: impacts due to sedimentation, canalization and erosion

Impacts due to canalisation and erosion can be significant and has the potential to affect the hydrological functioning and biodiversity of wetland systems. Construction related activities such as vegetation clearing and excavations may result in canalization of the wetland as well as erosion due to increased runoff. In addition to the removal of vegetation, surface roughness of the wetland area might be reduced resulting in increased sediment deposition within the wetland.

Activities and aspects register

Pre-Construction	Construction	Operational
Poor planning with regards to the placement of infrastructure within wetlands that could result in change of the sediment regime	Site clearing and further removal of vegetation resulting in increased runoff which leads to erosion	Disturbance of soils during maintenance
	Placing towers within wetland area leading to erosion and sedimentation	Indiscriminate driving within the wetland
	Movement of construction vehicles within wetlands resulting in soil compaction	
	Excavation leading to canalization of the wetland area	

7.3.3 Impact 3: impacts on ecological and sociocultural service provision

The removal of topsoil and disturbance of vegetation, will lead to the destruction of habitat and overall loss of biodiversity within the wetland. Impacts may lead to a loss of biodiversity maintenance as well as the provision of services such as chemical assimilation and flood attenuation. In addition the edge effects from the development could lead to the introduction of alien species.

Activities and aspects register

Pre-Construction	Construction	Operational
Inadequate design of the proposed powerline route leading to erosion and sedimentation of the wetland feature	Site clearing and further removal of vegetation impacting on the biodiversity maintenance of the wetland	Disturbance of soils during maintenance
	Contaminating wetland soils and water, further deteriorating the water quality	Increased water runoff into wetland areas due to unvegetated areas overlooked after construction
	Dumping of construction material within the wetland areas	
	Alteration of natural hydrological regime, impacting on flood attenuation and streamflow regulation capabilities	
	Loss of phosphate, nitrate and toxicant removal abilities	

7.3.4 Impact 4: impacts on wetland habitat

Impacts on the wetland habitat may result in complete loss and alteration of the integrity of the wetland habitat. Construction related activities that will be undertaken, such as the removal of the topsoil and disturbance of vegetation, will lead to the destruction of habitat and overall loss of biodiversity within the wetland. Impacts may lead to a loss of migratory routes for more mobile species. If left unmitigated, impacts will lead to significant impact on habitat and ecological structure, however with the implementation of mitigation measures the severity and spatial scale of the impact can be reduced.

Activities and aspects register

Pre-Construction	Construction	Operational
Layout planning and design leading to overall loss of floral habitat during the construction phase	Site clearing and the removal of wetland and riparian habitat	Disturbance of soils as part of rehabilitation activities
Inadequate design of infrastructure leading to changes to wetland and riparian habitat during the construction phase	Compaction of soils due to construction activities	Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment
Increased anthropogenic activity within wetland and riparian areas	Site clearing and the disturbance of soils	On-going erosion and sedimentation of riparian and wetland habitat
	Movement of construction vehicles as well as access road construction within the riparian and wetland zones	
	Dumping waste and construction material within riparian and wetland areas	
	Dumping of material leading to alien plant species proliferation	
	Loss of vegetation resulting in a loss of breeding and foraging habitat and overall biodiversity	

7.4 Dams and Channels

7.4.1 Impact 1: impacts on wetland recharge, inundation and instream flow

Impacts on wetland recharge and instream flow can be significant and has the potential to affect the biodiversity and functioning of the system. Specific issues can be encroachment of terrestrial species and impacts on biota with a specific requirement for instream flow. During excavations, runoff from the road reserve may become confined in the trenches and areas of disturbed soils leading to reduced wetland recharge.

During construction there is a possibility that the bed and bank profiles might be altered, which in turn can lead to inundation of wetland systems. Inundation can affect wetland habitat conditions which in turn can affect wetland biota. Inundation can also affect bankside and wetland vegetation which can die back due to altered soil wetness profiles. With the construction of towers, there is a risk that developments could alter wetland profiles and by so doing lead to inundation of the areas upstream of the development.

