FRESHWATER RESOURCE ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR A PROPOSED COAL MINE ON THE REMAINING EXTENT OF THE FARM THE DUEL 186 MT, LIMPOPO PROVINCE

Prepared for

Jacana Environmentals CC

May 2019

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Report Reference: **SAS 219046**
Date: **May 2019**

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the freshwater resources as part of the environmental assessment and authorisation process for the proposed coal mine on the Remaining Extent of the farm The Duel 186 MT ("The Duel Coal Mine"), located approximately 70 km to the south of Musina within the Limpopo Province.

The background information available from national and provincial databases indicate that the drainage features of the local area are relatively sensitive and ecologically important. Based on the findings of the field assessment it is evident that the drainage features within The Duel project area consist mainly of ephemeral drainage lines that cannot be defined as wetland or rivers with riparian zones, with fewer larger linear features that convey sufficient water to be defined as true watercourses with an associated riparian zone. In addition, it is important to note that the Mutamba River is located approximately 500m north of the northern border of the study area with drainage features located within The Duel project area draining to the system.

Based on the study, the Mutamba River is seen to be a water stressed system, characterized by seasonal flow variation compounded by water abstraction for agricultural purposes. Desktop EIS/PES data indicate a PES classified as C (Moderately Modified), Ecological Importance (EI) classified as "Moderate", Ecological Sensitivity (ES) as "High" and default Ecological Category (EC) as B ("Largely Natural"). The *In situ* water quality analysis revealed an exceedance of the Target Water Quality Range (TWQR) for aquatic ecosystems as set out by the Department of Water and Sanitation (DWS) (DWAF, 1996) for Total Dissolved Solids (TDS), mainly due to trampling of the riparian zone by wildlife causing sedimentation, as well as the evapo-concentration effect caused by a weir established upstream. Temperature measurements also exceeded the recommended TWQR at the time of the assessment which is due to the seasonal and diurnal fluctuations encountered during the survey. The temporal analysis revealed changes exceeding the recommended variation for pH and Dissolved Oxygen (DO) although these changes still fell within the acceptable range, and would not have been a limiting factor to aquatic biota at the time of the assessment.
The macroinvertebrate assemblage based on the South African Scoring System Version 5 (SASS5) methodology was classed Seriously Modified (Category E/F). A significant decrease in both SASS score (33.9%) and the Average Score per Taxon (ASPT) score (27.5%) since the February 2015 survey was evident. This is likely largely due to lower flows limiting habitat availability compared to that encountered during the February 2015 survey. The fish community based on the Fish Response Assessment Index (FRAI) assessment was classed Largely Modified (Category D) with only five of 15 expected species sampled during both surveys, this is largely due to the low flows associated with the Mutamba River at the time of the assessments. One fish species of conservation concern was sampled during the February 2015 survey namely *Oreochromis mossambicus* (Mozambique Tilapia) rated Near Threatened (NT) by the IUCN (2019), mining activities should therefore be managed in such a way as to minimise the impact on the Mutamba River and the associated aquatic communities of the system.

Legislative requirements were used to determine the extent of buffer zone required for each watercourse depending on whether a group is considered rivers with riparian habitat or not. The Mutamba River, as well as smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year floodlines exemption terms of Regulation GN 704 of the NWA, 1998 (Act No. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice No. 509 of 2016 as it relates to the NWA will also apply and therefore a Water Use License will be required.

Several potential risks of varying significance to the receiving environment by the proposed mining operation have been identified which relate to the physical attributes of the freshwater resources as well as their hydrological, biological and physico-chemical properties. These impacts have been assessed in detail in the impact assessment phase of the project and as far as possible mitigatory recommendations have been presented in line with the mitigation hierarchy as advocated by the DMR (2013) in order to ensure informed decision making and promote sustainable development in the area.

Based on the impact assessment for the freshwater resources excluding the Mutamba River impacts ranged from low to Medium-High during all the development phases associated with the proposed activities, with recommended mitigation employed these impacts may be reduced to the Low to Medium-Low significance.
The impact assessment for the Mutamba River revealed impacts ranging from Medium-Low to High during all the development phases, with the recommended mitigation applied these impacts may be reduced to the Low to Medium-Low significance.

MANAGEMENT SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct an investigation of the freshwater resources within the proposed new mining area which is situated on the remaining extent of the farm The Duel 186 MT, hereafter referred to as the "study area". An assessment of the study area was conducted by SAS in 2015/2016 and this report serves to update the results of the previous assessment (SAS 214206, 2016) and to review and update the impact assessment undertaken at that time.

The proposed infrastructure to be developed includes (Figure 3):

- Coal Handling Processing Plant;
- Overburden Waste Dump;
- Temporary Discard Dump;
- Haul roads;
- Pollution Control Dams;
- Raw water storage facility and distribution systems;
- Access road; and
- Auxiliary infrastructure including a workshop and store, office and change house, electrical power supply and security fencing.

The purpose of this report is to define the ecology of the proposed development in terms of watercourse characteristics, including mapping of the watercourses, defining areas of increased Ecological Importance and Sensitivity (EIS), and defining the Present Ecological State (PES) of the watercourses associated with the study area. This report additionally presents the results obtained during the aquatic ecological assessment, which include the *In-situ* water quality at one point within the Mutamba River associated with the study area, a survey of habitat conditions for aquatic macro-invertebrates and aquatic macro-invertebrate community integrity. The protocols of applying the indices were strictly adhered to and all work was carried out by a South African River Health Program (SA RHP) accredited assessor.

This study further aims to provide detailed information to guide the proposed project activities in the vicinity of the watercourses, to ensure the ongoing functioning of the ecosystems, 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. This report, after consideration of the above, must guide the relevant authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed mining activities from a freshwater resource management point of view and in the context of sustainable development and in consideration of the principles of Integrated Environmental Management.

The points below summarise the key aspects of the study:

- A desktop study was conducted, in which possible watercourses were identified for on-site investigation, and relevant national and provincial databases were consulted. This study included the results obtained of the previous freshwater resource studies undertaken on the subject property (SAS, 2015). The results of the desktop study are contained in Section 4 of this report;
- Field assessments took place in February 2015 and February 2019, to ground-truth the extent and characteristics of the identified watercourses associated with the study area; and
- During the field assessment, several watercourses, comprising of the riverine Hydrogeomorphic (HGM) type, was identified within the study area. These watercourses are largely natural to moderately modified (B/C) due to slight disturbances caused by agricultural activities; and
- Due to the extent of the study area, only those watercourses which are located within the subject property were assessed in detail while those within 500m of the proposed mining infrastructure were assessed using desktop methods with limited field verification. The exception is the assessment of the Mutamba River, which was assessed in detail since it is the major drainage feature of the area and most likely the most important water resource in the area to understand and consider when assessing the impact of the proposed mining development. Due to the topography and the existing developments within the study area, the proposed mining activities located further than 500m of a watercourse are considered to pose a negligible risk to those watercourses.

A summary of the assessment of the watercourses are presented in the table below.

Aquatic Assessment

Table A: Summary of the results of the biota specific water quality and potential impacts on the aquatic community of the Mutamba River.

Water management area: Limpopo

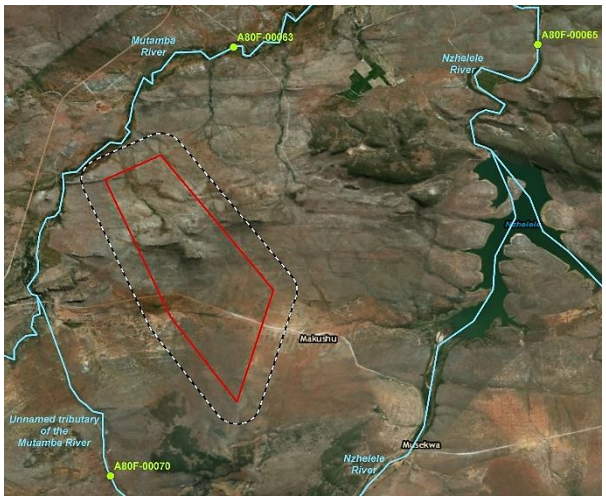
Quaternary Catchment: A80F

Ecoregion: Soutpansberg

Flows: Moderately low during both assessments.

Water Clarity: Discoloured during both assessments.

Map: The Mutamba River and associated Sub Quaternary Reaches (SQRs) associated with the study area.



Site DH1

Water quality:

pH	8.32
EC (mS/m)	103.7
Temperature (ºC)	34
DO (mg/L)	8.73
DO saturation (%)	93.4
TDS (mg/l)	674.05

Aquatic Macro-invertebrate community assessment:

SASS5 Score:	37
ASPT Score:	3.7
Dallas (2007):	Category E/F
MIRAI:	66.6 (Category C)

Fish Response Assessment Index:
FRAI: 47.8 (Category D)

Invertebrate Habitat Assessment:

Class:	Poor
IHAS Score:	53

Habitat Integrity:

Instream IHI:	67.9(Category C)
Riparian IHI:	68.8 (Category C)

Riparian Vegetation Response Assessment Index:
VEGRAI: 79.7 (Category B/C)

Variable	February 2015	February 2019
SASS	E/F	E/F
FRAI	D	D
VEGRAI	B/C	B/C

Integrated Ecological Category: Category C

Feature	VEGRAI Ecostatus	PES Classes	EIS Class	REC Class
Mutamba River	B/C	C	Moderate	C
Smaller drainage lines	B/C	B	Low	B

From the results of the impact assessment conducted on the habitat associated with the freshwater resources, it is evident that prior to mitigation all impacts on the riparian systems are low to medium-low throughout all phases. Mitigation measures available will have limited ability to minimise the impacts on the receiving riparian environment (particularly the small draining lines within the study area). However, the low sensitivity of these small drainage line resources already mitigates the potential impact score based on the likelihood aspect of the method employed. As a result, impact significance is generally reduced to very low or low levels in the majority of cases after mitigation.

From the results of the assessment it is evident that prior to mitigation all impacts on the Mutamba River are medium-low to medium-high, with the majority of potential impacts rated medium-high and impacts on water quality considered high. With mitigation, impacts on the Mutamba River are anticipated to be reduced to medium-low to low levels, with loss of aquatic habitat and deteriorating water quality being the greatest concerns.

Table B: Summary of impact significance on habitat surrounding freshwater resources (i.e. riparian systems) excluding the Mutamba River.

Construction Phase		
Impact	**Unmanaged**	**Managed**
1: Loss of Riparian Habitat and Ecological Structure	Medium-High	Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-Low	Medium-Low
4. Impacts on Water Quality	Medium-Low	Low
5. Loss of Aquatic Habitat	Low	Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Low	Very-Low
Operational Phase		
Impact	**Unmanaged**	**Managed**
1: : Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-Low	Medium-Low
4. Impacts on Water Quality	Medium-Low	Low
5. Loss of Aquatic Habitat	Medium-Low	Medium-Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-Low	Low
Decommissioning and Closure Phase		
Impact	**Unmanaged**	**Managed**
1: : Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-Low	Medium-Low
4. Impacts on Water Quality	Medium-High	Low
5. Loss of Aquatic Habitat	Medium-Low	Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-Low	Low
Summary	**Medium-Low to Medium-High**	**Low to Medium-Low**

Table C: Summary of impact significance on the Mutamba River.

Construction Phase		
Impact	**Unmanaged**	**Managed**
1: Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-High	Medium-Low
4. Impacts on Water Quality	Medium-High	Medium-Low
5. Loss of Aquatic Habitat	Medium-Low	Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-High	Low
Operational Phase		
Impact	**Unmanaged**	**Managed**
1: Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-High	Medium-Low
4. Impacts on Water Quality	Medium-High	Medium-Low
5. Loss of Aquatic Habitat	Medium-High	Medium-Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-High	Low
Decommissioning and Closure Phase		
Impact	**Unmanaged**	**Managed**
1: Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	High	Medium-Low
3. Loss of Instream Flow and changes in Sediment Balance	High	Medium-Low
4. Impacts on Water Quality	High	Medium-Low
5. Loss of Aquatic Habitat	Medium-Low	Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-High	Low
Summary	**Medium-Low to High**	**Low to Medium-Low**

Recommendations

- All employees should undertake a basic environmental awareness induction, including understanding the fundamentals of freshwater resource management;
- Measures to contain and reuse as much water as possible within the mine process water system and water from dewatering of operational areas should be sought;
- All storm water and pollution control dams and dumps should be appropriately lined;
- Water uses which will affect the instream flow in the Mutamba River and the associated drainage lines and needs to be very carefully designed and managed to minimise the impact on the system;
- Upstream dewatering boreholes and stream diversions can potentially be utilised to minimise the creation of dirty water and this clean water should be used to recharge the natural systems downstream of the mining rights areas wherever possible;
- Very strict control of water consumption and detailed monitoring must take place, and where possible all water usage must continuously be optimised;
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas which recharge the receiving aquatic environment;
- If mining infrastructure is to encroach on the riparian zones and associated buffer zones, authorisation in line with the requirements of Regulation GN704 of 1999 and GN509 of 2016 must be applied for along with the relevant applications in terms of NEMA and the associated Regulations of 2014, as amended;
- No dirty water runoff must be permitted to reach the freshwater resources during the entire life of mine, and clean and dirty water management systems must be put in place to prevent the contaminated runoff (suspended solids and salts and water with low pH) from entering the

receiving aquatic environment. Clean and dirty water runoff systems should be constructed before construction of any other infrastructure takes place;

- Strict control of sewage water treatment must take place and the sewage system should form part of the mine's closed process water system or removed from site by an appropriately registered contractor;
- Due to climate change risks and increasing severity of storms and the relatively long life of mine all dirty water containment structures should be designed to contain a 1:100 year storm event;
- All pollution control facilities must be managed in such a way as to ensure that storage and surge capacity is available if a rainfall event occurs;
- The mines water balance must be strictly controlled at all times to ensure that discharge from the process water systems does not occur;
- Any dirty water runoff containment facilities must remain outside of the defined riparian areas and their buffers as a measure to minimise the impact on the receiving environment;
- Adequate storm water management must be incorporated into the design of the proposed development in order to prevent erosion and the associated sedimentation of the riparian and instream areas;
- During all phases of development, or exploration drilling activities no vehicles should be allowed to indiscriminately drive through the watercourses and vehicles must remain on designated roadways;
- All areas of increased ecological sensitivity near to mining operations should be clearly marked as "out of bounds" areas for all mining staff. In particular, mention is made of remaining watercourses and associated zones systems and their associated buffers;
- During the construction and operational phases of the proposed mining development erosion berms should be constructed on roadways to prevent gully formation and siltation of the freshwater resources;
- No dumping of waste should take place within the riparian zone. If any spills occur, they should be immediately cleaned up;
- Implement alien vegetation control program within riparian areas with special mention of water-loving species such as *Cereus jamacaru* (Queen of the night) *and Datura ferox* (Large thorn-apple);
- Concurrent/progressive rehabilitation must be implemented at all times and disturbed areas must be rehabilitated as soon as possible. This will not only reduce the total disturbance footprint, but will also reduce the overall rehabilitation effort and cost;
- All areas affected by stockpiling during the operational phase of the mine should be rehabilitated and stabilised using cladding or a suitable grass mix and selected replanting of trees to prevent sedimentation of the aquatic resources in the area;
- As far as possible, the area should become free draining and support the recharge of the receiving environment; and
- Upon closure all haul and access roads as well as all unnecessary mining infrastructure should be removed in order to minimise the impacts on the aquatic resources of the area beyond the life of mine.

DOCUMENT GUIDE

The Document Guide below is for reference to the procedural requirements for environmental authorisation applications in accordance to GN267 of 24 March 2017, as it pertains to the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA);

No.	Requirement	Section in report
a)	Details of -	
(i)	The specialist who prepared the report	Appendix G
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	Appendix G
b)	A declaration that the specialist is independent	Appendix G
c)	An indication of the scope of, and the purpose for which, the report was prepared	Section 1.2
cA)	An indication of the quality and age of base data used for the specialist report	Section 2.1 and 3.1
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	Section 5.1 and 6.1
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 1.1
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 2 and Appendix C
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	Section 4.4 and 5
g)	An identification of any areas to be avoided, including buffers	Section 4.4
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Section 4.3
i)	A description of any assumption made and any uncertainties or gaps in knowledge	Section 1.4
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	Section 4, 5, and 6
k)	Any mitigation measures for inclusion in the EMPr	Section 6 and 7
l)	Any conditions for inclusion in the environmental authorisation	Section 6
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	Section 6
n)	A reasoned opinion -	
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	Section 7
(iA)	Regarding the acceptability of the proposed activity or activities	Section 6 and 7
(ii)	If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	Section 7
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	N/A
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
q)	Any other information requested by the competent authority	N/A

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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.
Base flow:	Long-term flow in a river that continues after storm flow has passed.
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 where water is collected by the natural landscape, where all rain and run-off water ultimately flows into a river, wetland, lake, and ocean or contributes to the groundwater 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".
Ephemeral stream:	Ephemeral systems flow for less time than they are dry. Flow or flood for short periods of most years in a five-year period, in response to unpredictable high rainfall events. Support a series of pools in parts of the channel.
Episodic stream:	Highly flashy systems that flow or flood only in response to extreme rainfall events, usually high in their catchments. May not flow in a five-year period, or may flow only once in several years**.**
Facultative species:	Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas
Fluvial:	Resulting from water movement.
Gleying:	A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.
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.
Hydrophyte:	Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.
Intermittent flow:	Flows only for short periods.
Indigenous vegetation:	Vegetation occurring naturally within a defined area.
Mottles:	Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.
Obligate species:	Species almost always found in wetlands (>99% of occurences).
Perched water table:	The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater
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.

RDL (Red Data listed) species:	Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status
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
Watercourse:	In terms of the definition contained within the National Water Act, a watercourse means: • A river or spring; • A natural channel which water flows regularly or intermittently; • A wetland, dam or lake into which, or from which, water flows; and • Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse; • and a reference to a watercourse includes, where relevant, its bed and banks
Wetland Vegetation (WetVeg) type:	Broad groupings of wetland vegetation, reflecting differences in regional context, such as geology, climate, and soils, which may in turn have an influence on the ecological characteristics and functioning of wetlands.

ACRONYMS

°C	Degrees Celsius.
AMD	Acid Mine Drainage
ASPT	Average Score Per Taxon
BAP	Biodiversity Action Plan
BAR	Basic Assessment Report
BAS	Best Attainable State
BGIS	Biodiversity Geographic Information Systems
CBA	Critical Biodiversity Area
CSIR	Council of Scientific and Industrial Research
CVB	Channelled Valley Bottom
DO	Dissolved Oxygen (mg/l)
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EC	Ecological Class or Electrical Conductivity (mS/m) [use to be defined in relevant sections]
EI	Ecological Importance
EIA	Environmental Impact Assessment
EIS	Ecological Importance and Sensitivity
EMP	Environmental Management Program
EMS	Environmental Management System
ES	Ecological Sensitivity
ESA	Ecological Support Area
EWR	Ecological Water Requirements
FEPA	Freshwater Ecosystem Priority Areas
FRAI	Fish Response Assessment Index
GIS	Geographic Information System
GN	Government Notice
GPS	Global Positioning System
HGM	Hydrogeomorphic
HF	High Flow
IC	Infrastructure Complex
IHAS	Invertebrate Habitat Assessment
IHI	Index of Habitat Integrity
IHIA	Intermediate Habitat Integrity Assessment
KR	Kimberley Reef
LF	Low Flow
m	Meter
MAMSL	Meters Above Sea Level
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MIRAI	Macro-Invertebrate Response Assessment Index
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
NWCS	National Wetland Classification System
PES	Present Ecological State
REC	Recommended Ecological Category
RMO	Recommended Management Objective

ROM	Run of mine
RQIS	Research Quality Information Services
SACNASP	South African Council for Natural Scientific Professions
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
SASS5	South African Scoring System Version 5
subWMA	Sub-Water Management Area
SQR	Sub Quaternary Reach
VEGRAI	Riparian Vegetation Response Assessment Index
WetVeg Groups	Wetland Vegetation Groups
WMA	Water Management Areas
WMS	Water Management System
WRC	Water Research Commission
WULA	Water Use License Application

1 INTRODUCTION

1.1 *Background*

Scientific Aquatic Services (SAS) was appointed to conduct an investigation of the freshwater resources within the proposed new mining area which is situated on the remaining extent of the farm The Duel 186 MT, hereafter referred to as the "study area" (Figures 1 - 2). An assessment of the study area was conducted by SAS in 2015/2016 and this report serves to update the results of the previous assessment (SAS 214206, 2016).

The N1 between Musina, west from the study area, meets the R525 regional road that reaches the village of Tshipise, north of the study area. The Nzhelele Nature Reserve is situated west of the study area. The land coverage in the vicinity and within the, The Duel Project area is characterised by mixed landuse comprising of rural settlements, hunting and ecotourism. Some of the properties are also focused on mixed farming, with a mixture of livestock, game farming and irrigated crop production. Hunting, game trading and eco-tourism is an established socio-economic driver in the area. There are a number of properties utilised for conventional and trophy (for local and foreign tourists).

The purpose of this report is to map aquatic, riparian and wetland resources and define areas of increased Ecological Importance and Sensitivity (EIS) and to define the Present Ecological State (PES) of the aquatic, riparian and wetland (if present) resources in the vicinity of the proposed mining operation.

To identify all potential watercourses that may potentially be impacted by the mining activities, a 500m "zone of investigation" around the study area, in accordance with Government Notice 509 as it relates to activities as stipulated in Section 21(c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998) was used as a guide in which to assess possible sensitivities of the receiving environment. This area will henceforth be referred to as the "investigation area".

It is the objective of this study to provide detailed information to guide the environmental assessment and authorisation process as well as planning of infrastructure and activities associated with the proposed mining operations in the vicinity of the drainage features of the region to ensure that the ongoing functioning of the episodic drainage lines and non perennial rivers are facilitated with specific mention of the following:

- Ensure that hydrological connectivity of the watercourses is maintained, as far as possible in the vicinity of proposed mining operations;
- Ensure ongoing functioning of the watercourses in the vicinity of proposed mining operation with specific mention of the post closure mining landscape;

- Ensure measures are implemented in order that no incision and canalisation of the river systems takes place as a result of the proposed mining operation;
- Ensure measures are implemented in order that impacts on water quality are managed as best possible;
- Ensure measures are implemented in order to minimise impacts on the ecology of the resources with specific mention of losses of riverine habitat and loss of goods and services provided by the watercourses within and adjacent to the study area; and
- Ensure measures are implemented in order to minimise the loss of biodiversity within the local area and regionally.

The study further aimed to identify and quantify any impacts on the freshwater resources in the area and to present a set of mitigatory measures which could be employed to minimise impacts on the receiving aquatic environment, given the objectives defined above.

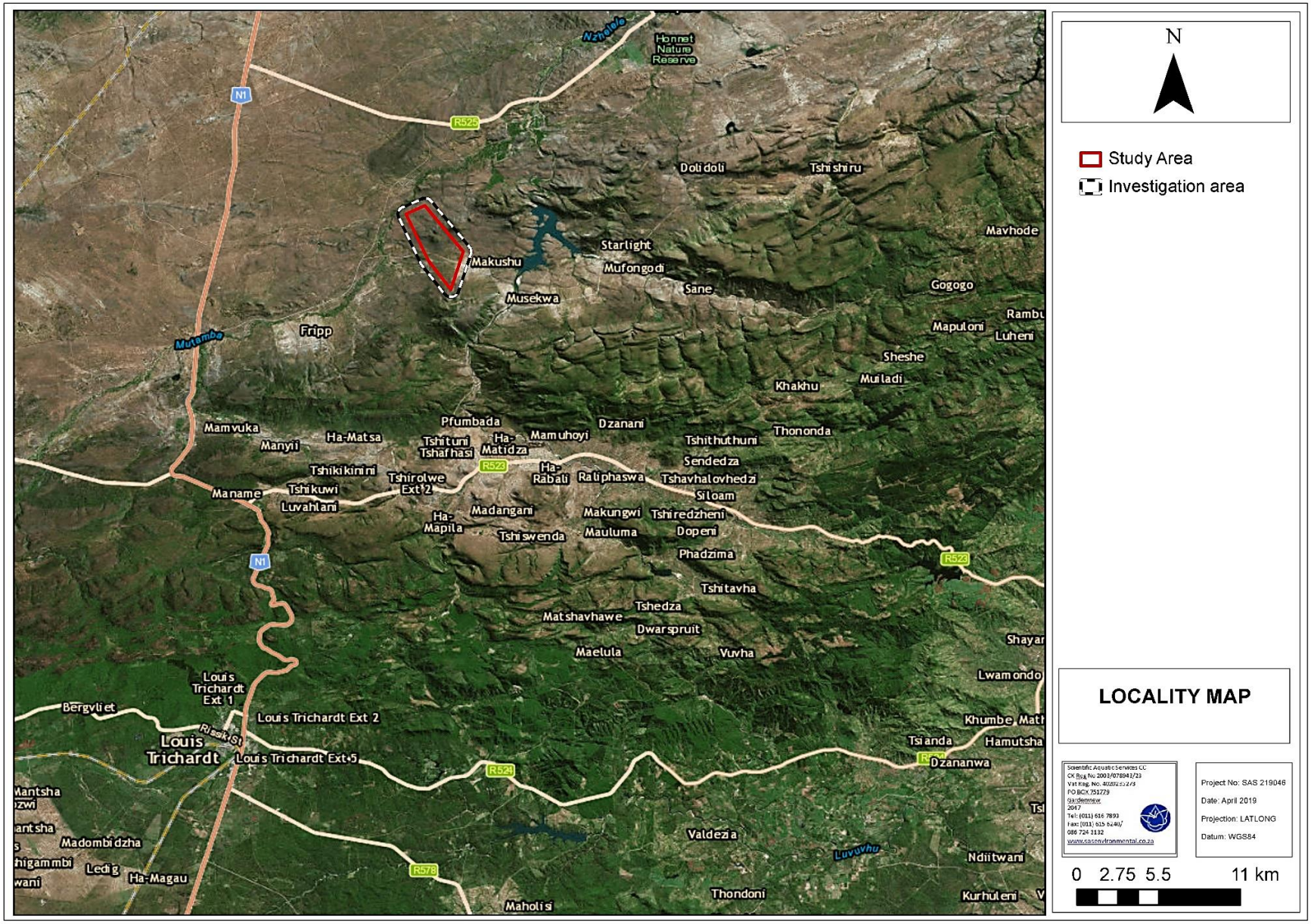


Figure 1: Digital satellite image depicting the location of the study area in relation to surrounding areas.

