WETLAND ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED CONSTRUCTION OF A WATER PIPELINE FROM THE DORSFONTEIN WEST TO THE DORSFONTEIN EAST MINE NEAR KRIEL WITHIN THE MPUMALANGA PROVINCE

Prepared for

SRK Consulting (South Africa) (Pty) Ltd

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EXECUTIVE SUMMARY

Based on the findings of this assessment, it is the opinion of the ecologists that the project is regarded as having low levels of impact on the surrounding freshwater resources identified, provided that all construction footprints are kept as small as possible. With strict implementation of mitigation measures throughout all phases of the proposed project, impacts can be reduced to low significance levels and the proposed project should, from a freshwater resource point of view, be authorised for development.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater resource assessment as part of the environmental assessment and authorisation process for the proposed construction of a water pipeline from the Dorsfontein West to the Dorsfontein East Mine near Kriel within Mpumalanga Province. The proposed project has three alternative water pipeline routes namely Route 1 (10,5km in length), Route 2 (8,9km in length) and Route 3 (11,2km in length), hereinafter collectively referred to as the "linear development" (Figure 1 & 2). An area of 15m on either side of each proposed route was investigated during the site visit. In addition, freshwater resources in the vicinity of the proposed open pit expansion was delineated and assessed.

The purpose of this report is to assess the freshwater resources within the study area, to provide supporting, detailed information to guide the proposed activities and to ensure the ongoing functioning of the freshwater resources that would be affected. A further goal is to support local and regional conservation requirements and the provision of ecological services in the local area. The study also aims to identify and quantify any impacts of the project on the freshwater resources, and to present a set of mitigation measures to minimise impacts on the receiving aquatic environment.

The assessment took the following approach:

- A desktop study was conducted, in which freshwater resources were identified for on-site investigation, and relevant national and provincial databases were consulted. The results of the desktop study are contained in Section 3 of this report;
- Field assessments took place on June 9 2016, in order to ground-truth the identified freshwater resources within the study area. The following freshwater features were identified:
  - Unchannelled valley bottom wetlands,
  - Channelled valley bottom wetlands; and
  - Hillslope seep wetlands.
- The detailed results of the field assessment are contained in Section 4 of this report and are summarised in the table below.

Table A: Summary of the results of the field assessment

Resource	Present Ecological State (PES) Category	Ecological function and service provision	Ecological Importance and Sensitivity (EIS)	Recommended Ecological Class (REC)
Channelled valley bottom	C	Intermediate	B	B
Hillslope seep	B	Intermediate	C	C
Unchannelled valley bottom	C	Intermediate	C	C

Following the assessment of the freshwater resources, an impact assessment was performed to ascertain the significance of potential impacts on the receiving environment, should the proposed development proceed.

All of the proposed routes traverse or encroach upon the various wetland systems, and as such will impact upon the features at various points of interception. Route 1 traverses mainly the higher lying areas, utilising existing road and agricultural field fringes, and as such is overall likely to have a lower impact on the overall environment. Route 1 crosses a number of hillslope seeps, however these seeps are located within the agricultural lands and as such have been subjected to historical impacts from agriculture and the edge effects of the current adjacent agricultural activities. The two channelled valley bottom wetlands that route 1 traverses are also located in historically impacted areas, are small in size and have been impacted upon by alien vegetation, with stands of alien vegetation present within these wetlands.

Route 2 extends through the lower lying valleys, directly impacting upon large areas of intact hillslope seeps and channelled valley bottom wetlands. The vegetation and biodiversity of these areas is considered good, and as such route 2 is likely to have a high impact upon the geomorphology, hydrology and biodiversity of these lower lying wetlands, which in turn will have a significant effect on ecoservice provision by the systems crossed.

Route 3 will impact upon a number of channelled valley bottom wetlands, as well as a large section of the Unchannelled valley bottom wetland. The proposed route 3 runs directly within the channelled valley bottom wetland for approximately 1.3km within the permanent and seasonal zones, and as such would have an extensive impact on this feature. Furthermore, route 3 traverses a large hill, comprising of shallow rocky soils. Blasting would most likely be required to lay a pipeline through this areas, which will result in greater impacts to the environment.

No wetlands were observed within the pit expansion area, with this area being characterised almost wholly of agricultural land. However, a wetland system was observed approximately 120m to the east of the proposed pit expansion area. As such it must be noted that the expansion pit may impact on this system. The excavation of the expansion pit may result in the dewatering of this wetland system, altering the natural hydrological cycle and in turn negatively impacting upon the ecoservices provision of this wetland.

The wetland features will be affected in terms of the loss of habitat and ecological structure, ecological functioning and hydrological functioning, as well as the clearance of vegetation and the compaction of soil during construction. Prior to mitigation measures, the routes are deemed to have a “medium high” significance, however in terms of impacts on the hydrological function route 1 is deemed to have a lower impact than the alternative routes, scoring a “medium-low” significance. With the implementation of mitigation measures, impact significance is deemed to be mitigated to predominantly “low” levels, however route 3 is only expected to be mitigated to “medium-low” impact levels on the habitat and ecological structure of the wetlands even with mitigation measures in place.

During the operational phase, the routes are deemed to have a “medium-high” impact significance prior to mitigation measures, however route 1 is deemed to have a decreased impact significance on the hydrological functioning, scoring a “medium-low” impact. Following mitigation measures, impacts are deemed to be of a “low” significance, however route 3 scored a “medium-low” impact in terms of the habitat and ecological structure with mitigation measures.

The results of the impact assessment are summarised in the table below:

Table: A summary of the results obtained from the impact assessment (Appendix F)

	Impact 1: Loss of habitat and ecological structure	Pre-mitigation	Post-mitigation
Route 1	Construction	Medium high	Low
	Operational	Medium high	Low
Route 2	Construction	Medium high	Low
	Operational	Medium high	Low
Route 3	Construction	Medium high	Medium-low
	Operational	Medium high	Medium-low
	Impact 2: Changes to the ecological and sociocultural service provision	Pre-mitigation	Post-mitigation
Route 1	Construction	Medium high	Low
	Operational	Medium high	Low
Route 2	Construction	Medium high	Low
	Operational	Medium high	Low
Route 3	Construction	Medium high	Low
	Operational	Medium high	Low
	Impact 3: Impacts on hydrological function	Pre-mitigation	Post-mitigation
Route 1	Construction	Medium Low	Low
	Operational	Medium Low	Low
Route 2	Construction	Medium high	Low
	Operational	Medium high	Low
Route 3	Construction	Medium high	Low
	Operational	Medium high	Low

Mitigation measures were developed to manage the perceived impacts on the freshwater resources, as outlined in Section 5 and Appendix F of this report. The following mitigation measures are considered particularly important:

- During the construction phase of the development, all wetland areas other than the immediate areas of crossing are to be demarcated as no-go areas for vehicles and construction personnel;
- Access roads for support vehicles, and vehicles used in the construction of the crossings, should not encroach into the freshwater features.
- Any storage facilities and all other non-essential activities should be located away from the identified wetlands in order to avoid water and soil contamination, which would affect the structure and function of these resources;
- No stockpiling of construction material is allowed within the wetlands or the buffer zones, and all stockpiles must be removed immediately following construction;
- Rehabilitation should be conducted in a manner that ensures that the wetland features' conditions are reinstated to as natural a state as possible;
- As much vegetation growth as possible should be promoted within the wetland features in order to protect soils. In this regard, special mention is made of the need to prevent the loss of large areas of the freshwater features' vegetation and the use of indigenous vegetation species' where hydroseeding and rehabilitation planting (where applicable) are to be implemented;
- Vegetation removal should be kept at a minimum to avoid loss of freshwater features' assimilation and attenuation abilities;

- Ensure that all activities affecting the freshwater features in the vicinity of the proposed route are managed according to the relevant DWS licensing regulations;
- Activities that lead to elevated levels of sedimentation in the freshwater features should be minimised. Increased runoff due to vegetation clearance and/or soil compaction must be managed. Where necessary, access roads should have erosion berms installed in order to reduce the speed of any surface runoff, which could initiate erosion.
- The following points should serve as a guideline for berm installation:
  - Where the track has slope of less than 2%, berms should be installed every 50m;
  - Where the track has slope between 2%-10%, berms should be installed every 25m;
  - Where the track has slope between 10%-15%, berms should be installed every 20m;
  - Where the track has slope greater than 15%, berms should be installed every 10m;
  - Flow continuity and connectivity of the freshwater features must be reinstated post-construction activities.
- Alien vegetation encountered within the wetlands during the construction phase should be removed, with alien plant management practices put in place during the operational phase. A suitably qualified Environmental Control Officer (ECO) should check for the presence of alien vegetation at least every six months, and before they have a chance to seed. Any alien vegetation that colonises the disturbed areas should be removed immediately; and
- It is recommended that a suitably qualified and independent ECO should monitor the activities during the construction. The aim of the environmental monitoring would be to ensure that the recommendations made in this report to reduce wetland ecological impacts are adhered to. The same person should also inspect the sites at six monthly intervals for a maximum of two years, or until they are satisfied that the area has been suitably rehabilitated where impacted, whichever is the shorter.

Special mention is made of the requirement to immediately implement a rehabilitation plan after the construction phase, to ensure that the remaining areas of the freshwater features are rehabilitated and improved upon, to restore the ecological functioning for the freshwater features as soon as possible.

DOCUMENT GUIDE

	Relevant section in report
Details of the specialist who prepared the report	Appendix G
The expertise of that person to compile a specialist report including a curriculum vitae	Appendix G
A declaration that the person is independent in a form as may be specified by the competent authority	Appendix G
An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2
Assumption and limitations	Section 1.3
A description of the methodology adopted in preparing the report	Appendix C & D
The specific identified sensitivity of the site	Section 4
Indicators considered during wetland delineation and parameters adopted in allocating a buffer for the resource	Section 4.3
A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment	Section 5
Management and mitigation measures for inclusion in the Environmental Management Programme (EMPr)	Section 5 and Appendix F
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GLOSSARY OF TERMS

Alien vegetation:	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.
Alluvial soil:	A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.
Biodiversity:	The number and variety of living organisms on earth, the millions of plants, animans and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.
Buffer:	A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.
Catchment:	The area contributing to runoff at a particular point in a river system.
Chroma:	The relative purity of the spectral colour which decreases with increasing greyness.
Delineation (of a wetland):	To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.
Ecoregion:	An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas.
Groundwater:	Subsurface water in the saturated zone below the water table.
Hydromorphic soil:	A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).
Hydrology:	The study of the occurrence, distribution and movement of water over, on and under the land surface.

Hydromorphy:	A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Perennial:	Flows all year round.
Ramsar:	The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.
Seasonal zone of wetness:	The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface.
Temporary zone of wetness:	The outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year.

ACRONYMS

CBA	Critical Biodiversity Area
CSIR	Council of Scientific and Industrial Research
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EI	Ecological Importance
EIS	Ecological Importance and Sensitivity
ES	Ecological Sensitivity
ESA	Ecological Support Area
FEPA	Freshwater Ecosystem Priority Areas
GIS	Geographic Information System
GPS	Global Positioning System
HGM	Hydro-geomorphic
IHI	Index of Habitat Integrity
MAP	Mean Annual Precipitation
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PES	Present Ecological State
REC	Recommended Ecological Category
RQS	Research Quality Services
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

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater resource assessment as part of the environmental assessment and authorisation process for the proposed construction of a water pipeline from the Dorsfontein West to the Dorsfontein East Mine near Kriel within Mpumalanga Province. The proposed project has three alternative water pipeline routes namely Route 1 (10,5km in length), Route 2 (8,9km in length) and Route 3 (11,2km in length), hereinafter collectively referred to as the “linear development” (Figure 1 & 2). An area of 15m on either side of each proposed route was investigated during the site visit. In addition, freshwater resources in the vicinity of the proposed open pit expansion was delineated and assessed.

The linear development is situated approximately 2,1km east of the town Thubelihle and traverses the R544 roadway. A portion of route 1 is situated approximately 500m south east of the intersection of the R547 and R544, and the linear development is situated around the Dorsfontein East Mine extending to Dorsfontein West Mine, hence transporting water between the two mines.

The purpose of this report is to define the ecology of the linear development in terms of freshwater resource characteristics, mapping of the resources, defining areas of increased Ecological Importance and Sensitivity (EIS), and to define the Present Ecological State (PES) of the freshwater resources associated with the linear development. In addition, this report aims to define the socio-cultural and ecological service provision of the freshwater resources and the Recommended Ecological Category (REC) for each resource. It is a further objective of this study to provide detailed information to guide the proposed project activities in the vicinity of the freshwater resources, to ensure that the ongoing functioning of the ecosystem, such that local and regional conservation requirements and the provision of ecological services in the local area are supported while considering the need for sustainable economic development.

An impact assessment, considering the impact on the freshwater resources associated with the linear development will be conducted to determine the significance of the potential impacts on the receiving aquatic environment in relation to the proposed development. In addition, proposed mitigation measures will be developed to minimise the impacts, where possible, followed by an assessment of the significance of the impacts after mitigation, assuming that they are fully implemented.

This report, after consideration and a description of the ecological integrity of the linear development, must guide the Environmental Assessment Practitioner (EAP) and authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed development activities in relation to the freshwater resources.

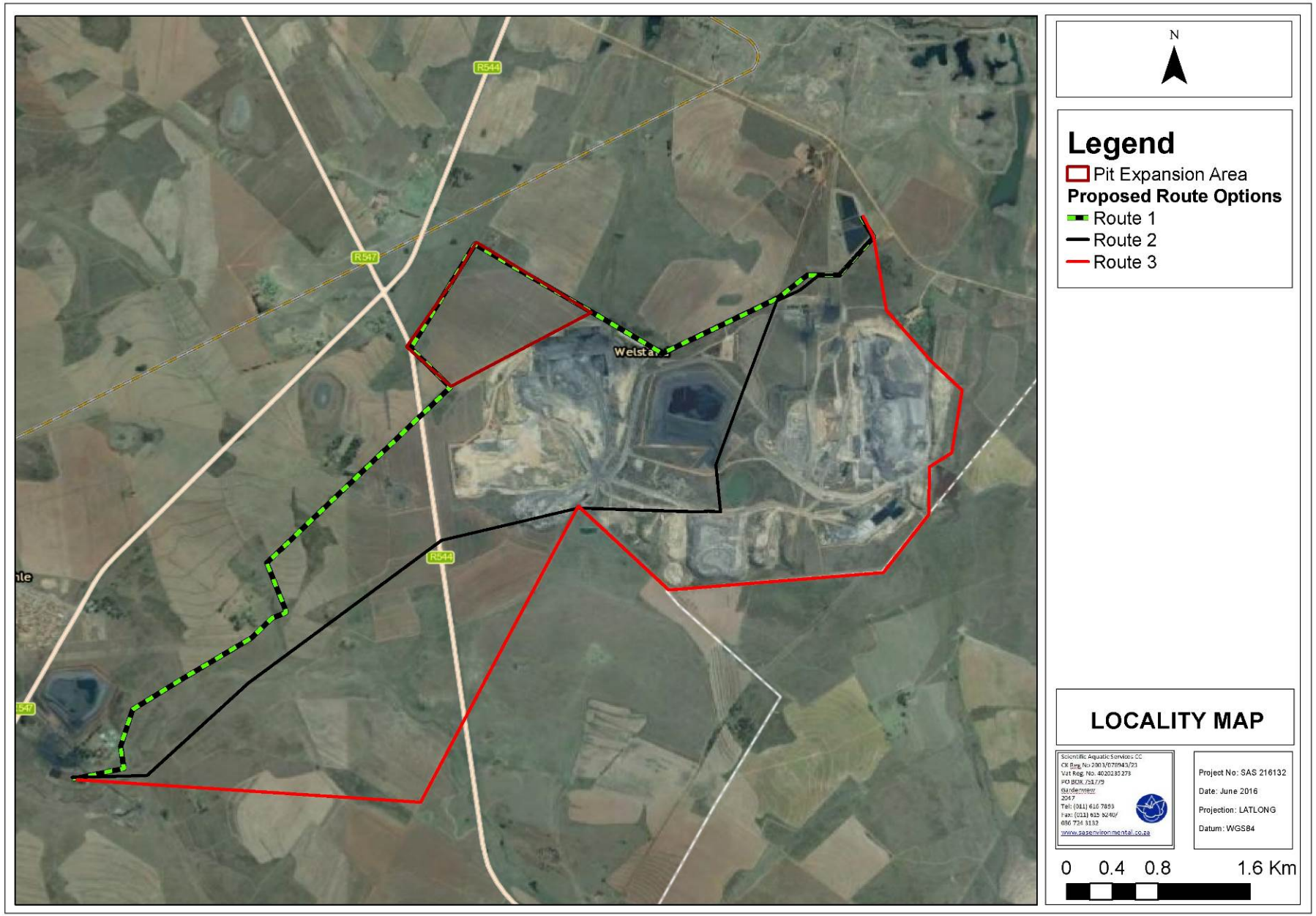


Figure 1: A digital satellite image depicting the location of the linear development in relation to the surrounding area.

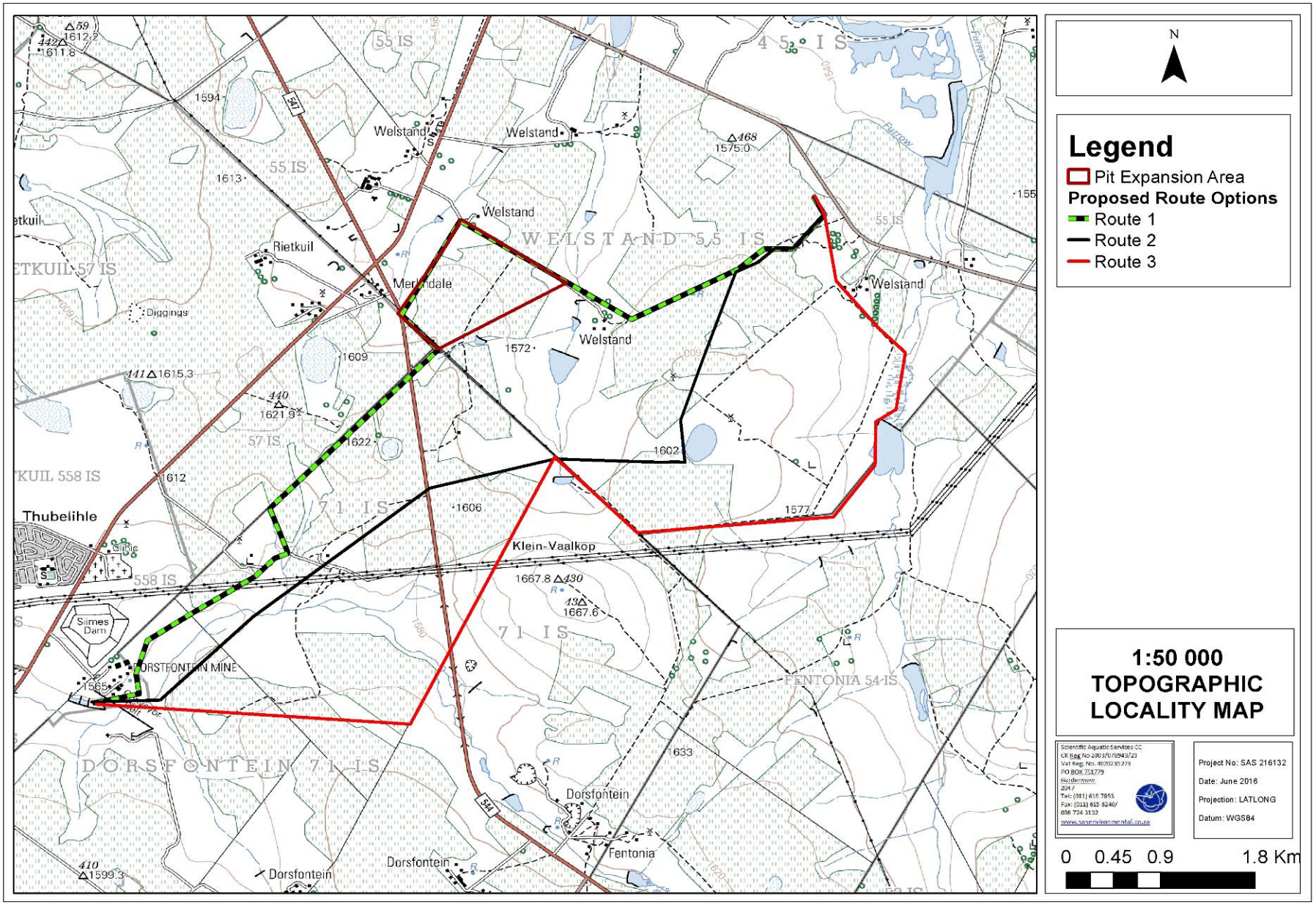


Figure 2: The linear development depicted on a 1:50 000 topographical map in relation to the surrounding area.