Aspects and activities register

Pre-Construction	Construction	Operational
Poor planning with regards to the placement of infrastructure within wetland areas that could result in change of the hydrological regime	Site clearing and the removal of vegetation leading to increased runoff	Indiscriminate driving of vehicles within the wetlands leading to soil compaction, which results in increased runoff
	Earthworks within of near the wetlands leading to altered stream flow and recharge patterns	Increased water runoff into the rivers due to unvegetated areas overlooked after construction
	Stream flow discontinuation leading to drying of downstream areas	
	Streamflow diversion and draining water from the wetlands resulting the alteration of hydrological zones	
	Increased water inputs due to hardened surfaces resulting from compacted soils	

7.4.2 Impact 2: impacts due to sedimentation, canalization and erosion

Impacts due to sedimentation can be significant and have the potential to affect the biodiversity and functioning of the system. Specific issues can have an impact on taxa requiring a rocky substrate clear of sediment and taxa requiring fast clear flowing water free of suspended solids. With disturbance of the soils associated with the project, there is a risk of sedimentation of the wetland systems being crossed which in turn could lead to an alteration of the vegetation characteristics of the system.

Impacts due to canalisation and erosion can be significant and has the potential to affect the hydrological functioning and biodiversity of wetland systems. Disturbances caused by vegetation clearing and soil disturbance are the key activities which could lead to this impact.

There is a risk that excavations could lead to altered drainage patterns and the removal of vegetation and the disturbance of the soil could lead to erosion and incision of the stream banks.

Aspects and activities register

Pre-Construction	Construction	Operational
Poor planning with regards to the placement of infrastructure within wetlands that could result in change of the sediment regime	Site clearing and the removal of vegetation leading to erosion which alters the geomorphology of the wetlands	Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management
	Excavations within wetland areas leading to the draining of water from the wetlands	
	Soil piling within wetland areas, thus altering the depth of the wetland channel and/or levelling in case of pans	
	Reduced surface roughness leading to erosion	
	Soil compaction reducing soil infiltration capabilities	

7.4.3 Impact 3: impacts on ecological and sociocultural service provision

Wetland systems potentially provide several services to local communities. In addition, there is the potential for impacts upstream of areas to affect the socio-cultural conditions in these areas. Wetlands provide resources to people in the local area surrounding them. With the towers there is a risk that the impacts on the system could lead to impacts on the socio-cultural benefits derived from the systems due to alien vegetation encroachment and other physical alteration such as inundation and erosion and incision.

Aspects and activities register

Pre-Construction	Construction	Operational
Inappropriate design of the powerline leading to loss of ecosystem services provision	Site clearing and further removal of vegetation impacting on the biodiversity maintenance of the wetlands	Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management
	Draining water from wetlands for construction purposes, resulting in loss of streamflow regulation services	Increased water runoff into wetland areas due to unvegetated areas overlooked after construction
	Alteration of natural hydrological regime, impacting on flood attenuation and streamflow regulation capabilities	

Pre-Construction	Construction	Operational
	Loss of phosphate, nitrate and toxicant removal abilities due to vegetation clearing	
	Inability to support biodiversity as a result of changes to water quality, increased sedimentation and alteration of natural hydrological regimes	

7.4.4 Impact 4: impacts on wetland habitat

Impacts on the wetland habitat may result in complete loss and alteration of the PES of the wetland habitat. Wetlands specifically at risk are those that are within areas unaffected by agricultural development and those that have increased habitat diversity. Disturbances caused by vegetation clearing and soil disturbance are the key activities which could lead to this impact. Wetland systems are generally known for supporting increased levels of biodiversity due to the niche habitats created through the ecotones between aquatic and terrestrial systems. Impacts on these systems therefore have increased significance and any larger impacts would lead to reductions in the species diversity in these systems.

Aspects and activities register

Pre-Construction	Construction	Operational
Inappropriate planning leading to overall loss of floral habitat	Site clearing leading to the removal of indigenous wetland vegetation	Ongoing disturbance of soils and vegetation during general maintenance activities
Inappropriate design of infrastructure leading to changes to wetland habitat	Compaction of soils due to construction activities	Continuous introduction and proliferation of alien plant species and further transformation of natural habitat
Increased anthropogenic activity within wetland areas	Dumping waste and construction material within wetlands leading to alien plant species proliferation	
	Movement of construction vehicles as well as access road construction within the wetland zones	
	Loss of vegetation resulting in a loss of breeding and foraging habitat and overall biodiversity	

8 IMPACT RATINGS AND MINIMISATION

The tables below serve to summarise the significance of perceived impacts on the riparian and wetland ecology of the study area. The table present the impact assessment according to the method described in Section 3 and also indicate the mitigation measures required to minimise the impacts. In addition, an assessment of the perceived impacts is presented, taking into consideration the available mitigating measures assuming that they are fully implemented.