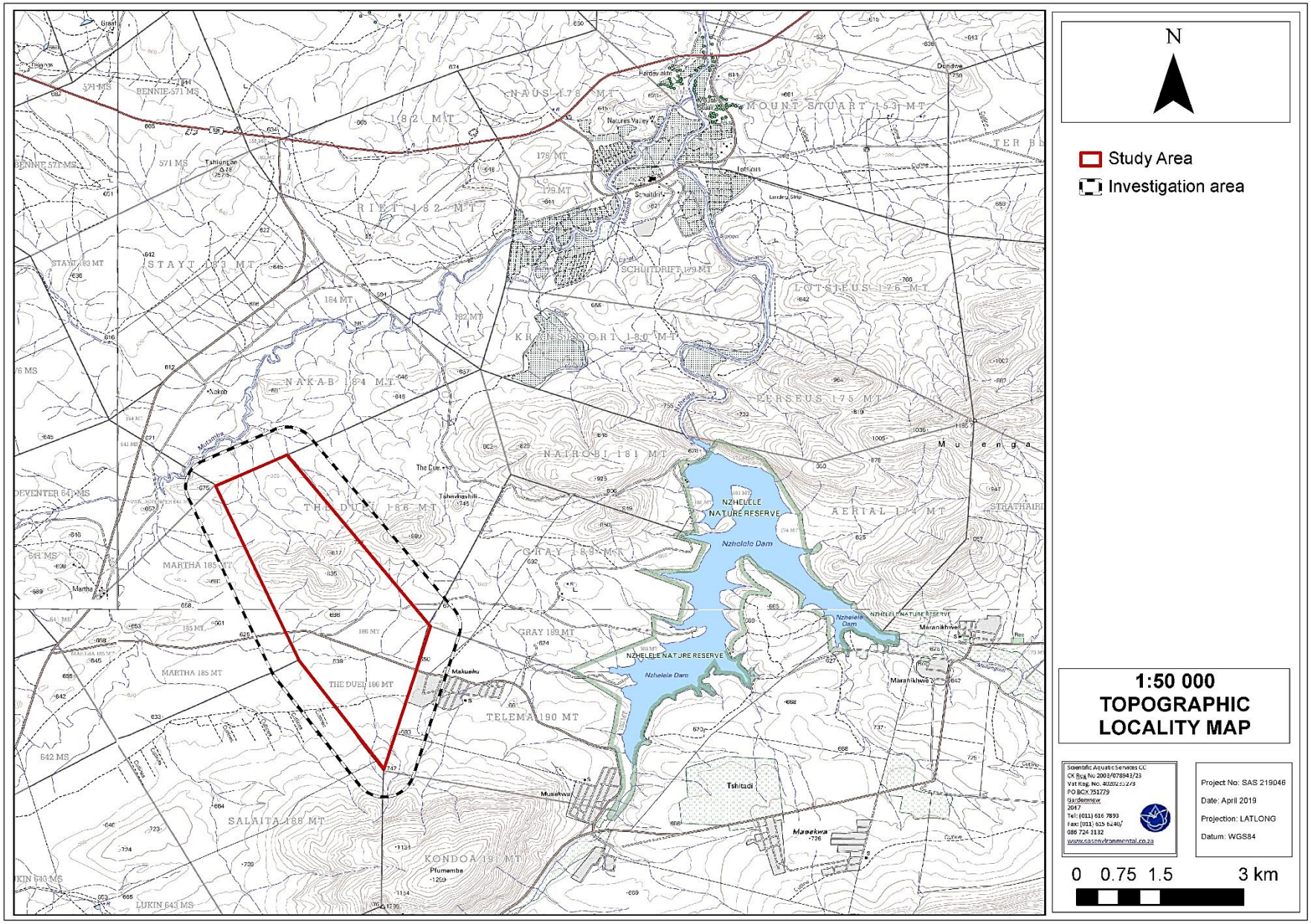


Figure 2: Study area depicted on a 1:50 000 topographical map in relation to its surrounding area.

1.2 *Project Description*[1]

Subiflex (Pty) Ltd holds a Prospecting Right on the farms Lotsieus 176 MT, Kranspoort 180 MT, Nairobi 181 MT and The Duel 186 MT. The proposed project is for the mining of coal on the Remaining Extent of The Duel 186 MT (i.e. the study area) using a combination of mining methods, i.e. underground mining (long-wall methodology[2]) and open cast (conventional drill and blast operation with truck and shovel, load and haul). The expected life of mine (LoM) is 24 years.

Mining of the Open Pit (Figure 3) will form part of the first operations, whereas the underground mining is planned to commence from year 10, continuing for five years. Selected positions within the Open Pit will be used to gain access for underground mining activities and upon completion all access points will be closed. The Open Pit will be rehabilitated.

The proposed infrastructure to be developed includes (Figure 3):

- Coal Handling Processing Plant;
- Overburden Waste Dump;
- Temporary Discard Dump;
- Haul roads;
- Pollution Control Dams;
- Raw water storage facility and distribution systems;
- Access road; and
- Auxiliary infrastructure including a workshop and store, office and change house, electrical power supply and security fencing.

The final discard material from the plant will be disposed of in the mined-out open pit. If the pit is unavailable due to existing mining activities, the discard material will be placed on an interim surface discard dump, from where it will be reclaimed and dumped into the mined-out open pit towards the end of the mine life as part of the rehabilitation of the mining site.

[1] 05-03-2015 The Duel Coal Project BID final approved.

[2] "Long-wall mining recovers and extracts a high percentage of the coal and can be very costly. It involves the full extraction of coal from a section of the seam or face using mechanical shearers (WCI, 2009)." Shongwe Bonisile Nolwando Master's Thesis (2018): The Impact of Coal Mining on the Environment and Community Quality of Life: A Case Study Investigation of the Impacts and Conflicts Associated with Coal Mining in the Mpumalanga Province, South Africa.

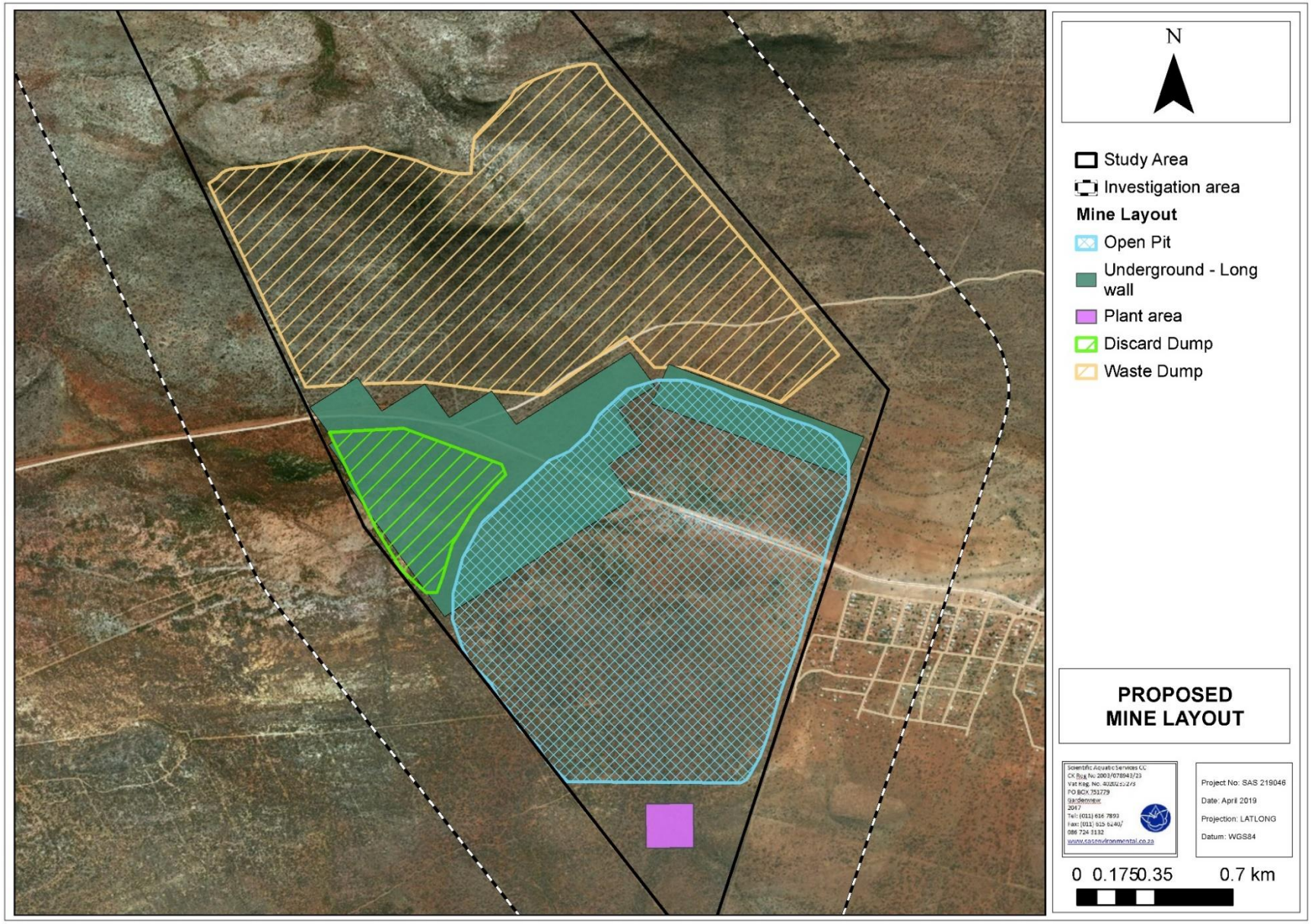


Figure 3: Proposed mine layout and associated infrastructure within the study area.

1.3 *Scope of Work*

SAS has previously undertaken freshwater resource studies within the study area. The aim of the current study was to re-assess all watercourses associated with the Duel project and to update, where and if required, the results of the previous studies. A detailed background study of relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas [NFEPA] 2011 database; and the Department of Water and Sanitation Research Quality Information Services [DWS RQIS PES/EIS] 2014 database), including the historical baseline studies (SAS 214206, 2016), was reviewed to ensure that all information previously presented remains valid. A site visit was undertaken at which time watercourses associated with the study area was re-assessed.

Specific outcomes in terms of this report are outlined below:

- All watercourses within 500m of the study area were delineated using desktop methods in accordance with GN 509 of 2016 as it pertains to the NWA, with limited field verification thereof;
- The wetland and riverine 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);
- Provide a presentation of the findings of the site assessment, as well as all maps and data from national and provincial databases that have bearing on the watercourse PES and EIS. In this regard specific mention is made of the NFEPA database and relevant Conservation datasets;
- Reporting on the aspects regarding watercourse drivers and receptors as required by the DWS Chief Directorate Instream Water Use, including the following:
    - Watercourse drivers:
        - Hydrology;
        - Water quality; and
        - Sediment balance and the geomorphological regime.
    - Watercourse receptors:
        - Habitat; and
        - Biota.
- Mapping of watercourses according to the ecological sensitivity of the hydrogeomorphic (HGM) unit in relation to the study area. Applicable buffer zones and/or zones of regulation according to relevant legislation or provincial guidelines was delineated around the watercourses. The applicable buffer maps are provided within this report;

- Allocation of a suitable Recommended Ecological Category (REC), Recommended Management Objective (RMO) and Best Attainable State (BAS) based on the outcome of the PES, EIS and ecological service provision assessments;
- To determine the impact that the project might have on the watercourses as a result of the proposed activities and to aim to quantify the significance thereof; and
- To present management and mitigation measures which should be implemented during the various development phases to assist in minimising the impact on the receiving environment.
- To collect baseline data and present recommendations with the intention to:
  - Maintain the PES of the system in support of the EIS of the aquatic ecosystem;
  - Ensure that connectivity of the aquatic resources is maintained between the areas upstream and downstream of the proposed development areas;
  - Ensure that no further incision and erosion of the river system takes place as a result of the proposed development;
  - Ensure that no significant persistent impact on water quality will take place;

This study further aims to provide detailed information to guide the proposed project activities in the vicinity of the watercourses, to ensure the ongoing functioning of the ecosystems, 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. This report, after consideration of the above, must guide the relevant authorities, by means of a reasoned opinion and recommendations, as to the viability of the proposed mining activities from a freshwater resource management point of view and in the context of sustainable development and in consideration of the principles of Integrated Environmental Management.

1.4 *Assumptions and Limitations*

The following assumptions and limitations are applicable to this report:

- The freshwater resource assessment is confined to the study area as well as the immediate adjacent areas of relevance and does not include the neighbouring and adjacent properties;
- Due to the extent of the areas that form part of the study area, use was made of aerial photographs, digital satellite imagery as well as provincial and national wetland databases to identify areas of interest prior to the field survey. Any additional watercourses and drainage lines were noted during the field survey were also assessed and added to the number of survey points.

Although all possible measures were undertaken to ensure all watercourses were assessed and delineated, some smaller ephemeral drainage lines may have been overlooked. However, if the sensitivity map is consulted during the planning phases of the mine all riparian habitats considered to be of increased EIS will be safeguarded;

- Due to the majority of drainage features being ephemeral within the region, very few areas were encountered that displayed more than one wetland characteristic as defined by the DWA (2008) method. As a result, identification of the outer boundary of riparian zones proved difficult in some areas and in particular in the areas where riparian zones were marginal; and
- Aquatic, wetland and riparian ecosystems are dynamic and complex. Some aspects of the ecology of these systems, some of which may be important, may have been overlooked. The findings of this study were initially based on a single site visit undertaken at a time when low flows were being experienced (February 2015). An additional site visit was undertaken in February 2019 to update, where necessary, the results of the 2015 field assessment. A more reliable assessment would have required that seasonal assessments take place with at least one assessment in the high flow season also undertaken. Some historical data for Mutamba River was available in the vicinity of the proposed project, from which limited additional inferences could be made about the drainage systems of the area in different seasons.

1.5 *Legislative Requirements and Provincial Guidelines*

The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development.

Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive realisation of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.

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

- National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA);
- National Water Act, 1998 (Act 36 of 1998) (NWA);
- Government Notice (GN) 509 as published in the Government Gazette 40229 of 2016 as it relates to the NWA, 1998 (Act 36 of 1998); and
- Government Notice 704 Regulations as published in the Government Gazette 20119 of 1999 as it relates to the NWA, 1998 (Act 36 of 1998) regarding the use of water for mining and related activities aimed at the protection of water resources.

2 ASSESSMENT APPROACH

2.1 *Watercourse Field Verification and Assessment*

For the purposes of this investigation, the definitions of a watercourse, a wetland and riparian systems were taken as per that in the National Water Act, 1998 (Act 36 of 1998). The definitions are as follows:

A **watercourse** is defined as:
(a) a river or spring;
(b) a natural channel in which water flows regularly or intermittently;
(c) a wetland, lake or dam into which, or from which, water flows; and
(d) any collection of water which the Minister may, by notice in the *Gazette,* declare to be a watercourse and a reference to a watercourse includes, where relevant, its bed and banks.

Wetland habitat is “land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.”

Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which

are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure **distinct** from those of adjacent areas.

As mentioned in Section 1.4 use was made of historical aerial photographs, historical and current digital satellite imagery, topographic maps and available provincial and national wetland databases to aid in the delineation of those portions of the watercourses located within 100m-500m from the study area following the field assessment. The following was taken into consideration when utilizing the above during delineation:

- Hydrophytic and riparian vegetation: a distinct increase in density, changes in species composition, as well as tree size near drainage lines;
- Hue: with wetlands, riparian areas and drainage lines displaying varying chroma created by varying vegetation cover and soil conditions in relation to the adjacent terrestrial areas; and
- Texture: with wetland and riparian areas displaying various textures which are distinct from the adjacent terrestrial areas, created by varying vegetation cover and soil conditions within the watercourse.

The watercourse delineation was verified in the field, and this delineation took place according to the method presented in the “Updated manual for the identification and delineation of wetland and riparian resources” (DWAF, 2008). The foundation of the method is based on the fact that watercourses 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.

Aquatic ecological assessments were undertaken at one point on the Mutamba River a very long distance upstream of the proposed “The Duel” Project.
In addition, historical information from several sites upstream of the “The Duel” project was available which was used to further aid in the characterisation of the aquatic ecology of the Mutamba River by means of the discussion only.

Table 1 below present geographic information with regards to the monitoring point on the Mutamba River. Figure 4 visually presents the location of the point, assessed in relation to the study area.

Table 1: Location of the aquatic assessment point with co-ordinates

Site	Detailed Site Description	GPS Coordinates	
		Latitude	Longitude
TD1	Mutamba River in the vicinity of the proposed The Duel Coal Mine development.	22°43'12.64"S	30°1'15.43"E

The assessed site was visually assessed with the following aquatic methodologies employed. The Invertebrate Habitat Assessment System (IHAS), Intermediate Habitat Integrity Assessment (IHIA), fish Habitat Cover Ratings (HCR), the South African Scoring System version 5 (SASS5) and Macro-Invertebrate Risk Assessment Index (MIRAI) for the assessment of the macro-invertebrate community and the Fish Risk Assessment Index (FRAI) in order to assess the risks to the fish community at site TD1 on the Mutamba River in addition to the analyses of biota specific water quality. The protocols of applying the indices were strictly adhered to and all work was carried out by a South African River Health Program (SA RHP) accredited assessor.

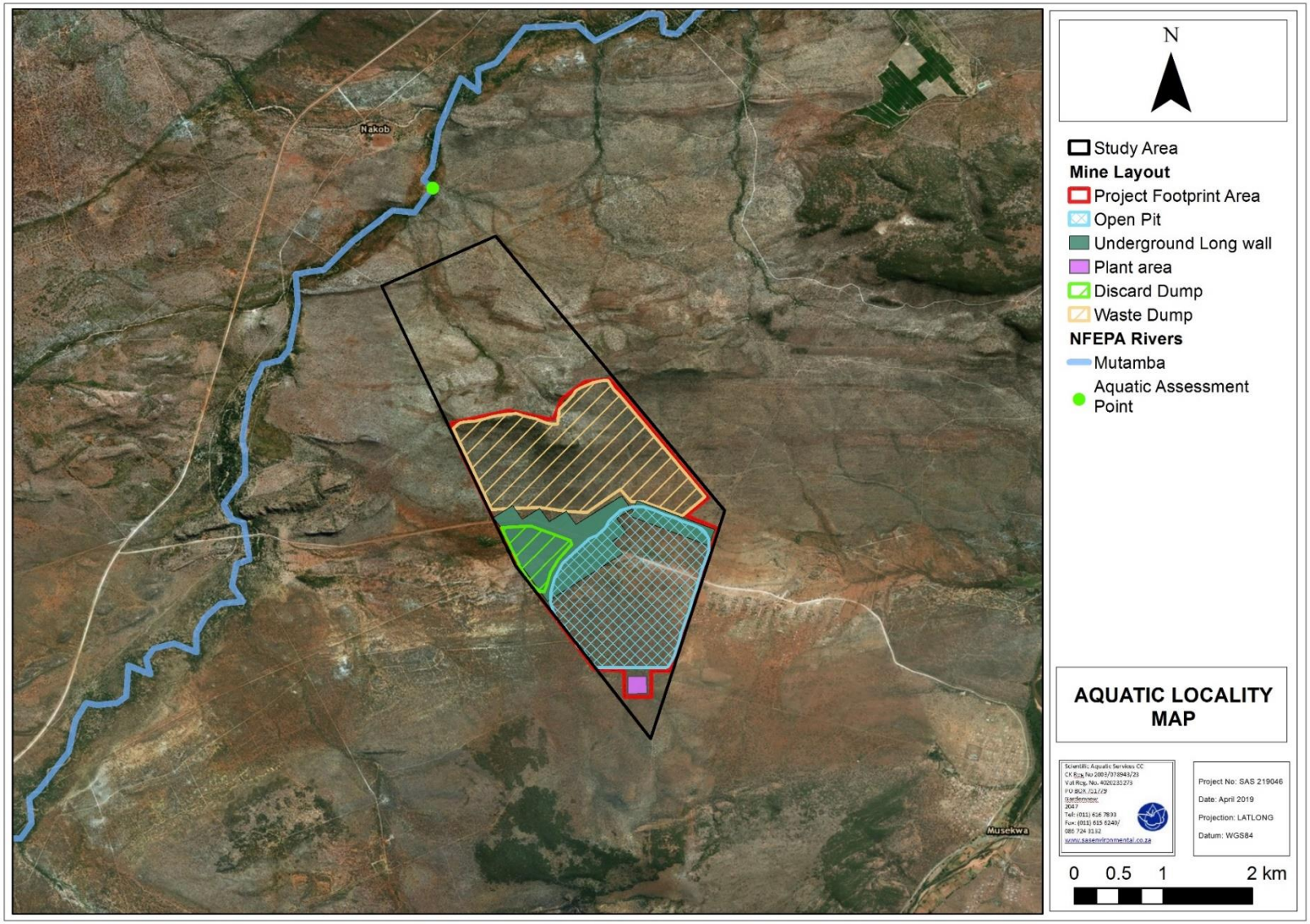


Figure 4: Depiction of the aquatic assessment point position within the study area.

Initial field assessments were undertaken during February 2015 to assess as many of the points of interest as possible which were identified during the desktop assessment phase. The presence of any wetland characteristics as defined by the DWA 2005 or riparian habitat as defined by the NWA (Act 36 of 1998) was noted at each river, drainage line and artificial impoundment to determine if features can be considered to contain areas displaying wetland or riparian characteristics. Factors influencing the habitat integrity of each feature group identified during the field survey was noted, the functioning and the environmental and socio-cultural services provided by the various features was determined.

A second field assessment was undertaken from the 26th to the 28th of February 2019 where the results of the 2015 field assessment were confirmed and/or updated. In addition to the delineation process, detailed assessments of the delineated watercourses were undertaken, at which time factors affecting the integrity of the watercourses were taken into consideration and aided in the determination of the functioning and the ecological and socio-cultural services provided by the watercourses. A detailed explanation of the methods of assessment undertaken is provided in Appendix C of this report.

2.2 *GIS Mapping*

Digital signatures were identified during the initial desktop assessment that were ground truthed during the assessment of each site that was selected. These digital signatures were then used to determine if wetland or riparian habitat is present within a feature. The following digital signatures were considered:

- **Riparian vegetation:** a distinct increase in density as well as tree size near drainage lines;
- **Hue:** with drainage lines and outcrops displaying soils of varying chroma created by varying vegetation cover and soil conditions identified;
- **Surface water:** to aid with the identification of artificial impoundments that may sustain wetland habitat the presence of surface water were considered informative; and
- **Texture:** with areas displaying various textures, created by varying vegetation cover and soil conditions being identified.

2.3 *Sensitivity Mapping*

All watercourses associated with the study area were delineated with the use of a Global Positioning System (GPS).

A Geographic Information System (GIS) was used to project these features onto digital satellite imagery and topographic maps. The sensitivity map presented in Section 4 should guide the design and layout of the development.

2.4 *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.

The recommendations provided also include general 'best practice' management measures, which apply to the proposed developments as a whole, and which are presented in Appendix F. 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 6 of this report.

3 RESULTS OF THE DESKTOP ANALYSIS

The following section contains data accessed as part of the desktop assessment and are largely presented in "dashboard" style below (Table 3). The dashboards aim to present concise summaries of the data on a few pages as possible to allow for the integration of results by the reader to take place.

It is important to note that although all data sources used to provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the actual site characteristics of the study area at the scale required to inform the environmental authorisation and/or water use licencing processes. However, this information is considered 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.

Table 2: Desktop data relating to the character of freshwater resources within the study area.

AQUATIC ECOREGION AND SUB-REGIONS IN WHICH THE STUDY AREA IS LOCATED			
Ecoregion	Soutpansberg Aquatic Ecoregion		
Catchment	Limpopo		
Quaternary Catchment	A80F		
WMA	Limpopo		
subWMA	Nzhelele/Nwanedzi		
DOMINANT CHARACTERISTICS OF THE SOUTPANSBERG ECOREGION LEVEL 2 (2.03) (KLEYNHANS *et al.* 2007)			
Ecoregion	Soutpansberg (2.03)	**Rainfall concentration index**	60 to >65
Terrain Morphology: Broad division	Closed hills, Mountains; moderate and high relief	**Rainfall seasonality**	Mid-summer
Vegetation types	Soutpansberg Arid Mountain Bushveld	**Mean annual temp. (°C)**	16 to 22
Altitude (m a.m.s.l)	300-1500	**Winter temperature (July)**	4 to 24
MAP (mm)	300 to 700	**Summer temperature (Feb)**	14 to 32
Coefficient of Variation (% of MAP)	20 to 34	**Median annual simulated runoff (mm)**	5 to 10; 20 to 100; (80 to 100 limited); 150 to 200 (limited)

ECOLOGICAL STATUS OF THE MOST PROXIMAL SUB-QUATERNARY REACH (DWS, 2014)			
	Sub-quaternary reach		
	A80F-00063 (Mutamba)	**A80F-00070 (Unnamed tributary of the Mutamba River)**	**A80F-00065 (Nzhelele)**
Assessed by expert?	Yes	Yes	Yes
Present Ecological State (PES) category median	C	B	D
Mean Ecological Importance (EI) class	Moderate	Moderate	Moderate
Mean Ecological Sensitivity (ES) class	High	Moderate	Moderate
Length	17.7	9.1	9.8
Stream order	2	1	2
Default Ecological Class (EC) (based on median PES and highest EI or ES mean)	B	C	C

DETAIL OF THE STUDY AREA IN TERMS OF THE NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREA (NFEPA) (2011) DATABASE	
FEPACODE	The study area is located within a subWMA not considered important in terms of River or Fish conservation (FEPACODE = 0)
NFEPA Wetlands	According to the NFEPA database, no wetlands are located within the study area, nor within 500m of the study area boundary.
Wetland vegetation Type (Figure 5)	The study area is located within the Mopane Group 1 and the Central Bushveld Group 1 wetland vegetation types, which are both classified as Critically Endangered (SANBI, 2012; Mbona *et al*, 2014). These are sensitive vegetation types that have been afforded hardly any to no protection, thus, this could lead to limitations on the proposed The Duel Coal Mine project footprint.
NFEPA Rivers	According to the NFEPA database, there are no Rivers within the study area or investigation area. The closest River is located approximately 0.6 km north of the study area, i.e. the Mutamba River.
IMPORTANCE OF THE STUDY AREA ACCORDING TO THE MINING AND BIODIVERSITY GUIDELINES (2013) – FIGURE 6	
Highest Biodiversity Importance (Figure 7)	According to the Mining and Biodiversity Guideline the majority of the project footprint area is located within an area considered to be of Highest Biodiversity Importance (Figure 7). Highest Biodiversity Importance areas include areas where mining is not legally prohibited, but where there is a very high risk that, due to their potential biodiversity significance and importance to ecosystem services (e.g. water flow regulation and water provisioning), mining projects will be significantly constrained or may not receive the necessary authorisations. The white areas are areas for which no importance is indicated.
LIMPOPO CONSERVATION PLAN VERSION 2 (C-PLAN, 2013) - FIGURE 7	
CBA 1	The entire project footprint area falls within a **CBA 1**. These are **Irreplaceable Sites** required to meet biodiversity pattern and / or ecological processes targets. Land Management Recommendations: Obtain formal conservation protection where possible. Implement appropriate zoning to avoid net loss of intact habitat or intensification of land use. Incompatible Land-Use: Urban land-uses including Residential (including golf estates, rural residential, resorts), Business, Mining & Industrial; Infrastructure (roads, power lines, pipelines).
CBA 2	The remaining extent of the study area, i.e. all areas excluding the footprint area, falls within a **CBA 2**. These are **Best Design Selected Sites** that are selected to meet biodiversity pattern and / or ecological processes targets. Alternative sites may be available to meet targets. Land Management Recommendations: Avoid conversion of Agricultural land to more intensive land uses, which may have a negative impact on threatened species or ecological processes. Incompatible Land-Use: Urban land-uses including Residential (including golf estates, rural residential, resorts), Business, Mining & Industrial; Infrastructure (roads, power lines, pipelines). ***Note**: Certain elements of these activities could be allowed subject to detailed impact assessment to ensure that developments were designed to CBA2. Alternative areas may need to be identified to ensure the CBA network still meets the required targets.*

CBA = Critical Biodiversity Area; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; m.a.m.s.l = Metres Above Mean Sea Level; MAP = Mean Annual Precipitation; NFEPA = National Freshwater Ecosystem Priority Areas; PES = Present Ecological State WMA = Water Management Area.