1.2 Scope of Work

Specific outcomes in terms of this report are outlined below:

- Freshwater resources were delineated according to the Department of Water Affairs and Forestry (DWAF[1]) 2005 and 2008: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". Aspects such as soil morphological characteristics, vegetation types and wetness were used to delineate the freshwater resources;
- The wetland classification assessment was undertaken according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013);
- The services provided by the freshwater resources in the vicinity of the linear development were assessed according to the method of Kotze *et al.* (2009) in which services to the ecology and to the people were defined;
- Determine the Present Ecological State (PES) as well as the Ecological Importance and Sensitivity (EIS) of the freshwater features;
- To allocate a Recommended Ecological Category (REC) to the freshwater features;
- Desktop delineate and provide impact statements where deemed necessary to all freshwater resources located further from the proposed footprint still located within the 500m boundary of applicability of GN 1199 as it related to the National Water Act;
- To assess environmental impacts that the proposed development might have on the freshwater resources; and
- Recommendations on management and mitigation measures (including opportunities and constraints) with regards to the development and operation of the proposed development in order to improve, manage and mitigate impacts on the freshwater ecology of the area will be provided.

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The freshwater assessment is confined to the linear development and 15m buffer thereof as well as areas of relevance immediately adjacent to the project footprint up to 500m from the project footprint which were assessed on a desktop level in

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

accordance with Regulation GN 1199. The general surroundings were however considered in the desktop assessment undertaken for the project;

- The freshwater resource delineations as presented in this report are regarded as a best estimate of the freshwater resource boundaries based on the site conditions at the time of the assessment;
- With ecology being dynamic and complex, certain aspects (some of which may be important) may have been overlooked. It is, however, expected that the linear development has been accurately assessed and considered, based on the field observations undertaken and the consideration of existing studies and monitoring data in terms of the wetland ecology; and
- The freshwater resources were delineated according to "DWAF, 2008: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". The delineation as presented is considered the best estimate of the functional 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 freshwater resources will need to be surveyed and pegged according to surveying principles.

1.4 Legislative Requirements

The following legislative requirements were taken into consideration during the assessment. A detailed description of these legislative requirements is presented in Appendix B:

- National Environmental Management Act (NEMA) (Act No. 107 of 1998);
- National Water Act (NWA) (Act No. 36 of 1998); and
- General Notice (GN) 1199 as published in the Government Gazette 32805 of 2009 as it relates to the NWA, 1998 (Act 36 of 1998). It should be noted that at the time of this report, this notice is under review and was published in the Government Gazette 39548 on 27th November 2015 for public comment.

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

2 ASSESSMENT APPROACH

2.1 Freshwater Resources Site Selection and Field Verification

During the desktop phase, use was made of aerial photographs, digital satellite imagery, and available provincial and national wetland databases to identify points of interest prior to the field survey. Details of the relevant databases which were consulted are contained in Section 3 of this report.

For the purposes of this investigation, the definition of a wetland habitat as defined in the NWA (1998) was used:

- 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.”

A single site visit was undertaken during June 2016. The presence of any freshwater characteristics as defined by the DWAF (2008) was noted and the freshwater resources delineated accordingly. Factors influencing the habitat integrity of the freshwater resources identified during the field survey were noted, and the functioning, environmental and socio-cultural services provided by the freshwater features were determined.

A detailed explanation of the method of assessment related to the freshwater features assessment is provided in Appendix C of this report and for the methodologies relating to the impact assessment and development of the mitigation measures, please refer to Appendix D of this report.

2.2 Sensitivity Mapping

All ecological features within the study area were considered, and sensitive areas were delineated with the use of a hand-held GPS. Geographic Information System (GIS) was used to project these features onto digital satellite imagery and topographic maps. The sensitivity map presented in Section 4.4 should guide the design and layout of the proposed development.

2.3 Impact Assessment and Recommendations

Following the completion of the assessment, an impact assessment was conducted (please refer to Appendix D for the method of approach) and recommendations were developed to

address and mitigate impacts associated with the proposed development. These recommendations also include general management measures, which apply to the proposed development. Mitigation measures have been developed to address issues in all phases throughout the life of the operation including planning, construction and operation. The detailed site specific mitigation measures are outlined in Section 5 of this report, whilst the general management measures which are considered to be best practice mitigation applicable to this project, are outlined in Appendix F.

3 RESULTS OF THE DESKTOP ANALYSIS

The following section contains data accessed as part of the desktop assessment and are presented as a “dashboard” report below (Table 1). The dashboard report aims to present concise summaries of the data on as few pages as possible in order to allow for integration of results by the reader to take place. Where required, further discussion and interpretation is provided, and information that was considered to be of particular importance was emboldened.

It is important to note that although all data sources used provide useful and often verifiable, high quality data, the various databases used do not always provide an entirely accurate indication of the linear development’s actual site characteristics at the scale required to inform the Environmental Impact Assessment (EIA) process. However, this information is considered to be useful as background information to the study. Thus, this data was used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance. Ground truthing and numerous soil test holes were investigated in order to determine the temporary zone boundary as best under the current site conditions during the field assessment.

Table 1: Desktop data relating to the character of freshwater resources within the linear development and surrounding region.

Aquatic ecoregion and sub-regions in which the proposed linear development is located	
Ecoregion (Figure 3)	Highveld
Catchment	Olifants North Catchment
Quaternary Catchment	B11D & B11B
WMA	Olifants
subWMA	Upper Olifants
Dominant characteristics of the Highveld Ecoregion (Kleynhans *et al.*, 2005)	
Dominant primary terrain morphology	Lowlands, Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to High Relief; and Closed Hills; Mountains; Moderate and High Relief.
Dominant primary vegetation types	Dry Sandy Highveld Grassland, Moist Cool Highveld Grassland
Altitude (m a.m.s.l)	1100-2100, 2100-2300 Very limited
MAP (mm)	400 to 1000
Coefficient of Variation (% of MAP)	<20 to 35
Rainfall concentration index	45 to 65
Rainfall seasonality	Early to late summer
Mean annual temp. (°C)	12 to 20
Winter temperature (July)	– 2 to 18 °C
Summer temperature (Feb)	14 – 32 °C
Median annual simulated runoff (mm)	5 to >250
Ecological Status of the most proximal sub-quaternary reach (DWS, 2014)	

Detail of the linear development in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database (Figure 4-7)	
FEPACODE	The area within which the linear development falls does not have a FEPA status.
NFEPA Wetlands	1. All three route options traverse various channelled valley bottom wetlands and a floodplain wetland. 2. In addition, routes 1 and 3 are located in close proximity with a flat wetland, whereas route 2 traverses a flat wetland. 3. All the wetlands associated with the proposed linear development are considered natural. 4. The wetland feature that is traversed by route 2 and 3 is in an AB wetland condition, hence it is in a good condition. 5. The floodplain wetland that is traversed by all three routes are in a DEF condition (Heavily modified). 6. The remaining wetland features are moderately modified (Class C condition).
Wetland vegetation Type	Mesic Highveld Grassland Group 4 (Critically Endangered)
NFEPA Rivers	1. Olifants River is situated approximately 1,6km north of the proposed linear development. 2. The Steenkoolspruit River is situated approximately 3,1km west of the proposed linear development. 3. Both abovementioned rivers are in a class D condition (Largely Modified).
Detail of the proposed linear development in terms of the Mpumalanga Biodiversity Sector Plan (MBSP, 2014) Figure 8 & 9	
ESA Subcatchments Heavily Modified	According to the MBSP much of the area traversed by the linear development is considered to be currently modified to such an extent that any valuable biodiversity and ecological function has been lost.
ESA Subcatchments Other Natural Areas	Areas that have not been identified as priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions.
Dams	Dams are artificial impoundments that are not considered as typical wetlands. The small 'lakes' in the Chrissiesmeer area are technically, pans, occasionally interconnected by wet-season overflows.

Sub-quaternary reach	B11B-01327 (Olifants)	B11D-01366 (Steenkoolspruit)		
Assessed by expert?	Yes	Yes	ESA Wetlands	All non-FEPA wetlands. Although not classed as FEPAs, these wetlands support the hydrological functioning of rivers, water tables and freshwater biodiversity, as well as providing a host of ecosystem services through the ecological infrastructure that they provide.
Mean Ecological Importance (EI) Class	High	Moderate		
Mean Ecological Sensitivity (ES) Class	High	High		
Stream Order	3	3	Detail of the linear development in terms of the Municipal Biodiversity Summary Project (2010)	
Default Ecological Class (based on median PES and highest EI or ES mean)	Class B (Largely Natural)	Class B (Largely Natural)	The linear development is located within the Emalahleni Local Municipality. The dataset for this municipality corresponded with the national and provincial datasets utilised in the development of this desktop report.	

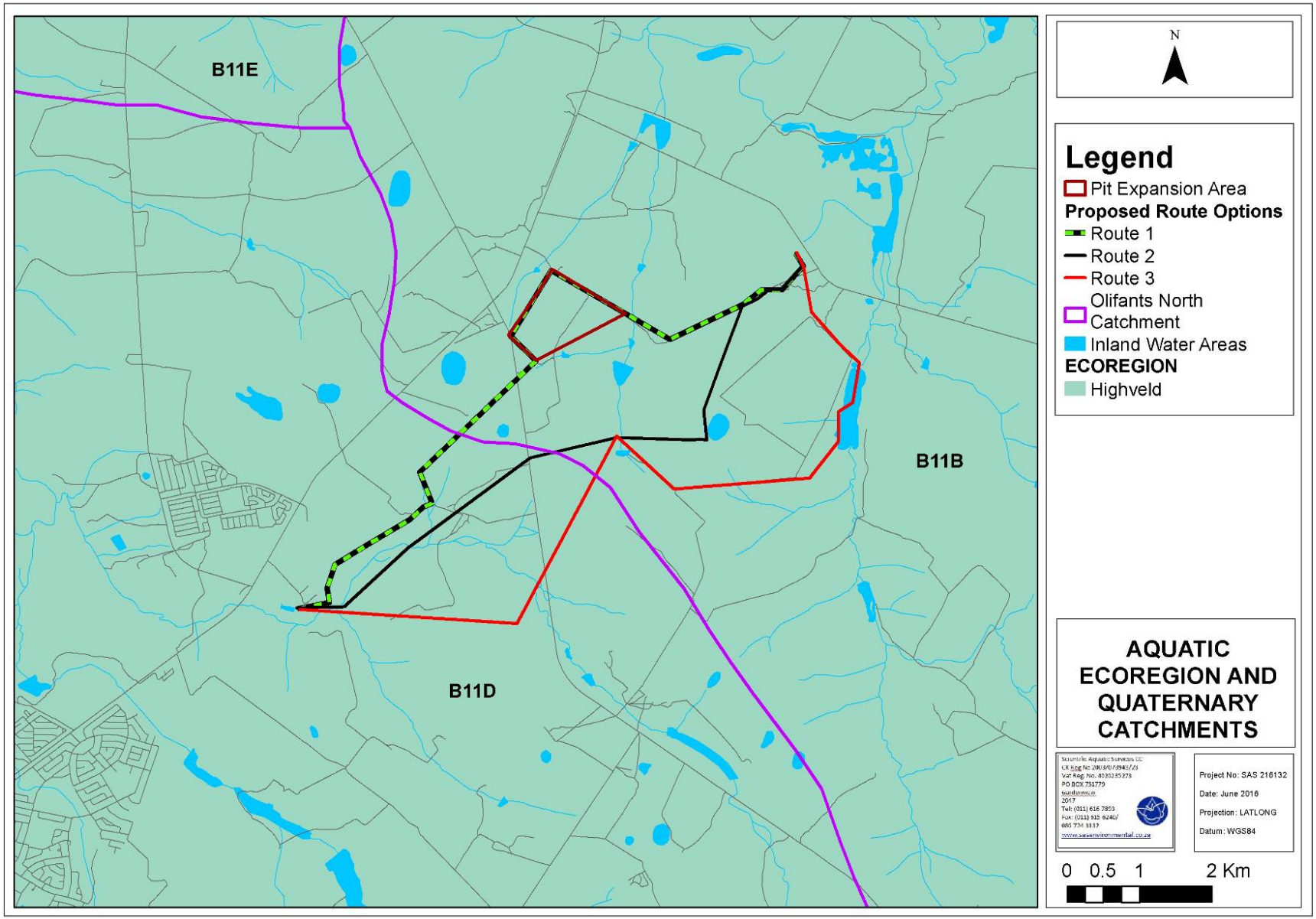


Figure 3: Ecoregion and Quaternary Catchments associated with the linear development.

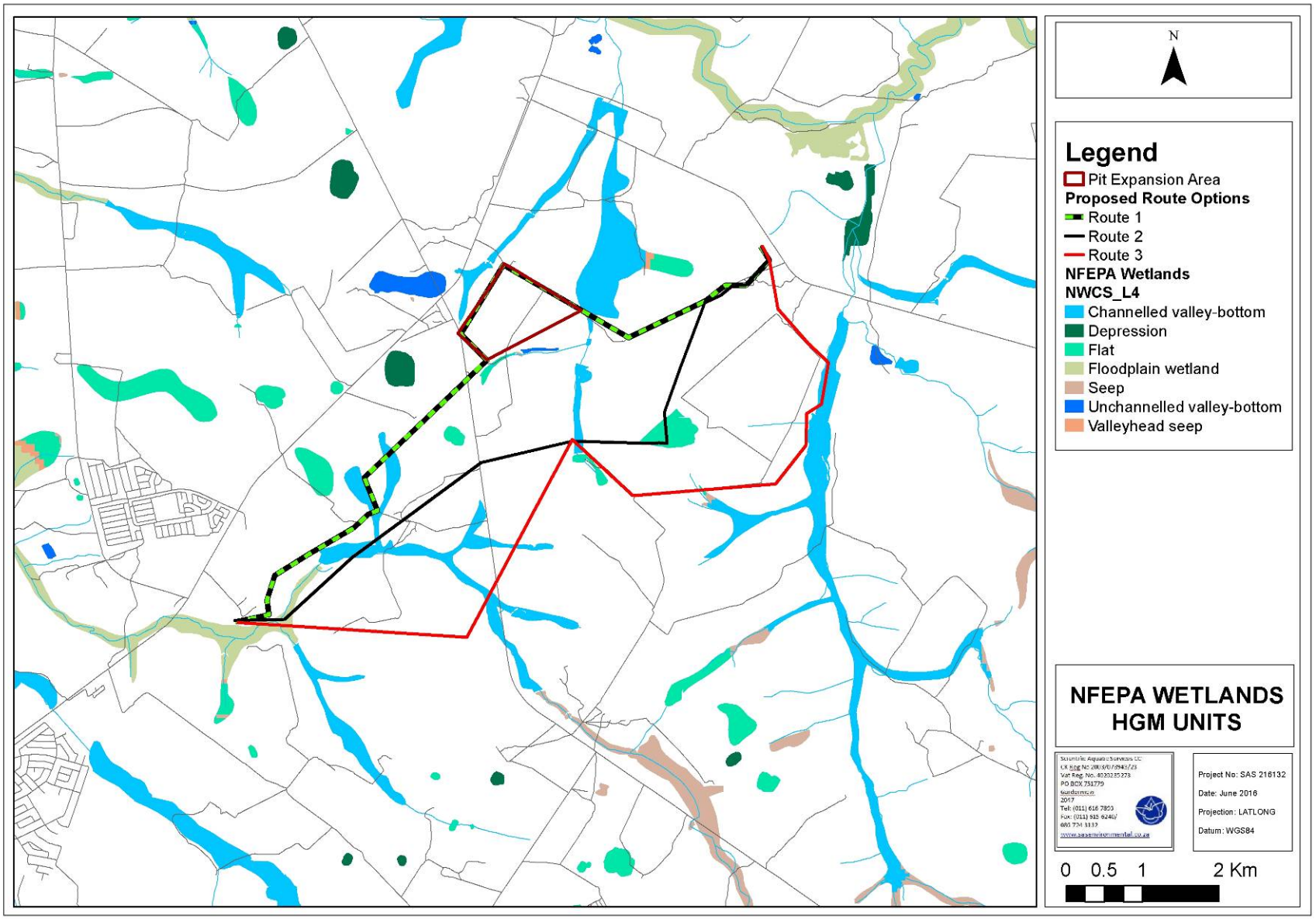


Figure 4: HGM Units of the wetland features associated with the linear development, as indicated by NFEPA Database (2011).

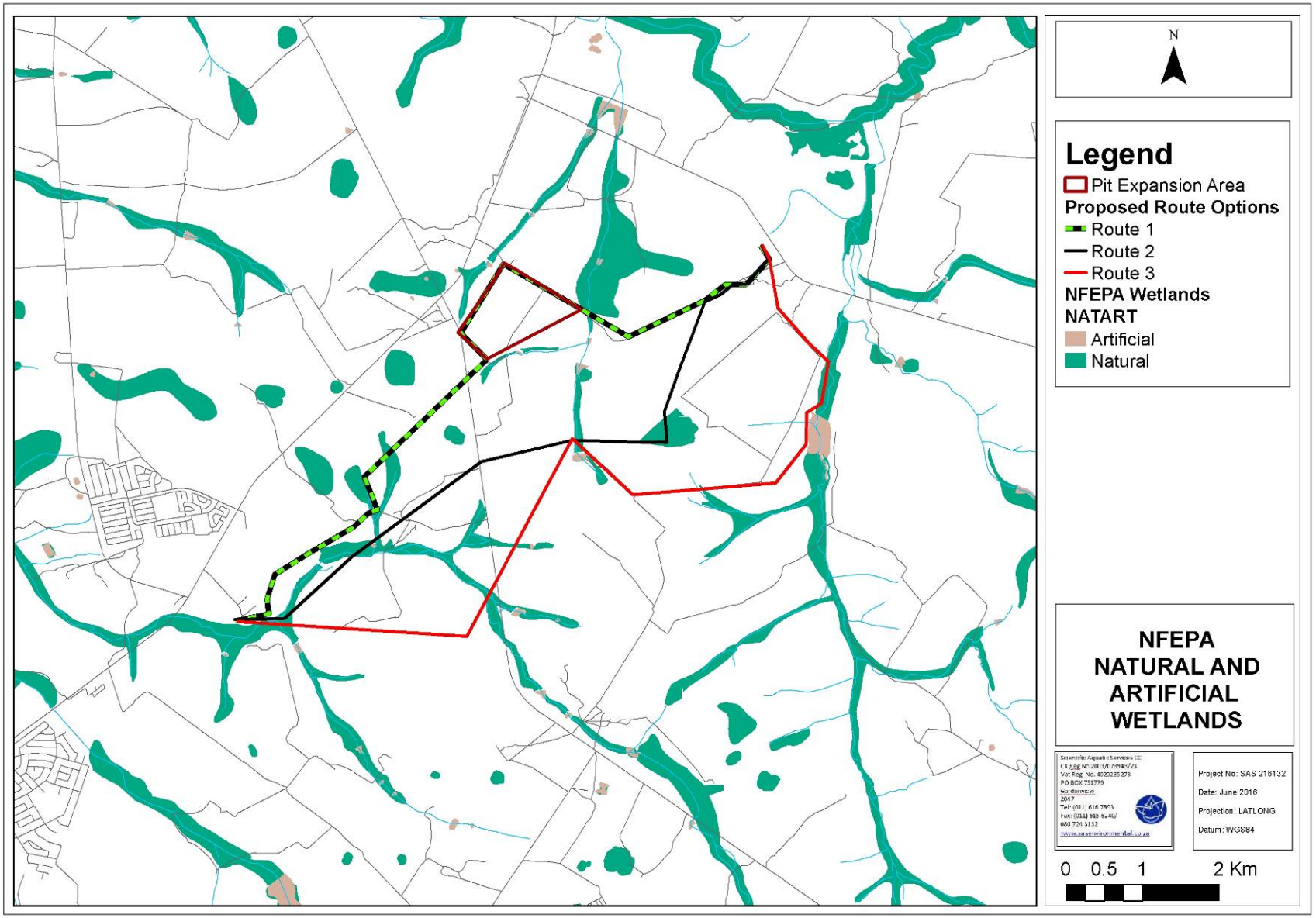


Figure 5: Natural and artificial wetlands traversed by the linear development and associated surrounding areas according to NFEPA (2011).