Table 21: Construction phase impact ratings and proposed mitigation measures for the wetland and river features along the alternative powerline 1.

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Impacts on wetland recharge, inundation and instream flow for wetlands and rivers identified	3	2	2	2	2	**28**	**ML Maintain Current Management**	Edge effects of all construction activities, such as erosion and alien plant species proliferation, which may affect wetlands and rivers habitat, need to be strictly managed	2	1	1	1	1	**8**	**L No Management Required**
Site clearing and the removal of vegetation leading to increased runoff								Ensure that all activities impacting on water resources along the powerline routes are managed according to the relevant DWAF Licensing regulations. After completion of the construction phase of the development, it must be ensured that wetland functions are re-instated							
Construction within stream crossings resulting in streamflow discontinuation which leads to drying of downstream areas								It must be ensured that flow connectivity along the wetland and riparian features is maintained							
Streamflow diversion resulting in inundation of upstream areas								Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Sediment deposition and stream bed scouring								Minimise loss of runoff to adjacent riparian areas and instream flow							
Site clearing and the removal of vegetation leading to erosion which alters the geomorphology of the wetlands and riparian areas								Ensure that all areas affected by construction are rehabilitated upon completion of the construction phase. Areas should be reseeded with indigenous vegetation as required							
Indiscriminate driving of vehicles within the wetlands leading to soil compaction, which results in increased runoff								Reprofile area to ensure that no changes to runoff patterns occurs							
Impacts due to sedimentation canalisation and erosion for wetlands and rivers identified	3	2	2	2	2	**32**	**ML Maintain Current Management**	No dumping of waste material should be allowed within the construction area at any stage of the development, and all building materials should be removed when construction is completed	2	1	1	1	1	**8**	**L No Management Required**
Excavations and creation of canals along the river banks, thus altering the meandering nature of the river								Restrict construction to the drier winter months, if possible, to avoid sedimentation							
Trampling and indiscriminate driving in wetlands and riparian areas leading to soil compaction								Monitor all systems for erosion and incision							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Soil piling within wetland areas, thus altering the depth of the wetland channel and/or levelling in case of pans								It must be ensured that flow connectivity along the wetland an riparian features is maintained							
Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management								Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles							
Compaction and loss of soils due to movement of construction vehicles								As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils							
Impacts on ecological and sociocultural service provision for wetlands and rivers identified	2	2	2	2	2	**24**	**L No Management Required**	Adequate stormwater management must be incorporated into the design of the powerline routes in order to prevent erosion. In this regard special mention is made of the installation of drift fences to capture silt	1	1	1	1	1	**6**	**L No Management Required**
Site clearing and further removal of riparian vegetation resulting in loss of resources such as grass for cattle grazing								All areas affected by construction should be rehabilitated upon completion of the construction phase of the development. Areas should be reseeded with indigenous grasses as required							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Inability to support biodiversity as a result of changes to water quality, increased sedimentation and alteration of natural hydrological regimes								Edge effects of activities, including erosion and alien/weed control need to be strictly managed in the wetland and riparian areas as well as the associated buffer zone							
Alteration of the natural hydrological regime, impacting on flood attenuation and streamflow regulation capabilities								Stay in road reserve wherever possible							
Loss of phosphate, nitrate and toxicant removal abilities due to vegetation clearing								Minimise changes to instream habitat and water quality							
Impacts on instream and wetland habitat for wetlands and rivers identified	3	2	2	3	2	**35**	**ML Maintain Current Management**	Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles	2	1	1	1	2	**12**	**L No Management Required**
Inappropriate design of infrastructure leading to changes to wetland and riparian habitat								It must be ensured that flow connectivity along the wetland features is maintained							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Construction of access roads traversing rivers and wetlands resulting in the modification of the river channel and wetland habitat								It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil							
Loss of vegetation resulting in a loss of breeding and foraging habitat and overall biodiversity								All spills should be immediately cleaned up and treated accordingly							
Dumping waste and construction material within wetlands leading to alien plant species proliferation								Restrict construction to the drier winter months if possible to avoid further sedimentation of wetland features in the vicinity of the study area							
Impacts on refugia for aquatic species in rivers	3	2	2	3	2	**35**	**ML Maintain Current Management**	Ensure that all activities impacting on water resources of powerline are managed according to the relevant DWAF Licensing regulations. After completion of the construction phase of the development, it must be ensured that wetland functions are re-instated	2	1	1	2	1	**12**	**L No Management Required**
Loss of refuge pools due to sedimentation								Prevent sedimentation in order to preserve refuge pools							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Limited mobility of aquatic species due to the disturbance of corridors								Informal fires in the vicinity of development area should be prohibited during all development phases							
Contamination of water during construction phase								It must be ensured that flow connectivity along the riparian features is maintained to promote mobility of aquatic species between corridors							
Loss of vegetation resulting in a loss of breeding and foraging habitat for aquatic species															