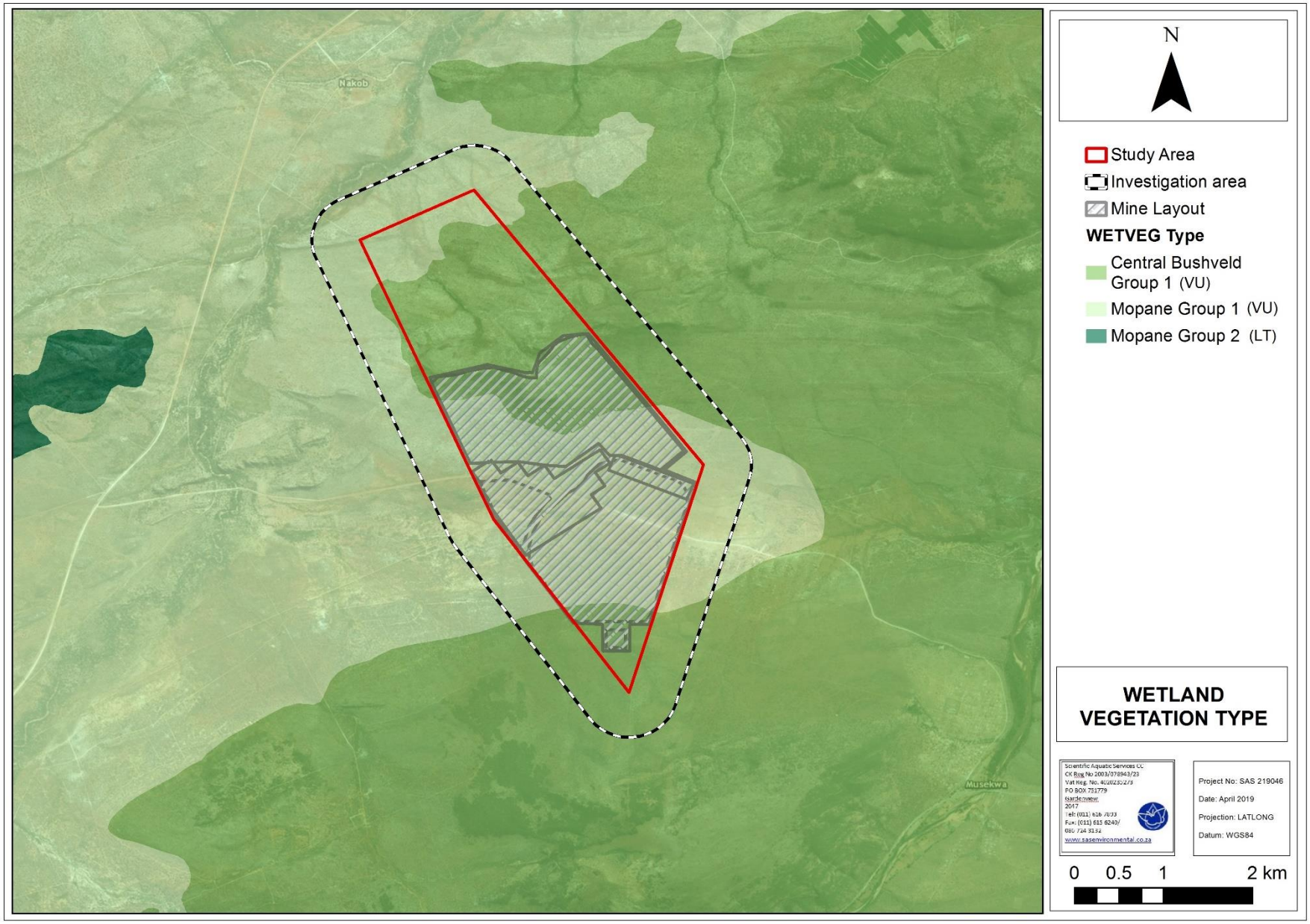


Figure 5: Importance of the study area in relation to the Wetland vegetation (WETVEG) types that it falls in, according to NFEPA (2011) database.

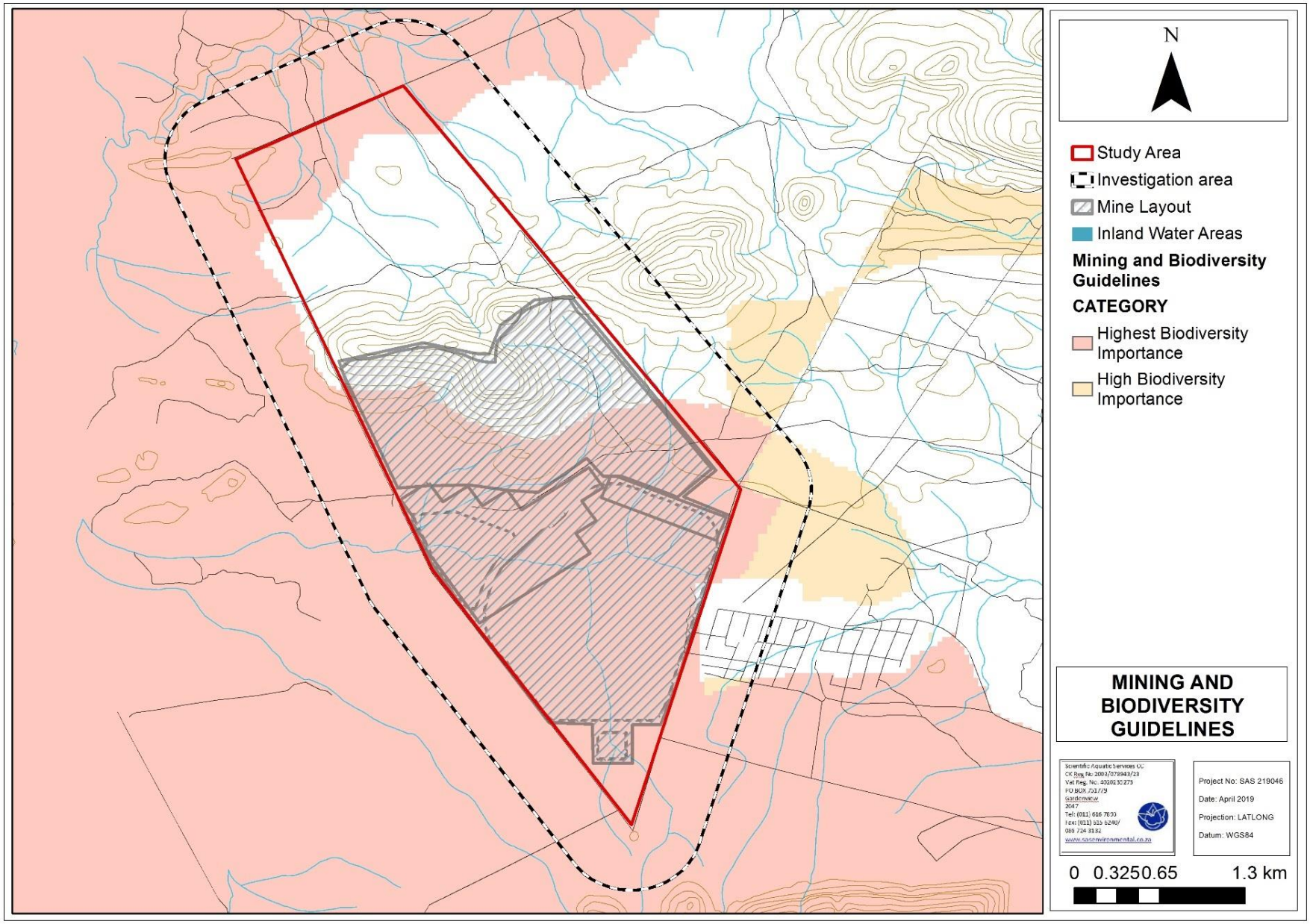


Figure 6: Areas of biodiversity importance that are associated with the study area (Mining and Biodiversity Guidelines, 2013).

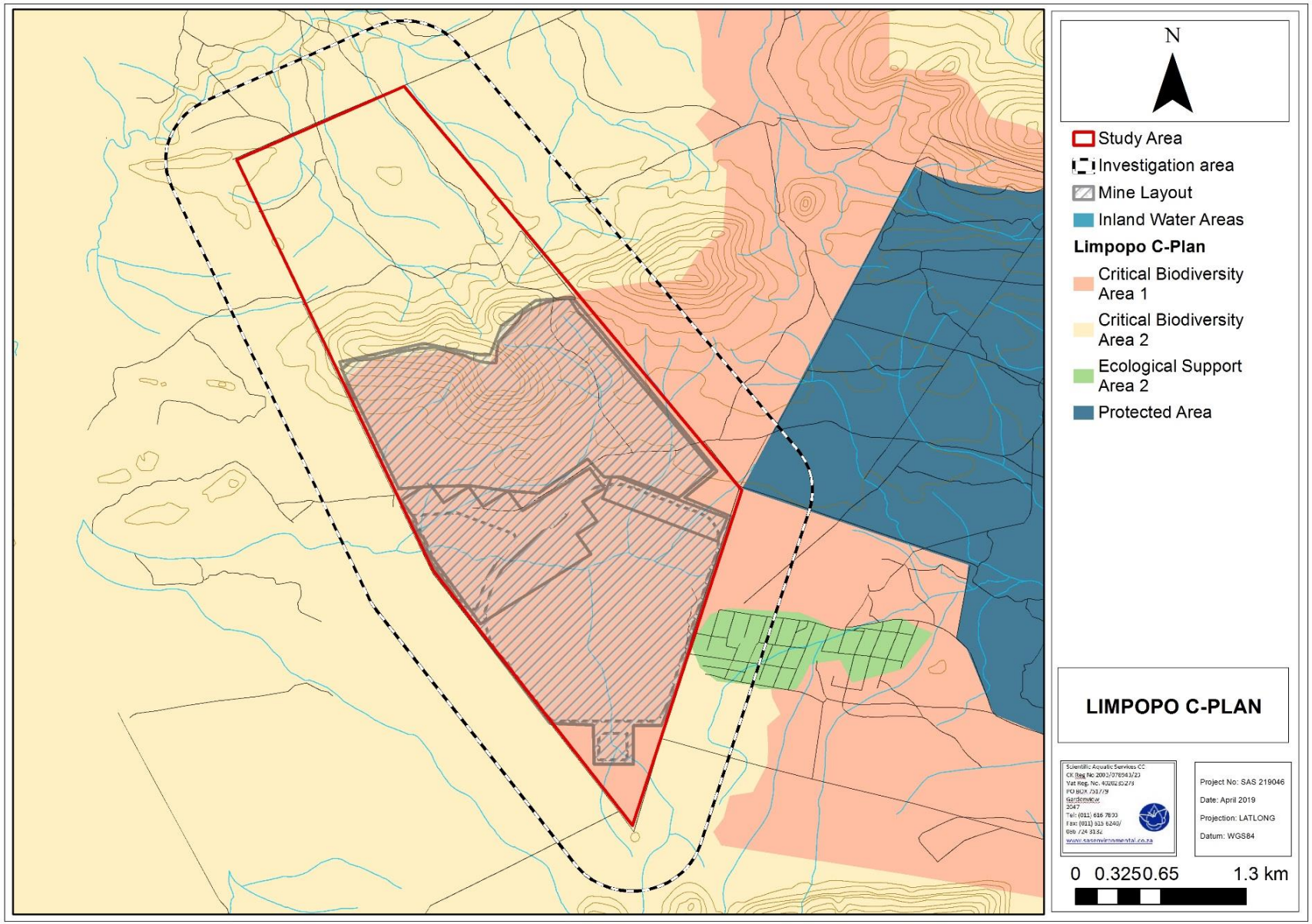


Figure 7: Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs) that are associated with the study area (Limpopo C-Plan v2)

3.1 *Ecostatus Classification*

Studies undertaken by the Institute for Water Quality Studies assessed all quaternary catchments as part of the Resource Directed Measures for Protection of Water Resources. In these assessments, the Ecological Importance and Sensitivity (EIS), Present Ecological Management Class (PEMC) and Desired Ecological Management Class (DEMC) were defined and serve as a useful guideline in determining the importance and sensitivity of aquatic ecosystems, prior to assessment or as part of a desktop assessment.

This database was searched for the catchment of concern in order to define the EIS, PEMC and DEMC for the study area. The results of the assessment are summarised in the table below. It must be noted, however, that the assessment point for the quaternary catchment is located on the Mutamba River which is a perennial river system, as such some significant deviations from the conditions in the Mutamba River adjacent to the proposed mining project area are likely. Extrapolation of these observations must therefore be done with caution.

Table 3: Summary of the ecological status of quaternary catchments A80F based on Kleynhans (1999)

Catchment	Resource	EIS	PESC	DEMC
A80F	Nzhelele River	High	Class D	B: Sensitive system

Catchment A80F

According to the ecological importance classification for the quaternary catchment, the system can be classified as a *Sensitive* system which, in its present state, can be considered a Class D (largely modified) stream.

The points below summarise the impacts on the aquatic resources in the A80F quaternary catchment (Kleynhans 1999):

- The aquatic resources within this quaternary catchment have been marginally affected by scouring of the system;
- Flow modification within the catchment is considered very high due to the control of flow by a dam upstream;
- Marginal impacts from inundation of the system occur;
- Riparian zones and stream bank conditions are considered to be moderately impacted by erosion*;*
- A low impact occurs as a result of the introduction of instream biota with special mention of *Azzola* sp. (Water Fern) and *Cyprinus carpio*. (Carp)*;* and

- Impacts on water quality in the system are considered high as water released by the dam has a modified temperature and quality.

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

- The riverine systems in this catchment have a high diversity of habitat types;
- The site has a moderate importance in terms of conservation with special mention of a gorge in the system;
- The riverine resources in this system have a moderate intolerance to flow and flow related water quality changes;
- The aquatic resources in the area have a high importance in terms of migration of species and form a transition zone between mountain and low veld. Special mention is made of the migration of eels, fish and birds;
- The system is considered to be of high importance in terms of rare and endemic species conservation. Some species may occur upstream of Nzhelele Dam;
- The aquatic resources in this catchment are moderately important in terms of the provision of refuge areas;
- The riverine resources in this system have a moderate sensitivity to changes in water quality and flow. The gorge area is particularly sensitive to changes in flow;
- The aquatic resources in this area are of high importance in terms of Species/Taxon richness with up to 15 different species present; and
- The system is of high importance with regards to unique or endemic species with special mention of *Enteromius eutenea* (Orangefin Barb), *Enteromius lineamaculatus* (Line-spotted Barb).

3.2 *Ecological status of sub-quaternary catchments [Department of Water and Sanitation (DWS) Resource Quality Services (RQS) PES/EIS database]*

The PES/EIS database, as developed by the DWS RQIS department, was utilised to obtain additional background information on the project area. The information from this database is based on information at a sub-quaternary catchment reach (SQR) level. Descriptions of the aquatic ecology is based on information collated by the DWS RQIS department from available sources of reliable information, such as SA RHP sites, Ecological Water Requirements (EWR) sites and Hydro Water Management system (WMS) sites.

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the area is located within. This knowledge allows for improved interpretation of data

to be made, since reference information and representative species lists are often available on this level of assessment, which aids in guiding the assessment. The Duel Project Area falls within both the Soutpansberg aquatic ecoregion and the A80F quaternary catchment. The Duel Project Area is located between the Mutamba River in the west and north, an unnamed tributary of the Mutamba towards the south-west and the Nzhelele River towards the east. Information for the following sub-quaternary catchment reaches (SQRs) is thus applicable:

Mutamba River: A80F-00063 (Figure 8).

The site assessed was located on the Mutamba River and as a result information from this SQR is considered primary. However, information from the following two SQRs will also be provided as they have relevance to the larger study area:

- Unnamed tributary of the Mutamba River: A80F-00070;
- Nzhelele River: A80F-00065.

Key information on fish species, invertebrates and background conditions, associated with the above listed assessment areas, as contained in this database and pertaining to the Present Ecological State (PES), ecological importance and ecological sensitivity for the Rivers, are tabulated in Tables 4 to 8 below.

Table 4: Fish species previously collected from or expected in the various SQR monitoring points associated with the various assessment areas.

	A80F-00063*	A80F-00065 (Nzhelele)
Aplocheilichthys johnstoni Günther, 1893		X
Enteromius paludinosus Peters, 1852	X	X
Enteromius trimaculatus Peters, 1852	X	X
Enteromius unitaeniatus Günther, 1866	X	X
Enteromius viviparous, Weber 1897	X	X
Clarias gariepinus (Burchell, 1822)	X	X
Labeobarbus marequensis Smith, 1841	X	X
Labeo cylindricus Peters, 1852	X	X
Labeo molybdinus Du Plessis, 1963	X	X
Marcusenius macrolepidotus (Peters, 1852)		X
Oreochromis mossambicus (Peters, 1852)	X	X
Petrocephalus catostoma, (Günther, 1866)		X
Pseudocrenilabrus philander (Weber, 1897)	X	X
Schilbe intermedius Rüppell, 1832		X
Tilapia sparmanii Smith, 1840	X	X

***Important to note**: for the A80F-00070 (unnamed tributary of the Mutamba), no expected fish species or invertebrate taxa lists are available which may be due to the ephemeral nature of this system thus the closest SQR was used (A80F-00063).

Table 5: Invertebrate taxa previously collected from or expected at the various SQR monitoring points associated with the various assessment areas.

	A80F-00063*	A80F-00065 (Nzhelele)
Atyidae	X	X
Aeshnidae	X	X
Ancylidae	X	X
Baetidae 2 spp.	X	X
Belostomatidae	X	X
Caenidae	X	X
Coenagrionidae	X	X
Corixidae	X	X
Ceratopogonidae	X	X
Chironomidae	X	X
Culicidae	X	X
Corbiculidae	X	X
Dytiscidae	X	X
Elmidae/Dryopidae	X	X
Gyrinidae	X	X
Gomphidae	X	X
Gerridae	X	X
Hirudinea	X	X
Hydracarina	X	X
Hydrometridae	X	X
Hydroptilidae	X	X
Hydrophilidae	X	X
Hydropsychidae 1 sp.	X	X
Libellulidae	X	X
Leptophlebiidae	X	X
Lymnaeidae	X	X
Leptoceridae	X	X
Muscidae	X	X
Naucoridae	X	X
Notonectidae	X	X
Nepidae	X	X
Oligochaeta	X	X
Palaemonidae		X
Potamonautidae	X	X
Pleidae	X	X
Turbellaria	X	X
Tabanidae	X	X
Tipulidae	X	X
Thiaridae	X	X
Simuliidae	X	X
Veliidae/Mesoveliidae	X	X

***Important to note**: for the A80F-00070 (unnamed tributary of the Mutamba), no expected fish species or invertebrate taxa lists are available which may be due to the ephemeral nature of this system thus the closest SQR was used (A80F-00063).

Table 6: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR A80F-00063 (Mutamba) based on the DWS RQS PES/EIS database

Synopsis (SQ reach A80F-00063 (Mutamba)					
PES[1] category median	Mean EI[2] class	Mean ES[3] class	Length	Stream order	Default EC[4]
C	Moderate	High	17.74	2	B
PES details					
Instream habitat continuity MOD	Small	**Riparian/wetland zone MOD**	Moderate		
RIP/wetland zone continuity MOD	Small	**Potential flow MOD activities**	Moderate		
Potential instream habitat MOD activities	Moderate	**Potential physico-chemical MOD activities**	Moderate		
EI details					
Fish spp/SQ	11.00	**Fish average confidence**	1.00		
Fish representivity per secondary class	Low	**Fish rarity per secondary class**	Low		
Invertebrate taxa/SQ	40.00	**Invertebrate average confidence**	1.00		
Invertebrate representivity per secondary class	High	**Invertebrate rarity per secondary class**	Moderate		
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating	High	**Habitat diversity class**	Low		
Habitat size (length) class	Low	**Instream migration link class**	Very High		
Riparian-wetland zone migration link	Very High	**Riparian-wetland zone habitat integrity class**	High		
Instream habitat integrity class	High	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**	High		
Riparian-wetland natural vegetation rating based on expert rating	Low				
ES details					
Fish physical-chemical sensitivity description	High	**Fish no-flow sensitivity**	High		
Invertebrates physical-chemical sensitivity description	High	**Invertebrates velocity sensitivity**	Very high		
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	High				
Stream size sensitivity to modified flow/water level changes description	High				
Riparian-wetland vegetation intolerance to water level changes description	Low				
Main habitats	Small seasonal river, alluvial stream bed, riparian trees and shrubs, pools, grassy edges and reeds				
Main adverse conditions	Lack of surface flows, return flows and irrigation				

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;
[2] EI = Ecological Importance;
[3] ES = Ecological Sensitivity
[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

Table 7: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR A80F-00070 (unnamed tributary of the Mutamba) based on the DWS RQS PES/EIS database

Synopsis (SQ reach A80F-00070 (unnamed tributary of the Mutamba))					
PES[1] category median	Mean EI[2] class	Mean ES[3] class	Length	Stream order	Default EC[4]
B	Moderate	Moderate	9.14	1	C
PES details					
Instream habitat continuity MOD	None	**Riparian/wetland zone MOD**	Small		
RIP/wetland zone continuity MOD	Small	**Potential flow MOD activities**	None		
Potential instream habitat MOD activities	None	**Potential physico-chemical MOD activities**	None		
EI details					
Fish spp/SQ	12	**Fish average confidence**	1.17		
Fish representivity per secondary class	Low	**Fish rarity per secondary class**	Very High		
Invertebrate taxa/SQ	1.00	**Invertebrate average confidence**	1.00		
Invertebrate representivity per secondary class	Very Low	**Invertebrate rarity per secondary class**	High		
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating	Low	**Habitat diversity class**	Moderate		
Habitat size (length) class	Very low	**Instream migration link class**	High		
Riparian-wetland zone migration link	Very high	**Riparian-wetland zone habitat integrity class**	Very high		
Instream habitat integrity class	Moderate	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**	Very High		
Riparian-wetland natural vegetation rating based on expert rating	Low				
ES details					
Fish physical-chemical sensitivity description	Very High	**Fish no-flow sensitivity**	Very High		
Invertebrates physical-chemical sensitivity description	High	**Invertebrates velocity sensitivity**	Very high		
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	Low				
Stream size sensitivity to modified flow/water level changes description	Low				
Riparian-wetland vegetation intolerance to water level changes description	Low				
Main habitats	Mountain drainage, seasonal.				
Main adverse conditions	Lack of perennial flows.				

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;
[2] EI = Ecological Importance;
[3] ES = Ecological Sensitivity
[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

Table 8: Summary of the ecological status of the sub-quaternary catchment (SQ) reach SQR A80F-00065 (Nzhelele) based on the DWS RQS PES/EIS database

Synopsis (SQ reach A80F-00065 (Nzhelele))					
PES[1] category median	Mean EI[2] class	Mean ES[3] class	Length	Stream order	Default EC[4]
D	Moderate	Moderate	9.83	2	C
PES details					
Instream habitat continuity MOD		Large	**Riparian/wetland zone MOD**		Moderate
RIP/wetland zone continuity MOD		Moderate	**Potential flow MOD activities**		Serious
Potential instream habitat MOD activities		Large	**Potential physico-chemical MOD activities**		Large
EI details					
Fish spp/SQ		15.00	**Fish average confidence**		1.13
Fish representivity per secondary class		Moderate	**Fish rarity per secondary class**		High
Invertebrate taxa/SQ		41.00	**Invertebrate average confidence**		1.00
Invertebrate representivity per secondary class		High	**Invertebrate rarity per secondary class**		High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		High	**Habitat diversity class**		Moderate
Habitat size (length) class		Very low	**Instream migration link class**		Moderate
Riparian-wetland zone migration link		High	**Riparian-wetland zone habitat integrity class**		High
Instream habitat integrity class		Moderate	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**		High
Riparian-wetland natural vegetation rating based on expert rating					Low
ES details					
Fish physical-chemical sensitivity description		High	**Fish no-flow sensitivity**		High
Invertebrates physical-chemical sensitivity description		High	**Invertebrates velocity sensitivity**		Very high
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					High
Stream size sensitivity to modified flow/water level changes description					Low
Riparian-wetland vegetation intolerance to water level changes description					Low
Main habitats		Incised channel with flow, grassy edge, thin band of riparian shrubs and trees, riffles, and rapids, pools.			
Main adverse conditions		Vegetation removal, water temperature increase, agricultural activities.			

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;
[2] EI = Ecological Importance;
[3] ES = Ecological Sensitivity
[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

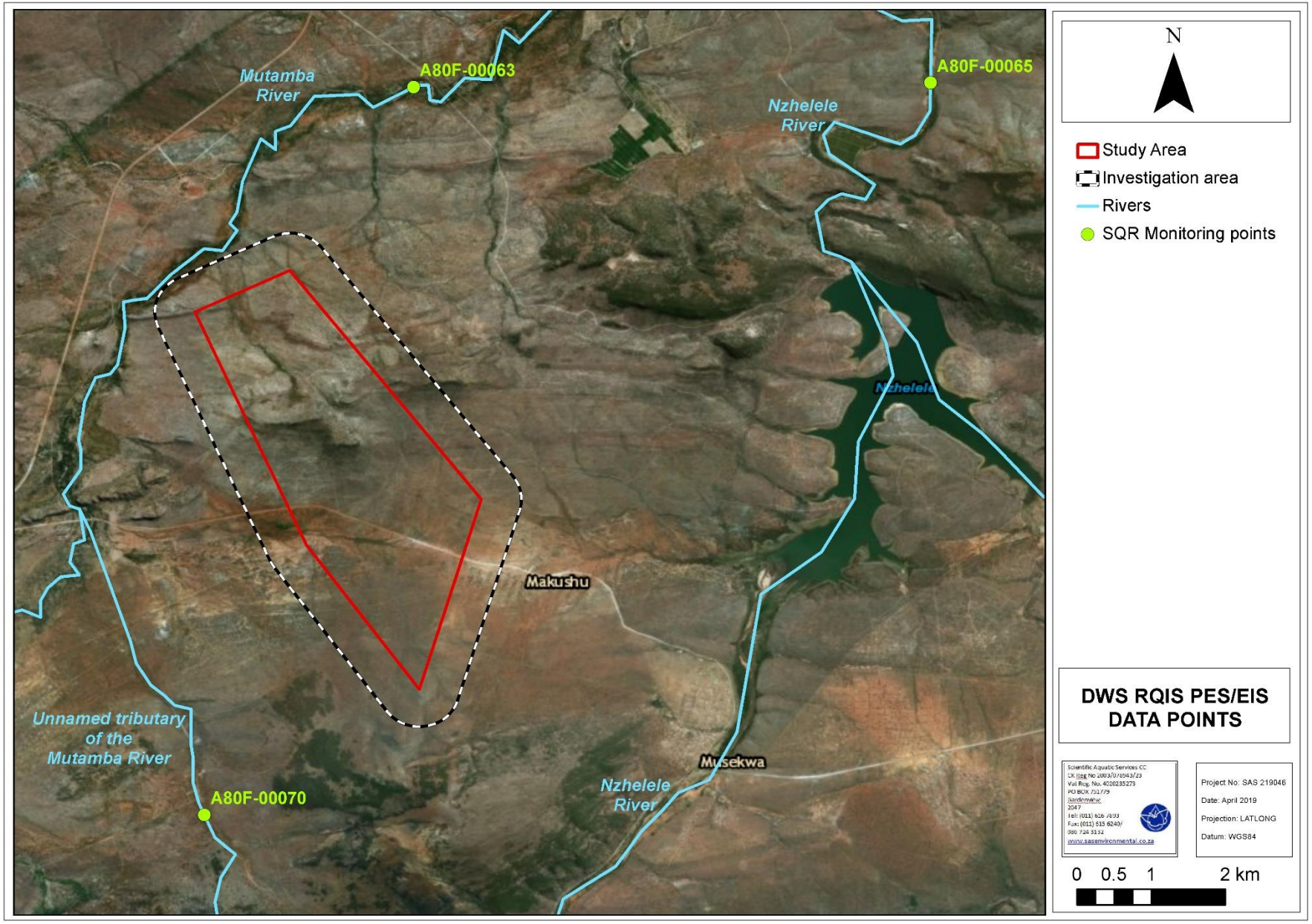


Figure 8: DWS RQIS PES/EIS sub-quaternary catchment reaches (SQRs) indicated in the vicinity of the study area.