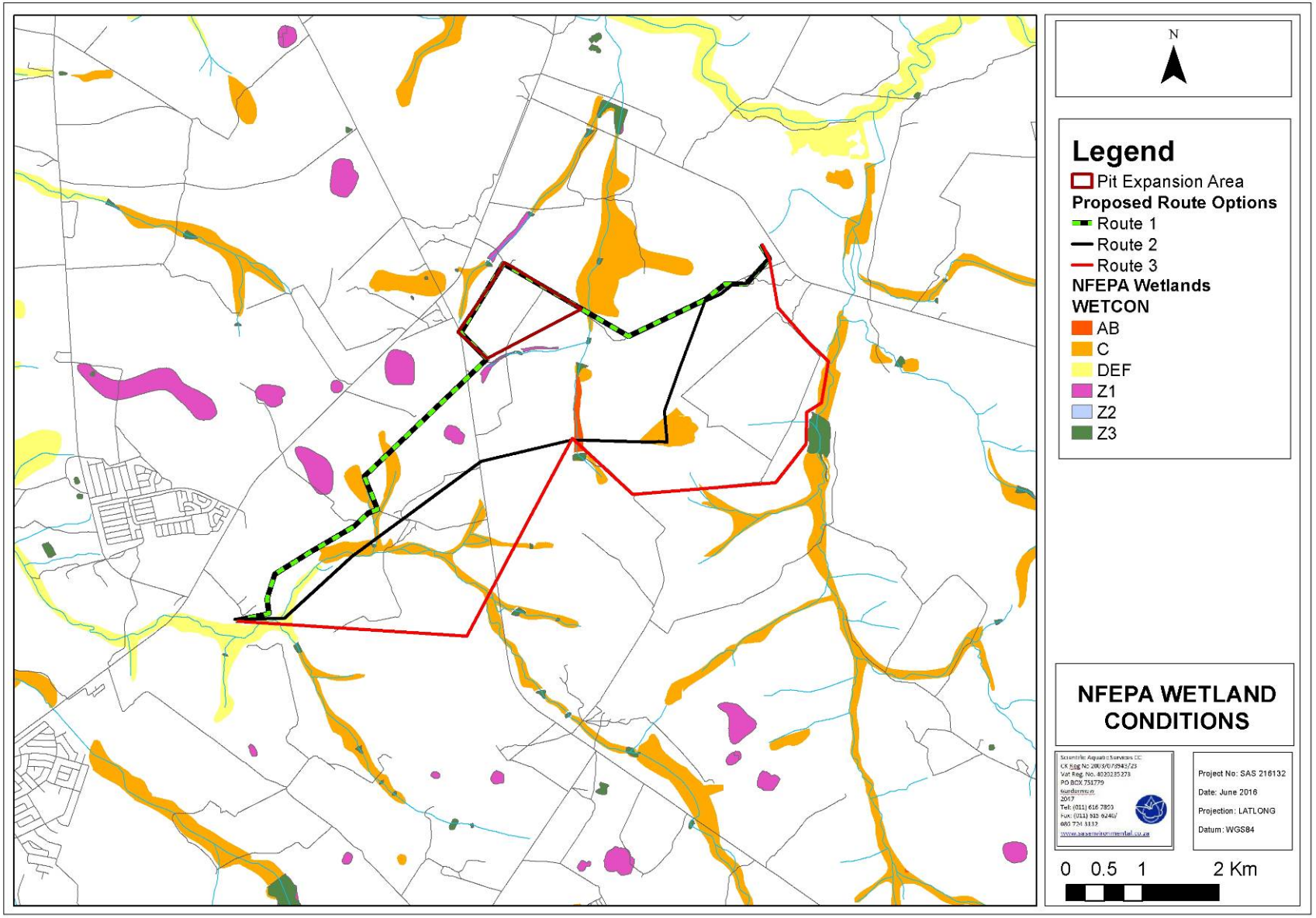


Figure 6: Wetland conditions of the wetland features identified by NFEPA (2011) that are traversed by the linear development.

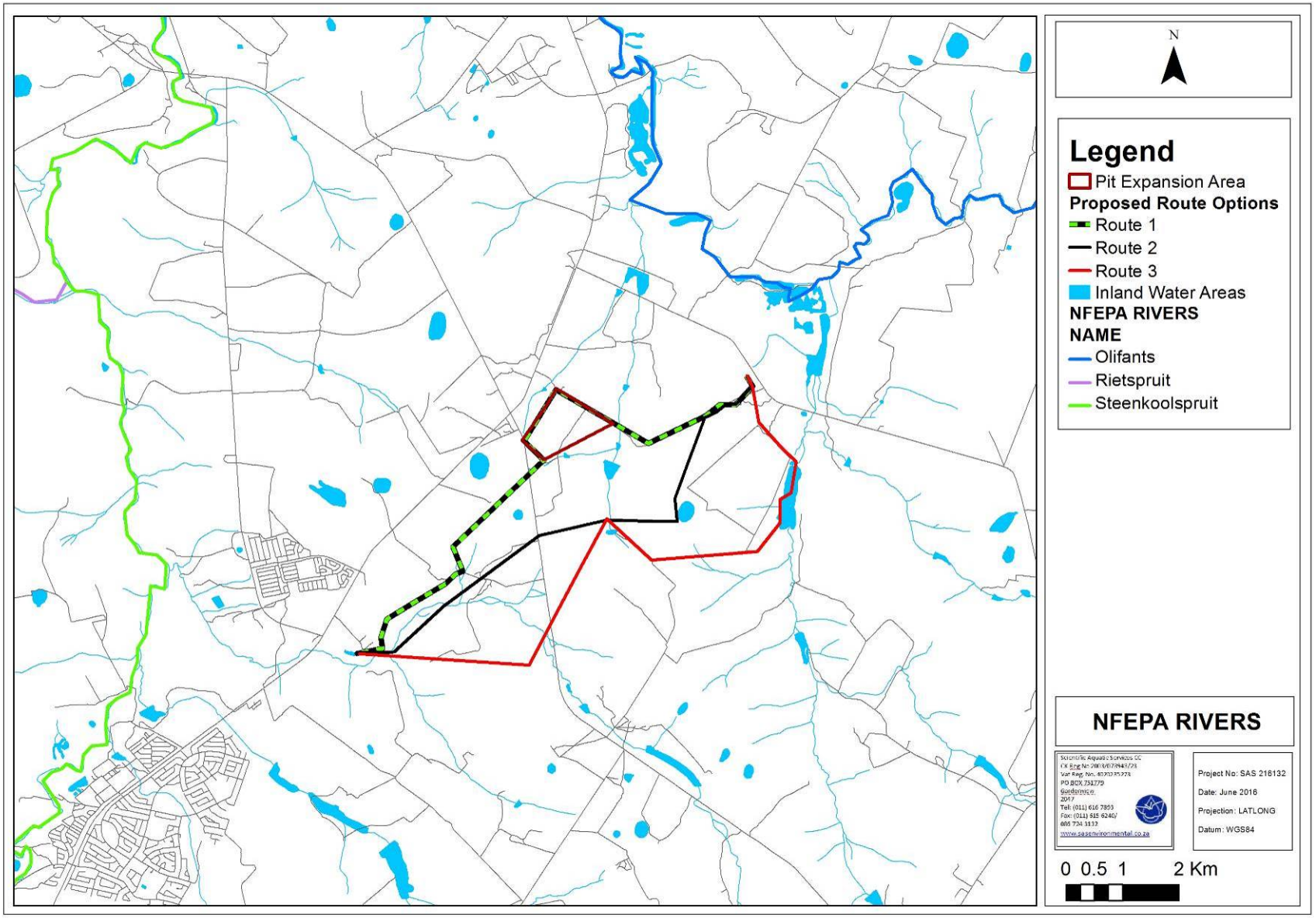


Figure 7: The Olifants and Steenkoolspruit Rivers located within close proximity (±1.6-3.1km) to the linear development.

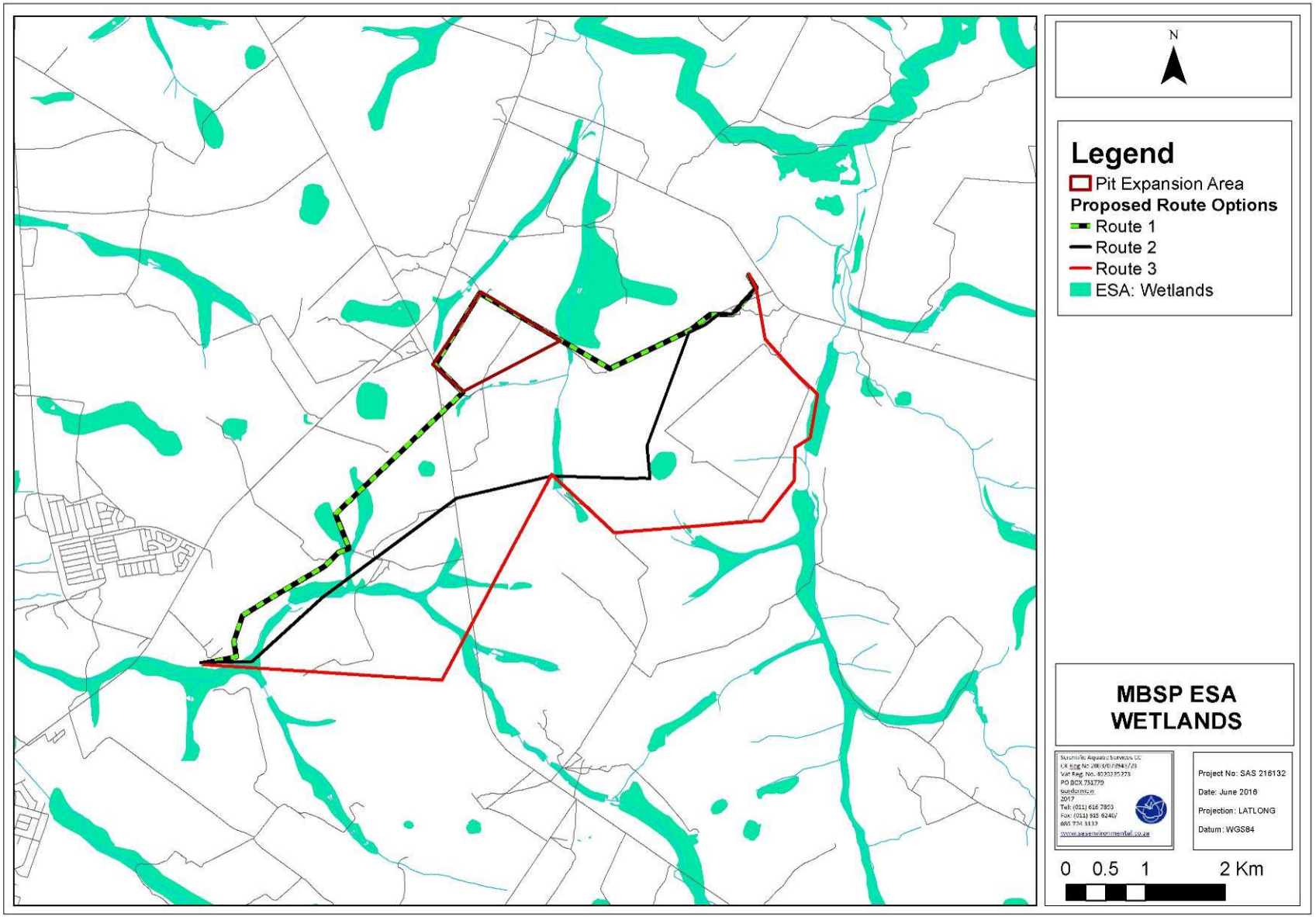


Figure 8: MBSP Freshwater Assessment indicating ESA wetlands traversed by and in the vicinity of the linear development (MBSP, 2014).

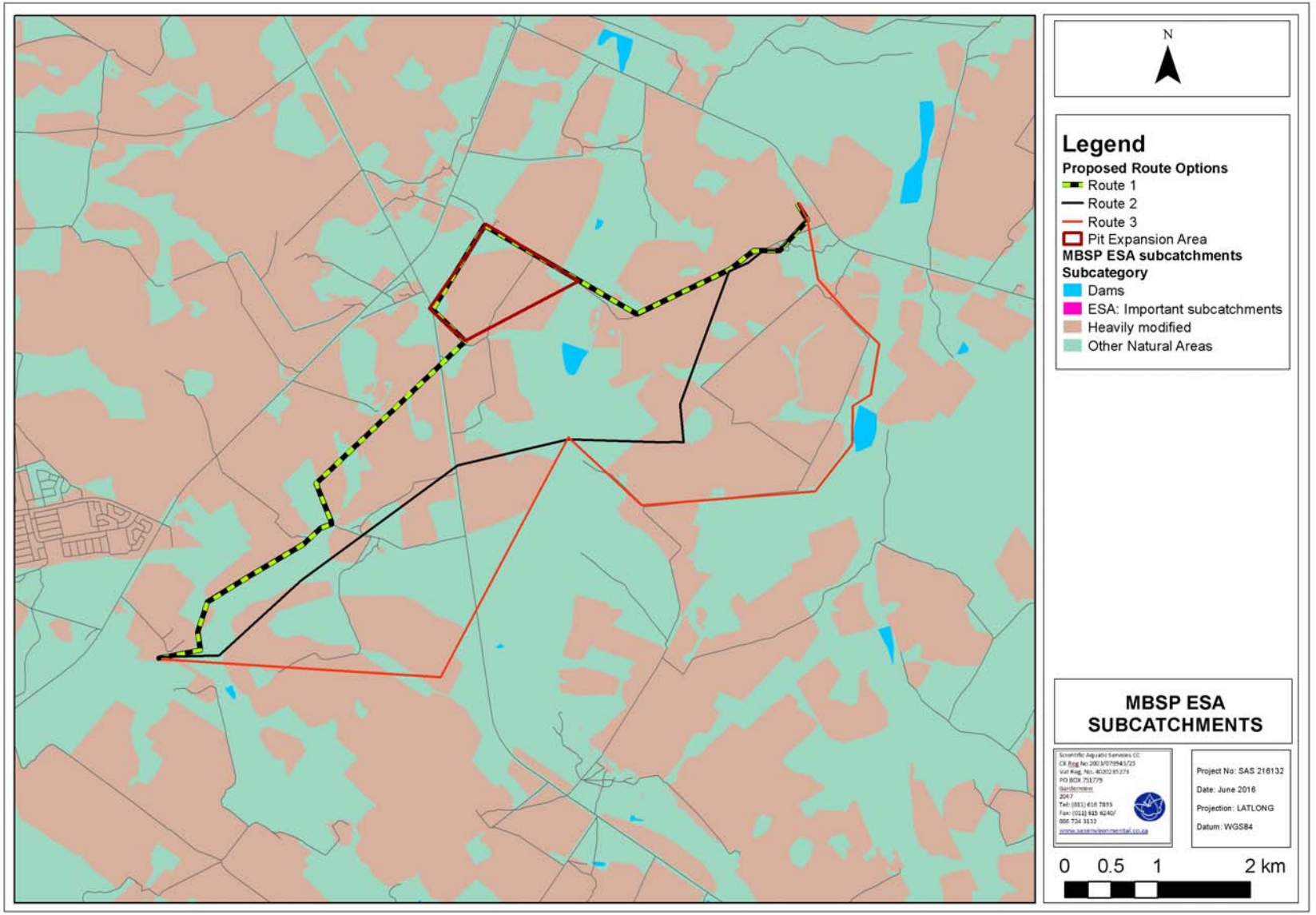


Figure 9: MBSP Freshwater Assessment indicating ESA subcatchments of the area (MBSP, 2014).

4 RESULTS

4.1 Wetland System Characterisation

During the field assessment, one freshwater resource, comprising three HGM types, was identified along the proposed pipeline routes. The resource was characterised as an inland system (i.e. a system having no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically), located within the Highveld Aquatic Ecoregion. The applicable WetVeg group is the Mesic Highveld Grassland Group 4. The characterisation of this resource is summarised in Table 2 below, whilst Figure 11, 12 and 13 illustrate the locality of the resources in relation to the linear development.

Table 2: Characterisation of the resources identified along the linear development.

Freshwater Resource	Level 3: Landscape unit	Level 4: HGM Type
Dorsfontein Wetland	Valley: The typically gently sloping, lowest surface of a valley.	Channelled valley bottom: A valley bottom wetland with a river channel running through it.
		Unchannelled valley bottom: A valley-bottom wetland without a river channel running through it.
	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.	Hillslope 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.

For the purpose of this report and in order to suitably quantify and assess the Dorsfontein wetland systems, the HGM units will be assessed individually, namely:

- Channelled valley bottom wetlands;
- Unchannelled valley bottom wetlands; and
- Hillslope Seeps.

It was noted during the site assessment that a number of small artificial dams have been excavated in some of the areas nearby the proposed linear development routes. Route 1 traverses one of these artificial dams, however the dam at the time of assessment was dry, with a portion of the dam wall broken, so that the dam is no longer functional and does not retain any water. *Imperata cylindrica* was observed in and around the old artificial dams, all of which had broken dam walls and were no longer functional. Although *Imperata cylindrica* is typically associated with moist/ saturated conditions, it can also be associated with areas were soil disturbance has occurred. Furthermore, the soil profiles in and around the

decommissioned artificial dams did not indicate wetland conditions (No mottling of the soil was evident).

No wetlands were observed within the pit expansion area, with this area being characterised almost wholly of agricultural land. However, a wetland system was observed approximately 120m to the east of the proposed pit expansion area. As such it must be noted that the expansion pit may impact on this system. The excavation of the expansion pit may result in the dewatering of this wetland system, altering the natural hydrological cycle and in turn negatively impacting upon the ecoservices provision of this wetland.

Figure 10: Representative photographs of the artificial dam encountered along the north-eastern portion of route one and soil profile picture indicating no mottling present.