Table 22: Operational phase impact ratings and proposed mitigation measures for the wetland and river features along the alternative powerline 1.

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Impacts on wetland recharge, inundation and instream flow for wetlands and rivers identified	2	1	2	1	2	**15**	**L No Management Required**	Monitor all areas where towers are located for erosion and incision	1	1	1	1	2	**9**	**L No Management Required**
Indiscriminate driving of vehicles within the riparian area								Avoid waste dumping within wetlands and riparian areas during maintenance							
Increased water runoff into the rivers due to unvegetated areas overlooked after construction								It must be ensured that flow connectivity along the wetland and riparian features is maintained							
Impacts due to sedimentation canalisation and erosion for wetlands and rivers identified	2	2	1	1	1	**10**	**L No Management Required**	No dumping of waste material should be allowed within wetland and riparian areas during operational phase	1	1	1	1	1	**6**	**L No Management Required**
Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management								It must be ensured that flow connectivity along the wetland an riparian features is maintained							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Contamination of water as a result of waste dumping								Monitor all systems for erosion and incision							
Contamination of water as a result of waste dumping								Ensure that there is no indiscriminate driving of vehicles during maintenance							
Impacts on ecological and sociocultural service provision for wetlands and rivers identified	1	1	1	1	1	**6**	**L No Management Required**	Monitor all systems for erosion and incision	1	1	1	1	1	**6**	**L No Management Required**
Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management								Avoid water contamination							
Impacts on instream habitat for wetlands and rivers identified	2	1	1	2	1	**12**	**L No Management Required**	Monitor all systems for erosion and incision	1	1	1	1	1	**6**	**L No Management Required**
Continuous introduction and proliferation of alien plant species and further transformation of natural habitat								Avoid water contamination							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management								Ensure that there is no indiscriminate driving of vehicles during maintenance							
Ongoing disturbance of soils during maintenance activities															
Impacts on refugia for aquatic species in rivers								Ensure that there is no waste dumping in stream							
Ongoing disturbance of refugia for aquatic species during general maintenance activities	1	1	1	1	1	**6**	**L No Management Required**	Avoid water contamination	1	1	1	1	1	**6**	**L No Management Required**
Contamination of water during maintenance activities															

Table 23: Construction phase impact ratings and proposed mitigation measures for the wetland and river features along the alternative powerline 2.