4 RESULTS: WATERCOURSE ASSESSMENT

Due to the extent of the study area, sites were selected considered to be representative of the characteristics of the features within the study area. Selection of areas representative of the different feature groups took place with the use of desktop methods (contours, digital satellite imagery and topographical maps indicating depressions or drainage lines) after which selected points of interest (Figure 9) were identified which are representative of the various systems. Each point of interest was assessed during the field survey to distinguish as potential wetlands, true riparian and non-riparian habitat.

Points of interest were defined taking the following into consideration (Figure 9):

- Ensuring a geographic spread of points to ensure that conditions in all areas were addressed; and
- Ensuring that features displaying a diversity of digital signatures were identified in order to allow for field verification. In this regard specific mention is made of the following:
    - Riparian vegetation: a distinct increase in density as well as tree size near drainage lines.

Points of interest were defined taking the following into consideration:

- Ensuring a geographic spread of points to ensure that conditions in all areas were addressed; and
- Ensuring that features displaying a diversity of digital signatures were identified in order to allow for field verification. In this regard specific mention is made of the following:
    - **Riparian vegetation:** a distinct increase in density as well as tree size near drainage lines;
    - **Hue:** with drainage lines and outcrops displaying soils of varying chroma created by varying vegetation cover and soil conditions identified;
    - **Surface water:** to aid with the identification of artificial impoundments that may sustain wetland habitat, the presence of surface water was considered informative; and
    - **Texture:** with areas displaying various textures, created by varying vegetation cover and soil conditions being identified.

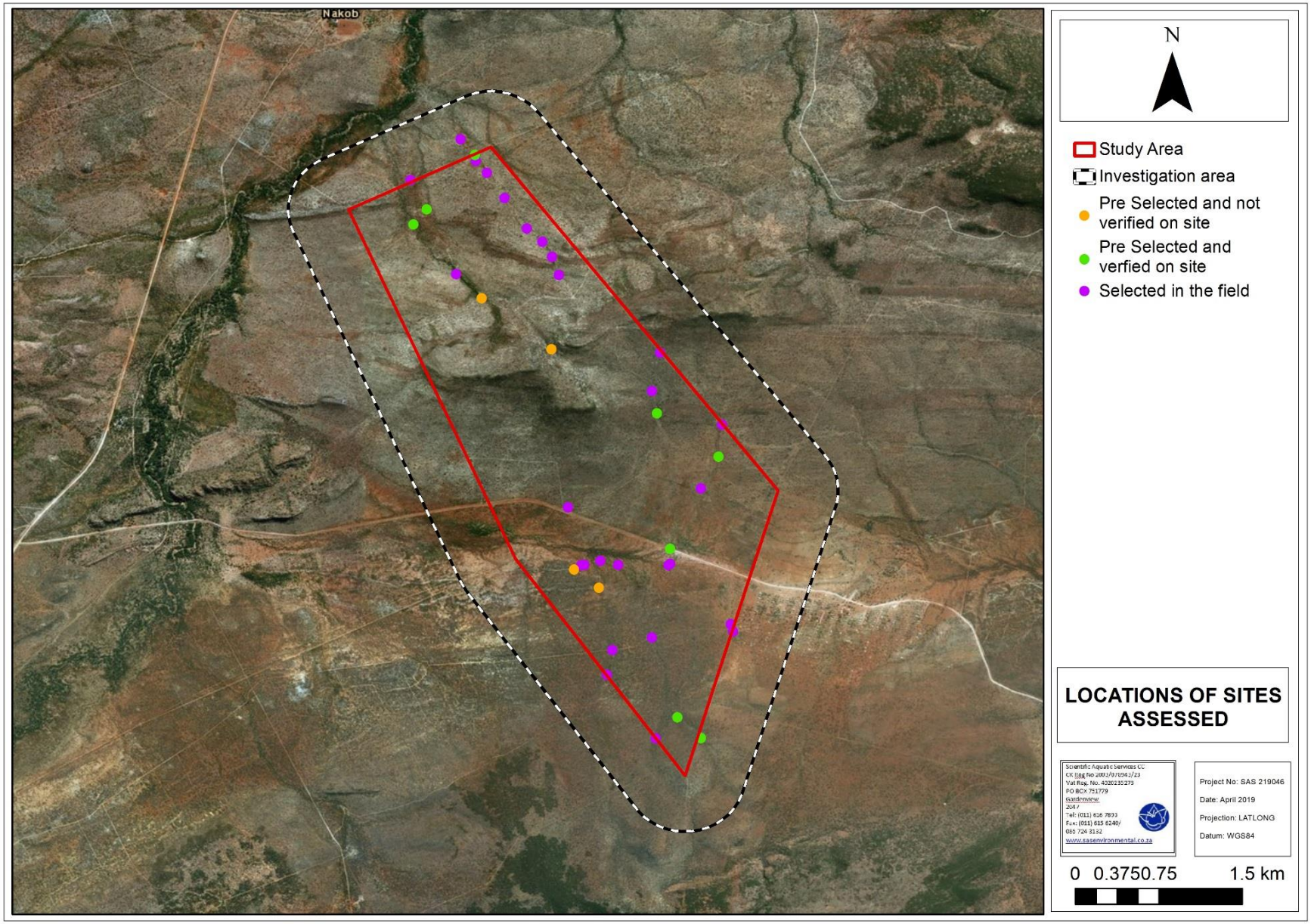


Figure 9: Points of interest selected or used for assessment during the field survey.

4.1 *Watercourse System Characterisation*

Features within the study area were categorised with the use of the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis *et al*, 2013). After the field assessment it can be concluded that two main feature groups are present within the study area or 500m thereof (i.e., within the investigation area), namely the Mutamba River and smaller non-perennial drainage lines. Within the area, several very small drainage lines were also observed, most of which do not hold surface water for periods long enough for the formation of hydromorphic soil that would support vegetation adapted to life in saturated soils and lead to the formation of wetlands, thus it was not deemed necessary to assess these features. Figure 10 illustrates the locality of the freshwater resources in relation to the study area.

In terms of the Classification System for Wetlands and other Aquatic Ecosystems in South Africa (Ollis *et. al*, 2013), all freshwater resources identified within the proposed study area are classified as inland systems (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 Soutpansberg Ecoregion. The applicable wetland vegetation (WetVeg) group is the Mopane Group 1 and the Central Bushveld Group 1 wetland vegetation types, which are both classified as Critically Endangered (SANBI, 2012; Mbona et al, 2014). The characterisation of the wetlands is summarised in Table 9 below.

Table 9: Characterisation of the Rivers and drainage lines identified within the study area.

Freshwater Resource	Level 3: Landscape unit	Level 4: HGM Type
Mutamba River and smaller non-perennial drainage lines	**Valley floor:** The base of a valley, situated between two distinct valley side-slopes.	**River:** linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit
	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.	

With the use of *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis *et al*, 2013) all features within the study area could be divided into two main groups namely rivers and smaller drainage lines. The Mutamba River occurs on the valley floor while the smaller drainage lines are located on sloping ground and are best defined as small episodic systems on slopes.

The Mutamba River was defined as a non-perennial riverine system with associated true riparian habitat due to the presence of alluvial soil, with a composition and physical structure,

distinct from adjacent areas. Several smaller drainage lines within the study area also display these characteristics and were therefore also defined as systems with riparian habitat. The catchment of some of the drainage lines are however smaller and did not allow for the establishment of the defined riparian habitat characteristics and were therefore defined as non-riparian ephemeral drainage lines.

In summary, the rivers and smaller drainage lines were subdivided into systems that support both riparian or non-riparian habitat. The Mutamba River and its smaller episodic tributaries are discussed further in the sections below.

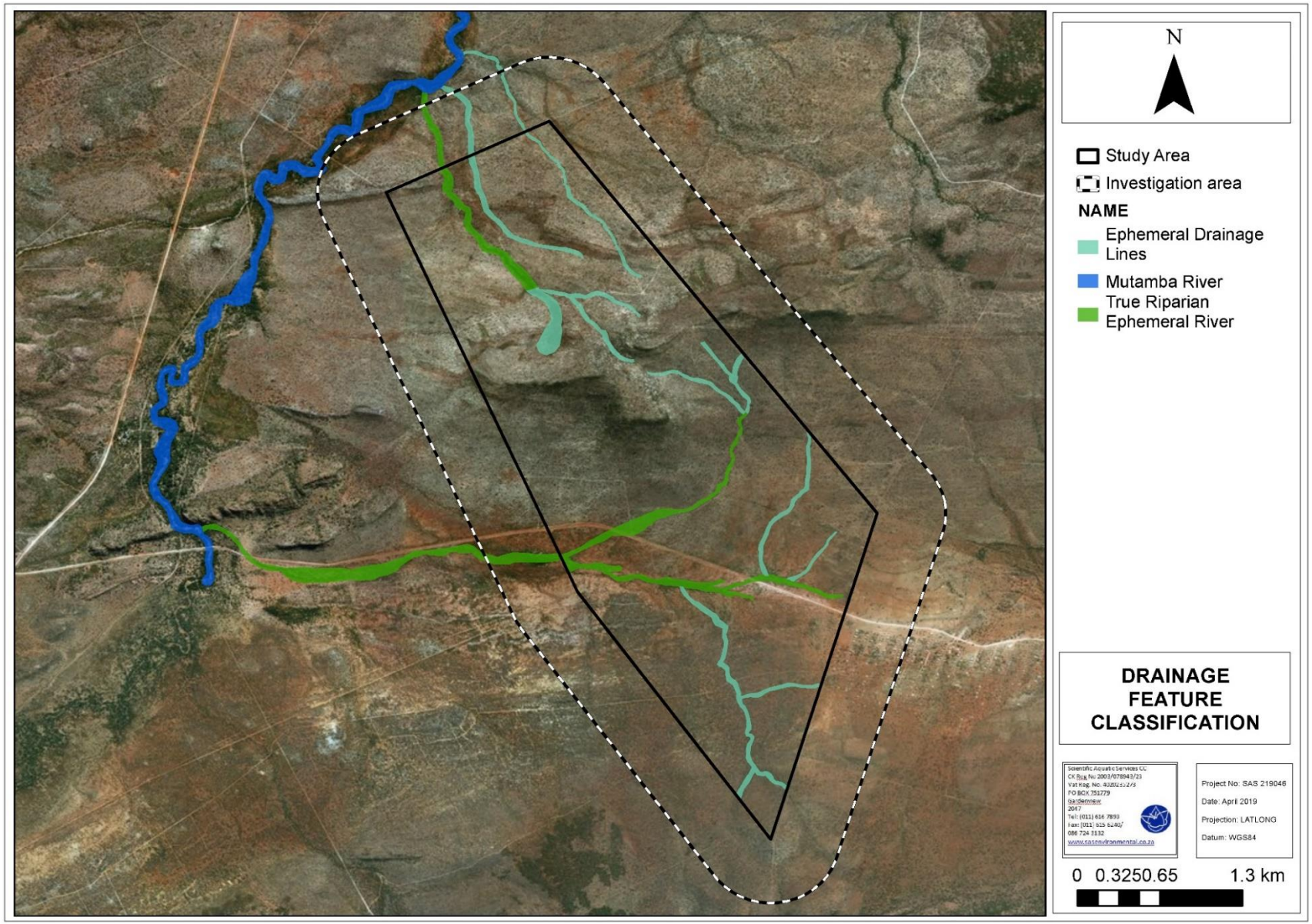


Figure 10: Locations of the watercourse types in relation to the study area.

4.1.1 Delineation and Sensitivity Mapping

All features were delineated with the use of desktop methods with the use of aerial photographs, digital satellite imagery and topographical maps. Portions of the features were verified during the field survey according to the guidelines advocated by the DWA (2005) and the wetland/riparian delineations as presented in this report are regarded as a best estimate of the temporary and riparian zone boundaries based on the site conditions present at the time of assessment.

The following indicators were used during the verification of the extent of the riparian zones in the region:

- Terrain units were used as the primary indicator for freshwater resources;

Figure 11: Terrain unit used as primary indicator and vegetation as the secondary indicator

- Vegetation was considered informative at all features.
  - A riparian zone is defined as an area that supports vegetation with a composition and physical structure distinct from the adjacent terrestrial zones. Vegetation could therefore be used as secondary indicator for rivers and smaller drainage lines;
  - Facultative and obligate floral species were encountered at all drainage lines, with a distinct increase of *Colophospermum mopane* (Mopane tree) density and tree size along drainage lines; and
- Soil form as indicator was used within areas where vegetation and landscape transformation have taken place.
  - For the soil form indicator on well-established drainage lines, the presence of gleyed soils (most of the iron has been leached out of the soil leading to a greyish/greenish/bluish colour) and mottling (created by a fluctuating water table) were investigated; and

- For the soil form indicator at rivers and smaller drainage lines, the presence of leached alluvial soils was investigated.

➢ No surface water or saturated soils were present in the smaller drainage lines while the Mutamba River was characterised by isolated pool like sections with no aquatic connectivity in the system at the time of survey.

4.1.2 Legislative requirements

Legislative requirements were used to determine the zones of regulation applicable to each watercourse group depending on whether a group is considered a watercourse supporting true riparian habitat or not. The Mutamba River, as well as smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year flood lines exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice No. 509 of 2016 as it relates to the NWA will also apply and therefore a Water Use License will be required.

Smaller drainage lines *without* well-defined riparian zones are rivers from an ecological resource management perspective, due to the absence of riparian vegetation with a distinctly different structure and composition of vegetation from the adjacent terrestrial areas but may still be defined as watercourses if a 1:100 year floodline is applicable to the systems. If any activities are to take place with the 1:100 year floodline exemption terms of Regulation GN 704 of the NWA, 1998 (Act No. 36 of 1998) needs to be obtained, however General Notice No. 509 of 2016 as it relates to the NWA does not apply to these features.

4.2 *Field Verification Results for the Mutamba River*

Table 10: Results of the field survey for the TD1 monitoring point

Biomonitoring point TD1

Figure 12: Downstream representation of the TD1 biomonitoring point at the time of the assessment.

Algal proliferation	Isolated patches
Depth profiles	0.5 to a meter
Flow condition	Slow to stagnant
Riparian zone characteristics	Generally comprised of grasses, with scattered trees
Water clarity and odour	Turbid, no odour present at the time of the survey
Significance	Major River situated in the Northern section of the study area
Dallas (2007) **MIRAI** **VEGRAI** **FRAI**	**Category E/F** **Category C** **Category B/C** **Category D**
EcoStatus	**Category C**

In situ physico-chemical water quality

		TWQR for Aquatic Ecosystems (DWAF,1996)	
pH	8.32	**pH**	6.5-9.0
EC (mS/m)	103.7	**EC (mS/m)**	<15%
TDS (mg/l)	**674.05**	**TDS (mg/l)**	<520
DO (mg/L)	8.73	**DO (mg/l)**	<15
DO sat (%)	93.4	**DO (sat %)**	80-120
Temp (°C)	**34**	**Temp (°C)**	5 – 30

Site specific temporal water quality variations (% Var.)

Parameter	% Var from baseline data (Feb 2015)		
	Feb 2019	**Feb 2015**	**% Var.**
pH	8.32	6.83	**+21.8**
EC (mS/m)	103.7	90.2	+14.9
DO	8.73	6.8	**+28.4**

Aquatic Indices

	February 2019	February 2015	% Var.
SASS5	37	56	**-33.9**
No of Taxa	10	11	-9.0
ASPT	3.7	5.1	**-27.5**
IHAS	53	68	**-22.0**
MIRAI	66.6	49.65	**+34.1**
VEGRAI	79.7	80.0	-0.3
FRAI	47.8	33.2	**+43.9**

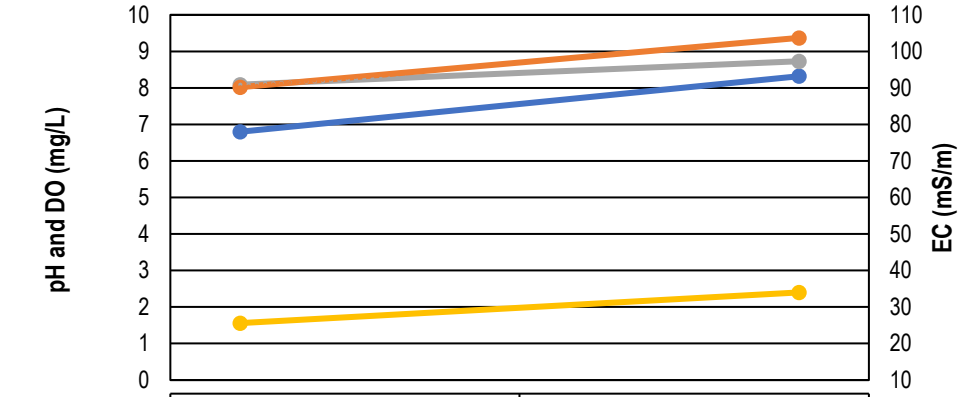
The mean SASS score for the Soutpansberg ecoregion is 136 with an ASPT of 6.2
Negative value = decrease; Positive value = increase.
A spatial and temporal deterioration exceeding 15% was considered significant.

Bold text = significant change (compared to guideline);
Red text = significant deterioration in relation to DWAF (1996);
Blue text = significant improvement in relation to DWAF (1996).

Key Drivers of System Change

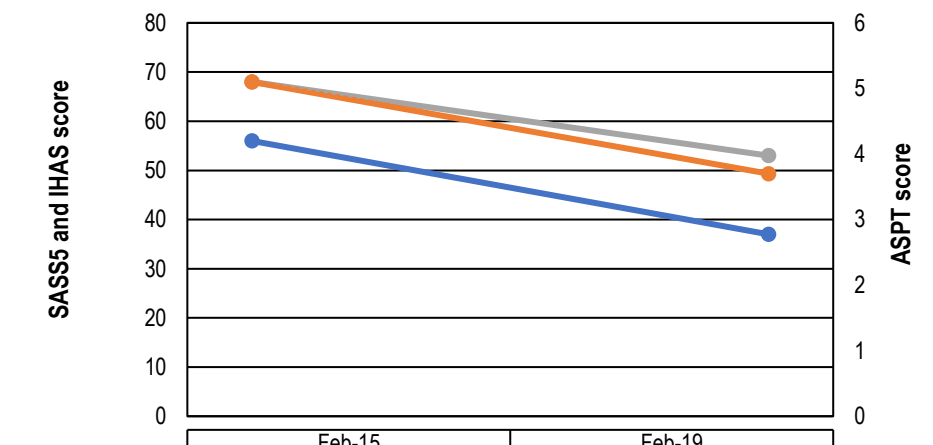
- Based on the *In situ* analysis Total Dissolved Solids (TDS) and Temperature exceeded the recommended Target Water Quality Range as set out for aquatic ecosystems by the DWS (DWAF, 1996) during the February 2019 assessment;
- Exposure to prolonged high TDS values have the potential of reducing nutrient cycling, osmotic stress, increased predation of juvenile fish and mortality in extreme cases;
- The temperature exceedance recorded at the time of the survey is mainly due to normal diurnal changes in association with lack of overhanging vegetation. Prolonged exposure to high temperatures have impacts to fish species which includes thermal mortality from acute exposure as result of metabolic malfunctions (fluid-electrolyte imbalance, alterations in gaseous exchange and osmoregulation, hypoxia of the central nervous system and inactivation of enzyme systems);
- The macroinvertebrate assemblage based on the SASS5 protocol classed the reach Seriously Modified (Category E/F), this is likely due to the absence of the stone in current biotope paired with very slow to stagnant flow conditions associated with the reach at the time of the survey. These conditions promote the dominance of semi-intolerant and tolerant taxa;
- The available macroinvertebrate habitat associated with the monitoring point was classed Poor, this is mainly due to the connectivity of the reach and biotopes associated, restricted to the Gravel, Sand and Mud Biotope. With the implementation of the IHAS adjustment score, which predicts an alternate SASS score if the habitat encountered on site was optimal (+30), the monitoring point would still be classed Seriously Modified (Category E/F), indicating that the absence of flow and connectivity of the reach are the major limiting factors associated with the reach;
- The macroinvertebrate assemblage based on the MIRAI protocol was classed Moderately Modified (Category C) indicating that slight modifications to the assemblage and instream characteristics have occurred, although the reach is still capable of supporting a diverse assemblage with sufficient flow, the increase in MIRAI score since the February 2015 survey is attributed to slight variations in sampling location ;
- The fish community based on the FRAI protocol was classed Largely Modified (Category D), due to the limited flow associated with the reach paired with the exceedances in water quality promoting more tolerant taxa to thrive within the reach. Fish species sampled during both surveys included *Enteromius anoplus, Enteromius paludinosus, Enteromius unitaneatus, Enteromius viviparus* and *Oreochrois mossambicus* and;
- The overall ecological integrity based on the Ecostatus model was classed Moderately Modified (Category C) indicating slight disturbances to the natural flow regimes and riparian areas of the reach, along with slightly impaired aquatic communities although the reach still has the ability to support a diverse aquatic community with sufficient flow.

Table 11: Temporal variations observed at the TD1 biomonitoring point since the initial assessment in February 2015



	Feb-15	Feb-19
TD1 pH	6.8	8.32
TD1 DO	8.09	8.73
TD1 EC	90.2	103.7
TD1 Temp	25.6	34

Figure 13: Site-specific temporal water quality variation of the TD1 biomonitoring point



	Feb-15	Feb-19
TD1 SASS5	56	37
TD1 IHAS	68	53
TD1 ASPT	5.1	3.7

Figure 14: Site-specific temporal macro-invertebrate community integrity variation of the TD1 biomonitoring point

Comment:

- Based on the temporal assessment, pH increased by 21.8 % since the initial assessment. This temporal change exceeds the DWS target water quality guidelines (DWAF, 1996) which advocates that seasonal and temporal changes should not exceed 15%. However, the absolute value complies with the TWQR recommended pH range (6.5 – 8.5), which would not have been a limiting factor to aquatic taxa at the time of the survey;
- The Dissolved Oxygen (DO) concentration improved slightly since the previous survey (Feb 2015) by 28.4%. The DO saturation associated with the monitoring point fell within the TWQR (>80 %), which would not have been a limiting impact on aquatic biota of the reach;
- The Electrical Conductivity (EC) of the monitoring point increased by 14.9% compared to the initial assessment in Feb 2015. This change falls within the acceptable temporal change set out by the DWS target (DWAF, 1996) which advocates that seasonal and temporal changes should not exceed 15%, however, the increase in electrical conductivity exceeds the South African Guidelines (DWA,2011) which is likely to have a limiting impact on aquatic biota at the time of the assessment. Prolonged exposure to high Electrical Conductivity measurements have a limiting impact to rheophilic/ sensitive taxa ranging from altered nutrient cycling, increased predation and increased mortality in extreme cases; and
- The temperatures measured during the two surveys are characteristic of diurnal changes, although prolonged exposure to high temperatures such as those observed in the February 2019 survey is likely to have a limiting impact on aquatic biota.

Comment:

- The macroinvertebrate integrity of this biomonitoring point was classed Seriously Modified (Category E/F) during the February 2019 assessment; and
- Based on the temporal analysis a significant decrease in SASS score was observed since the initial survey conducted in February 2015 of 33.9 % while the ASPT score decreased by 27.5% indicating assemblages primarily composed of tolerant taxa, this is mainly due to lower flows encountered during the February 2019 survey which resulted in limited available habitat (as is also evident from the temporal decrease in IHAS score.

4.2.1 Fish Species of Conservation Concern

One species of conservation concern was observed during the first survey (February 2015) namely *Oreochromis mossambicus* (Mozambique Tilapia) rated Near Threatened (NT) by the IUCN (2019). Distributed throughout east coastal rivers from the lower Zambezi River south to the Bushmans River system. It generally occurs in all waters apart from fast flowing. This species is widely used in commercial and subsistence fisheries. Threats to this species are not mainly anthropogenically based, the hybridization with the alien *Oreochromis niloticus* (Nile Tilapia) has created a hybrid species which is outcompeting this species. Care should be taken to preserve all reaches harbouring uncompromised populations of this species (Skelton, 2001).

No species of conservation concern were found during the February 2019 survey, which is likely due to the disconnected nature of the ephemeral rivers (scattered pools) paired with the low water levels observed at the time of the assessment.

4.2.2 Terrain Units

The degree of incision of the various riverine features formed a clear continuum. Smaller drainage features showed very limited levels of incision while the larger drainage features were more incised. The Mutamba River showed the most incision and confinement of the channel and obvious stream banks.

4.2.3 Soil

The active channel of all drainage features mainly constituted of alluvial soil and within the larger Mutamba River larger boulders and cobbles were observed in certain areas. The coarse, alluvial sands showed clear indications of surface water movement from time to time with the degree of development characterised by the size of the system and the runoff received by the system. Water movement for prolonged periods has resulted in leaching of soil components such as iron and manganese from the soil resulting in alluvial sands with a lower chroma than the adjacent terrestrial areas. A distinct increase in chroma and decrease in particle size is evident on the banks where significantly less leaching has taken place and where soil material is more related to the local parent material and less associated with alluvium washed in from areas further upstream.

4.2.4 Vegetation

The larger drainage features are considered characteristic of the Subtropical Alluvial vegetation type characterised by flat alluvial riverine terraces supporting an intricate complex of macrophytic vegetation, marginal reed belts (in sheltered oxbows and along very slow flowing water courses) as well as riverine thickets (Mucina and Rutherford, 2006).

Abundance and diversity of vegetation were assessed at each site selected for a river system giving attention to zonation of the freshwater resource assessment. A distinctive change in vegetation abundance as well as diversity was noted in the lower and upper zones compared to the surrounding terrestrial zones. Although the width of the active channel of the different rivers varied, the dominant riparian vegetation communities within the lower and upper zones were considered uniform. The most distinct difference between the different rivers assessed was identified in the vegetation structure of the marginal zone. The Mutamba River hosted *Cyperus spp*. and *Typha capensis* (bulrush) not identified within any of the marginal zones of the other smaller river systems. These floral species are obligate riparian floral species and are therefore adapted to the anaerobic soil conditions found within the active channel of larger river systems or in areas which regularly become saturated with water. Therefore, their presence is directly related to the availability of baseflow within a system for the largest part of the year. The additional permanent and seasonal habitat provided by the Mutamba River do increase the importance of the riparian areas and it is deemed likely that with the continuation and possible increase in the volume of water abstracted from these systems that a decline in obligate/facultative floral species habitat may occur. It should further be noted that larger tree species located within the lower and upper zones would most likely also be impacted upon by a decrease in the water table resulting from ongoing and/or increased water abstraction.