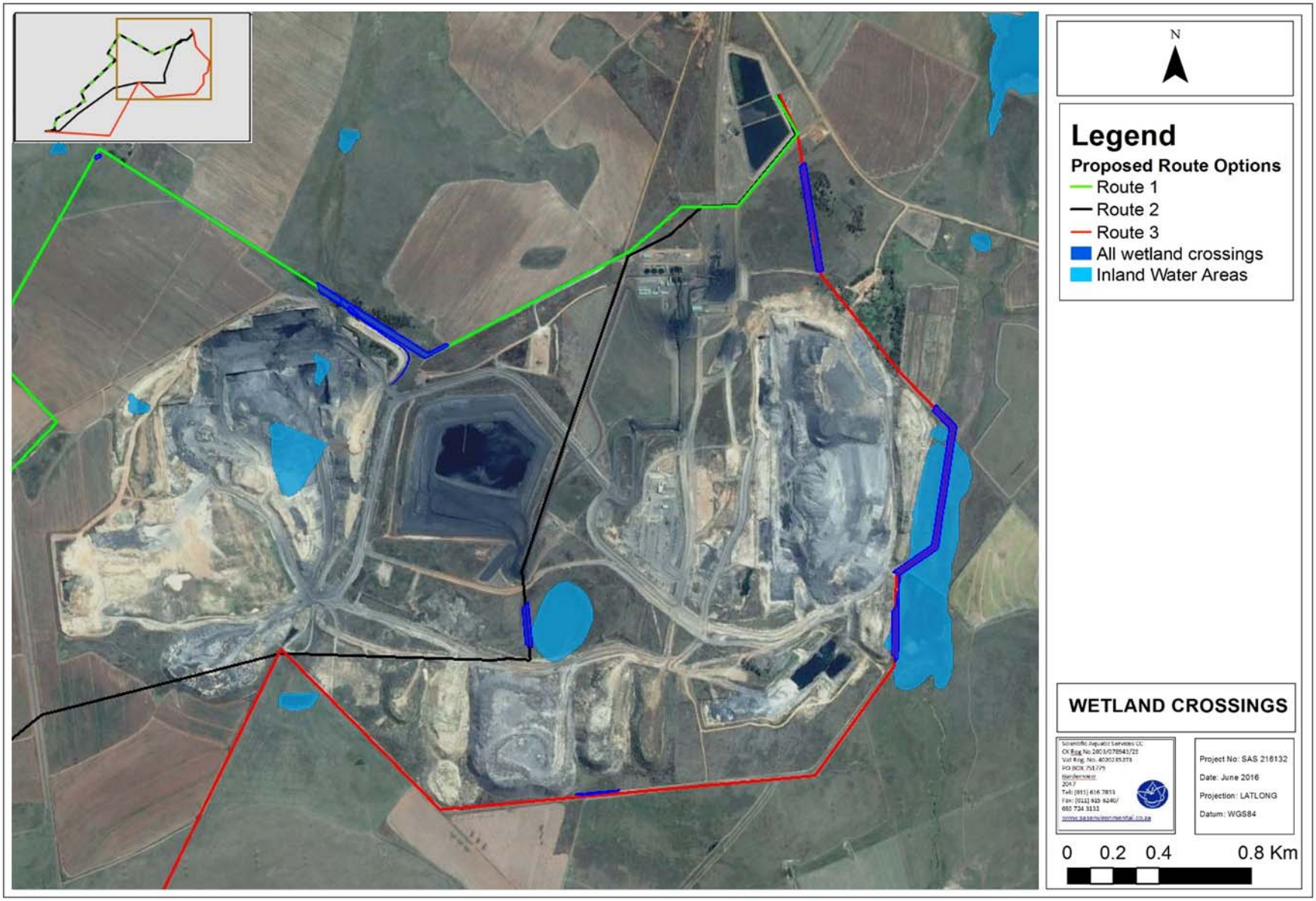


Figure 11: The location of the watercourses identified during the field assessment.

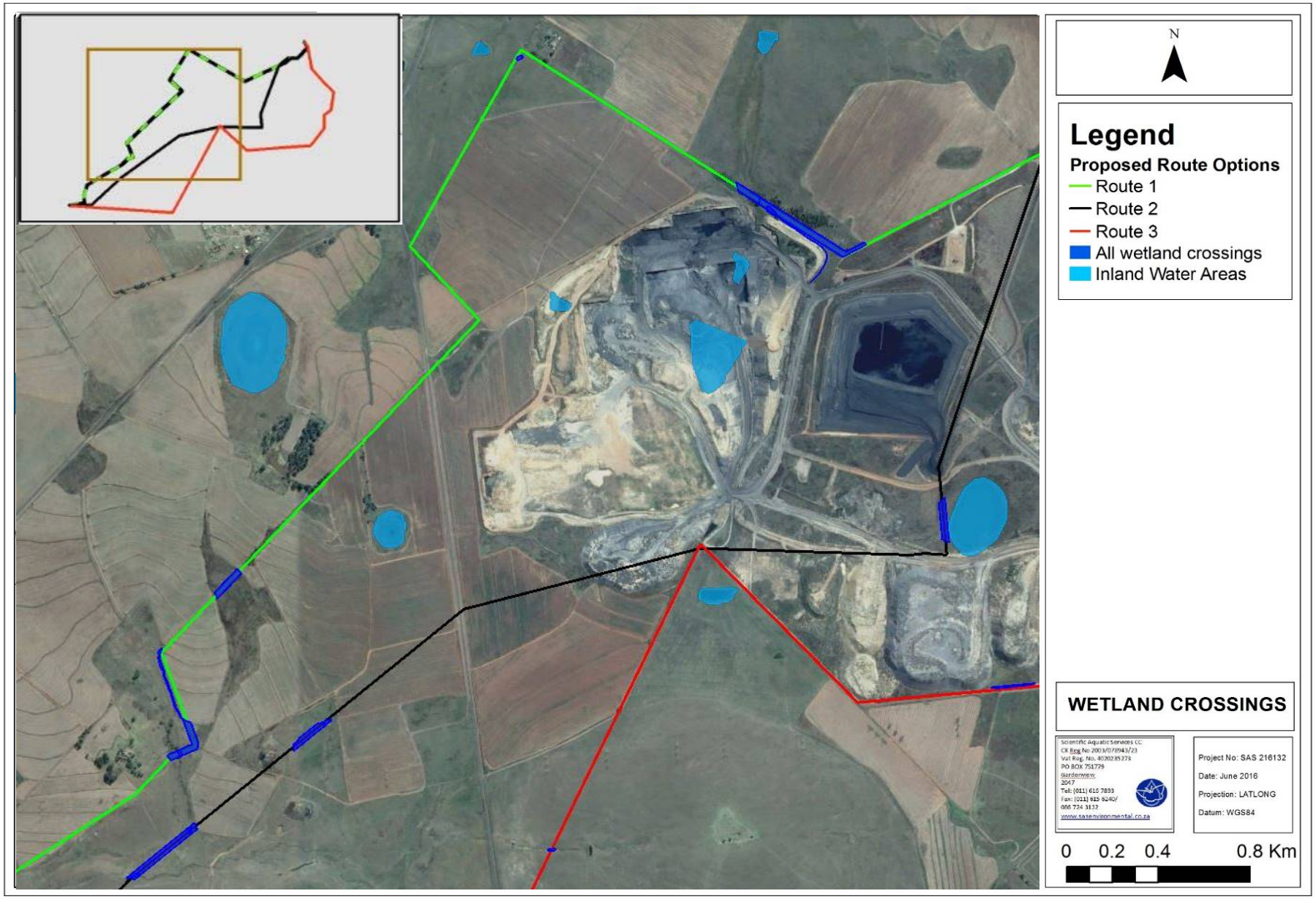


Figure 12: The location of the watercourses identified during the field assessment.

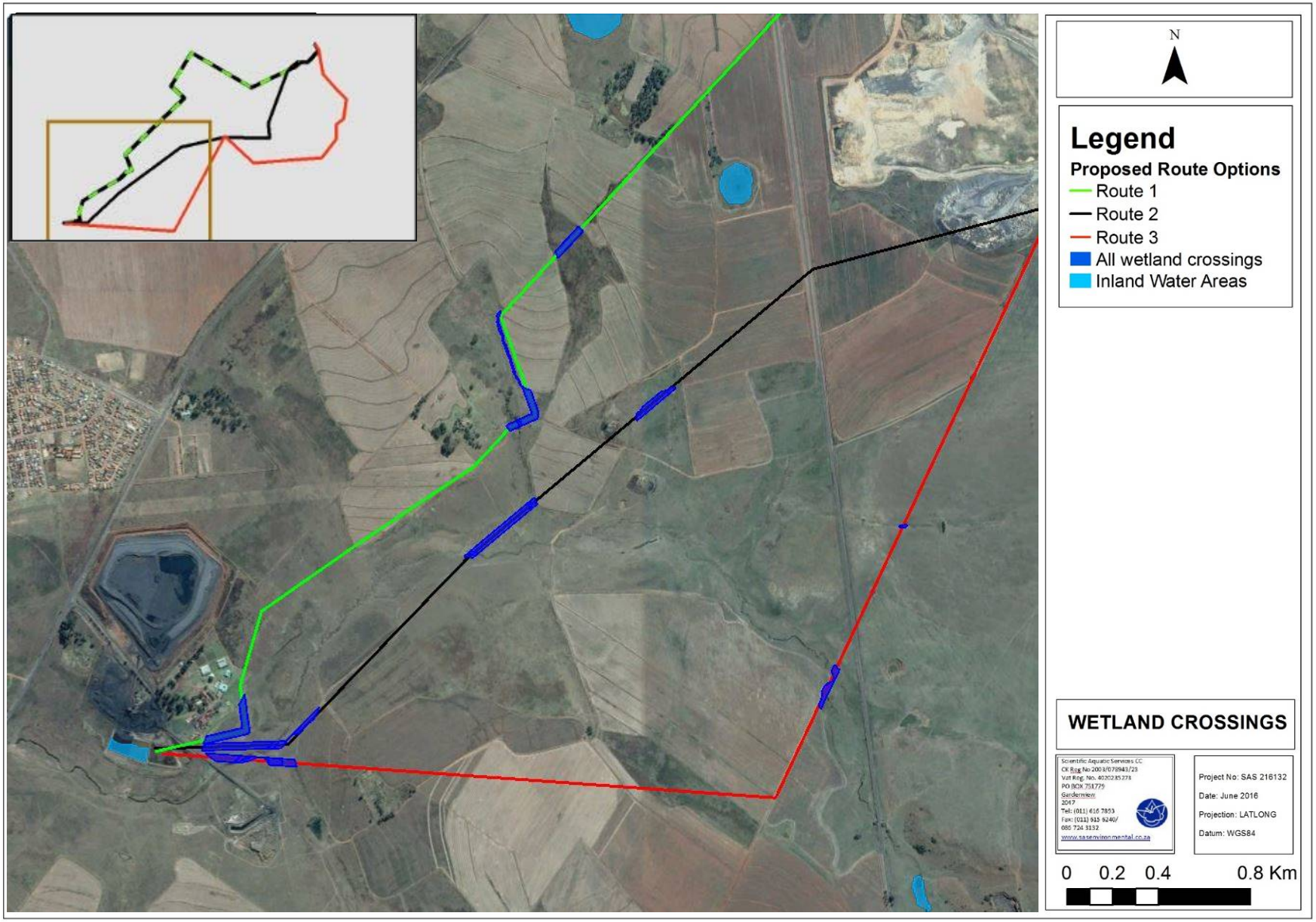
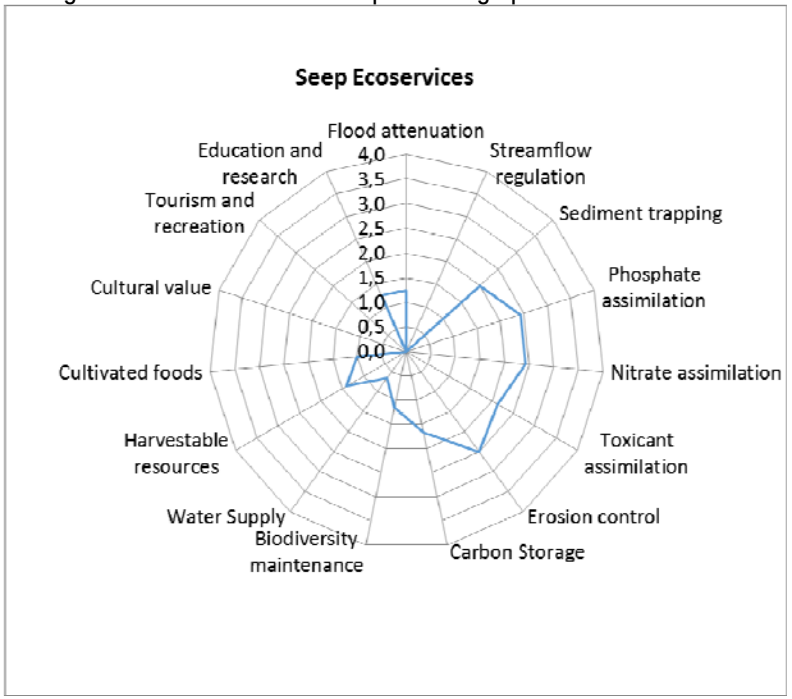


Figure 13: The location of the watercourses identified during the field assessment.

4.2 Field Verification Results

The tables below summarise the findings of the field assessment in terms of relevant aspects (hydrology, geomorphology and vegetation components) of freshwater ecology. The details pertaining to the methodology used to assess the various features is contained in Appendix C of this report whilst Appendix E presents the calculations for each of the watercourses identified within the study area.

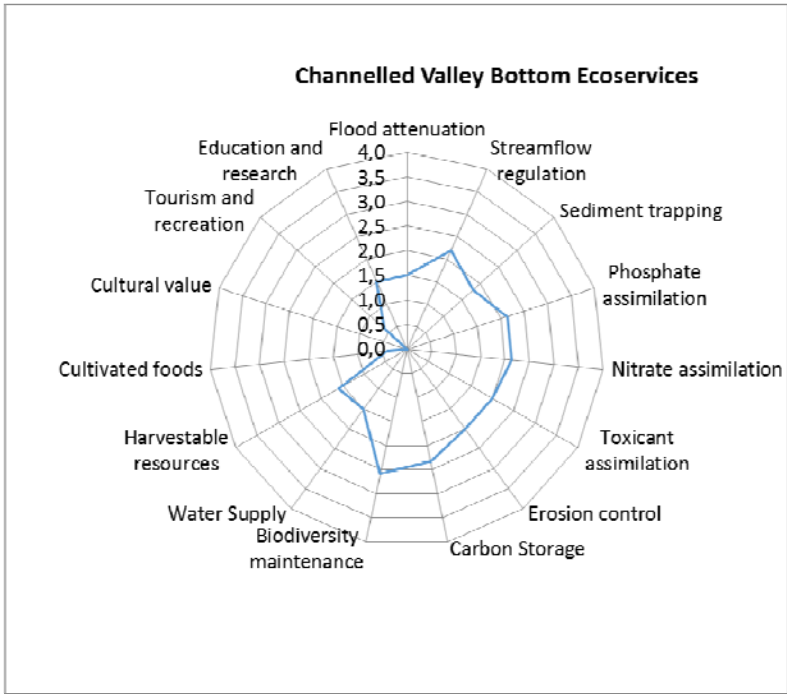
Table 3: Summary of the assessment of Hillslope Seep wetlands

<table>
<tr><td colspan="3">Resource: Hillslope Seep wetlands
Ecological & socio-cultural service provision graph:
 
</td><td colspan="4">  </td></tr>
<tr><td>Feature HGM Unit Description</td><td>Hillslope Seep</td><td>Fatal Flaw?</td><td>N</td><td>Photograph notes</td><td>Photos illustrating various seeps observed along the proposed linear development, as well as soil with mottling. Some of the seeps are located between agricultural land (bottom left) and are dominated by alien vegetation. Less impacted seeps (bottom right) had a very low soil moisture content and are utilised for cattle grazing.</td></tr>
<tr><td>PES discussion</td><td colspan="5">PES Category: B
In general, the seeps observed are considered to be in a good condition, proving suitable habitat for floral and faunal species. Modifiers to these features include agricultural activities and an increase in alien vegetation due to edge effects from surrounding farming and mining activities. The ecological integrity and hydrology of this feature may degrade as a result of erosion and increased sediment deposition should mitigation measures not be adhered to during the construction of the linear development.

Watercourse characteristics:
a) Hydraulic regime
The hydraulic regime of the seep wetlands have been altered as a result of current impacts related to crop cultivation and soil disturbance activities. A number of dirt roads and cultivated lands are located alongside the hillslope seep wetlands, which as a result have impacted upon the natural hydrological regime. Following such, there is now an increased potential of water ponding in areas which may have previously been classified as terrestrial ecosystems. Many of the seeps observed were dry, possibly as a result of a loss of hydrological connectivity or as a result of the decreased water input into the systems from natural discharges (ground water, rainfall).</td></tr>
</table>

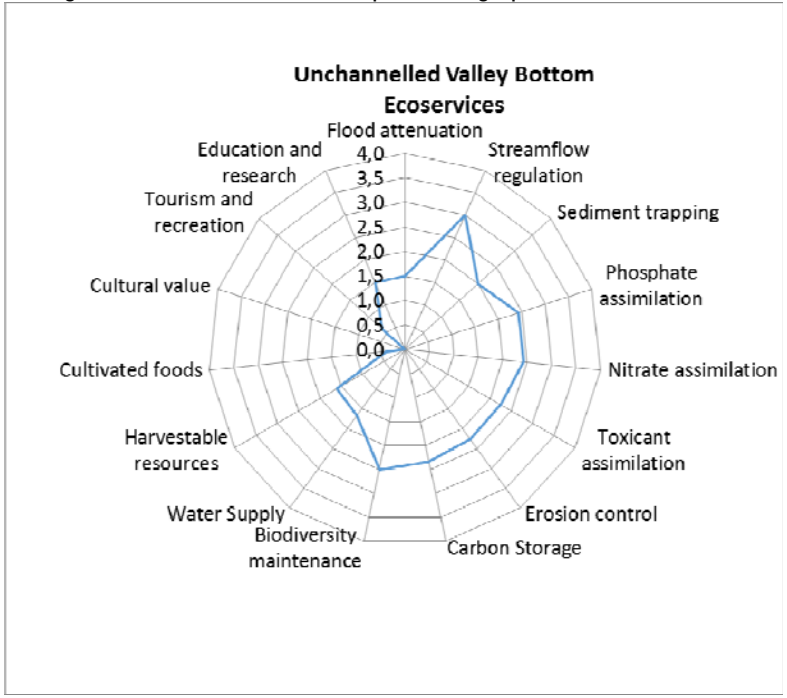
Ecoservice provision	Intermediate: Despite the modifications to the wetland and the subsequent effects on the ecological integrity thereof, the hillslope seeps are deemed to provide intermediate levels of ecological functioning, particularly in terms of nitrate, phosphate and toxicant assimilation.as well as erosion control. Whilst the vegetation community composition has been slightly altered from reference conditions, the structure and basal cover is nevertheless deemed to be adequate for the provision of certain ecological services. The hillslope seeps however are not considered important for education and research purposes or for water supply for human use.		b) Water quality No water was observed within the seeps at the time of assessment. However, the water quality is presumed to be of a moderate to moderately high quality. No waste water discharge from local sewage works into the wetland systems was observed, however water runoff from the agricultural lands containing chemicals and fertilizers is likely to impact upon the water quality, the water.
EIS discussion	EIS Category C: Although the ecological integrity of the wetland has been compromised to a degree, sufficient habitat remains at a reasonable level of integrity to retain ecologically important processes. Furthermore, species such as Asio *capensis* (Marsh Owl) and *Sagittarius serpentarius* (Secretarybird) were observed foraging within the seep wetlands. Evidence of the small carnivore species *Leptailurus serval* (serval) were also observed, with the tall grass structure providing suitable hunting habitat for this species. In conclusion, the hillslope seep wetlands are considered to be of moderate ecological importance and sensitivity.		c) Geomorphology and sediment balance It was apparent during the field assessment that several modifiers have impacted upon the geomorphology of the hillslope seeps, notably the ploughing of agricultural fields and presence of dirt roads. These modifiers have resulted in hard surfaces (roads) around the HGM allowing for greater water and sediment runoff into the water, as well as increased sediment loads from the loose soils of the ploughed fields.
REC Category	Category C: This feature is considered to be ecologically moderately intact. This REC category indicates that management measures should be implemented to ensure that present levels of ecological services and functioning of this feature are retained and are not permitted to deteriorate further.		d) Habitat and biota Since the assessment took place in late autumn, some floral species with a spring/summer flowering season could not be identified, and some species may have already entered a period of dormancy The majority of this feature is well vegetated, however, areas of the temporary zones have been ploughed and utilised for crops. Alien plant proliferation is evident in a number of the hillslope seeps that are in close proximity to agricultural lands, with a stands of *Populus x canescens*, *Salix babylonica* and *Tagetes minuta* observable. Nevertheless, several indigenous graminoid species were identified, including *Eragrostis curvula, Eragrostis gummiflua, Imperata cylindrica* and *Cirsium vulgare*, indicating that although vegetation communities have been impacted upon, the alterations are not deemed severe. Faunal species such as *Asio capensis* (marsh owl) and *Sagittarius serpentarius* (Secretarybird) were observed, indicating that the seep wetlands are still viable and utilised by faunal species.
Impact significance prior to mitigation	MH	The hillslope seep wetlands will be impacted upon as a result of the linear development. Impacts could alter the habitat and sensitivity of the system. Therefore, impacts will be of "medium high" level without mitigation measures. However, if mitigation measures are implemented, impacts will be of "low" level.	Business case, Conclusion and Mitigation Requirements: Although much of the area has been ploughed or is being mined out, there has been notably intermediate levels of disturbance to the seep wetlands. These wetlands still provide suitable habitat and good vegetation cover for floral and faunal species. Potential impacts on the wetland arising from the proposed linear development include increased erosion potential, disturbances to vegetation (and therefore reduced capacity to perform certain functions) and an increased proliferation of alien invasive flora as a result of disturbances to the soils. Although the ecological integrity of the feature has been compromised as a result of the surrounding farming activities, the feature is not considered severely modified, and further degradation should not be permitted. Strict enforcement of mitigation to prevent further impacts on the feature during all phases of the proposed development must take place.
Impact significance post mitigation	L		