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Impacts on wetland recharge, inundation and instream flow for wetlands and rivers identified	4	3	3	3	3	**60**	**MH Maintain Current Management**	Edge effects of all construction activities, such as erosion and alien plant species proliferation, which may affect wetlands and rivers habitat, need to be strictly managed	3	2	2	2	2	**21**	**L No Management Required**
Site clearing and the removal of vegetation leading to increased runoff								Ensure that all activities impacting on water resources along the powerline routes are managed according to the relevant DWAF Licensing regulations. After completion of the construction phase of the development, it must be ensured that wetland functions are re-instated							
Construction within stream crossings resulting in streamflow discontinuation which leads to drying of downstream areas								It must be ensured that flow connectivity along the wetland and riparian features is maintained							
Streamflow diversion resulting in inundation of upstream areas								Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Sediment deposition and stream bed scouring								Minimise loss of runoff to adjacent riparian areas and instream flow							
Site clearing and the removal of vegetation leading to erosion which alters the geomorphology of the wetlands and riparian areas								Ensure that all areas affected by construction are rehabilitated upon completion of the construction phase. Areas should be reseeded with indigenous vegetation as required							
Indiscriminate driving of vehicles within the wetlands leading to soil compaction, which results in increased runoff								Reprofile area to ensure that no changes to runoff patterns occurs							
Impacts due to sedimentation canalisation and erosion for wetlands and rivers identified	4	2	3	4	3	**63**	**MH Maintain Current Management**	No dumping of waste material should be allowed within the construction area at any stage of the development, and all building materials should be removed when construction is completed	3	1	1	2	2	**20**	**L No Management Required**
Excavations and creation of canals along the river banks, thus altering the meandering nature of the river								Restrict construction to the drier winter months, if possible, to avoid sedimentation							
Trampling and indiscriminate driving in wetlands and riparian areas leading to soil compaction								Monitor all systems for erosion and incision							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Soil piling within wetland areas, thus altering the depth of the wetland channel and/or levelling in case of pans								It must be ensured that flow connectivity along the wetland an riparian features is maintained							
Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management								Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles							
Compaction and loss of soils due to movement of construction vehicles								As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils							
Impacts on ecological and sociocultural service provision for wetlands and rivers identified	3	2	3	2	2	**40**	**ML Maintain Current Management**	Adequate stormwater management must be incorporated into the design of the powerline routes in order to prevent erosion. In this regard special mention is made of the installation of drift fences to capture silt	2	1	2	1	1	**10**	**L No Management Required**
Site clearing and further removal of riparian vegetation resulting in loss of resources such as grass for cattle grazing								All areas affected by construction should be rehabilitated upon completion of the construction phase of the development. Areas should be reseeded with indigenous grasses as required							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Inability to support biodiversity as a result of changes to water quality, increased sedimentation and alteration of natural hydrological regimes								Edge effects of activities, including erosion and alien/weed control need to be strictly managed in the wetland and riparian areas as well as the associated buffer zone							
Alteration of the natural hydrological regime, impacting on flood attenuation and streamflow regulation capabilities								Stay in road reserve wherever possible							
Loss of phosphate, nitrate and toxicant removal abilities due to vegetation clearing								Minimise changes to instream habitat and water quality							
Impacts on instream and wetland habitat for wetlands and rivers identified	4	3	3	3	4	**70**	**MH Maintain Current Management**	Reinforce banks and drainage features where necessary with gabions, reno mattresses and geotextiles	1	1	2	1	2	**12**	**L No Management Required**
Inappropriate design of infrastructure leading to changes to wetland and riparian habitat								It must be ensured that flow connectivity along the wetland features is maintained							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Construction of access roads traversing rivers and wetlands resulting in the modification of the river channel and wetland habitat								It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil							
Loss of vegetation resulting in a loss of breeding and foraging habitat and overall biodiversity								All spills should be immediately cleaned up and treated accordingly							
Dumping waste and construction material within wetlands leading to alien plant species proliferation								Restrict construction to the drier winter months if possible to avoid further sedimentation of wetland features in the vicinity of the study area							
Impacts on refugia for aquatic species in rivers	3	1	2	3	3	**36**	**ML Maintain Current Management**	Ensure that all activities impacting on water resources of powerline are managed according to the relevant DWAF Licensing regulations. After completion of the construction phase of the development, it must be ensured that wetland functions are re-instated	2	1	1	2	1	**12**	**L No Management Required**
Loss of refuge pools due to sedimentation								Prevent sedimentation in order to preserve refuge pools							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Limited mobility of aquatic species due to the disturbance of corridors								Informal fires in the vicinity of development area should be prohibited during all development phases							
Contamination of water during construction phase								It must be ensured that flow connectivity along the riparian features is maintained to promote mobility of aquatic species between corridors							
Loss of vegetation resulting in a loss of breeding and foraging habitat for aquatic species															

Table 24: Operational phase impact ratings and proposed mitigation measures for the wetland and river features along the alternative powerline 2.