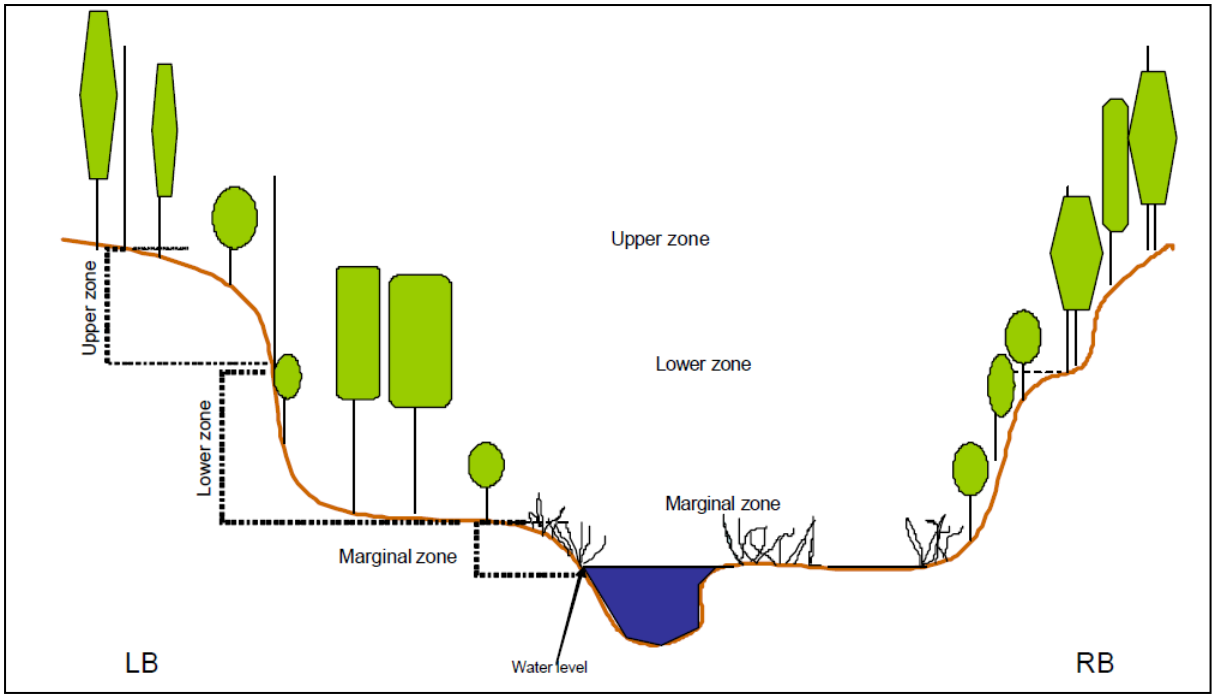


Figure 15: Cross sectional sketch[3] of a river system and associated riparian zone.

The table below lists the dominant floral species identified during the assessment of all the rivers, the dominant species listed for the marginal zone are only applicable to the Mutamba River.

Table 12: Dominant floral species identified during the assessment of the rivers.

Upper zone	Lower zone	Marginal zone
Colophospermum mopane (Mopane)	*Faidherbia albida* (Ana tree)	*Phragmites mauritianus* (Grass reed)
Combretum apiculatum (Red bushwillow)	*Grewia flava* (Velvet raisin)	*Cyperus sexangularis*
Dichrostachys cinerea (Sickle bush)	*Cyperus fastigiatus*	*Cyperus fastigiatus*
Vachellia karroo (Sweet thorn)	*Cynodon dactylon* (Couch grass)	*Cyperus distans*
Senegalia nigrescens (Knob thorn)	*Panicum maximum* (Guinea grass)	*Ammannia baccifera* (Waterbessiekruid)
Terminalia prunioides (Lowveld cluster-leaf)	*Heliotropium sp.*	*Typha capensis* (Bulrush)
Ficus craterostoma (Strangler fig)	-	-
Ficus salicifolia (Willow leaf fig)	-	-
Ziziphus mucronata (Buffalo-thorn)	-	-
Sclerocarya birrea subsp. *caffra* (Marula)	-	-
Euclea crispa (Blue guarri)	-	-
Grewia bicolor (White raisin)	-	-
Gymnosporia senegalensis (Red spike thorn)	-	-
Combretum imberbe (Leadwood)	-	-
Xanthocercis zambesiaca (Nyala tree)	-	-
Schotia brachypetala (Weeping boerbean)	-	-
Combretum molle (Velvet bushwillow)	-	-
Spirostachys africana (Tamboti)	-	-

[3] Kleynhans et al., 2007

4.2.5 Riparian Vegetation Response Assessment Index (VEGRAI)

The VEGRAI index was applied to the Mutamba River to assist in defining the ecological integrity and PES of the riparian zone of the system.

Table 13: VEGRAI Ecological Category Description Scores for the Mutamba River.

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	83.5	37.1	3.0	2.0	80.0
NON MARGINAL	76.7	42.6	0.0	1.0	100.0
	2.0				180.0
LEVEL 3 VEGRAI (%)				79.7	
VEGRAI EC				**B/C**	
AVERAGE CONFIDENCE				1.5	

It is evident from the results above that the riparian ecosystem has remained largely intact, with limited change of cover, abundance and species composition when compared to the reference condition in both the marginal as well as non-marginal zones. The score is as a result of some disturbance from anthropogenic activity in the immediate surroundings, which resulted in an increase in non woody species and some loss of tree diversity within the riparian zone and the presence of some alien forbs. It is also considered highly likely that the water abstracted along the river for agricultural purposes, leads to increasing stress on the riparian zone in a downstream direction. An increased impact on the non-marginal zone in relation to the marginal zone is also evident due to impacts from moisture stress and altered species composition.

4.2.6 Index of Habitat Integrity (IHI)

The Index of habitat integrity has been developed to class the instream and riparian habitat integrity of rivers (Kleynhans et al. 2008). The instream integrity of the Mutamba River was classed Moderately Modified (Category C) due to several established weirs within the reach which have altered the natural flow regimes, extensive trampling due to agricultural activities causing erosion and sedimentation and the establishment of several low-lying bridges within the Sub Quaternary Reach (SQR).

The riparian integrity of the Mutamba River was classed Moderately Modified (Category C) largely due to established dams within the non-marginal zone downstream, clearing of riparian areas for dry farming and abstraction for agricultural activities.

4.2.7 Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) method (DWAF, 1999) was applied to the Mutamba River in order to ascertain the current sensitivity and importance of the system. The results of the assessment are presented in Table 14 below:

Table 14. Results of the EIS assessment for the Unnamed Tributary of the Mutamba River within the study area.

Category	Score
Biotic Determinants	
Rare and endangered biota	1
Unique biota	1
Intolerant biota	0
Species/taxon richness	2
Aquatic Habitat Determinants	
Diversity of aquatic habitat types or features	2
Refuge value of habitat type	1
Sensitivity of habitat to flow changes	2
Sensitivity of flow-related water quality changes	2
Migration route/corridor for instream and riparian biota	1
Nature Reserves, Natural Heritage sites, Natural areas, PNEs	0
RATINGS	**1.2**
EIS CATEGORY	**Moderate**

The Ecological Importance and Sensitivity assessment analysis of the Mutamba River provided a score of 1.2 which can be regarded as of **moderate importance and sensitivity**. The system has a moderate importance with regards to serving as a migration route for aquatic fauna and has a high species and taxon richness (Kleynhans, 1999). Based on present ecological state data obtained from the DWS (DWAF, 2014) the Mutamba River has a moderate importance based on the expected presence of one protected fish species namely *Oreochromis mossambicus* (Mozambique Tilapia).

4.2.8 Synopsis

After the assessment it can be concluded that the Mutamba River is important in terms of function and service provision with special mention of biodiversity as well as water provision for farmers within a water stressed region. Game farming is the present land use of the majority of the farms in the area with limited areas utilised for crop cultivation, consequently the river systems have remained largely undisturbed and are therefore important in terms of biodiversity value. The Mutamba River has significant downstream importance for socio-cultural purposes with special mention of water supply as well as biodiversity maintenance and other basic ecosystem services. Measures to ensure the ongoing functioning of these rivers in the area are therefore considered to be of high importance.

Mining related activities and infrastructure as proposed by the present layout provided by the proponent have the potential to impact on the tributaries of the Mutamba River. Should mining activity encroach onto the allocated 100m buffer zones, effective mitigation of impacts would be unlikely to significantly minimize the impacts on these smaller systems, however with mitigation the impact on the major drainage lines in the area can be significantly limited.

It should be noted that the region in the vicinity of the study area is significantly water stressed and as a result, farmers depend on water from the rivers for general water provision for agriculture with specific reference to the Nzhelele River while some water provisioning from the Mutamba River for game farming in the catchment takes place. Furthermore, it would be difficult to substitute the water supply from rivers with alternative water sources except for possible groundwater use due to the extensive distribution network that would be required from the Nzhelele Dam. The Nzhelele and Mutamba Rivers are also considered to be of increased significance with regards to biodiversity maintenance due to the presence of fish that would be restricted to river corridors and refugia formed during the winter months. Therefore, reduced water volumes or impaired water quality will directly impact on the survival as well as migratory corridors of aquatic species. Any reduction of streamflow that leads to the loss of refugia for aquatic species or the significant loss of downstream water supply or impaired water quality is be considered potential impact on the lower reaches of the Mutamba River and to a lesser degree the Nzhelele River.

It is recommended that all requirements in terms of GN 704, Section 21 of the NWA as well as General Notice No. 509 of 2016 as it relates to the NWA, be adhered to for any proposed activities associated with mining in these areas. In this regard specific mention is made of obtaining authorisation in terms of Section 21 c and i of the NWA for all activities which would affect these water courses.

4.3 *Field Verification Results for the Smaller Drainage Lines with True Riparian Ephemeral Habitat*

Numerous ephemeral drainage lines, with poorly defined riparian zones were identified throughout the study area. As a result, many of these features could not be considered as either wetland or riparian habitat due to the lack of characteristics as defined by the NWA (Act 36 of 1998) and DWA (2005). Consequently, the digital signatures identified on a desktop level and verified during the field survey were used to distinguish between drainage lines with riparian zones and drainage lines without riparian zones. True riparian features were delineated as accurately as possible.

Features resembling drainage lines were also encountered, however, many of these features were considered to be mainly as a result of roads or other anthropogenic activity that canalised streamflow and consequently resulted in erosion canals being formed and cannot be defined as true wetland or riparian features.

Figure 16: Example of a drainage line with a true riparian zone within the study area.

4.3.1 Surface Water

The field assessment was undertaken during late summer and the southern feature was completely dry. It is considered highly likely that this feature is event driven, due to the high permeability of the sandy soils associated with the drainage lines.

4.3.2 Biodiversity

The drainage lines with riparian zones may provide migratory connectivity as well as sheltered nesting habitat for terrestrial avifaunal species. Amphibians and waterfowl may, however, opportunistically utilise these systems in times of increased rainfall. The systems can be considered to have some importance in terms of provision of drinking water for mammal species in the area.

Furthermore, these features provide an important habitat type due to the longitudinal connectivity of the habitat offered by the riparian zones. The vegetation cover within riparian zones is often denser and therefore offers better habitat cover for many faunal species for longer periods of the season. This aspect consequently leads to a higher predator species

component that not only relies on the better habitat cover, but also a more reliable prey source. This complex habitat type therefore often has relatively high species diversity. Localised impacts invariably have negative impacts on the system as a whole.

4.3.3 Terrain Units

Terrain units associated with drainage lines were considered uniform throughout the study area. All features assessed had a distinct active channel consisting of leached alluvial soil and incised banks. The incision of banks results from the sandy nature of the soil which is prone to erosion during rainfall events.

4.3.4 Soil

Soil within the drainage lines without riparian zones had a higher chroma and finer texture when compared to soil from drainage lines with riparian zones. This is considered to be a result of more volumes of water conveyed by the drainage lines with riparian zones that resulted in the leaching of minerals and the transport of smaller soil particles downstream. Soils in riparian systems had characteristically clear alluvial substrates.

4.3.5 Vegetation

Due to the sandy nature of the soil, surface water within smaller drainage lines is only expected during a couple of days after sufficient rainfall and therefore saturated soil will not be present long enough within the majority of drainage lines to support floral species which are representative of riparian zones of small drainage lines. As a result, the smaller drainage lines were divided based on the presence or absence of distinctive riparian vegetation. The dominant floral species of the riparian community is considered similar to the river systems as assessed in section 5.1.3, with a slight decrease in tree species diversity. The drainage lines with riparian zones do, however, capture enough water to support larger tree species such as *Combretum imberbe* (leadwood) (protected in accordance to the National Forests Act (Act No 84 of 1998 as amended September 2008)

The dominant floral species identified during the field survey are listed in the table below. All the drainage lines are considered ephemeral and therefore no facultative or obligate floral species were encountered that could be considered indicative of a marginal wetland/riparian zone.

Table 15: Dominant floral species identified during the assessment of the smaller drainage lines.

Upper zone	Lower zone
Balanites pedicellaris (Small green thorn)	*Brachiaria deflexa* (Annual brachiaria)
Colophospermum mopane (Mopane)	*Cynodon dactylon* (Couch grass)
Combretum apiculatum (Red bushwillow)	*Eragrostis lehmanniana* (Lehman Love Grass)
Terminalia prunioides (Lowveld clusterleaf)	*Tetrapogon tenellus*
Sclerocarya birrea subsp. *Caffra* (Marula)	*Panicum maximum* (Guinea grass)
Vachellia grandicornuta (Horned Thorn)	*Setaria verticillata* (Bur Bristle grass)
Vachellia karroo (Sweet thorn)	*Commelina africana* (Yellow Commelina)
Ziziphus mucronata (Buffalothorn)	*Commelina erecta* (Blouselblommetjie (a), Idangabane (z))
Euclea crispa (Blue guarri)	*Commicarpus plumbagineus* var *plumbagineus* (Wit Veldpatats (a))
Grewia bicolor (White raisin)	-
Gymnosporia senegalensis (Red spike thorn)	-
Combretum imberbe (Leadwood)	-
Salvadora australis (Narrow-leaved Mustard-tree)	-

4.3.6 Riparian Vegetation Response Assessment Index (VEGRAI)

Two major drainage lines were observed in the study area which were assessed within the study area to determine the characteristics of the riparian communities. When results were compared it was evident that the riparian vegetation abundance as well as diversity at the different drainage lines were very similar. One VEGRAI assessment was therefore undertaken as representative of all smaller drainage lines.

The limited disturbance on the subject property means that the only impact on the drainage lines is the crossing of dirt tracks as well as the crossing of the main dirt road on the southern feature, resulting in erosion and sedimentation within the immediate vicinity of the features. Within some features fewer woody species and more non-woody species with special mention of graminoids were noted that decreased the overall score to some degree. However, the EC class B/C (largely natural moderately modified) is considered representative of the two drainage lines located within the study area.

Table 16: VEGRAI Ecological Category Description Scores for the drainage lines with riparian zones.

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	79.3	44.0	3.0	1.0	100.0
NON MARGINAL	75.1	33.4	0.0	2.0	80.0
2.0					180.0
LEVEL 3 VEGRAI (%)				77.4	
VEGRAI EC				**B/C**	
AVERAGE CONFIDENCE				1.5	

4.3.7 Index of Habitat Integrity (IHI)

The instream integrity of the associated drainage lines situated to the south of the project area was classed Moderately Modified (Category C), this is mainly due to extensive trampling by domestic livestock and game, roads and low-level bridges established within the area. The riparian IHI for the area was classed Moderately Modified (Category C) this is due to removal of riparian vegetation for the establishment of low level bridges and roads, in association with activities associated with rural developments in close proximity. For the detailed analysis of the IHI model refer to Appendix E.

4.3.8 Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) method (DWAF, 1999) was applied to the drainage lines situated in the south of the study area in order to ascertain the current sensitivity and importance of the system. The results of the assessment are presented in Table 17 below:

Table 17. Results of the EIS assessment for the Smaller Drainage Lines with True Riparian Ephemeral Habitat within the study area.

Category	Score
Biotic Determinants	
Rare and endangered biota	1
Unique biota	1
Intolerant biota	0
Species/taxon richness	1
Aquatic Habitat Determinants	
Diversity of aquatic habitat types or features	1
Refuge value of habitat type	0
Sensitivity of habitat to flow changes	1
Sensitivity of flow-related water quality changes	1
Migration route/corridor for instream and riparian biota	1
Nature Reserves, Natural Heritage sites, Natural areas, PNEs	0
RATINGS	**0.7**
EIS CATEGORY	**Low**

The Ecological Importance and Sensitivity assessment analysis of the drainage lines provided a score of 0.7 which can be regarded as of **low importance and sensitivity**. The system has a low importance with regards to serving as a migration route for aquatic fauna (Kleynhans, 1999).

4.3.9 Synopsis

Characteristics of smaller drainage lines with riparian zones are considered to be largely uniform throughout the study area. The features are located within isolated areas and are therefore intact and the lack of water for extensive periods of the year does not make it feasible for abstraction. All these aspects have resulted in drainage features with limited levels of present impact, which can be considered important in terms of biodiversity conservation.

Due to the ephemeral nature of the drainage lines, not all drainage lines could be considered riparian habitat as defined by NWA No 36 of 1998. Therefore, distinction was made between drainage lines with riparian zones and drainage lines without riparian zones. Smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year floodlines of watercourses exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice No. 509 of 2016 as it relates to the NWA will also apply and therefore a Water Use License will be required.

Smaller drainage lines *without* riparian zones are not considered true rivers but are still defined as watercourses. If any activities are to take place with the 1:100 year floodline exemption terms of Regulation GN 704 of the NWA, 1998 (act no. 36 of 1998) needs to be obtained, however Section 21 of the NWA (Act 36 of 1998) as well as General Notice No. 509 of 2016 as it relates to the NWA does not apply and therefore no Water Use License will be required.

4.3.10 Synthesis

Sites selected with the use of desktop methods, were investigated during the field survey undertaken in February 2015. For the purposes of this investigation, use was made of distinguishing factors as either defined by DWA (2005) for ‘wetland habitat’ or defined in the Water Act (Act No 36 of 1998) for ‘riparian habitat’. After the field assessment it can be concluded that two groups representing with true riparian characteristics are present within the study area namely rivers and smaller drainage lines while no areas that can best be described as wetlands were observed. These four features were then assessed to determine importance in terms of function and service provision, discussed in the sections above. The bullets below summarise the key findings:

- The VEGRAI ecostatus tool was used to assess the response of riparian vegetation to impacts within rivers as well as smaller drainage lines. The scores calculated for the drainage lines and Mutamba River are both defined as Borderline Class B/C indicating largely natural to moderately modified conditions.

4.4 *Zones of Regulation*

During the field survey it became evident that the majority of features has remained largely undisturbed and can still be regarded to be in a high PES. Furthermore, features with surface water throughout the year play a vital role in the provision of water for both wildlife as well as agricultural activities further downstream. To comply with legislative requirements as defined above as well as to aid with conservation of habitat within the study area, during the proposed mining activities, 100m zones of regulation are recommended for all freshwater habitats. The location of the features in relation to the study area is conceptually depicted in the figure below.

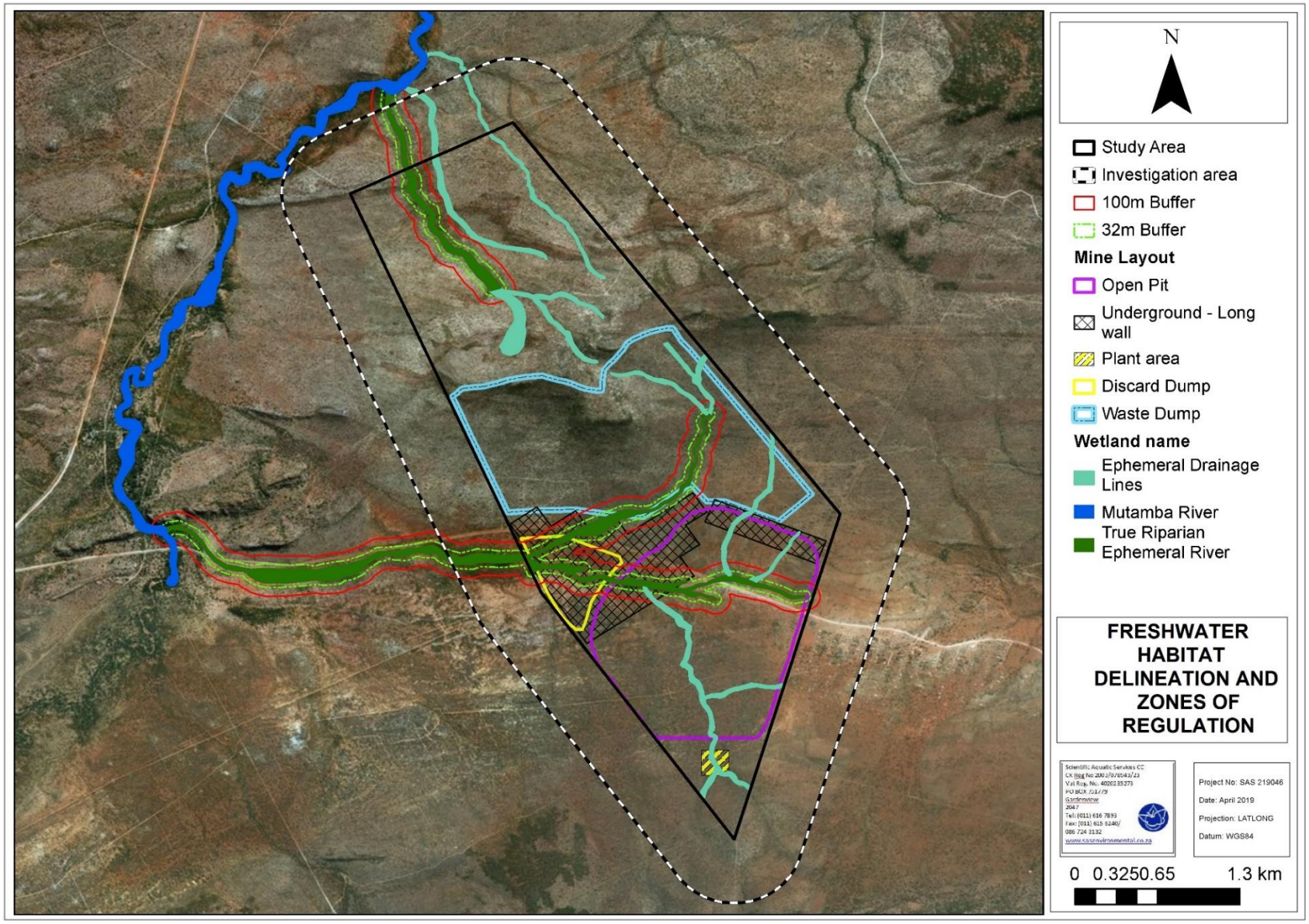


Figure 17: Freshwater habitat delineation and associated zones of regulation in relation to the mining footprint.

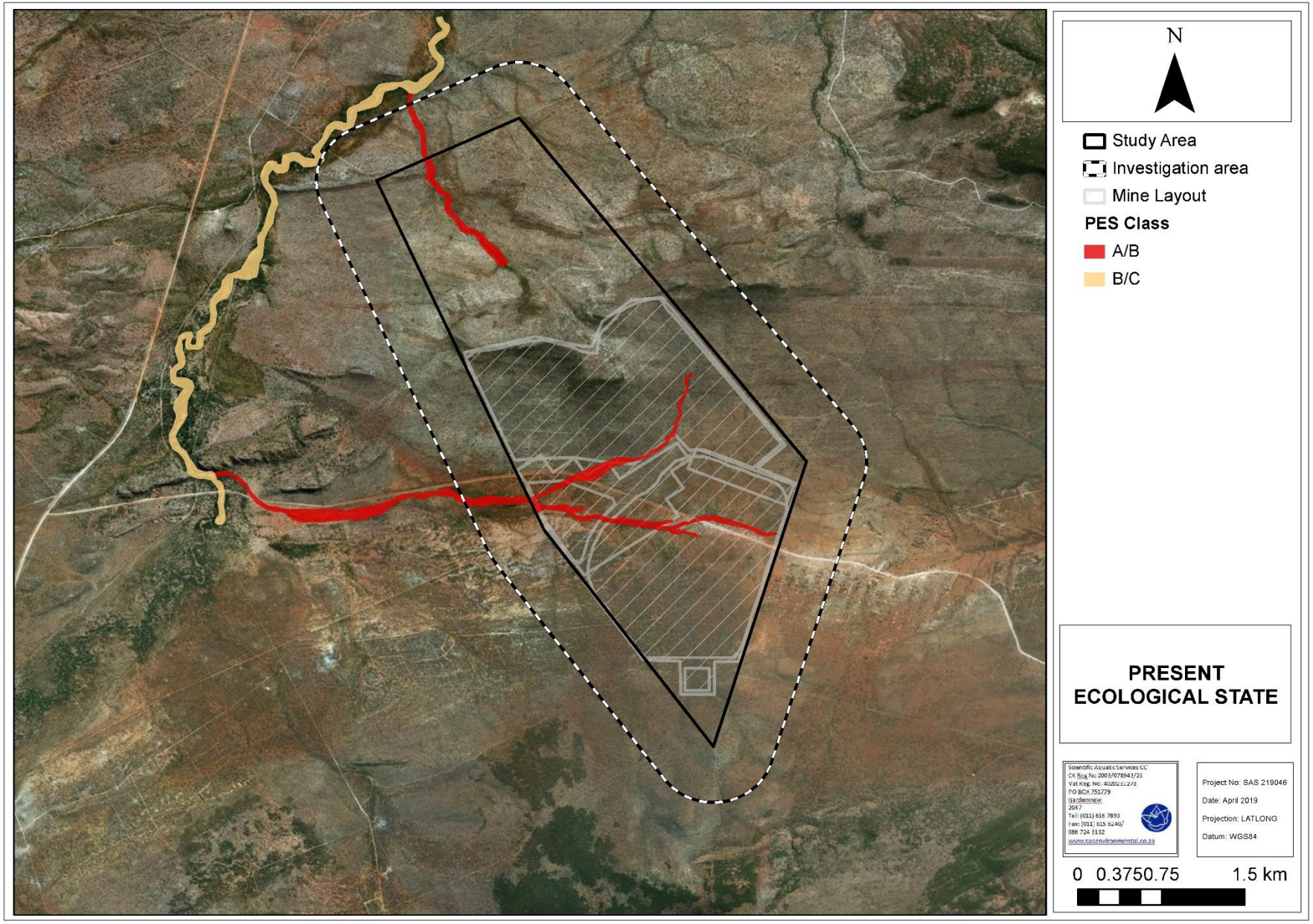


Figure 18: PES map in relation to the proposed mining footprint.