Table 4: Summary of the assessment of Channelled Valley Bottom wetlands

<table>
<tr><td colspan="3">Resource: Channelled Valley Bottom wetland
Ecological & socio-cultural service provision graph:
 
</td><td colspan="4">  </td></tr>
<tr><td>Feature HGM Unit Description</td><td>Channelled Valley Bottom</td><td>Fatal Flaw?</td><td>N</td><td>Photograph notes</td><td>Top: Surface water present within the wetland feature.
Bottom: Alien plant species (Salix babylonica) growing in one of the smaller channelled valley bottom wetlands.</td></tr>
<tr><td>PES discussion</td><td>PES Category: C
The channelled valley bottom wetland is considered to be in a moderately modified condition. The wetland provides suitable habitat for floral and faunal species, with specific mention of Asio capensis (Marsh Owl) and Crinum spp. The surrounding agricultural activities and grazing of the wetlands is the primary system modifier, which has also resulted in an intermediate increase in alien vegetation proliferation. Should suitable mitigation measures not be implemented, it is probable that the ecological integrity and hydrology of this feature</td><td colspan="4">Watercourse characteristics:
a) Hydraulic regime
The channelled valley bottom intercepted by the proposed linear development forms part of a much larger wetland system. A number of in-stream farm dams are located further upstream and within a few of the smaller tributaries. These small farm dams are likely to aid in the attenuation of flood waters but also possibly decrease the base flows in the valley bottom channels during the dryer winter months.</td></tr>
</table>

	will degrade.		
Ecoservice provision	Intermediate: Despite the large scale agricultural practices and coal mining activities occurring within the vicinity of the features, the channelled valley bottom wetlands do not appear to have been heavily impacted upon by the surrounding modifying activities. However, some areas appear to have been subject to an increased grazing regime, most likely attributed to the dry conditions currently being experienced. The channelled valley bottom wetlands are considered of high importance in terms of biodiversity maintenance, carbon storage and streamflow regulation. Nitrate and phosphate assimilation are also considered to be important. Not considered important for cultivated foods, cultural values or tourism and recreation.		b) Water quality The water quality within the wetland feature is likely to be in a good state. Although surface water was only observed within certain sections of the channelled valley bottom, the water that was present had a very low turbidity. With the exception of additional nutrients being added to the water from the surrounding agricultural areas, there are no waste water inputs into the wetland system. Mining activities are not likely to have a large impact upon the channelled valley bottom wetlands assessed, as the wetlands are on an opposite catchment divide to the current mining area.
EIS discussion	EIS Category B: This feature has undergone marginal changes to ecosystem processes. Although there is large scale crop farming and mining activities occurring alongside the larger wetland system, natural habitat of the wetland is predominantly intact and capable of supporting a number of faunal and floral species. This feature is considered ecologically important and sensitive.		c) Geomorphology and sediment balance Geomorphology of the channelled valley bottom wetlands is considered to be largely natural, with minimal impacts as a result of the surrounding crop lands, dirt roads and the small artificial farm dams found further up the system. Windblown dust and surface soil runoff from the surrounding dirt roads and crop fields are likely to increase the sediment balance of the channelled valley bottom wetland.
REC Category	Category B: This feature is considered to be ecologically moderately intact. This REC category indicates that management measures should be implemented to ensure that present levels of ecological services and functioning of this feature are retained and are not permitted to deteriorate further.		d) Habitat and biota The majority of this feature is well vegetated, with little to no evidence of vegetation clearing taking place. Although there were a small number of areas where alien plant species such as *Salix babylonica* were observed growing, the majority of the vegetation within the feature is considered to be natural, with species such as *Cyperus rupestris* and *Imperata cylindrica* being observed. The faunal species *Asio capensis* (marsh owl) were observed within this feature, as well as a number of other smaller avifaunal species. The channelled valley bottom is also likely to provide hunting grounds and corridors for movement to species such as *Canis mesomelas* (blackback jackal) and *Leptailurus serval* (serval).
Impact significance prior to mitigation	MH	The channelled valley bottom wetlands will be impacted upon as a result of the linear development. Impacts could alter the habitat and sensitivity of the system. Therefore, impacts will be of "medium high" level without mitigation measures. However, if mitigation measures are implemented, impacts will be of "low" level.	Business case, Conclusion and Mitigation Requirements: The wetland is considered to be moderately modified, and thus still provides essential ecological services, including habitat provision for various fauna and wetland associated flora. Potential impacts on the wetland arising from the proposed linear development include increased erosion potential, disturbances to vegetation (and therefore reduced capacity to perform certain functions) and an increased proliferation of alien invasive flora as a result of disturbances to the soils. Although the ecological integrity of the wetland has been compromised, the wetland is not considered severely modified, and further degradation should not be permitted. Strict enforcement of mitigation measures to prevent further impacts on the wetland during all phases of the proposed development must take place. It is highly recommended that directional drilling is utilised in order to lay the pipes under the wetland systems in order to minimise impacts.
Impact significance post mitigation	L		

Table 5: Summary of the assessment of Unchannelled Valley Bottom wetlands

<table>
<tr><td colspan="3">Resource: Unchannelled Valley Bottom wetland
Ecological & socio-cultural service provision graph:
 
</td><td colspan="3">  </td></tr>
<tr><td>Feature HGM Unit Description</td><td>Unchannelled Valley Bottom</td><td>Fatal Flaw?</td><td>N</td><td>Photograph notes</td><td>Photos illustrating the Unchannelled valley bottom wetland found to the east of the mine encountered along route 3. The wetland is extensive with some areas inundated with water. Vegetation such as Typha capensis was noted throughout the feature, whilst soils encountered showed strong signs of hydromorphy.</td></tr>
<tr><td>PES discussion</td><td colspan="5">PES Category: C
The close proximity of mining and agricultural activities has impacted upon the hydrology, geomorphology and vegetation characteristics of the wetland. The overburden dumps from the mine have encroached upon the wetland, increasing sediment deposition as well as altering water inputs into the wetland, which has decreased the ecological integrity of the wetland feature. Due to disturbances to the soil profiles,
Watercourse characteristics:
a) Hydraulic regime
The hydraulic regime of the wetland has been altered as a result of historical and current modifiers, notably from the surrounding mining and agricultural activities. Historical impacts include the placement of flow-altering infrastructure such as an old earthen dam wall located within the wetland which has resulted in decreased water flow downstream. Current impacts on the hydrology of the system primarily relate to the increased water runoff from the surrounding mining areas as water permeability is decreased in these areas. Further, upstream of</td></tr>
</table>

	vegetation communities have been transformed and the presence of alien invasive species has increased.		the feature are a number of small earthen dams which have also altered the overall hydrological regime of the system.
Ecoservice provision	Intermediate: Considered of high importance for stream flow regulation, due to the overall width, surface roughness and low gradient of the feature. Similarly, the wetland feature is considered important for phosphate, nitrate and toxicant assimilation as well as biodiversity maintenance and carbon storage. Not considered important for any tourism or recreational activities, or delivering any cultivated foods.		b) Water quality Water quality was deemed to be good, no waste water input is occurring, however as a result of the artificial dam structure and subsequent water retention, there is an increased level of rotting plant mass present, however no strong odours suggesting sewage input were detected.
EIS discussion	EIS Category C: This feature has undergone marginal changes to ecosystem processes. Although there is large scale crop farming and mining activities occurring alongside the wetland system, natural habitat of the wetland is still considered to be relatively intact and capable of supporting a number of faunal and floral species. This feature is considered ecologically important and sensitive, forming part of a much larger wetland system both up and downstream.		c) Geomorphology and sediment balance Impacts on the geomorphology of the wetland are predominantly driving by the local mining and farming activities, as well as a number of dirt roads in the vicinity of the wetland feature. Increased sedimentation of the wetland has occurred as a result of runoff from the crop fields and overburden dumps, however due to the wetland being well vegetated the system has been able to capture and control the increased sediment levels.
REC Category	Category C: This wetland is considered to be of a moderate ecological level. This REC category indicates that construction activities associated with the linear development should be properly managed and adequate mitigation measures should be implemented to ensure that present levels of ecological services and functioning of this feature are retained and are not permitted to deteriorate further.		d) Habitat and biota Alien vegetation was observed within the wetland feature, however the degree of alien plant proliferation is low, with most of the vegetation in the wetland being natural wetland species. The inundated areas of the wetland are primary amphibian habitat, whilst a number of waterfowl were also observed, whilst spoor of *Canis mesomelas* (blackback jackal) were also observed along the periphery edges of the feature.
Impact significance prior to mitigation	MH	The Unchannelled valley bottom wetlands will be impacted upon as a result of the linear development. Impacts could alter the habitat and sensitivity of the system. Therefore, impacts will be of "medium high" level without mitigation measures. However, if mitigation measures are implemented, impacts will be of "low" level.	Business case, Conclusion and Mitigation Requirements: The features is considered to be moderately modified, thus are still capable of providing essential ecological services, including fauna and flora habitat provision, trapping of sediments and management of storm water flows. Potential impacts on the wetland arising from the proposed linear development include increased erosion potential, disturbances to vegetation (and therefore reduced capacity to perform certain functions) and an increased proliferation of alien invasive flora as a result of disturbances to the soils. Although the ecological integrity of the wetland has been compromised, the wetland is not considered severely modified, and further degradation should not be permitted. Strict enforcement of mitigation to prevent further impacts on the wetland during all phases of the proposed development must take place.
Impact significance post mitigation	L		

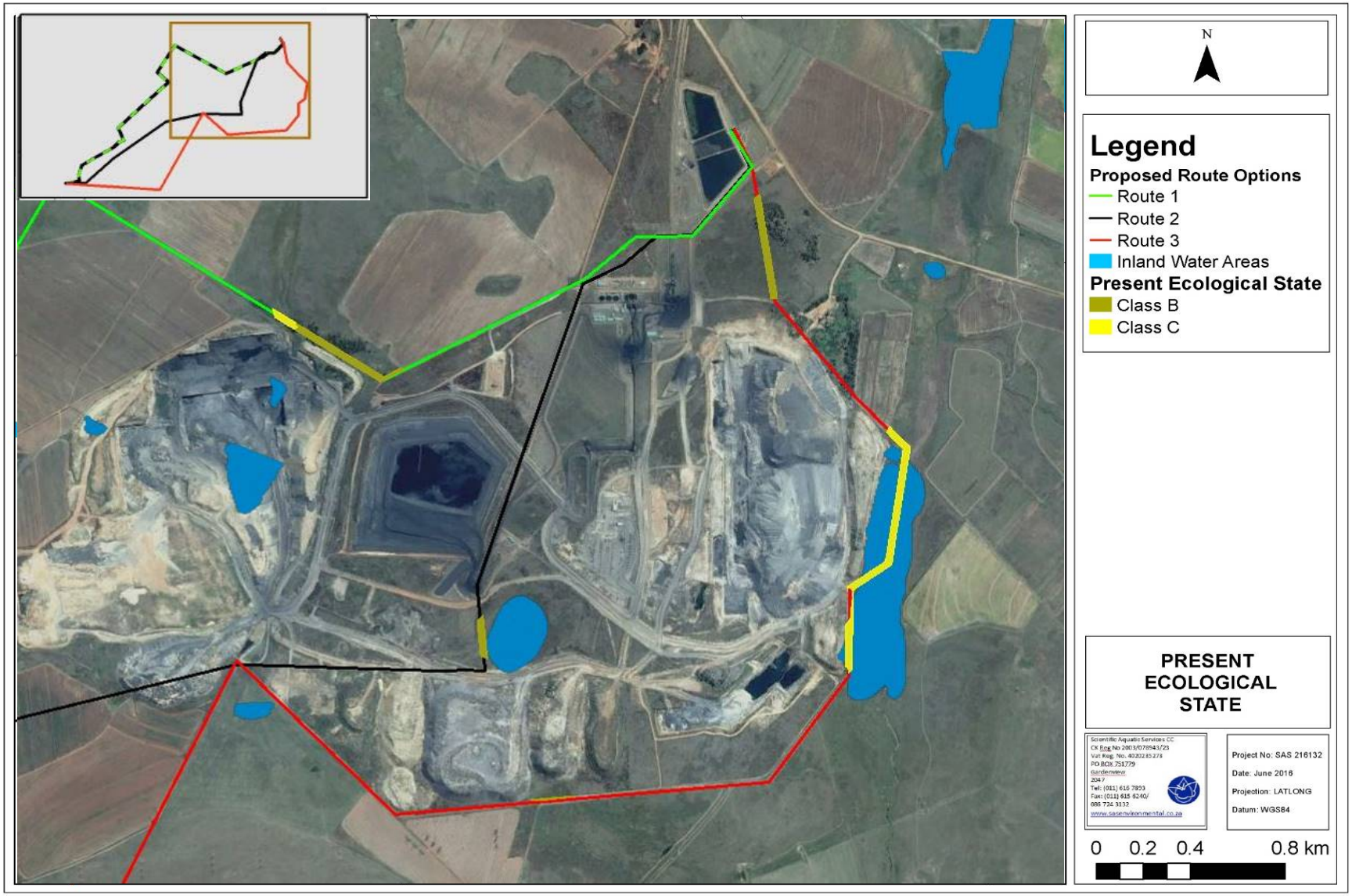


Figure 14: Conceptual illustration of the PES categories of the assessed freshwater features.

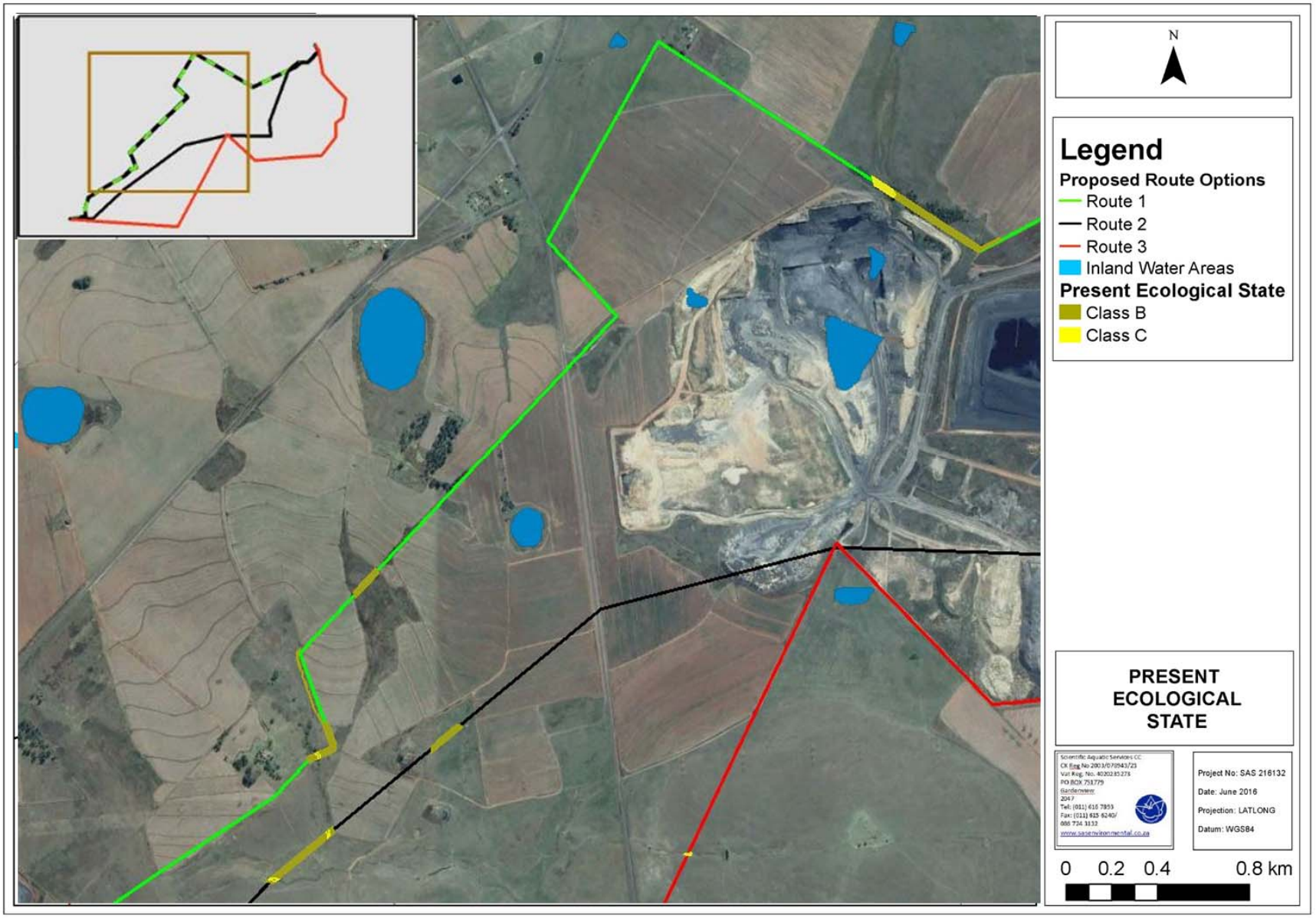


Figure 15: Conceptual illustration of the PES categories of the assessed freshwater features.