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Impacts on wetland recharge, inundation and instream flow for wetlands and rivers identified	2	1	2	2	2	**20**	**L No Management Required**	Monitor all areas where towers are located for erosion and incision	1	1	1	1	2	**9**	**L No Management Required**
Indiscriminate driving of vehicles within the riparian area								Avoid waste dumping within wetlands and riparian areas during maintenance							
Increased water runoff into the rivers due to unvegetated areas overlooked after construction								It must be ensured that flow connectivity along the wetland and riparian features is maintained							
Impacts due to sedimentation canalisation and erosion for wetlands and rivers identified	2	2	1	2	1	**15**	**L No Management Required**	No dumping of waste material should be allowed within wetland and riparian areas during operational phase	1	1	1	1	1	**6**	**L No Management Required**
Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management								It must be ensured that flow connectivity along the wetland an riparian features is maintained							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Contamination of water as a result of waste dumping								Monitor all systems for erosion and incision							
Contamination of water as a result of waste dumping								Ensure that there is no indiscriminate driving of vehicles during maintenance							
Impacts on ecological and sociocultural service provision for wetlands and rivers identified	2	2	1	1	2	**15**	**L No Management Required**	Monitor all systems for erosion and incision	1	1	1	1	1	**6**	**L No Management Required**
Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management								Avoid water contamination							
Impacts on instream and wetland habitat for wetlands and rivers identified	1	1	2	1	2	**12**	**L No Management Required**	Monitor all systems for erosion and incision	1	1	1	1	1	**6**	**L No Management Required**
Continuous introduction and proliferation of alien plant species and further transformation of natural habitat								Avoid water contamination							

POTENTIAL ENVIRONMENTAL IMPACT (NATURE OF THE IMPACT)	ENVIRONMENTAL SIGNIFICANCE BEFORE MITIGATION							RECOMMENDED MITIGATION MEASURES	ENVIRONMENTAL SIGNIFICANCE AFTER MITIGATION						
	Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline		Consequence			Likelihood (Probability)		Significance (Degree to which impact may cause irreplaceable loss of resources)	SRK Guideline
	Se	Sp	Du	Fa	Fi				Se	Sp	Du	Fa	Fi		
Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management								Ensure that there is no indiscriminate driving of vehicles during maintenance							
Ongoing disturbance of soils during maintenance activities															
Impacts on refugia for aquatic species in rivers								Ensure that there is no waste dumping in stream							
Ongoing disturbance of refugia for aquatic species during general maintenance activities	1	1	1	1	1	**6**	**L No Management Required**	Avoid water contamination	1	1	1	1	1	**6**	**L No Management Required**
Contamination of water during maintenance activities															

9 CONCLUSION

From the results of the study it was evident that the features obtained moderate scores for PES, even though they differed in aspects such as hydrology, geomorphology and vegetation. In their present state the wetlands and rivers along the proposed powerline route showed varying types of transformation with specific impacts noted resulting from:

- Alien vegetation encroachment
- Altered flow and inundation caused by the construction of roads and impoundments
- Impacts from increased sediment loading from both current and historical mining
- Impacts from cattle grazing
- Agricultural activities
- Impacts on water quality

From the results of the impact assessment it was observed that 5 major impact categories were applicable to the proposed powerline route. Furthermore, impacts were identified to differ between various wetland types.

The management of the impacts identified in this specialist assessment for the preconstruction, construction and operational phases present a comprehensive range of mitigation measures, which should be carried over to the EMP. Implementation of the programmes and plans should be institutionalised through regular monitoring and auditing. Based on the assumption that such programmes and plans will be effectively implemented on the proposed powerline route, which will be designed and constructed in accordance with national and international industry standards. It is the opinion of the specialist that the development should be authorised.