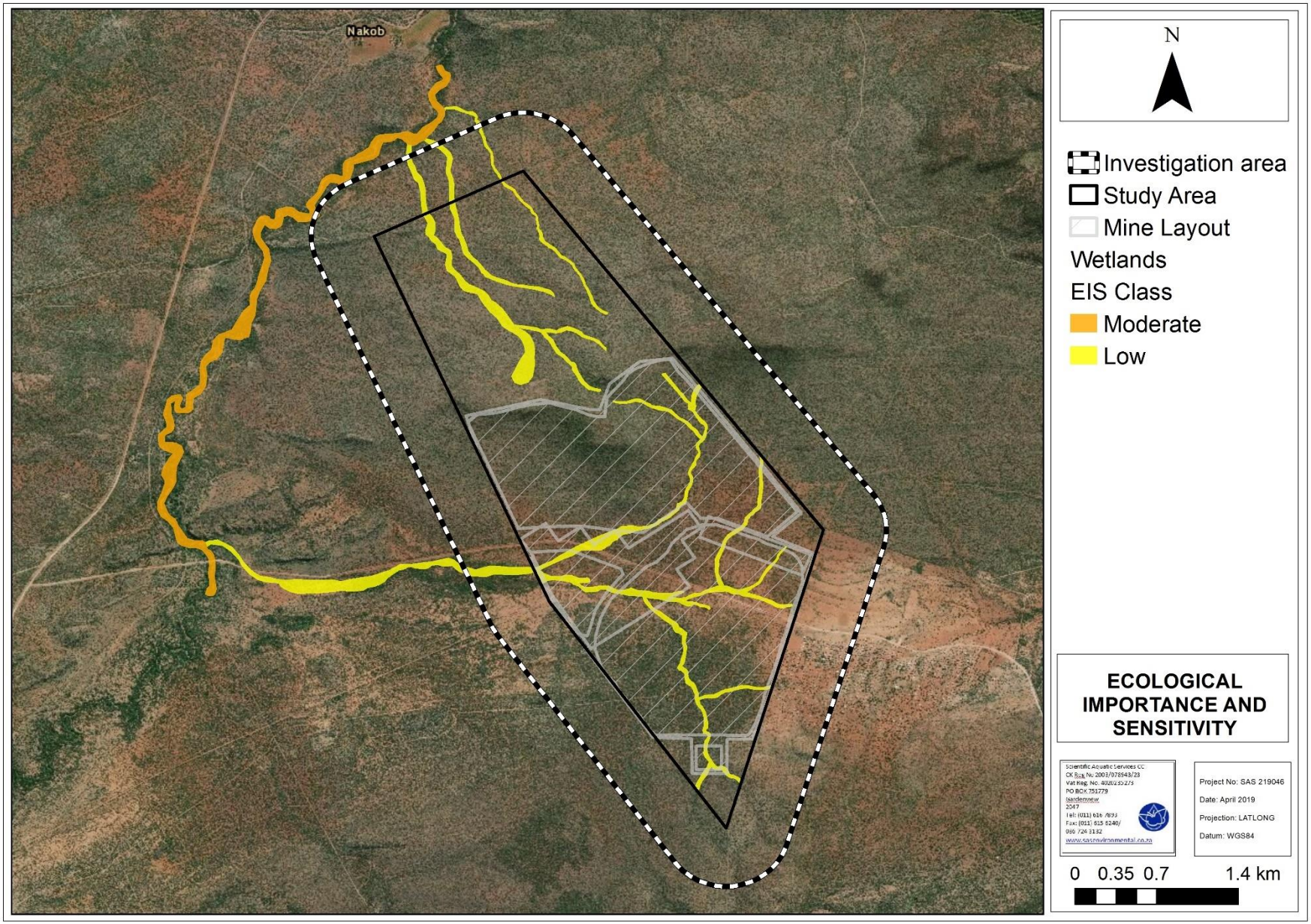


Figure 19: EIS map in relation to the proposed mining footprint.

4.5 *Recommended Ecological Category*

According to the resource directed measures for protection of water resources[4] a wetland or river may receive the same class for the PES, as the REC, if the habitat 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 to enhance the PES of the feature. The results obtained from the assessments indicate a relatively low level of transformation on all levels of ecology. It is therefore recommended that the features be assigned the same REC as the PES Class calculated. The EIS and REC values are presented in the table below:

Table 18: Assigned REC Classes.

Feature	VEGRAI Ecostatus	PES Classes	EIS Class	REC Class
Mutamba River	B/C	C	Moderate	C
Smaller drainage lines	B/C	B	Low	B

[4] DWA and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999*

5 KEY IMPACT ASSESSMENT CONSIDERATIONS

Several potential risks to the receiving environment by the proposed The Duel Coal Mine development have been identified and are presented in the bullets below:

- 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. Should the function of surrounding freshwater resource features not be managed or mitigated during the construction, operational and decommissioning phases of the mine, the ecoservices provision of the freshwater resources will be lost or changed and the PES of the system will be lowered. This is particularly significant in terms of the Mutamba River due the downstream importance of this system as well as the larger catchment it forms part of;
- Encroachment of infrastructure or construction or operational waste materials into riparian areas is likely to occur and would affect the habitat integrity of these areas;
- Earthworks in the vicinity of freshwater resources may lead to increased runoff and erosion and altered runoff patterns as well as sedimentation of the local drainage systems;
- The proposed open pit mining operations as well as general surface earthworks have the potential to impact on surface water volumes and habitat for riparian and instream fauna and flora;
- Coal mining is generally known for the generation of acidic and salt rich runoff and seepage. The aquatic resources of the local area are naturally prone to high salt content which presents a risk that the mining operations will lead to increased salinization of the systems as well as reducing pH which could affect the aquatic ecology of the local drainage systems and in particular the Mutamba River. In addition, disturbance of the area has the potential to lead to increased turbidity in the area and possibly lead to increased concentrations of metal salts and other salts such as sulphates, which can be detrimental to the freshwater resources and aquatic ecology of the region.

Sections below provide the full results of the impact assessment.

5.1 *Freshwater Resource Impact Assessment*

The impact assessment was undertaken on all aspects of freshwater resources deemed likely to be affected by the proposed The Duel Coal Project development. The sections below present the results of the findings per identified risk/impact for the instream and riparian zones within the mining rights area and the expected zone of influence.

5.1.1 Impact 1: Loss of Riparian Habitat and Ecological Structure

Construction related activities that will be undertaken, such as the removal of the topsoil and construction of mining infrastructure and infrastructure to support mining including plant infrastructure, offices, roads and discard/waste dumps. The construction of these facilities will lead to destruction of habitat and overall loss of riparian habitat and ecological structure and indirect impacts on freshwater resources may occur. Impacts on the freshwater resources will potentially lead to a loss of migratory routes for faunal species. All these activities will result in permanent impact on the riparian features in which mining activity is planned and will most likely extend to downstream/downgradient areas and impacts may occur on the Mutamba River.

Operational activities have the potential to lead to the contamination of soils and water within the preferential flow paths, which will lead to the alteration or loss of habitat of floral and faunal species associated with these riparian zones.

Activities which are likely to negatively affect riparian systems within and around the study area include, but are not limited to, the following:

- Placement of mining infrastructure within preferential flow paths and riparian areas;
- Destruction of riparian habitat during construction and operational activities;
- Dewatering of drainage lines;
- Discharge and/or spills and seepage from mining infrastructure;
- Diversion of surface water systems;
- Construction of clean and dirty water separation areas and a loss of catchment yield.

The above activities are highly likely to have a significant detrimental impact on the riparian habitat within and around the mining footprint and potentially downstream and to the Mutamba River. The following tables provide an indication of the anticipated impact significance pre- and post-mitigation.

Table 19: Anticipated activities and aspects regarding the loss of riparian habitat and ecological structure associated with the proposed The Duel Coal Project development.

Pre-Construction	Construction	Operational	Decommissioning & Closure
Planning of infrastructure within riparian areas	Site clearing and the removal of vegetation leading to direct loss of riparian habitat and increased runoff and erosion	Ongoing disturbance of soils with general operational activities	Disturbance of soils as part of demolition activities
Potential inadequate design of infrastructure leading to risks of pollution	Site clearing and the disturbance of soils leading to increased erosion	Spillages and seepage of hazardous waste material into the groundwater	Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure
Potential inadequate design of infrastructure leading to changes to riparian habitat	Earthworks in the vicinity of riparian resources leading to increased runoff and erosion and altered runoff patterns	Risk of contamination from the mining infrastructure	Ongoing risk of contamination from mining infrastructure beyond closure
-	Construction of stream crossings altering stream and base flow patterns and water velocities	Potential contamination from mining infrastructure	Potential contamination from the decommissioning of mining infrastructure
-	Topsoil stockpiling adjacent to riparian areas and runoff from stockpiles	Runoff, seepage and potential contamination from mining infrastructure such as clean and dirty water systems	Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure
-	Movement of construction vehicles within riparian areas	Dumping of hazardous and non-hazardous waste into the riparian areas	Decommissioning activities may lead to riparian habitat transformation and alien plant species proliferation
-	Dumping of hazardous and non-hazardous waste into the riparian areas	Erosion and sedimentation riparian areas leading to loss of riparian habitat	Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment
-	Waste material spills and waste refuse deposits into the riparian features	Sedimentation and incision leading to altered habitats	Ongoing erosion and sedimentation of riparian areas
-	-	Loss of riparian biodiversity	Loss of riparian biodiversity

Mutamba River								
Unmanaged								
	Probability of Impact	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
Construction phase	**5**	**4**	**3**	3	3	9	9	**81 Medium-High**
Operational phase	**5**	**4**	**3**	3	3	9	9	**81 Medium-High**
Decommissioning and closure phase	**5**	**4**	**3**	3	5	9	11	**99 Medium-High**
Managed								
	Probability of Impact	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
Construction phase	**3**	**4**	**3**	**3**	**3**	**7**	**9**	**63 Medium-Low**
Operational phase	**3**	**4**	**3**	**3**	**3**	**7**	**9**	**63 Medium-Low**
Decommissioning and closure phase	**3**	**4**	**3**	**3**	**5**	**7**	**11**	**77 Medium-High**

Smaller Drainage Lines								
Unmanaged								
	Probability of Impact	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
Construction phase	**5**	**3**	**4**	**2**	**4**	**8**	**10**	**80 (Medium High)**
Operational phase	**5**	**3**	**4**	**3**	**4**	**8**	**11**	**88 (Medium High)**
Decommissioning and closure phase	**5**	**3**	**3**	**2**	**5**	**8**	**10**	**80 (Medium High)**
Managed								
	Probability of Impact	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
Construction phase	**3**	**3**	**2**	**2**	**4**	**6**	**8**	**48 (Low)**
Operational phase	**3**	**3**	**2**	**3**	**4**	**6**	**9**	**54 (Medium Low)**
Decommissioning and closure phase	**3**	**3**	**2**	**2**	**5**	**6**	**9**	**54 (Medium Low)**

Potential impacts on the Mutamba River on loss of riparian habitat and ecological structure from the proposed development of the mine highlighted above, without mitigation, are considered to potentially have a medium-high impact during all the respective phases. With mitigation employed the significance of the impacts may be reduced to medium-low during the construction and operational phases and a reduced medium-high for the decommissioning phase.

Potential impacts on the smaller drainage lines on riparian habitat and ecological structure from the proposed development of the mine highlighted above, without mitigation, are considered to have a potentially medium-high throughout all the respected phases. With recommended mitigation employed these ratings significance range from low in the construction and operational phases and medium-low in the decommissioning phase

5.1.2 Impact 2: Changes to Riparian Ecological and Socio-Cultural Service Provision

Construction related activities that will be undertaken, such as the removal of the topsoil and construction of mining infrastructure, will lead to destruction of habitat and overall loss of riparian ecological and socio-cultural service provision such as cultural value, biodiversity maintenance and nutrient and toxicant assimilation. All these activities will result in permanent impact on the riparian features and will most likely extend to downstream/downgradient areas and possibly the Mutamba River.

Operational activities could result in the contamination of soils and water, which will lead to the alteration or loss of riparian ecological and socio-cultural service provision.

Activities which are likely to negatively affect riparian systems within and around the mining footprint area have been listed in Section 5.1.1 also apply to this section. :

The following tables provide an indication of the anticipated impact significance pre- and post-mitigation.

Table 20: Anticipated activities and aspects regarding the changes to riparian ecological and socio-cultural service provision associated with the proposed The Duel Coal Project development.

Pre-Construction	Construction	Operational	Decommissioning & Closure
Planning of infrastructure within riparian areas	Site clearing and the removal of vegetation leading to increased runoff and erosion	Ongoing disturbance of soils with general operational activities	Disturbance of soils as part of demolition activities
Potential inadequate design of infrastructure leading to risks of pollution	Site clearing and the disturbance of soils leading to increased erosion	Spillages and seepage of hazardous waste material into the groundwater	Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure

Pre-Construction	Construction	Operational	Decommissioning & Closure
Potential inadequate design of infrastructure leading to changes to riparian habitat beyond the mine footprint	Earthworks in the vicinity of riparian areas leading to increased runoff and erosion and altered runoff patterns	Risk of contamination from the mining infrastructure	Ongoing risk of contamination from mining infrastructure beyond closure
-	Construction of stream crossings altering stream and base flow patterns and water velocities	Potential contamination from mining infrastructure	Potential contamination from the decommissioning of mining infrastructure
-	Topsoil stockpiling adjacent to riparian areas and runoff from stockpiles	Runoff, seepage and potential contamination from mining infrastructure such as clean and dirty water systems	Ongoing seepage and runoff from mining infrastructure to the groundwater regime beyond closure
-	Movement of construction vehicles within riparian areas	Dumping of hazardous and non-hazardous waste into the riparian areas	Decommissioning activities may lead to riparian habitat transformation and alien plant species proliferation
-	Dumping of hazardous and non-hazardous waste into the riparian areas	Erosion and sedimentation of riparian areas leading to loss of riparian habitat	Ineffective rehabilitation may lead to habitat transformation and alien vegetation encroachment
-	Waste material spills and waste refuse deposits into the riparian features	Sedimentation and incision leading to altered habitats	Ongoing erosion and sedimentation of riparian areas
-	-	Loss of riparian floral diversity	Loss of riparian floral diversity

Mutamba River								
Unmanaged								
	Probability of Impact	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
Construction phase	**5**	**4**	**4**	3	3	9	10	**90 Medium-high**
Operational phase	**5**	**4**	**4**	3	3	9	10	**90 Medium-high**
Decommissioning and closure phase	**5**	**4**	**4**	3	5	9	12	**108 High**
Managed								
	Probability of Impact	**Sensitivity of receiving environment**	**Severity**	**Spatial scale**	**Duration of impact**	**Likelihood**	**Consequence**	**Significance**
Construction phase	**3**	**4**	**3**	**3**	**3**	**7**	**9**	**45 Low**
Operational phase	**3**	**4**	**3**	**3**	**3**	**7**	**9**	**45 Low**
Decommissioning and closure phase	**3**	**4**	**3**	**3**	**5**	**7**	**11**	**55 Medium-Low**

Smaller Drainage Lines								
Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	1	4	3	3	6	10	60 (Medium Low)
Operational phase	5	1	4	3	3	6	10	60 (Medium Low)
Decommissioning and closure phase	5	1	4	3	5	6	12	72 (Medium Low)
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	1	3	3	3	4	9	36 (Low)
Operational phase	3	1	4	3	3	4	10	40 (Low)
Decommissioning and closure phase	3	1	3	3	5	4	11	44 (Low)

Potential impacts on the Mutamba River on changes to riparian ecological and socio-cultural service provision from the proposed development of the mine highlighted above, without mitigation, are considered to potentially have a medium-high during the construction and operational phases and high during the decommissioning phase. With mitigation employed the significance of the impacts may be reduced to low during the construction and operational phases and medium-low for the decommissioning phase.

Potential impacts on the smaller drainage lines on changes to riparian ecological and socio-cultural service provision from the proposed development of the mine highlighted above, without mitigation, are considered to have a potentially medium-low throughout all the respected phases. With recommended mitigation employed these ratings significance in all the respected phases will be reduced to low.

5.1.3 Impact 3: Loss of Instream Flow and Changes in Sediment Balance

Impacts on reduced instream flow will in turn affect aquatic refugia, loss of taxa dependent on persistent surface water along with the potential for deterioration in water quality. In terms of aquatic and riparian zone ecology relating to the mining right application area, the Mutamba River (site TD1) must be considered the most important aquatic resource. However, the smaller drainage lines in the study area should also be taken into account when planning of

the proposed mine takes place. Without impact from any mining activities, the Mutamba River is already experiencing significant impact due to water abstraction from the system within the vicinity of the study area and the wider catchment, leading to reduced instream flow and loss of refuge pools along extensive sections of the system. Likewise, the smaller drainage lines in the area are episodic with water only persisting for short periods after significant rainfall. Such seasonal no-flow conditions may present with associated negative impacts on water quality, particularly increased salt levels which may in turn manifest in more important larger systems.

It is expected that the activity proposed to take place within the mining rights area, if not managed, may cause significant change to flows in the minor drainage lines that may in turn negatively impact on the Mutamba River. Factors which may play a role are indicated below:

- Change in surface coverage. Development of the mining rights area will change the surface coverage in some areas from vegetated soil to buildings, hardened gravel roads, paved areas (parking), and compacted earth;
- Separation and management of clean and dirty water management systems and capture of run-off and capture of rainfall in the 'dirty' area would possibly lower instream flow in the receiving environment and reduce catchment yield for the life of mine;
- Canalisation of run-off. Intercepting run-off around mining activities and infrastructure could reduce the amount of time that water would take to reach the Mutamba River. This is likely to occur due to the decreased friction on the water associated with concentrated flow in, for example, a concrete-lined canal as opposed to sheet flow on a hill slopes, and the consequently higher flow velocities and shortened peak flows and reduced streamflow regulation in the system; and
- The removal of topsoil for the proposed mining and infrastructural developments will likely lead to disturbances of watercourse hydrological function with an increase of sediment input.

The above factors are likely to lead to altered riverine recharge flood peaks and a general loss of runoff volumes successfully reaching the Mutamba River system as well as the other smaller drainage systems in the area. This in turn may lead to the loss of aquatic biota such as fish and aquatic macro-invertebrates which rely on the presence of surface water and the perennial presence of refugia.

Table 21: Anticipated activities and aspects regarding the loss of instream flow impacts and changes in sediment balance associated with the proposed The Duel Coal Project development.

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potentially poor planning leading to extensive dirty water areas which need to be managed which may reduce the MAR to the non-perennial drainage systems in the area	Construction of raw water storage dams and stream diversions may impact on the instream flow of the receiving systems	The abstraction of water from the Nzhelele Dam for use in the mine	Loss of MAR from latent dirty water areas may still impact on the flow even after operational phase
Potentially inadequate design of temporary stream diversions which may lead to loss of recharge of the larger systems	Construction of clean and dirty water separation structures for pollution control purposes may lead to altered flow levels	Loss of MAR from dirty water areas may impact on the instream flow of the receiving systems	Loss of water to inadequately rehabilitated areas such as discard dumps and open pits may still have an impact on the flow post operational phase
Encroachment of open pits into non-perennial drainage features which may lead to reduced instream flow in small drainage lines in the project area and subsequently also the Mutamba River	Clearing of areas for the initiation of the production pits may lead to reduced instream flow	Use of surface water runoff and groundwater as a water supply during the operational phase of the mine may lead to reduced instream flow	Use of surface water runoff and groundwater as a water supply during the closure phase of the mine may impact on the flow
Design of canals leading to rapid release of water which in turn may lead to a loss of streamflow regulation capabilities in the area	Use of surface water runoff and groundwater as a water supply during construction mining project may alter the flow in the receiving systems	Impact on natural streamflow regulation and stream recharge due to altered hydrology in the area may lead to altered instream flow	Impact on natural streamflow regulation and stream recharge due to altered hydrology in the area may impact on the flow post operational phase
Use of surface runoff and groundwater sources for the supply of production water for the mining project may alter the flow in the receiving systems	Loss of aquatic habitats and refugia for aquatic macro-invertebrates and fish	Operation of clean and dirty water separation systems as well as clean water diversion systems leading to changes in the pattern timing and quantity of water entering watercourses	Decommissioning of clean and dirty water separation systems as well as clean water diversion systems leading to changes in the pattern timing and quantity of water entering watercourses
-	Construction of stream crossings altering stream and base flow patterns and water velocities	Spillages and seepage of hazardous waste material into the groundwater	Disturbance of soils as part of demolition activities
-	Increased moisture stress on riparian vegetation	Ongoing disturbance of soils with general operational activities	

Mutamba River								
Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	4	4	3	3	9	10	90 Medium-High
Operational phase	5	4	4	4	4	9	12	108 High
Decommissioning and closure phase	5	4	5	3	5	9	13	117 High
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	4	3	2	3	7	8	56 Medium - Low
Operational phase	3	4	3	3	4	7	10	70 Medium-Low
Decommissioning and closure phase	3	4	3	2	5	7	9	63 Medium-Low

Smaller drainage lines								
Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	2	3	3	3	7	9	54 Medium-low
Operational phase	5	2	3	3	4	7	12	72 Medium low
Decommissioning and closure phase	5	2	3	3	5	7	11	66 Medium low
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	2	3	3	3	5	9	45 Medium-Low
Operational phase	3	2	3	3	4	5	10	50 Medium- Low
Decommissioning and closure phase	3	2	3	3	4	5	10	50 Medium-Low

Desktop EIS/PES assessment for the Mutamba system indicate a PES classified as C, EI classified as “moderate”, ES as “high” and default EC as B. However, the aquatic assessment results indicate that conditions in the project area is deteriorated from what could be expected based on the desktop assessment. The Mutamba River can thus be considered to be a system of limited Ecological Importance and Sensitivity, due to the limited provision of refugia and the limited support it provides to the aquatic ecology of the area. The system is also impacted upon by in-stream inundation, to a limited degree, and water abstraction for agricultural purposes. The system is, however, deemed important in terms of the provision of services to the terrestrial fauna of the area as well as fair significance from a socio-cultural point of view. The smaller drainage lines are of less ecological importance as frequent no-flow or completely dry conditions preclude settlement of sensitive or diverse taxa.
Potential impacts on the Mutamba River on instream flow and sediment balance from the proposed development of the mine highlighted above, without mitigation, are considered to potentially have a medium-high impact during the construction phase and a high impact during the operational and decommissioning/closure phases. on the Mutamba River

Potential impacts on the smaller drainage lines instream flow and sediment balance from the proposed development of the mine highlighted above, without mitigation, are considered to have a potentially medium low throughout all the respected phases. With recommended mitigation employed these ratings still fall within the same category but with a reduced probability.

5.1.4 Impact 4: Impacts on Water Quality

If all constituents in the cumulative contamination from the proposed mining activities are within the applicable target water quality ranges (DWAF, 1996), or are within acceptable variances from background water quality standards then the activities will not contribute significantly to an unacceptable cumulative impact. Thus a conservative approach is to be taken, in this case to account for possible contamination by future activities in the river catchment.

The Mutamba River (site TD1) is the most significant aquatic system in the vicinity of the mining rights area which may be impacted upon and requires the most attention when considering impacts on reduced water quality and the impact it may have on the aquatic community.

However, the smaller drainage lines within the project area will also be impacted upon. Although the significance of these systems on both a local and a regional scale is lower than

that of the Mutamba River, impacts on water quality affecting the smaller drainage lines may ultimately also negatively affect water quality in the Mutamba River which is of a higher ecological significance.

As mentioned in the aquatic ecological baseline study, the Mutamba River system already appears to be suffering water quality fluctuations resulting from water abstraction, inundation and reduced flow, all resulting in salinisation. The no-flow and often completely dry conditions of the smaller drainage lines also pose conditions conducive to salinisation. Consequently, current analyses of biota specific water quality indicated high salt loads in Mutamba River. This is deemed likely to constrain the aquatic community in the system to some degree.

Increased sediment load

Increased erosion of disturbed surfaces means that the run-off contains a higher silt or sediment load and are likely to contaminate the Mutamba River as well as the smaller drainage lines. In the current natural state of the mining rights area, the vegetation cover causes friction to rainfall run-off which reduces flow velocities and consequently shear forces between the water and the ground surface, resulting in the ground surface remaining intact and not being eroded away.

If for any reason the ground surface is disturbed and the flow velocities are increased, there is potential for significantly increased erosion to occur.

Increased sediment load contains suspended solids. If there are too many suspended solids in the water this can negatively affect biological life and affect refugia in the Mutamba River system.

The following activities are likely to cause an increase in movement of sediment loads, or directly increase erosion:

- Stripping (vegetation clearance) of mining areas prior to excavation of pits and stockpiles areas;
- Construction of hard-standing areas that increase run-off volumes, including roads, buildings and paved areas;
- Canalisation of run-off, particularly if canals do not discharge into the Mutamba River via smaller drainage lines in the project area;
- Construction activities that loosen the ground surface.

Impaired water quality due to pollutants released from processing plant

Wastewater from the coal ore beneficiation process would contain pollutants in excess of the target water quality ranges for the water uses of the receiving water body. The potential release of wastewater would thus impact negatively on the surface water quality. A further consideration is the run-off of pollutants from the process plant area following rainfall, due to the activities within that area.

Impaired water quality due to pollutants in run-off from waste/discard dumps

It is likely that run-off from the dumps will have a different chemical composition to natural run-off. In this event it is best practice to keep 'dirty' water from stockpile run-off separate from 'clean' water from natural run-off.

Impaired water quality due to pollutants in water released from opencast pits

Overflow of water (decant), whether surface or ground, from the pits could release pollutants to the surface water environment (if geochemical testing indicates a possible acid mine drainage or other water quality issue).

Impaired water quality due to petrochemical spills

Fuel or oil spills from vehicles could contaminate surface water resources. Leakages, spills or run-off from vehicle wash bays, workshop facilities, fuel depots or storage facilities of potentially polluting substances could contaminate surface water resources.

Heavy metal contamination

Increase in metal concentrations is commonly associated with tillage and blasting of the upper crust of the earth's surface. This releases metals into the associated surface and ground water systems. Under alkaline conditions, most of the metals remain biologically unavailable, however in the presence of acid mine drainage the metal-speciation changes and they become available. This may alter the species composition of the aquatic biota inhabiting the surrounding rivers especially downstream of the proposed development. This is particularly significant due to the presence of game farms in the surrounding areas, which plays host to a diversity of species that could be affected by bioaccumulation and biomagnification.

Table 22: Anticipated activities and aspects regarding the impacts on water quality of the freshwater habitat associated with the proposed The Duel Coal Project development.

Pre-Construction	Construction	Operational	Decommissioning and Closure
Potential poor planning leading to extensive and complex dirty water areas which need to be managed may impact on water quality	Clean and dirty water systems potentially not being constructed to the required specifications to prevent contamination of clean water areas may impact on water quality	Mining activities and the establishment of mining waste may impact on water quality and thus needs to be managed to prevent pollution	Inadequate closure and rehabilitation leading to ongoing pollution from contaminating sources such as discard dumps may impact on water quality
Potential poor planning leading to placement of polluting structures in non-perennial drainage lines which would increase mobility of pollutants and may impact on water quality	Major earthworks and construction activities may lead to impacts on water quality	Clean and dirty water systems not being maintained and operated to the required specifications to prevent contamination of clean water areas may impact on water quality	Clean and dirty water systems not being maintained or decommissioned properly to the required specifications to prevent contamination of clean water areas may impact on water quality
Potential inadequate separation of clean and dirty water areas leading to contaminated water leaving the defined dirty water area may impact in water quality	Potential poor housekeeping and management may lead to impacts on water quality	Potential poor housekeeping and management during operational phase may lead to impacts on water quality	Potential poor housekeeping and management during decommissioning phase may lead to impacts on water quality
Clean and dirty water systems potentially not being designed adequately to ensure protection of the water resources	Spills and other unplanned events may impact on water quality	Spills and other unplanned events during operational phase may impact on water quality	Spills and other unplanned events during decommissioning phase may impact on water quality
-	Impact on riparian vegetation structures due to impaired water quality	Impact on riparian vegetation structures due to impaired water quality	Impact on riparian vegetation structure due to impaired water quality
-	Build-up of contaminants in sediments leading to the creation of a sediment sink and chronic source of potential water contamination	Build-up of contaminants in sediments leading to the creation of a sediment sink and chronic source of potential water contamination	Latent release of contaminants in sediments leading to the formation of an ongoing source of potential water contamination
-	-	Impacts on groundwater quality which could manifest in surface water sources	Impacts on groundwater quality which could manifest in surface water sources
-	-	Potential bioaccumulation and biomagnification in fauna located in the Mutamba River system and smaller drainage lines in the project area	Potential bioaccumulation and biomagnification in fauna located in the Mutamba River system and smaller drainage lines in the project area

Mutamba River								
Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	3	3	4	3	8	10	80 Medium high
Operational phase	5	3	4	4	4	8	12	96 Medium high
Decommissioning and closure phase	5	3	4	4	5	8	13	104 High
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	3	3	3	6	9	54 Medium low
Operational phase	3	3	3	3	4	6	10	60 Medium low
Decommissioning and closure phase	3	3	3	3	4	6	10	60 Medium low

Smaller drainage lines								
Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	1	5	3	3	6	11	66 Medium low
Operational phase	5	1	5	3	4	6	12	72 Medium low
Decommissioning and closure phase	5	1	5	3	5	6	13	78 Medium high
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	5	1	3	2	3	6	8	48 Low
Operational phase	4	1	3	3	4	5	10	50 Low
Decommissioning and closure phase	4	1	3	3	4	5	10	50 Low

Desktop EIS/PES assessment indicate a PES classified as C, EI classified as “moderate”, ES as “high” and default EC as B. However, the aquatic assessment results indicate that conditions in the project area is deteriorated from what could be expected based on the desktop assessment, especially with reference to salinisation. In terms of water quality, the Mutamba River can thus be considered to be a system of limited Ecological Importance and Sensitivity due to elevated salt concentrations.