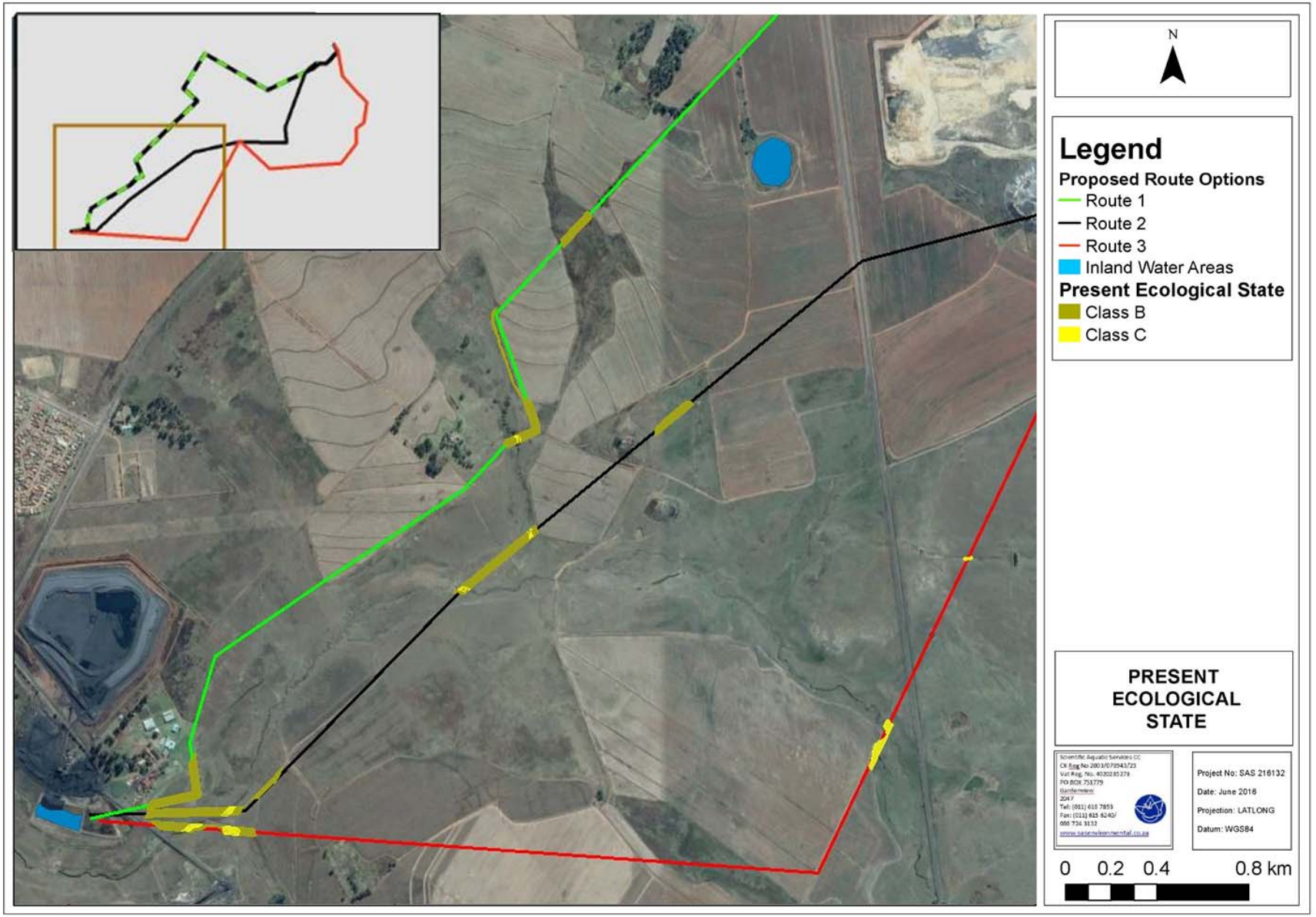


Figure 16: Conceptual illustration of the PES categories of the assessed freshwater features.

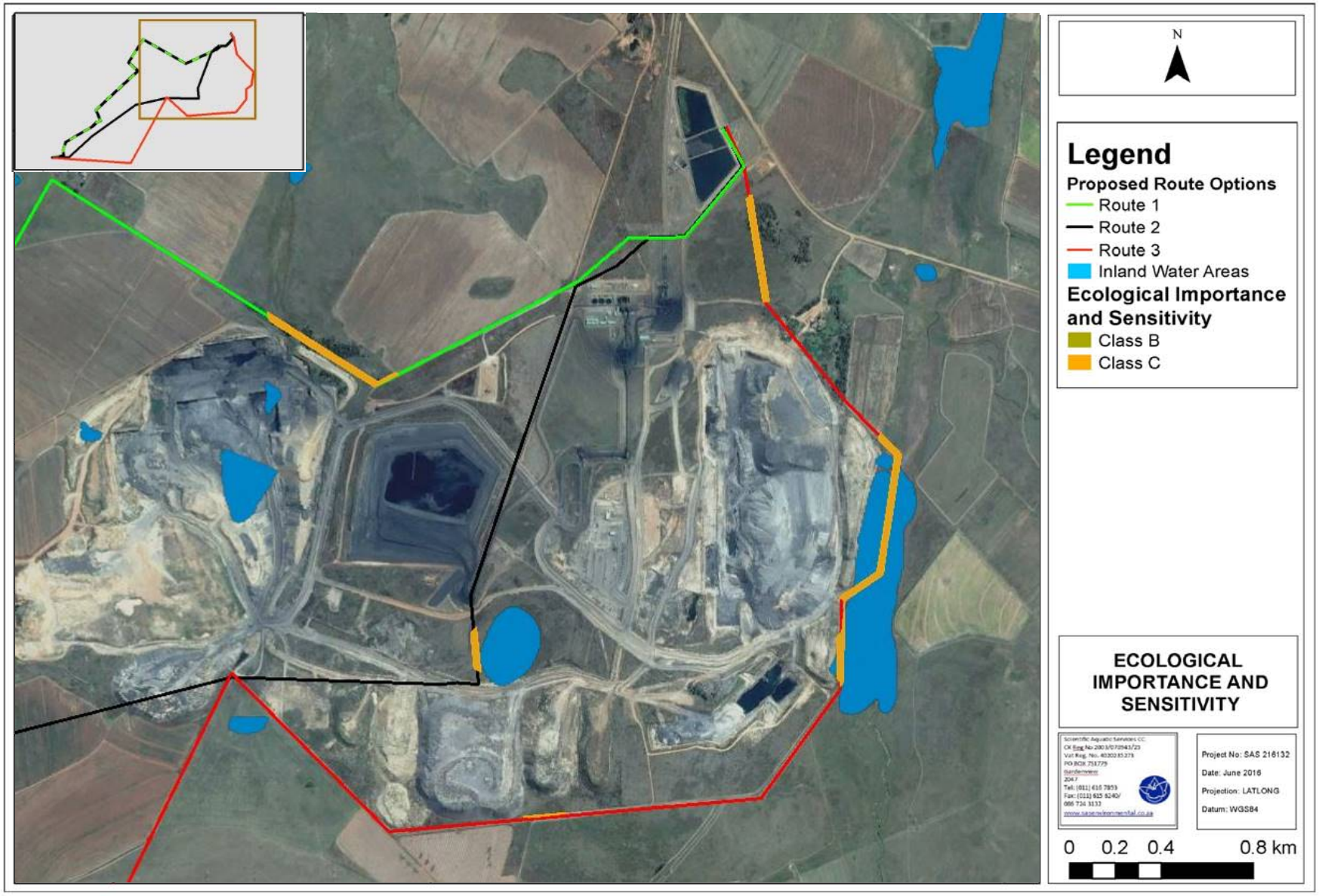


Figure 17: Conceptual illustration of the EIS categories of the assessed freshwater features.

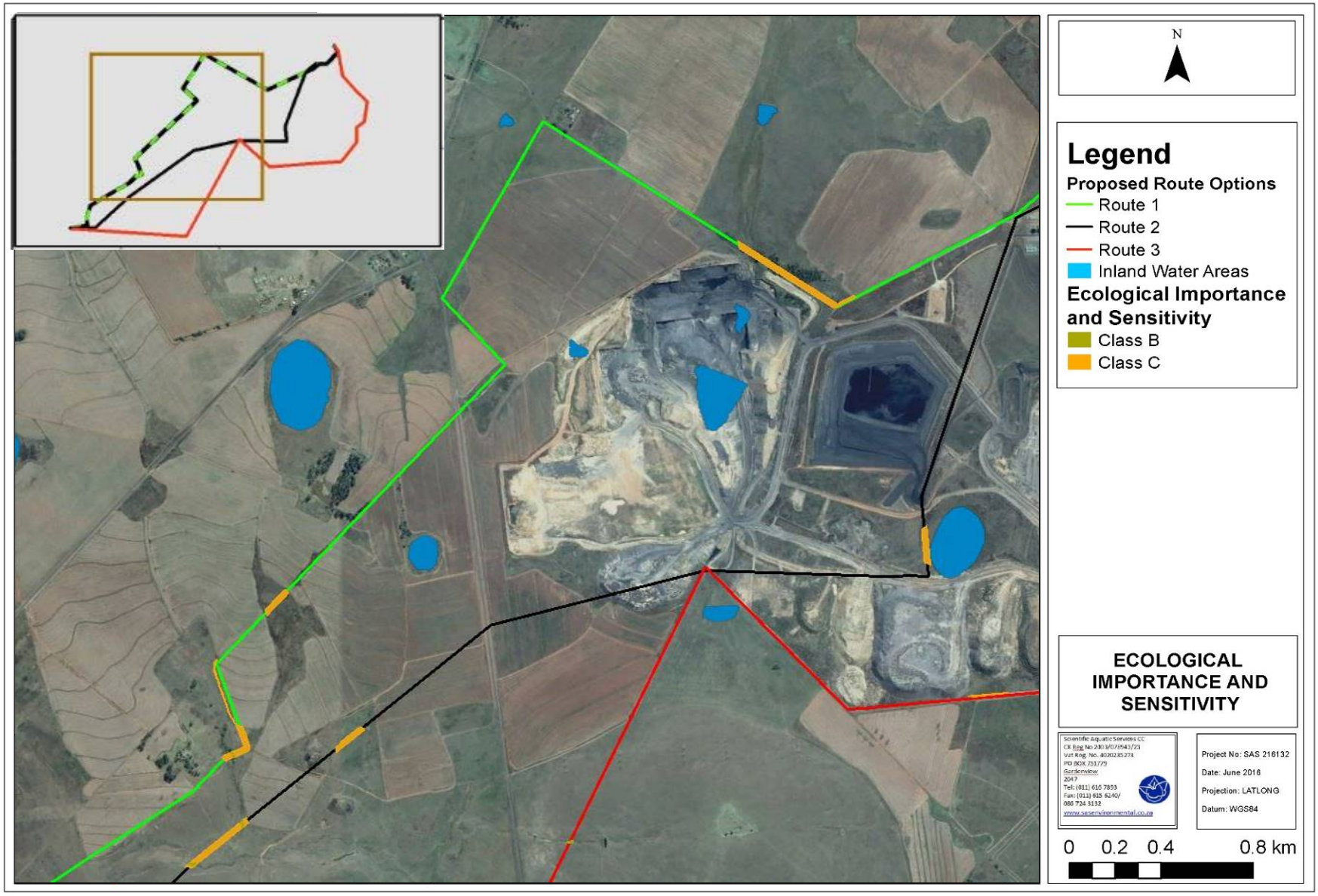


Figure 18: Conceptual illustration of the EIS categories of the assessed freshwater features.

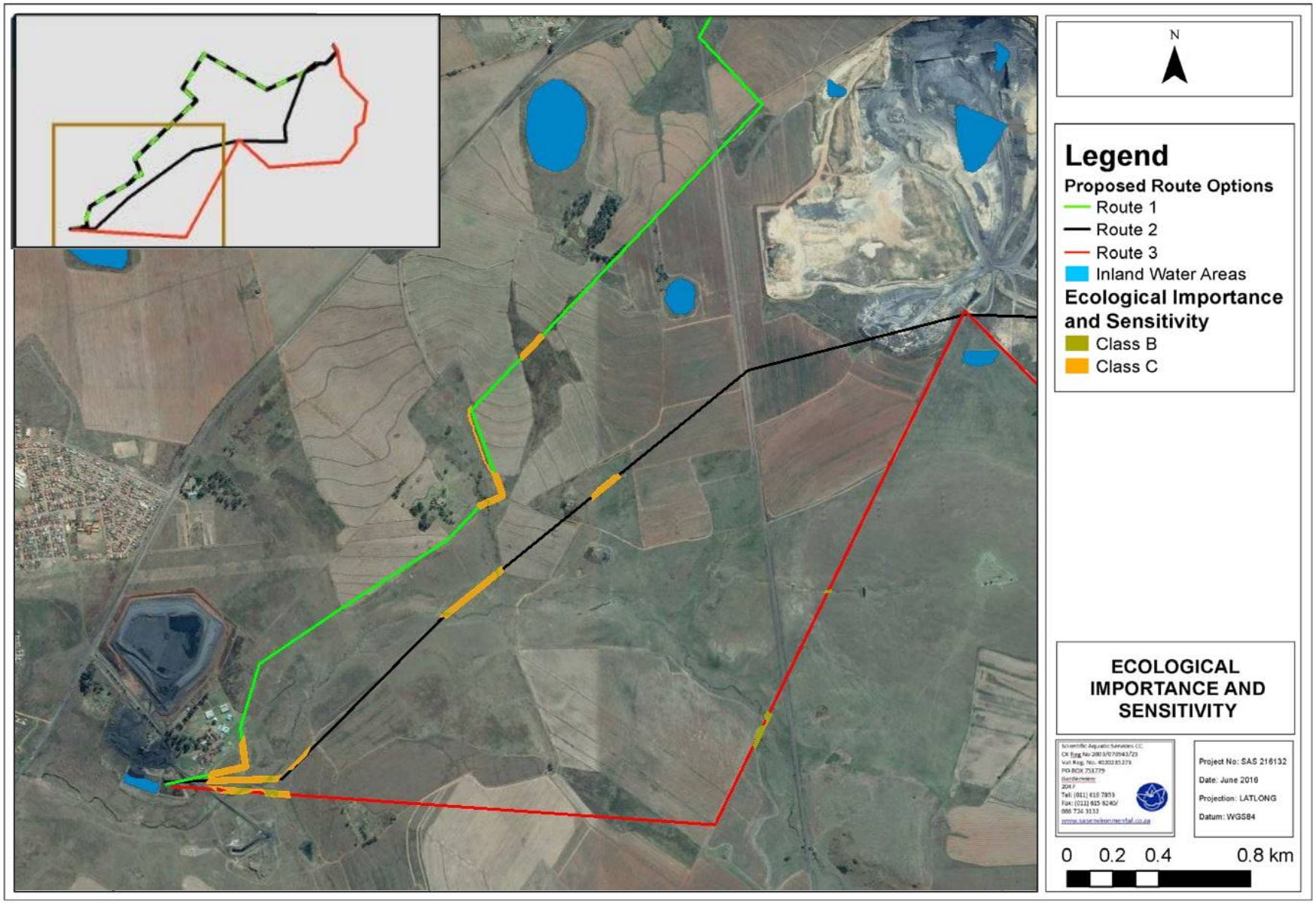


Figure 19: Conceptual illustration of the EIS categories of the assessed freshwater features.

4.3 Delineation and Sensitivity Mapping

Prior to the site visit, points of interest were identified during the desktop phase of the study, and verified during the field survey according to the guidelines advocated by DWAF (2005 and 2008). The freshwater features delineations as presented in this report are regarded as a best estimate of the temporary zone boundaries based on the site conditions present at the time; however, use was made of historical and current digital satellite imagery to further aid in the delineation of the freshwater features.

During the assessment, the following indicators were used to delineate the boundaries of the temporary zones of the freshwater features:

- Terrain units were used to determine in which parts of the landscape freshwater features would most likely occur in, as valley bottom wetlands are easily distinguishable, and the extent of its associated wetland area, if present, can often readily be determined.
- The soil form indicator was used to determine the presence of soils that are associated with prolonged and frequent saturation, as well as fluctuation in the depth of the saturated soil zone within 50cm of the soil surface. This indicator was used to identify gleyed soils, where the soil is a greyish/greenish/bluish colour due to the leaching out of iron. Whilst mottling was not extensive, it was present in the temporary zone.
- The vegetation indicator was used, where possible, in the identification of the freshwater feature boundary through the identification of the distribution of facultative and obligate wetland vegetation. Key species utilised included *Typha capensis* and *Imperata cylindrica.* Changes in vegetation density and levels of greening were also considered during the delineation process; and
- Surface water was noted within the permanent zone, where present and consideration was given to soil moisture in the delineation process.

According to Macfarlane *et al.* (2015), the definition of a buffer zone is variable, depending on the purpose of the buffer zone. However, in summary, it is considered to be “a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another”. The National Environmental Management Act (Act no. 107 of 1998) stipulates that no activity can take place within 32m of a watercourse without the relevant authorisation. In addition, the National Water Act (Act no. 36 of 1998) states that no diversion, alteration of bed and banks or impeding of flow in watercourses (which includes wetlands) may occur without obtaining a water use licence authorising the applicant to do so.

It is the intention of the proponent to construct a water pipeline (linear development) from the Dorsfontein West to the Dorsfontein East Mine, traversing through an area of mixed land uses and types. After the field assessment it is evident that the proposed linear developments will bisect a number of HGM's, namely Hillslope seeps, Channelled valley bottom wetlands and Unchannelled valley bottom wetlands. A buffer width of 15m either side of the linear developments was included in the assessment, with all wetland features encountered along the linear developments being assessed and delineated. Provided that the construction footprint of the linear development is kept to an absolute minimum, and that as far as possible if a wetland is to be crossed it is crossed at an acute angle, it is deemed that the construction of the linear development is unlikely to have any long term impacts on the receiving HGM units. Furthermore, it is recommended that where possible directional drilling is utilised in order to lay the pipe under the wetlands, thereby further minimising the overall impact risk to the wetlands. Provided that all mitigation measures are adhered to it is deemed to be sufficient to maintain the Present Ecological State whilst limiting any further impact on the remaining wetland areas outside of the linear development footprint.

5 IMPACT ASSESSMENT

This section presents the significance of potential impacts on the freshwater ecology within the proposed study area. In addition, it also indicates the required mitigation measures needed to minimise the impacts and presents an assessment of the significance of the impacts, taking into consideration the available mitigation measures and assuming that they are fully implemented.

5.1 Impact Analyses

5.1.1 Mitigation hierarchy and considerations given to application of mitigation measures

Following the assessment of the watercourses within the study area, the mitigation measures were compiled, as defined by the DEA *et al.* (2013), to serve as guidance throughout the development phases. The points below summarise the factors considered in the development of mitigation measures:

- It is preferable to avoid encroachment of activities into the watercourse. The sensitivity map presented in Section 4.3 must be taken into consideration and utilised to guide the footprint area of this development. Should the encroachment of the watercourse be unavoidable, based on the layout plan of the proposed development, then the applicant must obtain a water use licence from DWS prior to commencement of the construction activities;
- In a case where it is impossible to avoid development within the watercourse, it is advisable to minimise the extent and duration of the activities (i.e. during construction and rehabilitation and the use of less invasive methods such as directional drilling techniques) within the watercourse in order to reduce impacts on the biodiversity and ecoservices provision;
- The wetland features must be rehabilitated immediately after the construction phase. During rehabilitation, biodiversity reinstatement and functionality of the wetland features should be key focus areas. The area must be rehabilitated to conditions as close as possible to the original or pre-construction state;
- The following impacts must be prevented:
  - Increased runoff entering the watercourse, transporting with it toxicants and sediment from the road surface;
  - Increased risk of erosion and incision of the watercourse as a result of higher water volumes entering the features due to decreased permeable surface area;

- Increased sedimentation and pollution of the wetland features as a result of the above and also as a result of disturbances to soils during construction;
- Loss of connectivity of freshwater features as a result of crossings through the features habitat, resulting in altered hydrological patterns and fragmented habitats;
- Compaction of freshwater features soils due to indiscriminate movement of construction vehicles within these features; and
- Possible alterations to vegetation community composition as a result of alien vegetation proliferation due to disturbances to soil profiles and clearing of indigenous vegetation in the vicinity of the freshwater features.

5.1.2. Freshwater features impact discussion

There are three ecological impacts on watercourses that are anticipated to occur namely,

- loss of freshwater feature habitat and ecological structure;
- changes to the sociocultural and service provision; and
- impacts on the hydrology and sediment balance of the freshwater features.

Construction and operation of the proposed project may lead to these impacts. However, these impacts can be minimized or avoided, provided the mitigation measures as stated in the previous section (Section 5.1.1 and Appendix F) are implemented and adhered to.

According to the impact assessment calculations tabulated in Appendix F, the impact levels range from medium-low to low prior to mitigation, whereas if mitigation measures are implemented, the impact levels will be reduced to low and very-low. The table below presents a summary of the impact assessment.

Table 6: A summary of the results obtained from the impact assessment (Appendix F)

	Impact 1: Loss of habitat and ecological structure	Pre-mitigation	Post-mitigation
Route 1	Construction	Medium high	Low
	Operational	Medium high	Low
Route 2	Construction	Medium high	Low
	Operational	Medium high	Low
Route 3	Construction	Medium high	Medium-low
	Operational	Medium high	Medium-low
	Impact 2: Changes to the ecological and sociocultural service provision	Pre-mitigation	Post-mitigation
Route 1	Construction	Medium high	Low
	Operational	Medium high	Low
Route 2	Construction	Medium high	Low
	Operational	Medium high	Low
Route 3	Construction	Medium high	Low
	Operational	Medium high	Low
	Impact 3: Impacts on hydrological function	Pre-mitigation	Post-mitigation
Route 1	Construction	Medium Low	Low
	Operational	Medium Low	Low
Route 2	Construction	Medium high	Low
	Operational	Medium high	Low
Route 3	Construction	Medium high	Low
	Operational	Medium high	Low

All of the proposed routes traverse or encroach upon the various wetland systems, and as such will impact upon the features at various points of interception. Route 1 traverses mainly the higher lying areas, utilising existing road and agricultural field fringes, and as such is overall likely to have a lower impact on the overall environment. Route 1 crosses a number of hillslope seeps, however these seeps are located within the agricultural lands and as such have been subjected to historical impacts from agriculture and the edge effects of the current adjacent agricultural activities. The two channelled valley bottom wetlands that route 1 traverses are also located in historically impacted areas, are small in size and have been impacted upon by alien vegetation, with stands of alien vegetation present within these wetlands.

