mora
ecological services
(Pty)LTD

AQUATIC IMPACT ASSESSMENT

FOR THE PROPOSED PROSPECTING RIGHT ON SELECTED FARMS WITHIN MADIBENG LOCAL MUNICIPALITY IN NORTH WEST

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1. Introduction

MORA Ecological Services (Pty) Ltd was appointed by Archean Resources (Pty) Ltd to conduct a baseline aquatic assessment as for the proposed Chrome mine on selected portions Farm Mamagalieskraal and Bokfontein within Madibeng Local Municipality in the North West Province. The site is situated immediately to the West of the existing Bushveld Vametco Chrome Mine, Brits, North West. This report serves to presents the findings of the aquatic assessment, and proposed mitigation measures for the proposed prospecting. The field work was conducted on the 19th of December 2021.

The objectives of the report include the following:

- To assess the aquatic integrity of the aquatic systems associated with the proposed prospecting;
- To report any emerging issues; and
- To provide appropriate mitigation.

1.1 Legislative requirements

The following legislative requirements were adhered to as part of the assessment:

- The South African Screening tool;
- The National Water Act, 1998 (Act 36 of 1998) (NWA);
- The National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA); and
- The South African Water Quality Guidelines Volume 7 (Aquatic Ecosystems) (1996);
- The SANBI best practice guidelines (2020)

1.2 Assumptions and Limitations

Lack of temporal data: Due to the limited historic information available at the time of writing this report a temporal analysis of the water quality and aquatic integrity could not be determined.

2. Methodology

Good practice biomonitoring methodologies were used to assess the aquatic ecological integrity of the unnamed tributary of the Klein Rosespruit River reach associated with the industrial area. All work was conducted by a SACNASP professionally registered and accredited South African River Health Programme Assessor (South African Scoring System version 5). A general classification of the methodologies. The detailed descriptions of the methods below are listed in Appendix A

- A desktop assessment was conducted defining the baseline Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) of the associated Sub Quaternary Reach (SQR), which is based on work conducted by the Department of Water and Forestry (DWAF) now the Department of Water and Sanitation (DWS). (DWS, 2012);
- In situ water quality analysis was undertaken using multi-meter probes, which measured pH, Electrical Conductivity (EC), Dissolved Oxygen (DO) (concentration) mg/l, and Dissolved Oxygen saturation (%).
- Water results were analysed in accordance with the Target Water Quality Guidelines (TWQR) set out for Aquatic Ecosystems Volume 7 (DWAF, 1996);

- The Aquatic macroinvertebrate communities were assessed with the use of the South African Scoring System version 5 (SASS5), at every sampled site; and
- Spatial analysis of significant water quality parameters and aquatic macroinvertebrate communities SASS5 scores were included in the report.

3. Results

3.1 Desktop Assessment

The aquatic systems associated with the proposed prospecting is situated within the Limpopo Water Management Area (WMA) (WMA 1) in the Rosespruit Sub Quaternary Reach (SQR) and an unnamed SQR. Three (3) sampled sites were identified and inspected. General locations of the assessed sites are listed in **Table** 1.

Table 1: General location of the assessed sample sites

Sample site	Description	GPS co-ordinates	
		Latitude	Longitude
RS1	Sample site located in the proposed prospecting area, primarily thought a river which was a channel upon inspection located to the south.	25°34'22.49"S	27°50'27.46"E
RS2	Sample site located in the proposed prospecting area, primarily thought a river which was a channel upon inspection located downstream of RS1 in the North prior to the confluence with the Rosespruit.	25°33'58.15"S	27°50'30.25"E
RS3	Sample site located upstream of the proposed prospecting area in the Rosespruit.	25°33'18.07"S	27°52'47.01"E
RS4	Sample site located downstream of the proposed prospecting area in the Rosespruit.	27°48'27.54"E	27°48'27.54"E