Potential impacts on water quality from the proposed development of the mine highlighted above, without mitigation, are considered to potentially have a medium-low to medium - high

in the construction and operational phases to medium high impact in the decommissioning and closure phase on the Mutamba River, and a medium low negative effect on the aquatic resources of the smaller drainage lines.

Mitigation measures available will have limited ability to minimise the impacts on the small drainage lines in the direct vicinity of the proposed mining development. However, the low sensitivity of these resources already mitigates the potential impact score based on the likelihood aspect of the method employed. The perceived risk is likely to decrease from medium low to low.

Mitigation is deemed likely to alter the significance of impact on the Mutamba River from the pre-mitigation conditions to some extent, more specifically from a high impact rating to a medium low impact rating.

The key mitigation required to reduce impacts related to reduce water quality in the receiving environment is to ensure the separation of clean and dirty water systems which are adequately designed to contain runoff under a 1:50 year flood event in line with the requirements of Regulation GN704 of the National Water Act.

5.1.5 Impact 5: Loss of Aquatic Habitat

Habitat transformation and destruction is the alteration of a natural habitat to the point that it is rendered unfit to support species dependent upon it as their home territory. Loss or transformation of habitat may cause a reduction of biodiversity, due to organisms previously using the area being displaced or destroyed. Habitat destruction is presently ranked as the most significant cause of species population decrease and ultimately species extinction worldwide.

Globally modification of habitats for agriculture is the chief cause of such habitat loss. Additional causes of habitat destruction include surface mining, deforestation, slash-and-burn practices, urban development, water pollution, introduction of alien species, over grazing and over harvesting of resources such as fishing.

Riverine systems and particularly temporary riverine systems or river systems that have very low flows as part of their annual hydrological cycles are particularly susceptible to changes in habitat condition.

The proposed mining activity of the proposed Duel Project has the potential to lead to habitat loss and/or alteration of the aquatic and riparian resources on the mining rights area, with special reference to the smaller drainage lines within the project area as well as potential loss of refugia within the Mutamba River system.

Table 23: Anticipated activities and aspects regarding the loss of aquatic habitat associated with the proposed The Duel Coal Project development.

Pre-Construction	Construction	Operational	Decommissioning and Closure
The abstraction of water from the Nzhelele Dam for use in the mine	The abstraction of water from the Nzhelele Dam for use in the mine	The abstraction of water from the Nzhelele Dam for use in the mine	Disturbance of soils as part of demolition activities may alter the aquatic habitat
Potential poor planning leading to the placement of infrastructure within non-perennial drainage lines with special mention of the waste stockpile areas and the open pit areas themselves as well as roads, road crossings and bridges all may alter the	Site clearing and the removal of vegetation leading to increased runoff and erosion may alter the aquatic habitat	Ongoing disturbance of soils during general operational activities may alter the aquatic habitat	Inadequate separation of clean and dirty water areas may alter the aquatic habitat during the decommissioning phase
Potential inadequate design of infrastructure leading to changes to instream habitat	Site clearing and road construction and the disturbance of soils leading to increased erosion may alter the aquatic habitat	Potential inadequate separation of clean and dirty water areas may alter the aquatic habitat during the operational phase	Ongoing pollution from inappropriately decommissioned structures may alter the aquatic habitat
Potential inadequate design of infrastructure leading to changes to system hydrology may alter the aquatic habitat	Earthworks in the vicinity of drainage systems leading to increased runoff and erosion and altered runoff patterns may alter the aquatic habitat	Mining related activities leading to increased disturbance of soils and drainage lines may alter the aquatic habitat	Alien vegetation encroachment will impact on and alter the aquatic habitat
Potential inadequate separation of clean and dirty water areas and the prevention of the release of sediment rich water may alter the aquatic habitat within the receiving environment	Construction of bridge crossings altering streamflow patterns and water velocities may alter the aquatic habitat	Any activities which lead to the reduction of flow in the system with special mention of the open pits and the use of surface and groundwater sources for production water may alter the aquatic habitat	Erosion and incision of riparian zone
	Alien vegetation encroachment will impact on and alter the aquatic habitat	Alien vegetation encroachment will impact on and alter the aquatic habitat	Altered wetting patterns leading to impacts on riparian zone continuity
-	Erosion and incision of riparian zone	Erosion and incision of riparian zone	Loss of low flow refugia
-	Altered wetting patterns leading to impacts on riparian zone continuity	Altered wetting patterns leading to impacts on riparian zone continuity	Altered substrate conditions from sandy conditions to more muddy conditions
-	Loss of low flow refugia	Loss of low flow refugia	Alien vegetation proliferation

Pre-Construction	Construction	Operational	Decommissioning and Closure
-	Altered substrate conditions from sandy conditions to more muddy conditions	Altered substrate conditions from sandy conditions to more muddy conditions	-
-	Altered depth and flow regimes in the major drainage systems	Altered depth and flow regimes in the major drainage systems	-
-	Alien vegetation proliferation	Alien vegetation proliferation	-

Mutamba River

Unmanaged

	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	3	3	3	6	9	54 Medium low
Operational phase	4	3	4	4	4	7	12	84 Medium high
Decommissioning and closure phase	3	3	3	4	5	6	12	72 Medium low

Managed

	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	2	2	2	5	6	30 Low
Operational phase	3	3	3	3	4	6	10	60 Medium low
Decommissioning and closure phase	2	3	3	3	4	5	10	50 Low

Smaller drainage lines

Unmanaged

	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	1	4	3	3	5	10	50 Low
Operational phase	5	1	5	3	4	6	12	72 Medium low
Decommissioning and closure phase	4	1	4	3	5	5	12	60 Medium low

Managed

	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	1	3	2	3	5	8	40 Low
Operational phase	5	1	4	2	4	6	10	60 Medium low
Decommissioning and closure phase	4	1	3	3	4	5	10	50 Low

Desktop EIS/PES assessment indicate a PES classified as C, EI classified as “moderate”, ES as “high” and default EC as B. However, the aquatic assessment results indicate that conditions in the project area is deteriorated from what could be expected based on the desktop assessment. An overall score of 50.1% (Mutamba River, site TD1) was calculated using the IHIA assessment tool, placing site TD1 in “D” (“Largely modified”) classification. Whilst the IHAS index indicated habitat diversity and structure to be adequate to support a diverse aquatic macro-invertebrate community under the current flow conditions, aspects such as a lack of aquatic vegetation and bedrock, discolored conditions as well as limited diversity of flow types may limit establishment of sensitive and suitably adapted taxa.

Potential impacts on aquatic habitat from the proposed development of the mine highlighted above, without mitigation, are considered to potentially have a medium-low to medium-high impact on the Mutamba River. With mitigation, and a low impact in the construction and operational decommissioning/closure phases, and to a medium-low impact in the operational phase is anticipated.

Mitigation measures available will have limited ability to minimise the impacts on the small drainage lines in the direct vicinity of the proposed mining development. However, the low sensitivity of these resources already limits the significance of the impact score based on the likelihood aspect of the method employed. The perceived risk is likely to decrease from low, in the construction phase, and medium-low impact in the operational phase, to low significance impacts in thein the construction and decommissioning phase and a reduced medium low rating in the operationalphase.

5.1.6 Impact 6: Loss of Aquatic Biodiversity and Sensitive Taxa

Loss or a decrease of aquatic biodiversity and sensitive taxa is largely driven by impacts stressed by instream flow, altered water quality and habitat loss. The aquatic resources in the immediate area do not, however, support or potentially support an aquatic community of significant diversity and sensitivity, with specific reference to the smaller drainage lines.

The monitoring of aquatic communities such as macro-invertebrates and fish within aquatic systems vary over season and other factors such as weather play a vital role when field studies are conducted. It is thus crucial to implement a regular monitoring strategy which will increase the data set and understanding of the aquatic community within the surrounding aquatic systems linked in the vicinity of the proposed mining area. It is recommended that an annual high flow (summer) biomonitoring strategy be implemented as part of the ongoing monitoring program, with an initial quarterly assessment prior to major construction in the area.

The planned mining activities of the proposed Duel coal project have the potential to lead to a loss of aquatic biodiversity due to all the project aspects mentioned in sections above, since impacts on instream flow, water quality and habitat will all affect species diversity and especially more sensitive taxa.

Table 26 below summarise the aspects of aquatic biodiversity affected impacts on the Mutamba River and the second the smaller drainage lines.

Table 24: Anticipated activities and aspects regarding the loss of aquatic biodiversity and sensitive taxa associated with the proposed The Duel Coal Project development.

Pre-Construction	Construction	Operational	Decommissioning and Closure
The abstraction of water from the Nzhelele Dam for use in the mine, limiting available habitat for aquatic biodiversity	Sedimentation and loss of natural substrates	Sedimentation and loss of natural substrates	Sedimentation and loss of natural substrates
Potential poor planning leading to the placement of infrastructure within non-perennial drainage lines with special mention of the waste stockpile areas and the open pit areas themselves as well as roads, road crossings and bridges all may alter the aquatic habitat reducing aquatic biodiversity	Altered stream channel forms	Altered stream channel forms	Altered stream channel forms
Potential inadequate design of infrastructure leading to changes to instream habitat, which may be supporting sensitive taxa	Increased turbidity of water	Increased turbidity of water	Loss of refugia
Potential inadequate design of infrastructure leading to changes to system hydrology may reduce the abundance of flow dependent taxa	Loss of refugia	Loss of refugia	Deterioration in water quality with special mention of impacts from, heavy metals and salinisation
-	Deterioration in water quality	Deterioration in water quality with special mention of impacts from, heavy metals, AMD and salinisation	Eutrophication of the aquatic ecosystems
-	Loss of flow sensitive macro-invertebrates and fish	Eutrophication of the aquatic ecosystems	Loss of flow sensitive macro-invertebrates and fish
-	Loss of water quality sensitive macro-	Loss of flow sensitive macro-invertebrates and	Loss of water quality sensitive macro-invertebrates and fish

Pre-Construction	Construction	Operational	Decommissioning and Closure
-	Loss of riparian vegetation species	Loss of water quality sensitive macro-	Loss of riparian vegetation species
-	Loss of sensitive species and species of conservation concern in the Mutamba River. Because of the non-perennial nature of the smaller drainage lines	Loss of riparian vegetation species	Loss of sensitive species and species of conservation concern in the Mutamba River. Because of the non-perennial nature of the smaller drainage lines sensitive aquatic taxa are expected to
-	-	Loss of sensitive species and species of conservation concern in the Mutamba River. Because of the non-perennial nature of the smaller drainage lines	-

Mutamba River								
Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	3	4	4	3	7	11	77 Medium high
Operational phase	4	3	4	4	4	7	12	84 Medium high
Decommissioning and closure phase	3	3	4	4	5	6	13	78 Medium high
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	3	3	3	5	9	45 Low
Operational phase	2	3	3	3	4	5	10	50 Low
Decommissioning and closure phase	2	3	3	3	4	5	10	50 Low
Smaller drainage lines								
Unmanaged								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	1	4	3	2	5	9	45 Low
Operational phase	4	1	4	3	4	5	11	55 Medium low
Decommissioning and closure phase	4	1	4	3	5	5	12	60 Medium low
Managed								
	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance

Construction phase	**2**	**1**	**3**	**2**	**3**	**3**	**8**	**24 Very low**
Operational phase	**3**	**1**	**3**	**3**	**4**	**4**	**10**	**40 Low**
Decommissioning and closure phase	**3**	**1**	**3**	**3**	**4**	**4**	**10**	**40 Low**

Desktop EIS/PES assessment indicate a PES classified as C, EI classified as “moderate”, ES as “high” and default EC as B. However, the aquatic assessment results indicate that conditions in the project area is deteriorated from what could be expected based on the desktop assessment. Both fish and macro-invertebrate assessment indices presented with classifications ranging between D and E/F. Very few sensitive taxa were present at site TD1 (Mutamba River).

Potential impacts on aquatic biodiversity from the proposed development of the mine highlighted above, without mitigation, are considered to potentially have a medium high impact on the Mutamba River (all phases) and low (construction phase) to medium low (operational and closure phases) impact on the smaller drainage lines.

Mitigation measures available will have limited ability to minimise the impacts on the small drainage lines in the direct vicinity of the proposed mining development. However, the low sensitivity of these resources already mitigates the potential impact score based on the likelihood aspect of the method employed. The perceived risk is likely to decrease to very low (construction phase) from medium low to low (operational and closure phases). Mitigation is deemed likely to alter the significance of impact on the Mutamba River from the pre-mitigation conditions to some extent, more specifically from a medium high impact rating to a low impact rating for all phases.

5.1.7 Impact Assessment Summary

From the results of the riparian impact assessment it is evident that prior to mitigation all impacts on the smaller drainage lines range from low to medium-high, With the recommended mitigation measures applied the impacts can be reduced ranging from medium – low to low for the respective impacts.

From the results of the assessment it is evident that prior to mitigation all impacts on the Mutamba River are medium-low to high, with the majority of potential impacts rated medium-high to high and impacts on water quality considered high. With mitigation, impacts on the Mutamba River are anticipated to be reduced to medium-low to low levels, with loss of aquatic habitat and deteriorating water quality being the greatest concerns.

Table 25: Summary of impact significance on habitat surrounding the watercourses.

Construction Phase		
Impact	**Unmanaged**	**Managed**
1: Loss of Riparian Habitat and Ecological Structure	Medium-High	Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-Low	Medium-Low
4. Impacts on Water Quality	Medium-Low	Low
5. Loss of Aquatic Habitat	Low	Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Low	Very-Low
Operational Phase		
Impact	**Unmanaged**	**Managed**
1: : Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-Low	Medium-Low
4. Impacts on Water Quality	Medium-Low	Low
5. Loss of Aquatic Habitat	Medium-Low	Medium-Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-Low	Low
Decommissioning and Closure Phase		
Impact	**Unmanaged**	**Managed**
1: : Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-Low	Medium-Low
4. Impacts on Water Quality	Medium-High	Low
5. Loss of Aquatic Habitat	Medium-Low	Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-Low	Low
Summary	**Medium-Low to Medium-High**	**Low to Medium-Low**

Table 26: Summary of impact significance on the Mutamba River.

Construction Phase		
Impact	**Unmanaged**	**Managed**
1: Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-High	Medium-Low
4. Impacts on Water Quality	Medium-High	Medium-Low
5. Loss of Aquatic Habitat	Medium-Low	Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-High	Low
Operational Phase		
Impact	**Unmanaged**	**Managed**
1: Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	Medium-Low	Low
3. Loss of Instream Flow and changes in Sediment Balance	Medium-High	Medium-Low
4. Impacts on Water Quality	Medium-High	Medium-Low
5. Loss of Aquatic Habitat	Medium-High	Medium-Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-High	Low
Decommissioning and Closure Phase		
Impact	**Unmanaged**	**Managed**
1: Loss of Riparian Habitat and Ecological Structure	Medium-High	Medium-Low
2: Changes to Riparian Ecological and Socio Cultural Service Provision	High	Medium-Low

3. Loss of Instream Flow and changes in Sediment Balance	High	Medium-Low
4. Impacts on Water Quality	High	Medium-Low
5. Loss of Aquatic Habitat	Medium-Low	Low
6. Loss of Aquatic Biodiversity and sensitive taxa	Medium-High	Low
Summary	Medium-Low to High	Low to Medium-Low

6 INTEGRATED IMPACT MITIGATION

6.1 *Freshwater Resource Impact Mitigation*

6.1.1 Mitigation measures

Based on the findings of the aquatic ecological assessment, several recommendations are made to minimise the impact on the aquatic ecology of the area, should the proposed mining project proceed:

- All employees should undertake a basic environmental awareness induction;
- Measures to contain and reuse as much water as possible within the mine process water system and water from dewatering of operational areas should be sought;
- All storm water and pollution control dams and dumps should be appropriately lined;
- Water use will affect the instream flow in the Mutamba River and the associated drainage lines and needs to be very carefully managed;
    - Any water abstraction from surface water resources or groundwater resources must take place in such a way as to ensure that impacts on the instream flow of the Mutamba River are avoided and managed. This is particularly important during low flow periods to ensure that instream flow and refugia are maintained.
- Upstream dewatering boreholes and stream diversions can potentially be utilised to minimise the creation of dirty water and this clean water should be used to recharge the natural systems downstream of the mining rights areas wherever possible;
- Very strict control of water consumption must take place and detailed monitoring must take place and where all water usage must continuously be optimised;
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas which recharge the receiving aquatic environment;
- If mining infrastructure is to encroach on the riparian zones and associated buffer zones, authorisation in line with the requirements of Regulation GN704 of the National water Act must be applied for;
- No dirty water runoff must be permitted to reach the freshwater resources during the entire life of mine, and clean and dirty water management systems must be put in place to prevent the contaminated runoff (suspended solids and salts and water with low pH) from entering the receiving aquatic environment. Clean and dirty water runoff systems should be constructed before construction of any other infrastructure takes place;
- Strict control of sewage water treatment must take place and the sewage system should form part of the mine's closed process water system;

- Due to climate change risks and increasing severity of storms and the relatively long life of mine all dirty water containment structures should be designed to contain a 1:100 year storm event;
- All pollution control facilities must be managed in such a way as to ensure that storage and surge capacity is available if a rainfall event occurs;
- The mines water balance must be strictly controlled at all times to ensure that decant does not occur;
- Adequate storm water management must be incorporated into the design of the proposed development in order to prevent erosion and the associated sedimentation of the riparian and instream areas, as these systems have aquatic communities which rely on stream substrates clear of sediment and on clear, fast flowing water. In this regard special mention is made of:
    - Sheet runoff from cleared areas, paved surfaces and access roads needs to be curtailed;
    - Runoff from paved surfaces should be slowed down by the strategic placement of berms; and
    - All waste dumps must have berms and/catchment paddocks at their toe to contain runoff of the facilities.
- During all phases of development, or exploration drilling activities no vehicles should be allowed to indiscriminately drive through the watercourse systems and vehicles must remain on designated roadways;
- All areas of increased ecological sensitivity near to mining operations should be clearly marked as “out of bounds” areas for all mining staff. In particular mention is made of remaining riparian systems and their associated buffers;
- During the construction and operational phases of the proposed mining development erosion berms should be installed on roadways to prevent gully formation and siltation of the freshwater resources. The following points should serve to guide the placement of erosion berms:
    - Where the track has slope of less than 2%, berms every 50m should be installed;
    - Where the track slopes between 2% and 10%, berms every 25m should be installed;
    - Where the track slopes between 10%-15%, berms every 20m should be installed;
    - Where the track has slope greater than 15%, berms every 10m should be installed.
- No dumping of waste should take place within the riparian zone. If any spills occur, they should be immediately cleaned up;

- Implement alien vegetation control program within riparian areas with special mention of water-loving species such as *Cereus jamacaru* (Queen of the night) *and Datura ferox* (Large thorn-apple);
- Concurrent/progressive rehabilitation must be implemented at all times and disturbed areas must be rehabilitated as soon as possible. This will not only reduce the total disturbance footprint, but will also reduce the overall rehabilitation effort and cost;
- All areas affected by stockpiling during the operational phase of the mine should be rehabilitated and stabilised using cladding or a suitable grass mix to prevent sedimentation of the aquatic resources in the area; and
- Upon closure all haul and access roads as well as all unnecessary mining infrastructure should be removed in order to minimise the impacts on the freshwater resources of the area beyond the life of mine.

6.1.2 Freshwater Resource Monitoring

- Close monitoring of water quality must take place. Monitoring of water quality should take place at a minimum frequency of once a month during which time major salts and basic metals, are monitored along with basic parameters such as pH, TSS and TDS, dissolved oxygen and EC;
- Biomonitoring should take place at the following key points:
  - The Mutamba River upstream of the drainage lines entering the Mutamba River;
  - The Mutamba River downstream of the drainage lines entering the Mutamba River.
- Biomonitoring should take place on an annual basis as a minimum in the summer with quarterly assessments being undertaken in the first year prior to disturbance to gather more detailed baseline information. Biomonitoring should take place throughout the life of the mine, including the closure and aftercare phases. The results of the biomonitoring program should be compared to the results of this study to allow any temporal trends to be observed. Should any problems be indicated measures to minimise or prevent the impact should be implemented;
- Biomonitoring should take place using the SASS5, MIRAI, SPI VEGRAI and IHAS indices as a minimum along with sediment chemistry monitoring. It is further recommended that the FRAI fish ecostatus protocol be applied if an increased abundance of fish is observed in the system at any time. All aquatic biomonitoring should be undertaken by a SA RHP accredited aquatic ecologist;
- Toxicity testing of the mine process water facilities should take place concurrently with the biomonitoring program in order to monitor the toxicological risk of the process water system to the receiving environment. Tests should include the following test organisms as a minimum:

- *Vibrio fischeri;*
- *Poecilia reticulata;*
- *Daphnia pulex;* and
- *Selenastrum capricornutum.*

➢ The mine must, if possible, be managed as a zero discharge facility, however definitive toxicological testing according to the DEEEP protocol should take place should it become evident that process water discharge or decant of groundwater will occur for safety reasons in order to define safe discharge volumes and ensure sufficient dilution.

6.1.3 Probable Latent Impacts

Even with extensive mitigation latent impacts on the receiving aquatic environment are deemed highly likely. The following points highlight the key latent impacts that have been identified:

➢ Loss of riparian vegetation;
➢ Reduced availability of refugia for aquatic biota;
➢ Altered riparian vegetation structures;
➢ Impacts on water quality in local water courses due to runoff from the impacted mine area;
➢ Impacts on dissolved oxygen concentration and saturation;
➢ Silted up refuge pools are unlikely to be naturally rehabilitated by the mine and loss of refugia in the system is deemed likely;
➢ Loss of some flow dependent species is likely on a localised scale; and
➢ Loss of some species less tolerant of water quality changes is likely on a localised scale.

6.2 *Additional measures*

In order to ensure that impact mitigation takes place to an adequate level should mining proceed it is deemed essential that a Biodiversity Action Plan (BAP) be developed which contains details on all actions that need to be undertaken to manage impacts on the ecology of the region. In addition the BAP and its implementation should be overseen by an environmental panel which should include representatives from the mine, the local communities and the local farmers association. The BAP should also be seen as a living document and must be continuously updated based on the findings of management and the ecological monitoring program. The actions required from the BAP should be implemented into a fully automated Environmental Management System (EMS).

Since effective mitigation through avoidance, impact minimisation and rehabilitation is deemed unlikely to adequately limit the impact on the receiving ecology it is deemed important that an ecological offset initiative be initiated to contribute to the conservation of the area. In particular

mention is made of initiatives focused on the involvement of surrounding landowners and management of land to create the ecological corridors linking the various areas currently functioning as conservation areas.

7 CONCLUSION

Scientific Aquatic Services (SAS) was appointed to undertake a Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) analysis of the freshwater resources as part of the environmental assessment and authorisation process for the proposed coal mine on the Remaining Extent of the farm The Duel 186 MT ("The Duel Coal Mine"), located approximately 70km to the south of Musina within the Limpopo Province.

The background information available from national and provincial databases indicate that the drainage features of the local area are relatively sensitive and ecologically important. Based on the findings of the field assessment it is evident that the drainage features within The Duel project area consist mainly of ephemeral drainage lines that cannot be defined as wetland or rivers with riparian zones, with fewer larger linear features that convey sufficient water to be defined as true watercourses with an associated riparian zone. In addition, it is important to note that the Mutamba River is located approximately 500 m north of the northern border of the study area with drainage features located within The Duel project area draining to the system.

Based on the study, the Mutamba River is seen to be a water stressed system, characterized by seasonal flow variation compounded by water abstraction for agricultural purposes. Desktop EIS/PES data indicate a PES classified as category C (Moderately Modified), Ecological Importance (EI) classified as "Moderate", Ecological Sensitivity (ES) as "High" and default Ecological Category (EC) as B ("Largely Natural"). The *In situ* water quality analysis revealed an exceedance of the Target Water Quality Range (TWQR) for aquatic ecosystems as set out by the Department of Water and Sanitation (DWS) (DWAF, 1996) for Total Dissolved Solids (TDS), mainly due to trampling of the riparian zone by wildlife causing sedimentation, as well as the evapo-concentration effect caused by a weir established upstream. Temperature measurements also exceeded the recommended TWQR at the time of the assessment which is due to the seasonal and diurnal fluctuations encountered during the survey. The temporal analysis revealed changes exceeding the recommended variation for pH and Dissolved Oxygen (DO) although these changes still fell within the acceptable range, and would not have been a limiting factor to aquatic biota at the time of the assessment.
The macroinvertebrate assemblage based on the South African Scoring System Version 5 (SASS5) methodology was classed Seriously Modified (Category E/F). A significant decrease

in both SASS score (33.9%) and the Average Score per Taxon (ASPT) score (27.5%) since the February 2015 survey was evident. This is likely largely due to lower flows limiting habitat availability compared to that encountered during the February 2015 survey. The fish community based on the Fish Response Assessment Index (FRAI) assessment was classed Largely Modified (Category D) with only five of 15 expected species sampled during both surveys, this is largely due to the low flows associated with the Mutamba River at the time of the assessments. One fish species of conservation concern was sampled during the February 2015 survey namely *Oreochromis mossambicus* (Mozambique Tilapia) rated Near Threatened (NT) by the IUCN (2019), mining activities should therefore be managed in such a way as to minimise the impact on the Mutamba River and the associated aquatic communities of the system.

Legislative requirements were used to determine the extent of buffer zone required for each watercourse depending on whether a group is considered rivers with riparian habitat or not. The Mutamba River, as well as smaller drainage lines with riparian zones are defined as watercourses. If any activities are to take place within 100 meters or the 1:100 year floodlines exemption terms of Regulation GN 704 of the NWA, 1998 (Act No. 36 of 1998) needs to be obtained. Section 21 of the NWA (Act 36 of 1998) as well as General Notice No. 509 of 2016 as it relates to the NWA will also apply and therefore a Water Use License will be required.