Route 2 extends through the lower lying valleys, directly impacting upon large areas of intact hillslope seeps and channelled valley bottom wetlands. The vegetation and biodiversity of these areas is considered good, and as such route 2 is likely to have a high impact upon the geomorphology, hydrology and biodiversity of these lower lying wetlands, which in turn will have a significant effect on ecoservices provision by the systems crossed.

Route 3 will impact upon a number of channelled valley bottom wetlands, as well as a large section of the Unchannelled valley bottom wetland. The proposed route 3 runs directly within the channelled valley bottom wetland for approximately 1.3km within the permanent and seasonal zones, and as such would have an extensive impact on this feature. Furthermore, route 3 traverses a large hill, comprising of shallow rocky soils. Blasting would most likely be required to lay a pipeline through this areas, which will result in greater impacts to the environment.

No wetlands were observed within the pit expansion area, with this area being characterised almost wholly of agricultural land. However, a wetland system was observed approximately 120m to the east of the proposed pit expansion area. As such it must be noted that the expansion pit may impact on this system. The excavation of the expansion pit may result in the dewatering of this wetland system, altering the natural hydrological cycle and in turn negatively impacting upon the ecoservices provision of this wetland.

During the operational phase, it is expected that the impacts, with and without mitigation measures, will be lower than that of the construction phase. With the implementation of the mitigation measures, all impacts during the operational phase is expected to be of “very low” level.

It is highly recommended that an ongoing alien vegetation control plan is developed and implemented after the operational phase, to ensure that the affected wetlands are rehabilitated to the same or a better state than their current conditions.

Based on the findings of the wetland features ecological assessment, essential mitigation measures are made to minimise the impact on the wetland ecology:

- During the construction phase of the development, all wetland areas other than the immediate areas of crossing are to be demarcated as no-go areas for vehicles and construction personnel;
- Access roads for support vehicles, and vehicles used in the construction of the crossings, should not encroach into the freshwater features.
- Any storage facilities and all other non-essential activities should be located away from the identified wetlands in order to avoid water and soil contamination, which would affect the structure and function of these resources;
- No stockpiling of construction material is allowed within the wetlands or the buffer zones, and all stockpiles must be removed immediately following construction;
- Rehabilitation should be conducted in a manner that ensures that the wetland features’ conditions are reinstated to as natural a state as possible;
- As much vegetation growth as possible should be promoted within the wetland features in order to protect soils. In this regard, special mention is made of the need

to prevent the loss of large areas of the freshwater features' vegetation and the use of indigenous vegetation species' where hydroseeding and rehabilitation planting (where applicable) are to be implemented;

- Vegetation removal should be kept at a minimum to avoid loss of freshwater features' assimilation and attenuation abilities;
- Ensure that all activities affecting the freshwater features in the vicinity of the proposed route are managed according to the relevant DWS licensing regulations;
- Activities that lead to elevated levels of sedimentation in the freshwater features should be minimised. Increased runoff due to vegetation clearance and/or soil compaction must be managed. Where necessary, access roads should have erosion berms installed in order to reduce the speed of any surface runoff, which could initiate erosion.
- The following points should serve as a guideline for berm installation:
  - Where the track has slope of less than 2%, berms should be installed every 50m;
  - Where the track has slope between 2%-10%, berms should be installed every 25m;
  - Where the track has slope between 10%-15%, berms should be installed every 20m;
  - Where the track has slope greater than 15%, berms should be installed every 10m;
- Flow continuity and connectivity of the freshwater features must be reinstated post-construction activities.
- Alien vegetation encountered within the wetlands during the construction phase should be removed, with alien plant management practices put in place during the operational phase. A suitably qualified Environmental Control Officer (ECO) should check for the presence of alien vegetation at least every six months, and before they have a chance to seed. Any alien vegetation that colonises the disturbed areas should be removed immediately; and
- It is recommended that a suitably qualified and independent ECO should monitor the activities during the construction. The aim of the environmental monitoring would be to ensure that the recommendations made in this report to reduce wetland ecological impacts are adhered to. The same person should also inspect the sites at six monthly intervals for a maximum of two years, or until they are satisfied that the area has been suitably rehabilitated where impacted, whichever is the shorter.

6 CONCLUSION

Scientific Aquatic Services (SAS) was appointed to conduct a freshwater resource assessment as part of the environmental assessment and authorisation process for the proposed construction of a water pipeline from the Dorsfontein West to the Dorsfontein East Mine near Kriel within Mpumalanga Province. The proposed project has three alternative water pipeline routes namely Route 1, Route 2 and Route 3. An area of 15m on either side of each proposed route was investigated during the site visit. In addition, wetland resources in the vicinity of the proposed open pit expansion was delineated and assessed.

The background information available from national and provincial databases indicates that the linear development has several freshwater resources. The proposed route falls within close vicinity to and traverses several of these wetland features.

Since watercourses were identified within the study area, either a Water Use Licence (WUL) or a General Authorisation in terms of Section 21 (c) and (i) of the NWA may be required, depending on the exact locality and nature of the proposed activities. However, since the linear development encroaches on the 32m zone of regulation, as stipulated by the National Environmental Management Act (Act No. 107 of 1998), it is expected that the proposed project will have some degree of impact on the freshwater resources within the regulated zone. Thus, a full WUL application might be required. However, this should be clarified with the relevant DWS officials.

The implementation of an ongoing alien vegetation control plan is recommended after the operational phase has commenced. This will ensure that all wetland features impacted upon by the development will be maintained.

It is acknowledged that it will not be feasible to avoid the crossing of all the freshwater features identified within the dragline route. As such, impacts associated with the development were assessed in detail in the impact assessment (refer to Appendix F for the detailed impact assessment). Mitigation recommendations are presented in line with the mitigation hierarchy, in order to ensure informed decision-making and improved sustainable development in the study area.

Should the proposed linear development be approved, it is recommended that, as far as possible, the extent of construction activities (such as contractor laydown areas) should be kept outside of the wetland areas, so as not to impact on the wetland features further. These impacts were assessed in detail in the impact assessment (refer to Appendix C for the detailed impact assessment). Mitigation recommendations are presented in line with the

mitigation hierarchy, in order to ensure informed decision-making and improved sustainable development in the study area. These recommendations also include specific management measures applicable to individual wetland resources, infrastructure activities, and general management measures applicable to the project.

After the assessment of the various routes, wetland features and possible impacts, it is in the opinion of the specialists that route 1 is considered to be the preferable route.

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

APPENDIX B – Legislative Requirements

National Environmental Management Act, 1998

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations (GNR 982) as amended in 2014, 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 (GNR 983) or the Environmental Impact Assessment (EIA) (GNR 984) process depending on the scale of the impact. Provincial regulations as set out in GNR 985 must also be considered.

National Water Act, 1998

The National Water Act (NWA) (Act 36 of 1998) 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 Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i).
However, according to General Notice 1199 as published in the Government Gazette No. 32805 of 2009, it must be noted that as defined by the Replacement General Authorisation in terms of Section 39 of the National Water Act, on account of the extremely sensitive nature of wetlands and estuaries, the section 21(c) and (i) water use General Authorisation does not apply to:

- Any development within a distance of 500 meters upstream or downstream from the boundary of any wetland; and
- Any estuary or any water resource within a distance of 500 meters upstream from the salt mixing zone of any estuary.

General Notice (GN) 1199 as published in the Government Gazette 32805 of 2009 as it relates to the NWA, 1998 (Act 36 of 1998)

Wetlands are extremely sensitive environments and as such, the Section 21 (c) and (i) water use General Authorisation does not apply to any wetland or any water resource within a distance of 500 meters upstream or downstream from the boundary of any wetland. This notice is, at the time of this report, under review and the proposed replacement General Notice 1180 was published in the Government Gazette No. 39458 on 27th November 2015 for public comment.

APPENDIX C – Freshwater Resource Methodology

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 and ecostatus of the larger aquatic system within which the freshwater features present or in close proximity of the proposed study area are located. Aspects considered as part of the literature review are discussed in the sections that follow.

1.1 National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

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 in the vicinity of or within the proposed study area.

2. Classification System for Wetlands and other Aquatic Ecosystems in South Africa

The freshwater features encountered within the proposed study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013), hereafter referred to as the "Classification System". A summary of Levels 1 to 4 of the classification system are presented in Table C1 and C2, below.

Table C1: Proposed 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 C2: Hydrogeomorphic (HGM) Unit for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

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

Level 1: Inland systems

From the Classification System, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean[2] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically. It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions & NFEPA Wetland Vegetation Groups

For Inland Systems, the regional spatial framework that 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. 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 National Freshwater Ecosystem Priority Areas (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.

Level 3: Landscape Setting

At Level 3 of the Classification System, for Inland Systems, a distinction is made between four Landscape Units (Table C1) 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).

Level 4: Hydrogeomorphic Units

Seven primary HGM Types are recognised for Inland Systems at Level 4A of the Classification System (Table C2), 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.

[2] 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.

- 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).

4. WET-Health

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 eco-physical health of wetlands, and in so doing to promote their conservation and wise management.

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.

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).

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 above.

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 the impact of individual activities and then separately assessing the *intensity* of the 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 the table below.

Table C3: 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 recognisable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been completely modified with an almost complete loss of natural habitat and biota.	8-10	F

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 below).

Table C4: 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	↓↓

Overall health of the wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole need 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 provide a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

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".[3] The assessment of the ecosystem services supplied by the identified freshwater features 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
- Education and research

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the freshwater features. 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 freshwater features.

Table C5: 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

6. 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 as well as function and service provision to enable the assessor to determine the most representative EIS category for the feature 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 C6 below.

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

Table C6: Descriptions of the EIS Categories.

EIS Category	Range of Mean	Recommended Ecological Management Class[4]
Very high Wetlands 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 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 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 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

7. Recommended Ecological Category (REC)

"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 C7) 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 freshwater feature may receive the same class for the PES as the REC if the freshwater feature is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the freshwater feature.

Table C7: Description of REC classes.

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

8. Wetland Delineation

For the purposes of this investigation, a wetland is defined in the National Water Act (1998) as "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".

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

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

The wetland 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” published by DWA in 2005 and 2008. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- Landscape position;
- 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, wetlands 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 & 2008).

Riparian and wetland zones can be divided into three zones (DWA, 2005 & 2008). 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.

APPENDIX D – Impact Assessment Methodology

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation;
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[6]. The interaction of an aspect with the environment may result in an impact;
- **Environmental risks/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. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is;
- **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 freshwater features, flora and riverine systems;
- **Resources** include components of the biophysical environment;
- **Frequency of activity** refers to how often the proposed activity will take place;
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor;
- **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;
- **Spatial extent** refers to the geographical scale of the impact;
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor;

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration 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 and the frequency of the impact 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 and are used to determine whether mitigation is necessary[7].

The assessment of significance is undertaken twice. Initial, significance is based on only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment takes into account the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

[6] The definition has been aligned with that used in the ISO 14001 Standard.

[7] Some risks/impacts that have low significance will however still require mitigation

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

Table D1: Criteria for assessing significance of impacts.

LIKELIHOOD DESCRIPTORS

Probability of impact	RATING
Highly unlikely	1
Possible	2
Likely	3
Highly likely	4
Definite	5
Sensitivity of receiving environment	RATING
Ecology not sensitive/important	1
Ecology with limited sensitivity/importance	2
Ecology moderately sensitive/ /important	3
Ecology highly sensitive /important	4
Ecology critically sensitive /important	5

CONSEQUENCE DESCRIPTORS

Severity of impact	RATING
Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function Largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	RATING
Activity specific/ < 5 ha impacted / linear features affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / linear features affected < 100m	2
Local area/ within 1 km of the site boundary / < 5000ha impacted / linear features affected < 1000m	3
Regional within 5 km of the site boundary / < 2000ha impacted / linear features affected < 3000m	4
Entire habitat unit / Entire system/ > 2000ha impacted / linear features affected > 3000m	5
Duration of impact	RATING
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5

Table D2: Significance rating matrix.

LIKELIHOOD (Frequency of activity + Frequency of impact)	CONSEQUENCE (Severity + Spatial Scope + Duration)														
	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

Table D3: Positive/Negative Mitigation Ratings.

Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150	Improve current management	Maintain current management
High	101-125	Improve current management	Maintain current management
Medium-high	76-100	Improve current management	Maintain current management
Medium-low	51-75	Maintain current management	Improve current management
Low	26-50	Maintain current management	Improve current management
Very low	1-25	Maintain current management	Improve current management

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for all stages of the project cycle including:
  - Pre-construction;
  - Construction; and
  - Operation.
- If applicable, transboundary or global effects were assessed; and
- Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status were assessed.

Mitigation Measure Development

According to the DMR (2013) "Rich biodiversity underpins the diverse ecosystems that deliver ecosystem services that are of benefit to people, including the provision of basic services and goods such as clean air, water, food, medicine and fibre; as well as more complex services that regulate and mitigate our climate, protect people and other life forms from natural disaster and provide people with a rich heritage of nature-based cultural traditions. Intact ecological infrastructure contributes

significant savings through, for example, the regulation of natural hazards such as storm surges and flooding which is attenuated by wetlands".

According to the DMR, (2013) Ecosystem services can be divided into 4 main categories:

- Provisioning services are the harvestable goods or products obtained from ecosystems such as food, timber, fibre, medicine, and fresh water;
- Cultural services are the non-material benefits such as heritage landscapes and seascapes, recreation, ecotourism, spiritual values and aesthetic enjoyment;
- Regulating services are the benefits obtained from an ecosystem's control of natural processes, such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards; and
- Supporting services are the natural processes such as nutrient cycling, soil formation and primary production that maintain the other services.

Loss of biodiversity puts aspects of the economy, wellbeing and quality of life at risk, and reduces socio-economic options for future generations. This is of particular concern for the poor in rural areas who have limited assets and are more dependent on common property resources for their livelihoods. The importance of maintaining biodiversity and intact ecosystems for ensuring on-going provision of ecosystem services, and the consequences of ecosystem change for human well-being, were detailed in a global assessment entitled the Millennium Ecosystem Assessment (MEA, 2005), which established a scientific basis for the need for action to enhance management and conservation of biodiversity.

Sustainable development is enshrined in South Africa's Constitution and laws. The need to sustain biodiversity is directly or indirectly referred to in a number of Acts, not least the National Environmental Management: Biodiversity Act (No. 10 of 2004) (hereafter referred to as the Biodiversity Act), and is fundamental to the notion of sustainable development. In addition, International guidelines and commitments as well as national policies and strategies are important in creating a shared vision for sustainable development in South Africa (DMR, 2013).

Pressures on biodiversity are numerous and increasing. According to the DMR; (2013) Loss of natural habitat is the single biggest cause of biodiversity loss in South Africa and much of the world. The most severe transformation of habitat arises from the direct conversion of natural habitat for human requirements, including[8]:

- Cultivation and grazing activities;
- Rural and urban development;
- Industrial and mining activities, and
- Infrastructure development.

Impacts on biodiversity can largely take place in four ways (DMR 2013):

- **Direct impacts:** are impacts directly related to the project including project aspects such as site clearing, water abstraction and discharge of water from riverine resources;
- **Indirect impacts:** are impacts associated with a project that may occur within the zone of influence in a project such as surrounding terrestrial areas and downstream areas on water courses;
- **Induced impacts:** are impacts directly attributable to the project but are expected to occur due to the activities of the project. Factors included here are urban sprawl and the development of associated industries; and
- **Cumulative impacts:** can be defined as the sum of the impact of a project as well as the impacts from past, existing and reasonably foreseeable future projects that would affect the same biodiversity resources. Examples numerous residential developments within the same habitat for faunal or floral species.

Given the limited resources available for biodiversity management and conservation, as well as the need for development, efforts to conserve biodiversity need to be strategic, focused and supportive of sustainable development. This is a fundamental principle underpinning South Africa's approach to the management and conservation of its biodiversity and has resulted the definition of a clear mitigation strategy for biodiversity impacts.

[8] Limpopo Province Environment Outlook. A Report on the State of the Environment, 2002. Chapter 4.

'Mitigation' is a broad term that covers all components of the 'mitigation hierarchy' defined hereunder. It involves selecting and implementing measures – amongst others – to conserve biodiversity and to protect, the users of biodiversity and other affected stakeholders from potentially adverse impacts as a result of mining or any other land use. The aim is to prevent adverse impacts from occurring or, where this is unavoidable, to limit their significance to an acceptable level. Offsetting of impacts is considered to be the last option in the mitigation hierarchy for any project.

The mitigation hierarchy in general consists of the following in order of which impacts should be mitigated (DMR 2013):

- **Avoid/prevent impact:** can be done through utilising alternative sites, technology and scale of projects to prevent impacts. In some cases, if impacts are expected to be too high the "no project" option should also be considered, especially where it is expected that the lower levels of mitigation will not be adequate to limit environmental damage and eco-service provision to suitable levels;
- **Minimise impact:** can be done through utilisation of alternatives that will ensure that impacts on biodiversity and ecoservices provision are reduced. Impact minimisation is considered an essential part of any development project;
- **Rehabilitate impact:** is applicable to areas where impact avoidance and minimisation are unavoidable where an attempt to re-instate impacted areas and return them to conditions which are ecologically similar to the pre-project condition or an agreed post project land use, for example arable land. Rehabilitation can however not be considered as the primary mitigation tool as even with significant resources and effort rehabilitation that usually does not lead to adequate replication of the diversity and complexity of the natural system. Rehabilitation often only restores ecological function to some degree to avoid ongoing negative impacts and to minimise aesthetic damage to the setting of a project. Practical rehabilitation should consist of the following phases in best practice:
    - **Structural rehabilitation** which includes physical rehabilitation of areas by means of earthworks, potential stabilisation of areas as well as any other activities required to develop a long terms sustainable ecological structure;
    - **Functional rehabilitation** which focuses on ensuring that the ecological functionality of the ecological resources on the study area supports the intended post closure land use. In this regard special mention is made of the need to ensure the continued functioning and integrity of wetland and riverine areas throughout and after the rehabilitation phase;
    - **Biodiversity reinstatement** which focuses on ensuring that a reasonable level of biodiversity is re-instated to a level that supports the local post closure land uses. In this regard special mention is made of re-instating vegetation to levels which will allow the natural climax vegetation community of community suitable for supporting the intended post closure land use; and
    - **Species reinstatement** which focuses on the re-introduction of any ecologically important species which may be important for socio-cultural reasons, ecosystem functioning reasons and for conservation reasons. Species re-instatement need only occur if deemed necessary.
- **Offset impact:** refers to compensating for latent or unavoidable negative impacts on biodiversity. Offsetting should take place to address any impacts deemed to be unacceptable which cannot be mitigated through the other mechanisms in the mitigation hierarchy. The objective of biodiversity offsets should be to ensure no net loss of biodiversity. Biodiversity offsets can be considered to be a last resort to compensate for residual negative impacts on biodiversity.

The significance of residual impacts should be identified on a regional as well as national scale when considering biodiversity conservation initiatives. If the residual impacts lead to irreversible loss or irreplaceable biodiversity the residual impacts should be considered to be of *very high significance* and when residual impacts are considered to be of *very high significance*, offset initiatives are not considered an appropriate way to deal with the magnitude and/or significance of the biodiversity loss. In the case of residual impacts determined to have *medium to high significance*, an offset initiative

may be investigated. If the residual biodiversity impacts are considered of low significance no biodiversity offset is required.[9]

In light of the above discussion 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[10] 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 wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the wetland ecology associated with the proposed development within the study area.