Table 25: A summary of the results obtained from the assessment of the ecological impacts for alternative powerline 1

Construction phase		
Impact	**Unmanaged**	**Managed**
1 Impacts on wetland recharge, inundation and instream flow	Medium-Low	Low
2 Impacts due to sedimentation, canalization and erosion	Medium-Low	Low
3 Impacts on ecological and sociocultural service provision	Low	Low
4 Impacts on instream and wetland habitat	Medium-Low	Low
5. Impacts on refugia for aquatic species	Medium-Low	Low
Operational phase		
Impact	**Unmanaged**	**Managed**
1 Impacts on wetland recharge, inundation and instream flow	Low	Low
2 Impacts due to sedimentation, canalization and erosion	Low	Low
3 Impacts on ecological and sociocultural service provision	Low	Low
4 Impacts on instream and wetland habitat	Low	Low
5 Impacts on refugia for aquatic species	Low	Low

From the table it is evident that for the duration of the construction phase, prior to mitigation, all impacts are considered to be of medium-low level, whereas impact 3 is considered to be of low level. However, should mitigatory measures be implemented as recommended, all impacts will be reduced to a low level.

During operational phase, all impacts are considered to be of low level, both prior to mitigation as well as after implementation of mitigation measures.

Furthermore, impacts on the wetland and riparian features can be greatly reduced by re-alignment of the powerline outside wetlands and riparian features and their associated buffer zones, if this is feasible.

Table 26: A summary of the results obtained from the assessment of the ecological impacts for alternative powerline 2.

Construction phase		
Impact	**Unmanaged**	**Managed**
1 Impacts on wetland recharge, inundation and instream flow	Medium-High	Low
2 Impacts due to sedimentation, canalization and erosion	Medium-High	Low
3 Impacts on ecological and sociocultural service provision	Medium-Low	Low
4 Impacts on instream and wetland habitat	Medium-High	Low
5. Impacts on refugia for aquatic species	Medium-Low	Low
Operational phase		
Impact	**Unmanaged**	**Managed**
1 Impacts on wetland recharge, inundation and instream flow	Low	Low
2 Impacts due to sedimentation, canalization and erosion	Low	Low
3 Impacts on ecological and sociocultural service provision	Low	Low
4 Impacts on instream and wetland habitat	Low	Low
5 Impacts on refugia for aquatic species	Low	Low

From the table it is evident that for the duration of the construction phase, prior to mitigation, impact 1, impact 2, and impact 4 are considered to be of medium-high level, whereas impact 3 and impact 5 are considered to be of medium-low level. However, should mitigatory measures be implemented as recommended, all impacts will be reduced to a low level.

During operational phase, all impacts are considered to be of low level, both prior to mitigation as well as after implementation of mitigation measures.

Furthermore, impacts on the wetland and riparian features can be greatly reduced by re-alignment of the powerline outside wetlands and riparian features and their associated buffer zones, if this is feasible.

10 RECOMMENDATIONS

After conclusion of this ecological assessment, it is the opinion of the ecologists that the proposed powerline route be considered favourably provided that the following essential mitigation measures as listed below are adhered to:

- The boundaries of the development footprint areas are to remain as small as possible, be clearly defined and it should be ensured that all activities remain within defined footprint areas.
- All wetlands and rivers of increased ecological importance and sensitivity, should be considered during all phases of the development.
- Edge effects of all construction and operational activities, such as erosion and alien plant species proliferation, which may affect floral habitat, need to be strictly managed. Existing alien species should be eradicated and controlled to prevent further spread of these species.
- All areas of increased ecological sensitivity should be designated as No-Go areas and be off limits to all unauthorised vehicles and personnel. Vehicles should be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed powerline route activities.
- Access to the site should be limited to a single access entry point and access to the remainder of the wetland features should be prohibited to prevent compaction of soils, loss of vegetation and increased erosion.
- The proposed powerline route should be constructed in such a manner as to avoid upstream ponding and downstream erosion.
- Access into adjacent wetlands and rivers, particularly by vehicles, is to be strictly controlled.
- Run-off from dirty water areas entering the wetlands or rivers must be prevented.
- Flow continuity may not be affected by the proposed powerline route.
- All spills must be cleaned up and treated accordingly.
- Ensure that permanent, seasonal and temporary wetland zone as well as riparian zones functionality is maintained through provision of measures to ensure that soil wetting conditions are maintained.

After conclusion of this ecological assessment, it is the opinion of the ecologists that alternative powerline 1 be considered preferable due to less construction impacts that the area will be exposed to, since the line will only be upgraded, and taking into consideration the fact that the area has been previously impacted by similar construction

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