Several potential risks of varying significance to the receiving environment by the proposed mining operation have been identified which relate to the physical attributes of the freshwater resources as well as their hydrological, biological and physico-chemical properties. These impacts have been assessed in detail in the impact assessment phase of the project and as far as possible mitigatory recommendations have been presented in line with the mitigation hierarchy as advocated by the DMR (2013) in order to ensure informed decision making and promote sustainable development in the area.

Based on the impact assessment for the freshwater resources excluding the Mutamba River impacts ranged from low to Medium-High during all the development phases associated with the proposed activities, with recommended mitigation employed these impacts may be reduced to the Low to Medium- Low significance. The impact assessment for the Mutamba River revealed impacts ranging from Medium-Low to High during all the development phases, with the recommended mitigation applied these impacts may be reduced to the Low to Medium-Low significance.

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APPENDIX A – Terms of Use and Indemnity

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APPENDIX B – Legislative Requirements

National Environmental Management Act (NEMA) (Act No. 107 of 1998)	The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
National Water Act (NWA) (Act No. 36 of 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).
Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the NWA (Act 36 of 1998)	In accordance with Regulation GN509 of 2016, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: a) The outer edge of the 1 in 100 year floodline and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; b) In the absence of a determined 1 in 100 year floodline or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or c) A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice **replaces GN1199** and may be exercised as follows: i) Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation; ii) Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; iii) Do maintenance with their existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix; iv) Conduct river and stormwater management activities as contained in a river management plan; v) Conduct rehabilitation of wetlands or rivers where such rehabilitation activities has a LOW risk class as determined through the Risk Matrix; and vi) Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.
MPRDA **GN 704 – Regulations on the use of water for mining and related activities aimed at the protection of water resources, 1999**	These Regulations were put in place in order to prevent the pollution of water resources and protect water resources in areas where mining activity is taking place from impacts generally associated with mining. It is recommended that the proposed project complies with Regulation GN 704 of the NWA which contains regulations on the use of water for mining and related activities aimed at the protection of water resources. GN 704 states that: *No person in control of a mine or activity may:* *(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year floodline or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on waterlogged ground, or on ground likely to become waterlogged, undermined, unstable or cracked;* According to the above, the activity footprint must fall outside of the 1:100 year floodline of the aquatic resource or 100m from the edge of the resource, whichever distance is the greatest.

APPENDIX C – Method of Assessment

FRESHWATER RESOURCE METHOD OF ASSESSMENT

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 The Duel Coal Mine development 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 The Duel Coal Mine development.

1.2 *Department of Water and Sanitation (DWS) Resource Quality Information Services Present Ecological State / Ecological Importance and Sensitivity (PES/EIS) Database (2012)*

The PES/EIS database as developed by the DWS RQIS department was utilised to obtain background information on the project area. The PES/EIS database has been made available to consultants since mid-August 2014. The information from this database is based on information at a sub-quaternary catchment reach (subquat reach) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as SA RHP sites, EWR sites and Hydro WMS sites. The results obtained serve to summarise this information as a background to the conditions of the watercourse traversed by the proposed The Duel Coal Mine development.

2. Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: 'riparian habitat' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results[5]. Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

[5] Kleynhans et al, 2007

Table C1: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

3. 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".[6] 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; and
- 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.

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

Table C2: 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

4. Ecological Importance and Sensitivity (EIS) (Rountree & Kotze, 2013)

The purposed of assessing importance and sensitivity of water resources is to be able to identify those systems that provide higher than average ecosystem services, biodiversity support functions or are especially sensitive to impacts. Water resources with higher ecological importance may require managing such water resources in a better condition than the present to ensure the continued provision of ecosystem benefits in the long term (Rountree & Kotze, 2013).

In order to align the outputs of the Ecoservices assessment (i.e. ecological and socio-cultural service provision) with methods used by the DWA (now the DWS) used to assess the EIS of other watercourse types, a tool was developed using criteria from both WET-Ecoservices (Kotze, *et, al,* 2009) and earlier DWA EIA assessment tools. Thus, three proposed suites of important criteria for assessing the Importance and Sensitivity for wetlands were proposed, namely:

- Ecological Importance and Sensitivity, incorporating the traditionally examined criteria used in EIS assessments of other water resources by DWA and thus enabling consistent assessment approaches across water resource types;
- Hydro-functional importance, taking into consideration water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide; and
- Importance in terms of socio-cultural benefits, including the subsistence and cultural benefits provided by the wetland system.

The highest of these three suites of scores is then used to determine the overall Importance and Sensitivity category (Table C4) of the wetland system being assessed.

Table C3: Ecological Importance and Sensitivity Categories and the interpretation of median scores for biota and habitat determinants (adapted from Kleynhans, 1999).

EIS Category	Range of Mean	Recommended Ecological Management Class
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

5. Recommended Management Objective (RMO) and Recommended Ecological Category (REC) Determination)

"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" (DWA, 1999).

The RMO (table below) was determined based on the results obtained from the PES, reference conditions and EIS of the freshwater resource (sections above), with the objective of either maintaining, or improving the ecological integrity of the freshwater resource in order to ensure continued ecological functionality.

Table C4: Recommended management objectives (RMO) for water resources based on PES & EIS scores.

PES			Ecological and Importance Sensitivity (EIS)			
			Very High	High	Moderate	Low
	A	Pristine	A Maintain	A Maintain	A Maintain	A Maintain
	B	Natural	A Improve	A/B Improve	B Maintain	B Maintain
	C	Good	A Improve	B/C Improve	C Maintain	C Maintain
	D	Fair	C Improve	C/D Improve	D Maintain	D Maintain
	E/F	Poor	D* Improve	E/F* Improve	E/F* Maintain	E/F* Maintain

***PES Categories E and F are considered ecologically unnacceptable (Malan and Day, 2012) and therefore, should a freshwater resource fall into one of these PES categories, an REC class D is allocated by default, as the minimum acceptable PES category.**

A freshwater resource may receive the same class for the REC as the PES if the freshwater resource 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 resource.

Table C5: Description of Recommended Ecological Category (REC) classes.

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

C2: Aquatic Ecological Assessment

The sections below describe the methodology used to assess the aquatic ecological integrity of the two sites selected based on water quality, instream and riparian habitat condition and biological impacts and integrity as well as toxicological analysis.

6. Visual Assessment

Each site was selected in order to identify current conditions, with specific reference to impacts from surrounding activities where applicable. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the systems identified, was identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual records of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- Upstream and downstream significance of each point, where applicable;
- Significance of the point in relation to the study area;
- stream morphology;
- instream and riparian habitat diversity;
- stream continuity;
- erosion potential;

- depth flow and substrate characteristics;
- signs of physical disturbance of the area; and
- other life forms reliant on aquatic ecosystems.

7. Physico Chemical Water Quality Data

On site testing of biota specific water quality variables took place on all sites where surface water was present. The results of on-site biota specific water quality analyses were used to aid in the interpretation of the data obtained by the biomonitoring. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF, 1996 vol. 7).

8. General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C6 below.

Table C6: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.* 2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

9. Habitat for aquatic macro-invertebrates

The Invertebrate Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. However, according to a study conducted within the Mpumalanga and Western Cape regions, the IHAS method does not produce reliable scores with regard to the suitability of habitat at sampling sites for aquatic macroinvertebrates (Ollis *et al*., 2006). Furthermore, the performance of the IHAS seems to vary between geomorphologic zones and between biotope groups (Ollis *et al*., 2006). It has, however; become clear that IHAS requires further validation and testing, although the basic data remains of value (Thirion, 2007).

Table C7: IHAS Scores and their corresponding description of overall condition (quality and quantity) of available aquatic macroinvertebrate habitat (McMillan, 1998)

IHAS Score (%)	Description
>75	Excellent
65 – 74	Good
55 – 64	Adequate / Fair
<55	Poor

10. Index of Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans et al. 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C8 below.

Table C8: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans et al. 2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

11. Aquatic Macro-Invertebrates: South African Scoring System version 5 (SASS5)

Aquatic Macro-invertebrates were sampled using the qualitative kick sampling method called SASS5 (South African Scoring System version 5) (Dickens and Graham, 2002). The SASS5 method has been specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter (1998). The assessment was undertaken according to the protocol, as defined by Dickens & Graham (2002). All work was undertaken by an accredited SASS5 practitioner.

The SASS5 method was designed to incorporate all available biotypes at a given site and to provide an indication of the integrity of the of the aquatic macro-invertebrate community through recording the presence of various macro-invertebrate families at each site, as well as consideration of abundance of various populations, community diversity and community sensitivity. Each taxon is allocated a score according to its level of tolerance to river health degradation (Dallas 2007).

This method relies on churning up the substrate with your feet and sweeping a finely meshed SASS net, with a pore size of 1000 micron mounted on a 300 mm square frame, over the churned up area several times. In stony bottomed flowing water biotopes (rapids, riffles, runs, etc.) the net downstream of the assessor and the area immediately upstream of the net is disturbed by kicking the stones over and against each other to dislodge benthic invertebrates. The net was also swept under the edge of marginal and aquatic vegetation to cover from 1-2 meters. Identification of the organisms was made to family level (Thirion *et al*., 1995; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score, in conjunction with a low habitat score, can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score, together with a high habitat score,

would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

Classification of the system took place by comparing the present community status to reference conditions, which reflect the best conditions that can be expected in rivers and streams within a specific area and also reflect natural variation over time.

12. Aquatic Macro-Invertebrates: Macro-invertebrate Response Assessment Index (MIRAI)

The four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs. An interplay between these factors (particularly habitat and availability of food sources) result in the discontinuous, patchy distribution pattern of aquatic macro-invertebrate populations. As such aquatic invertebrates shall respond to habitat changes (i.e. changes in driver conditions).

To relate drivers to such changes in habitat and aquatic invertebrate condition, two key elements are required. Firstly, habitat preferences and requirements for each taxa present should be obtained. As such reference conditions can be established against which any response to drivers can be measured. Secondly, habitat features should be evaluated in terms of suitability and the requirements mentioned in the first point. As a result, expected and actual patterns can be evaluated to achieve an Ecostatus Category rating.

Based on the three key requirements, the MIRAI provides an approach to deriving and interpreting aquatic invertebrate response to driver changes. The index has been applied to the sites following methodology described by Thirion (2007). Aquatic macro-invertebrates expected at each point were derived both from the Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) PES/EIS database, as well as habitat, flow and water parameters (Thirion, 2007).

Table C9: Description of the discussion points used for the discussion of data for each site

ASPECT	DEFINITION
Biotopes sampled	Refers to the various biotopes sampled for aquatic macro-invertebrates during the collection of the SASS5 samples.
Sensitive taxa present	A list of the taxa that were captured during SASS5 sampling regarded as being sensitive taxa relevant to the conditions in the area.
Sensitive taxa absent	A list of the taxa that were not captured during SASS5 sampling of the site but that were captured at other sites in the program and regarded as sensitive taxa.
Adjusted SASS5 score	The adjusted SASS5 value based on the adjustment figure in the IHAS index for variances in habitat conditions.
SASS5 % of reference score	The result compared to the reference SASS5 score of 180.
ASPT % of reference score	The result for the site compared to the reference ASPT score of 7.0.
Dallas; 2007 classification	The classification of the site into ecological bands/categories based on data from the Western Bankenveld ecoregion.
Dickens and Graham, 2001 SASS5 classification	The classification of each site into one of five classes, based on the degree of impairment observed in the aquatic macro-invertebrate community.
McMillan, 1998 IHAS description	Description of the adequacy of habitat according to the guidelines of McMillan 1998
IHAS stones biotopes results	Discussion of the suitability of the stones biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS vegetation biotopes results	Discussion of the suitability of the vegetation biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS other biotopes results	Discussion of the suitability of the gravel, sand and mud biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS general stream characteristics	A summary of the notes made from the general stream characteristics section of the IHAS index.
Previous assessment IHAS score	The IHAS score obtained in the previous assessment.
Current IHAS score	The current score.
Current IHAS Adjustment score	The adjustment score from the IHAS index based on stream conditions.

13. Ecological Importance and Sensitivity (EIS) Method of assessment

The EIS method considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale (Table C10). The median of the resultant score is calculated to derive the EIS category (Table C11).

Table C10: Definition of the four-point scale used to assess biotic and habitat determinants presumed to indicate either importance or sensitivity

Four point scale	Definition
1	One species/taxon judged as rare or endangered at a local scale.
2	More than one species/taxon judged to be rare or endangered on a local scale.
3	One or more species/taxon judged to be rare or endangered on a Provincial/regional scale.
4	One or more species/taxon judged as rare or endangered on a National scale (i.e. SA Red Data Books)

Table C11: Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General Description	Range of median
Very high	Quaternaries/delineations that are considered to be unique on a national and international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3-4
High	Quaternaries/delineations that are considered to be unique on a national scale based on their biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases may have substantial capacity for use.	>2-≤3
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are not usually very sensitive to flow modifications and often have substantial capacity for use.	>1-≤2
Low/ marg -inal	Quaternaries/delineations that are not unique on any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have substantial capacity for use.	≤1

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 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 are possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[7]. 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 well-being, 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 wetlands, 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 necessary8.

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.

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

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

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

outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

Table 27: 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 < 1000m	2
Local area/ within 1 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m	3
Regional within 5 km of the site boundary / < 5000ha impacted / Linear features affected < 10 000m	4
Entire habitat unit / Entire system/ > 5000ha impacted / Linear features affected > 10 000m	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 28: Significance rating matrix

	CONSEQUENCE (Severity + Spatial Scope + Duration)														
LIKELIHOOD (Frequency of activity + Frequency of impact)	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 29: Positive/Negative Mitigation Ratings

Significance Rating	Value	Negative Impact management recommendation	Positive Impact management recommendation
Very High	126 - 150	Consider the viability of the project. Very strict measures to be implemented to mitigate impacts according to the impact mitigation hierarchy	Actively promote the project
High	101 - 125	Consider alternatives in terms of project execution and location. Ensure designs take environmental sensitivities into account and Ensure management and housekeeping is maintained and attention to impact minimisation is paid according to the impact mitigation hierarchy	Promote the project and monitor ecological performance
Medium High	76 – 100	Consider alternatives in terms of project execution and Ensure management and housekeeping is maintained and attention to impact minimisation is paid according to the impact mitigation hierarchy	Implement measures to enhance the ecologically positive aspects of the project while managing any negative impacts
Medium Low	51 - 75	Ensure management and housekeeping is maintained and attention to impact minimisation is paid	Implement measures to enhance the ecologically positive aspects of the project while actively managing any negative impacts
Low	26 - 50	Promote the project and ensure management and housekeeping is maintained	Monitor ecological performance and pay extensive attention to minimising potential negative environmental impacts

Low Very	1 - 25	Promote the project	Actively seek measures to implement impact minimisation according to the impact mitigation hierarchy and identify positive ecological aspects to be promoted

Control Measure Development

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

- Mitigation and performance improvement measures and actions that address the risks and impacts[9] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and
- 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, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the freshwater ecology of the resources in traversed by or in close proximity of the proposed infrastructure.

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

APPENDIX E – Results of Field Investigation

AQUATIC ASSESSMENT RESULTS

IHAS SCORESHEETS – (FEBRUARY 2019)

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: Mutamba River
Site Name: TD1 **Date**: 27/02/2019

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):				**6**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
Vegetation Score (max 15):					**13**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):					**6**	
HABITAT TOTAL (MAX 55):					**25**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX 45):						**28**
TOTAL IHAS SCORE (%):					**53**	

IHI SCORESHEETS – (February 2019)

Mutamba River

	MRU
INSTREAM IHI	
Base Flows	-0,5
Zero Flows	0,0
Floods	1,0
HYDROLOGY RATING	**0,4**
pH	0,0
Salts	-2,5
Nutrients	-2,0
Water Temperature	0,0
Water clarity	-2,0
Oxygen	-2,0
Toxics	0,0
PC RATING	**2,0**
Sediment	-2,0
Benthic Growth	-2,0
BED RATING	**2,0**
Marginal	-3,0
Non-marginal	-2,0
BANK RATING	**2,5**
Longitudinal Connectivity	-2,0
Lateral Connectivity	-1,0
CONNECTIVITY RATING	**1,9**
INSTREAM IHI %	**67,9**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**3,0**

	MRU
RIPARIAN IHI	
Base Flows	-0,5
Zero Flows	0,0
Moderate Floods	-0,5
Large Floods	-0,5
HYDROLOGY RATING	**0,3**
Substrate Exposure (marginal)	2,0
Substrate Exposure (non-marginal)	2,0
Invasive Alien Vegetation (marginal)	2,0
Invasive Alien Vegetation (non-marginal)	2,0
Erosion (marginal)	2,0
Erosion (non-marginal)	2,0
Physico-Chemical (marginal)	1,5
Physico-Chemical (non-marginal)	1,0
Marginal	2,0
Non-marginal	2,0
BANK STRUCTURE RATING	**2,0**
Longitudinal Connectivity	2,5
Lateral Connectivity	2,5
CONNECTIVITY RATING	**2,5**
RIPARIAN IHI %	**68,8**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**2,8**

Drainage Lines

	MRU
INSTREAM IHI	
Base Flows	-0,5
Zero Flows	0,0
Floods	1,0
HYDROLOGY RATING	**0,4**
pH	0,0
Salts	-2,5
Nutrients	-2,0
Water Temperature	0,0
Water clarity	-2,0
Oxygen	-2,0
Toxics	0,0
PC RATING	**2,0**
Sediment	-2,0
Benthic Growth	-2,0
BED RATING	**2,0**
Marginal	-3,0
Non-marginal	-2,0
BANK RATING	**2,5**
Longitudinal Connectivity	-2,0
Lateral Connectivity	-1,0
CONNECTIVITY RATING	**1,9**
INSTREAM IHI %	**67,9**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**3,0**

	MRU
RIPARIAN IHI	
Base Flows	-0,5
Zero Flows	0,0
Moderate Floods	-0,5
Large Floods	-0,5
HYDROLOGY RATING	**0,3**
Substrate Exposure (marginal)	2,0
Substrate Exposure (non-marginal)	2,0
Invasive Alien Vegetation (marginal)	2,0
Invasive Alien Vegetation (non-marginal)	2,0
Erosion (marginal)	2,0
Erosion (non-marginal)	2,0
Physico-Chemical (marginal)	1,5
Physico-Chemical (non-marginal)	1,0
Marginal	2,0
Non-marginal	2,0
BANK STRUCTURE RATING	**2,0**
Longitudinal Connectivity	2,5
Lateral Connectivity	2,5
CONNECTIVITY RATING	**2,5**
RIPARIAN IHI %	**68,8**
RIPARIAN IHI EC	**C**
RIPARIAN CONFIDENCE	**2,8**

MIRAI SCORESHEET

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC
FLOW MODIFICATION	**FM**	43,6	*0,167*	7,27273	1	50
HABITAT	**H**	58,1	*0,333*	19,3651	3	100
WATER QUALITY	**WQ**	80,0	*0,333*	26,6667	2	100
CONNECTIVITY & SEASONALITY	**CS**	80,0	*0,167*	13,3333	4	50
						300
INVERTEBRATE EC				66,6378		
INVERTEBRATE EC CATEGORY				**C**		

FRAI Scoresheet

AUTOMATED	
FRAI (%)	**47,8**
EC: FRAI	**D**

SASS5 SCORESHEETS

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																	
DATE: 27/02/2019	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3		**A**	**A**	**A**	Blepharoceridae	15				
SITE CODE:TD1	**ANNELIDA:**						Gerridae*	5		**A**		**A**	Ceratopogonidae	5				
RIVER: Mutamba	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		**A**	**A**	**A**
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1		**A**	**A**	**A**
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: ° C	Amphipoda	13					Notonectidae*	3		**A**		**A**	Empididae	6				
pH: 8,32	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 8,73 mg/l / 93,4 %	Atyidae	8					Veliidae/M…veliidae*	5					Muscidae	1				
Cond: 103,7 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3		**A**		**A**
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		0	37	12	37
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		0	10	4	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		####	3,7	3	3,7
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:					
	Coenagrionidae	4					Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8										
	Zygoptera juvs.	6					Gyrinidae*	5		**A**		**A**						
	Aeshnidae	8					Halipidae*	5										
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6		**A**	**A**	**A**	Hydraenidae*	8					SWC = South Western Cape			T = Tropical		
	Libellulidae	4		**A**		**A**	Hydrophilidae*	5		**A**		**A**	VG = all vegetation			ST = Sub-tropical		
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud			S = Stone & rock		
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

APPENDIX E1: February 2015 Field Results

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name: MUTAMBA
Site Name: TD1
Date: 27/01/2015

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
SIC Score (max 20):				**11**		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
Vegetation Score (max 15):					**11**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
Other Habitat Score (max 20):					**12**	
HABITAT TOTAL (MAX 55):					**34**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX 45):						**34**
TOTAL IHAS SCORE (%):					**68**	

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 27/01/2015	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E: °	**TURBELLARIA**	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: TD1	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5				
RIVER: MUTAMBA	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION: REPRESENTATIVE	Leeches	3					Naucoridae*	7			**A**	**A**	Culicidae*	1				
WEATHER CONDITION: HOT / DRY / CLEAR	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: ° C	Amphipoda	13					Notonectidae*	3		**A**	**A**	**A**	Empididae	6				
Ph:	Potamonautidae*	3			**A**	**A**	Pleidae*	4					Ephydridae	3				
DO: mg/l	Atyidae	8		**B**	**A**	**B**	Veliidae/M…veliidae*	5		**A**	**A**	**A**	Muscidae	1				
Cond: mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6		**B**	**A**	**B**	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: LOW	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY: MEDIUM	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		0	30	48	56
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		0	6	9	11
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		0	5.0	5	5.1
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:	68%				
	Coenagrionidae	4		**A**		**A**	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8										
	Zygoptera juvs.	6					Gyrinidae*	5			**A**	**A**						
	Aeshnidae	8					Halipidae*	5										
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6			**A**	**A**	Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4		**A**		**A**	Hydrophilidae*	5			**A**	**A**	VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

APPENDIX F – Specialist information

Declaration

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

Declaration that the specialist is independent in a form as may be specified by the competent authority

I, Jacobus Johannes du Plessis, 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

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Managing member, Ecologist with focus on Freshwater Ecology
Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)
Other Business	Trustee of the Serenity Property Trust and emerald Management Trust

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;
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc (Environmental Management) (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000
Tools for Wetland Assessment short course Rhodes University	2016

COUNTRIES OF WORK EXPERIENCE

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

PROJECT EXPERIENCE (Over 2500 projects executed with varying degrees of involvement)

1 Mining: Coal, Chrome, PGM's, Mineral Sands, Gold, Phosphate, river sand, clay, fluorspar
2 Linear developments
3 Energy Transmission, telecommunication, pipelines, roads
4 Minerals beneficiation
5 Renewable energy (wind and solar)
6 Commercial development
7 Residential development
8 Agriculture
9 Industrial/chemical

REFERENCES

- Terry Calmeyer (Former Chairperson of IAIA SA)
  Director: ILISO Consulting Environmental Management (Pty) Ltd
  Tel: +27 (0) 11 465 2163

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- Alex Pheiffer
  African Environmental Management Operations Manager
  SLR Consulting
  Tel: +27 11 467 0945
  Email: apheiffer@slrconsulting.com

- Marietjie Eksteen
  Managing Director: Jacana Environmental
  Tel: 015 291 4015

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF JACOBUS JOHANNES DU PLESSIS

PERSONAL DETAILS

Position in Company	Ecologist
Date of Birth	7 August 1991
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2018

EDUCATION

Qualifications

BSc Zoology and Botany (University of South Africa)	2015
BHons Zoology (University of Johannesburg)	2017

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Candidate Natural Scientist with the South African Council for Natural Scientific Professional

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Freestate
Namibia

SELECTED PROJECT EXAMPLES

Faunal Assessments

- Ecological Scan for the proposed upgrade of the Rondebult Sewer, Gauteng;
- Ecological Scan for the proposed Zandspruite Secondary School, Zandspruite, Gauteng;
- Ecological Scan for the proposed Mixed Use Township Development, Randburg, Gauteng;
- Biodiversity assessment for the expansion of the Overlooked Colliery near Delmas, Mpumalanga
- Biodiversity assessment for the proposed R101 interchange, the on-ramp C fencing area and the D3519 additional reserve, Mokopane, Limpopo;
- Vegetation screening and baseline ecological assessment for rural road upgrades in Hluhluwe, Kwazulu-Natal;
- Desktop biodiversity assessment for a proposed desalination plant, Elysium, Kwazulu-Natal;
- Baseline Biodiversity Assessment for the upgrade of Retention Dams, Germiston, Gauteng;
- Baseline Biodiversity Assessment for a proposed 100 hectare photovoltaic power plant, Mariental, Namibia;
- Desktop Biodiversity Assessment for a Commercial Office Park, Lusaka, Zambia;
- Baseline Biodiversity Assessment for Polokwane Smelter, Polokwane, Limpopo;
- Baseline Biodiversity Assessment for Mortimer Smelter, Rustenburg, North-West; and
- Baseline Biodiversity Assessment for the Pecanwood Estates, Hartebeespoort, North-West.

Aquatic Assessments

- Baseline Aquatic Assessment for the Dieter Hinze Dam, Paulpietersburg, KwaZulu-Natal;
- Baseline Aquatic Assessment for the Hein Hinzer Dam, Paulpietersburg, KwaZulu-Natal;
- Bio-monitoring of the Ngagane Siding, Newcastle, KwaZulu-Natal;
- Bio-monitoring for the Ikwezi Colliery, Newcastle, KwaZulu-Natal;
- Baseline Aquatic assessment for the Proposed Zimpande Mine, Newcastle, KwaZulu-Natal;
- SASS sample preservation for the River Ecostatus Monitoring programme 2016;
- Baseline Fish Community Assessment for a proposed Tented Camp in the Rhenosterkop Dam Nature Reserve;
- Baseline Aquatic Assessment for the P483 Road Upgrade, Newcastel, KwaZulu-Natal;
- Bio-monitoring for the proposed Boikarabelo Coal Mine;
- Bi-annual bio-monitoring for the Mooiplaats Colliery, Mooinooi, Brits;

- Bi-annual bio-monitoring for the Eastplats Eastern Limb Mines, Steelpoort, Limpopo;
- Bi-annual bio-monitoring for the Mooinooi, Buffelspoort and Milsell/Waterkloof Chrome Mines;
- Bi-annual bio-monitoring for the Zululand Anthracite Colliery, Hluhluwe, KwaZulu-Natal;
- Bi-annual bio-monitoring for the Voorslag Coal Siding, Ermelo, Mpumalanga;
- Bi-annual bio-monitoring for the Umlabu Colliery, Ermelo, Mpumalanga;
- Baseline Aquatic Biodiversity Assessment for the re-application of a water use license for Umlabu Colliery, Ermelo, Mpumalanga;
- Quarterly Aquatic bio-monitoring for the Tronox Sand Mines, Richardsbay, KwaZulu-Natal;
- Bi-annual bio-monitoring for the Eastplats Western Limb Chrome mines, Brits, North-West;
- Bi-annual bio-monitoring for the Vele Coal Mine, Musina, Limpopo; and
- Bi-annual bio-monitoring for the Lydenburg Smelter, Lydenburg, Mpumalanga.

Previous Work Experience

- Head of Aquatics – Environmental Assurance (October 2017- September 2018);
- Intern at The Biodiversity Company (January 2016 – July 2017);
- Demonstrator for first years at the University of Johannesburg (2015)
- Assessor/ Trainer at the South African Wildlife College (7 contracts during 2012-2014).