[9] Provincial Guideline on Biodiversity Offsets, Western Cape, 2007.

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

APPENDIX E – Calculation Results

PRESENT ECOLOGICAL STATE (PES), ECOSERVICES AND ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) RESULTS

Table E1: Presentation of the results of the WET-Health assessments applied to the Hillslope seep, Channelled valley bottom and Unchannelled Valley bottom wetlands.

Resource	Hydrology		Geomorphology		Vegetation		Overall PES Category of the Resource
	PES category	Trajectory of change	PES category	Trajectory of change	PES category	Trajectory of change	
Hillslope Seep	B	→	A	↓	B	↓	B - Largely natural with few modifications
Channelled Valley Bottom	C	→	B	↓	C	↓	C - Moderately modified
Unchannelled Valley Bottom	C	→	B	↓	C	↓	C - Moderately modified

Table E2: Presentation of the results of the ecosystem services provided by the Hillslope seep, Channelled valley bottom and Unchannelled Valley bottom wetlands.

Ecosystem service	HGM Unit 1 Seep	HGM Unit 2 CH Valley	HGM Unit 3 UnCh Valley
Flood attenuation	1,3	1,5	1,5
Streamflow regulation	0,0	2,2	3,0
Sediment trapping	2,0	1,8	2,0
Phosphate assimilation	2,4	2,1	2,4
Nitrate assimilation	2,4	2,1	2,4
Toxicant assimilation	2,1	2,0	2,3
Erosion control	2,5	2,0	2,3
Carbon Storage	1,7	2,3	2,3
Biodiversity maintenance	1,2	2,6	2,5
Water Supply	0,7	1,5	1,7
Harvestable resources	1,4	1,6	1,6
Cultivated foods	1,0	0,4	0,4
Cultural value	0,0	0,0	0,0
Tourism and recreation	0,0	0,6	0,6
Education and research	1,3	1,5	1,5
SUM	19,9	24,3	26,5
Average score	1,3	1,6	1,8

Table E3: Presentation of the EIS assessment applied to the Hillslope seep, Channelled valley bottom and Unchannelled Valley bottom wetlands.

Determinant	Score: Hillslope Seep	Score: Channelled valley bottom	Score: Unchannelled valley bottom
PRIMARY DETERMINANTS			
1. Rare & Endangered Species	3	3	3
2. Populations of Unique Species	2	2	1
3. Species/taxon Richness	2	2	1
4. Diversity of Habitat Types or Features	2	2	2
5 Migration route/breeding and feeding site for wetland species	2	2	1
6. PES as determined by WET-Health assessment	2	2	2
7. Importance in terms of function and service provision	2	2	2
MODIFYING DETERMINANTS			
8. Protected Status according to NFEPA Wetveg	4	4	4
9. Ecological Integrity	2	2	2
TOTAL	21	21	18
MEAN	2.3	2.3	2
OVERALL EIS	B		

APPENDIX F – Impact Analysis and Mitigation Measures

General management and good housekeeping practices

Latent and general everyday impacts, which may affect the wetland ecology and biodiversity, will include any activities which take place in the vicinity of the proposed study area that may impact on the receiving environment. Mitigation measures for these impacts are highlighted below and are relevant to the wetland systems identified in this report:

Development footprint

- The development footprint area should remain as small as possible and should not encroach onto surrounding areas beyond the proposed route;
- Ensure that only essential activities must occur within the wetland features which are traversed by the proposed route, all other non-essential activities should occur outside of the freshwater features;
- the wetland areas not indicated within the linear developments footprint are off-limits to construction vehicles and personnel;
- 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 freshwater feature areas;
- No fires should be permitted in or near the construction area;
- Restrict construction to the drier winter months if possible to avoid sedimentation of the wetland features and to minimise the severity of disturbance of the wetland habitat;
- Access to the construction site should be limited to a single entry point to minimise compaction of soils, loss of vegetation and increased erosion; 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 the topsoil;
- In the event of a vehicle breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil and subsequent habitat loss; and
- All spills should they occur, should be immediately cleaned up and treated accordingly.

Soils

- As much vegetation growth should be encouraged to protect soils;
- Dumped soils should be removed and the area must be levelled to improve the flow of water;
- Reinforce banks where necessary with gabions and reno-mattresses; and
- Monitor all areas traversed by the development for erosion and incision, during site clearing in the preconstruction phase and throughout the construction phase.

Rehabilitation

- Bare areas that resulted from vegetation clearing during site preparation, must be revegetated with indigenous species to protect the soils;
- Construction rubble must be collected and dumped at a suitable landfill site; and
- 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.

Impact ratings on the wetland ecology

The tables below serve to summarise the anticipated impacts that might occur throughout the development phases, as well as the mitigations that must be implemented in order to maintain and enhance the wetland features conditions.

IMPACT 1: LOSS OF WETLAND FEATURES HABITAT AND ECOLOGICAL STRUCTURE

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning, resulting in the placement of the linear development within wetland habitat, leading to altered habitat	Site clearing and the removal of vegetation leading to increased runoff and erosion during rainfall events	Poor rehabilitation of wetland features resulting in alien plant proliferation and erosion of construction areas.
Increased anthropogenic activity within the wetland feature	Potential indiscriminate driving through wetland feature areas leading to soil compaction	Potential movement of vehicles through wetland features during follow up work to ensure adequate rehabilitation and the alien vegetation control is taking place
	Earthworks in the vicinity of the wetland feature system leading to loss of wetland feature habitat, erosion and altered runoff patterns	
	Spillage from construction vehicles and waste dumping leading to contamination of wetland feature soils	
	Changes to the wetland feature vegetation community due to alien invasion resulting in altered wetland feature conditions	

Routes	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Route 1	Construction phase	5	4	3	3	3	9	9	81 (Medium high)
	Operational phase	5	4	3	3	3	9	9	81 (Medium high)
Route 2	Construction phase	5	4	4	3	4	9	11	99 (Medium high)
	Operational phase	5	4	3	3	3	9	9	99 (Medium high)
Route 3	Construction phase	5	4	4	3	4	9	11	99 (Medium high)
	Operational phase	5	4	3	3	4	9	10	90 (Medium high)
	Essential mitigation measures for construction phase: • Ensure that vegetation clearing and indiscriminate vehicle driving does not occur outside of the demarcated areas; • Minimize construction footprints prior to commencement of the construction and control the edge effects from construction activities; and • Implement alien vegetation control program within the wetland features. Recommended mitigation measures for construction phase: • Ensure that all activities impacting on the wetland features are managed according to the relevant DWS Licensing regulations (where applicable); and • As far as possible, all construction activities should occur in the low flow season, during the drier winter months. Essential mitigation measures for operational phase: • Any areas where active erosion within the wetland features are observed must be immediately rehabilitated in such a way as to ensure that the hydrology of the area is re-instated to conditions which are as natural as possible; • Cutting/ clearing of the herbaceous layer within the wetland areas along the linear development should be avoided so as to retain soil stability provided by the grass root structures Recommended mitigation measures for operational phase: • N/A								
	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Route 1	Construction phase	3	4	2	2	2	7	6	42 (Low)
	Operational phase	3	4	2	2	2	7	6	42 (Low)
Route 2	Construction phase	3	4	3	2	2	7	7	49 (Low)
	Operational phase	3	4	2	2	2	7	6	42 (Low)
Route 3	Construction phase	3	4	3	3	3	7	9	63 (Medium-low)
	Operational phase	3	4	2	3	3	7	8	56 (Medium-low)
	Probable latent impacts: • Erosion and incision of the wetland feature may occur if not effectively rehabilitated and managed; • Vegetation and habitat loss due to disturbance of the wetland features.								

IMPACT 2: CHANGES TO ECOLOGICAL AND SOCIO-CULTURAL SERVICE PROVISION

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning, resulting in the placement of the linear development within wetland habitat, leading to altered habitat	Loss of phosphate, nitrate and toxicant removal abilities due to vegetation clearing	Decrease ability to assimilate toxicants, phosphates and nitrates due to loss of wetland vegetation and increased runoff
Increased anthropogenic activity within the wetland feature leading to an increased impact on the biological structure of the wetland features and the associated effects that this will have on service provision	Inability to support biodiversity due to vegetation clearing and contamination of wetland feature soils and water as a result of waste rubble dumping, increased sedimentation and alteration of natural hydrological regimes.	Decrease in biodiversity as a result of loss of habitat and the introduction of alien plant species
	Earthworks within the wetland features leading to loss of flood attenuation abilities and streamflow regulation capabilities	
	Unmanaged oil leaks from construction vehicles leading to water quality deterioration	
	Loss of vegetation resulting in a loss of breeding and foraging habitat and overall decreased biodiversity	

Routes	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Route 1	Construction phase	5	4	4	3	3	9	10	90 (Medium high)
	Operational phase	4	4	3	3	3	8	9	81 (Medium high)
Route 2	Construction phase	5	4	4	3	3	9	10	90 (Medium high)
	Operational phase	4	4	4	3	3	8	10	90 (Medium high)
Route 3	Construction phase	5	4	4	3	4	9	11	99 (Medium high)
	Operational phase	4	4	4	3	3	8	10	81 (Medium high)
	Essential mitigation measures for the construction phase: • During construction use techniques which support the hydrology and sediment control functions of the freshwater features; and • Limit excavations to a limited extent to ensure that drainage patterns within the features returns to normal as soon as possible after construction. Recommended mitigation measures for the construction phase: • Restrict construction to the drier winter months if possible to avoid sedimentation of the freshwater feature and to minimize the severity of disturbance of the features and hydraulic function. Essential mitigation measures for the operational phase: • Monitor the wetland feature for erosion and incision; • Maintain the REC for each of the wetland features, as stated within the report during the life of the development; and • Implement an alien vegetation control program within the wetland features and ensure establishment of indigenous species within areas previously dominated by alien vegetation. Recommended mitigation measures for the operational phase: • N/A								
	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Route 1	Construction phase	3	4	2	2	2	7	6	42 (Low)
	Operational phase	2	4	2	1	2	6	5	30 (Low)
Route 2	Construction phase	3	4	3	2	2	7	7	49 (Low)
	Operational phase	2	4	2	1	2	6	5	30 (Low)
Route 3	Construction phase	3	4	3	2	2	7	7	49 (Low)
	Operational phase	2	4	2	2	2	6	6	36 (Low)
	Probable latent impacts: • Erosion and incision of the wetland feature may occur if not effectively rehabilitated and managed; • Vegetation and habitat loss due to disturbance of the wetland features								

IMPACT 3: LOSS OF HYDROLOGICAL FUNCTION AND SEDIMENT BALANCE

Aspects and activities register

Pre-Construction	Construction	Operational
Potential poor planning, resulting in the placement of the linear development within wetland habitat, leading to altered habitat	Site clearing and further removal of vegetation resulting in increased runoff which leads to erosion and alteration of the geomorphology of the wetland features	Increased runoff volumes due to compacted soils
	Disturbance of soils, topsoil stockpiling adjacent to the wetland features and runoff from stockpiles leading to sedimentation of the system	Disturbed soils may form erosional gulley's, leading altered hydrological flow patterns and increased sedimentation of downstream features
	Earthworks in the vicinity of the wetland features leading to incision, erosion and altered runoff patterns	
	Movement of construction vehicles within the wetland features resulting in soil compaction	

Routes	Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Route 1	Construction phase	3	4	3	2	3	7	8	56 (Medium low)
	Operational phase	3	4	3	2	3	7	8	56 (Medium low)
Route 2	Construction phase	4	4	4	3	3	8	10	80 (Medium high)
	Operational phase	4	4	4	3	4	8	11	88 (Medium high)
Route 3	Construction phase	4	4	4	3	3	8	10	80 (Medium high)
	Operational phase	4	4	4	3	4	8	11	88 (Medium high)
	Essential mitigation measures for the construction phase: • Any construction-related waste must not be placed in the vicinity of the wetland features; and • Limit the footprint area of the construction activity to what is absolutely essential in order to minimize environmental damage. Recommended mitigation measures for the construction phase: • Stockpiled soil must be removed and the area must be levelled to avoid sedimentation of the wetland features from runoff; and • As far as possible, all construction activities should occur in the low flow season, during the drier summer months. Essential mitigation measures for the operational phase: • Vehicles should not be driven indiscriminately within the wetland features during maintenance activities to prevent soil compaction. Recommended mitigation measures for the operational phase: • N/A								
	Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Route 1	Construction phase	2	4	2	2	2	6	6	36 (Low)
	Operational phase	1	4	2	2	2	5	6	30 (Low)
Route 2	Construction phase	3	4	3	2	2	7	7	49 (Low)
	Operational phase	2	4	2	2	2	6	6	36 (Low)
Route 3	Construction phase	3	4	3	2	2	7	7	49 (Low)
	Operational phase	2	4	3	2	2	6	7	42 (Low)
	Probable latent impacts: • Erosion and incision of the wetland feature may occur if not effectively rehabilitated and managed; • Vegetation and habitat loss due to disturbance of the wetland features.								

APPENDIX G – Declaration and Specialist CV's

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

S. van Staden MSc Environmental Management (University of Johannesburg)

C Hooton BTech Nature Conservation (Tshwane University of Technology)

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

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	91 Geldenhuis Rd, Malvern East, Ext 1		
Postal code:	1401	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	086 724 3132
E-mail:	stephen@sasenvironmental.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist, Aquatic Ecologist
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO)
Member of the Gauteng Wetland Forum

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2002
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2000
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	1999

COUNTRIES OF WORK EXPERIENCE

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

SELECTED PROJECT EXAMPLES

Development compliance studies

- Project co-leader for the development of the EMP for the use of the Wanderers stadium for the Ubuntu village for the World Summit on Sustainable Development (WSSD).
- Environmental Control Officer for Eskom for the construction of an 86Km 400KV power line in the Rustenburg Region.
- Numerous Environmental Impact Assessment (EIA) and EIA exemption applications for township developments and as part of the Development Facilitation Act requirements.
- EIA for the extension of mining rights for a Platinum mine in the Rustenburg area by Lonmin Platinum.
- EIA Exemption application for a proposed biodiesel refinery in Chamdor.
- Compilation of an EIA as part of the Bankable Feasibility Study process for proposed mining of a gold deposit in the Lofa province, Liberia.
- EIA for the development of a Chrome Recovery Plant at the Two Rivers Platinum Mine in the Limpopo province, South Africa.
- Compilation of an EIA as part of the Bankable Feasibility Study process for the Mooihoek Chrome Mine in the Limpopo province, South Africa.
- Mine Closure Plan for the Vlakfontein Nickel Mine in the North West Province.

Specialist studies and project management

- Development of a zero discharge strategy and associated risk, gap and cost benefit analyses for the Lonmin Platinum group.
- Development of a computerised water balance monitoring and management tool for the management of Lonmin Platinum

process and purchased water.
- The compilation of the annual water monitoring and management program for the Lonmin Platinum group of mines.
- Analyses of ground water for potable use on a small diamond mine in the North West Province.
- Project management and overview of various soil and land capability studies for residential, industrial and mining developments.
- The design of a stream diversion of a tributary of the Olifants River for a proposed opencast coal mine.
- Waste rock dump design for a gold mine in the North West province.
- Numerous wetland delineation and function studies in the North West, Gauteng and Mpumalanga Kwa-Zulu Natal provinces, South Africa.
- Hartebeespoort Dam Littoral and Shoreline PES and rehabilitation plan.
- Development of rehabilitation principles and guidelines for the Crocodile West Marico Catchment, DWAF North West.

Aquatic and water quality monitoring and compliance reporting
- Development of the Resource Quality Objective framework for Water Use licensing in the Crocodile West Marico Water Management Area.
- Development of the Resource Quality Objectives for the Local Authorities in the Upper Crocodile West Marico Water Management Area.
- Development of the 2010 State of the Rivers Report for the City of Johannesburg.
- Development of an annual report detailing the results of the Lonmin Platinum groups water monitoring program.
- Development of an annual report detailing the results of the Everest Platinum Mine water monitoring program.
- Initiation and management of a physical, chemical and biological monitoring program, President Steyn Gold Mine Welkom.
- Aquatic biomonitoring programs for several Xstrata Alloys Mines and Smelters.
- Aquatic biomonitoring programs for several Anglo Platinum Mines.
- Aquatic biomonitoring programs for African Rainbow Minerals Mines.
- Aquatic biomonitoring programs for several Assmang Chrome Operations.
- Aquatic biomonitoring programs for Petra Diamonds.
- Aquatic biomonitoring programs for several coal mining operations.
- Aquatic biomonitoring programs for several Gold mining operations.
- Aquatic biomonitoring programs for several mining operations for various minerals including iron ore, and small platinum and chrome mining operations.
- Aquatic biomonitoring program for the Valpre bottled water plant (Coca Cola South Africa).
- Aquatic biomonitoring program for industrial clients in the paper production and energy generation industries.
- Aquatic biomonitoring programs for the City of Tshwane for all their Waste Water Treatment Works.
- Baseline aquatic ecological assessments for numerous mining developments.
- Baseline aquatic ecological assessments for numerous residential commercial and industrial developments.
- Baseline aquatic ecological assessments in southern, central and west Africa.
- Lalini Dam assessment with focus on aquatic fish community analysis.
- Musami Dam assessment with focus on the FRAI and MIRAI aquatic community assessment indices.

Wetland delineation and wetland function assessment
- Wetland biodiversity studies for three copper mines on the copper belt in the Democratic Republic of the Congo.
- Wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Terrestrial and wetland biodiversity studies for developments in the mining industry.
- Terrestrial and wetland biodiversity studies for developments in the residential commercial and industrial sectors.
- Development of wetland riparian resource protection measures for the Hartbeespoort Dam as part of the Harties Metsi A Me integrated biological remediation program.
- Priority wetland mammal species studies for numerous residential, commercial, industrial and mining developments throughout South Africa.

Terrestrial ecological studies and biodiversity studies
- Development of a biodiversity offset plan for Xstrata Alloys Rustenburg Operations.
- Biodiversity Action plans for numerous mining operations of Anglo Platinum throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Assmang Chrome throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Xstrata Alloys and Mining throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plan for the Nkomati Nickel and Chrome Mine Joint Venture.
- Terrestrial and wetland biodiversity studies for three copper mines on the copper belt in the Democratic Republic of the Congo.
- Terrestrial and wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Numerous terrestrial ecological assessments for proposed platinum and coal mining projects.
- Numerous terrestrial ecological assessments for proposed residential and commercial property developments throughout most of South Africa.

- Specialist Giant bullfrog (*Pyxicephalus adspersus*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist Marsh sylph (*Metisella meninx*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Project management of several Red Data Listed (RDL) bird studies with special mention of African grass owl (*Tyto capensis*).
- Project management of several studies for RDL Scorpions, spiders and beetles for proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist assessments of terrestrial ecosystems for the potential occurrence of RDL spiders and owls.
- Project management and site specific assessment on numerous terrestrial ecological surveys including numerous studies in the Johannesburg-Pretoria area, Witbank area, and the Vredefort dome complex.
- Biodiversity assessments of estuarine areas in the Kwa-Zulu Natal and Eastern Cape provinces.
  Impact assessment of a spill event on a commercial maize farm including soil impact assessments.

Fisheries management studies

- Tamryn Manor (Pty.) Ltd. still water fishery initiation, enhancement and management.
- Verlorenkloof Estate fishery management strategising, fishery enhancement, financial planning and stocking strategy.
- Mooifontein fishery management strategising, fishery enhancement and stocking programs.
- Wickams retreat management strategising.
- Gregg Brackenridge management strategising and stream recalibration design and stocking strategy.
- Eljira Farm baseline fishery study compared against DWAF 1996 aquaculture and aquatic ecosystem guidelines.

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF CHRISTOPHER HOOTON

PERSONAL DETAILS

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

EDUCATION

Qualifications

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

COUNTRIES OF WORK EXPERIENCE

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

SELECTED PROJECT EXAMPLES

Faunal Assessments

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

Previous Work Experience

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

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

I, Stephen van Staden, declare that –

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

Signature of the Specialist