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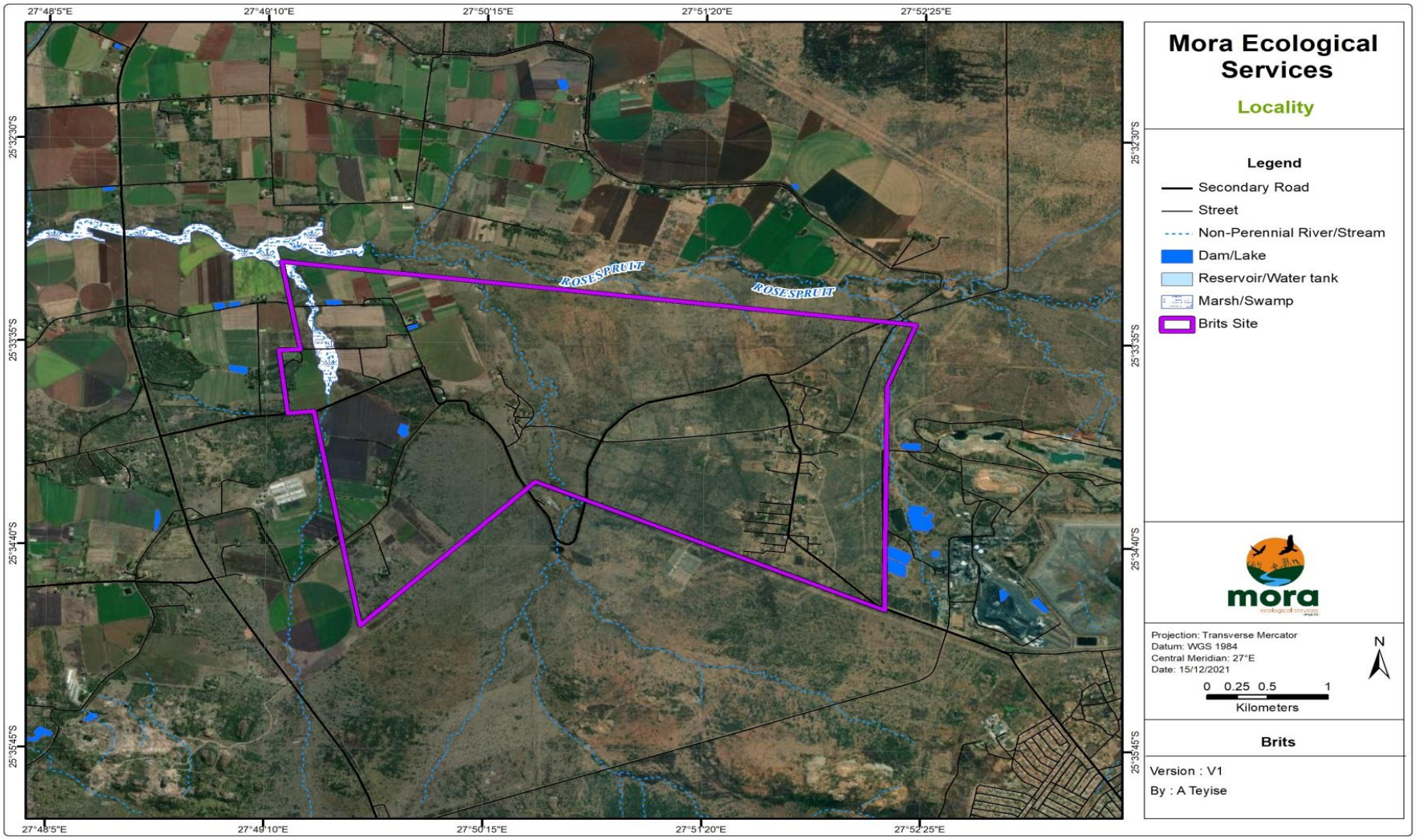

Figure 1: Location of the proposed prospecting area

3.1.1 Present Ecological State (DWS, 2014)

The sampled sites associated with the proposed prospecting are located in three Sub Quaternary Reaches (SQRs) located in an unnamed and Rosespruit SQR A21J. Based on data obtained from the DWS (2014), the Present Ecological State of this section of the associated watersheds are classified Largely Modified (Category D) to Largely Natural (Category B). Anthropogenic activities that have been recorded historically by the DWS within the watershed include:

The Rosespruit SQR located upstream of the proposed prospecting area (A21J-00980) is classified moderately modified (Category C) with a moderate Ecological Importance and Sensitivity. The following impacts/activities were identified LARGE: Abstraction, MODERATE: Agricultural fields, Algal growth, Low water crossings, Erosion, Alien vegetation, Mining, Runoff/effluent: Mining, Runoff/effluent: Urban areas, Grazing (land-use), Vegetation removal, SMALL: Small (farm) dams, Overgrazing/trampling, Inundation, Irrigation, Roads, Runoff/effluent: Irrigation, Sedimentation, Urbanization.

The watershed situated in the center of the proposed prospecting area (A21J-00999) is classified largely natural (category B) with a moderate Ecological Importance and Sensitivity. The following impacts/activities were identified: CRITICAL: None, SERIOUS: None, LARGE: Bed and Channel disturbance, MODERATE: Agricultural fields, Low water crossings, SMALL: Abstraction, Algal growth, Canalization, Chicken farms, Small (farm) dams, Alien vegetation, Overgrazing/trampling, Inundation, Natural areas/nature reserves, Roads, Sedimentation, Grazing (land-use), Vegetation removal.

The watershed associated with potential downstream impacts situated in the Rosespruit (A21J-00972) is classified largely modified (Category D) with a moderate Ecological Importance and High Ecological Sensitivity. The following impacts/activities were identified: CRITICAL: Agricultural fields, Irrigation, SERIOUS: Runoff/effluent: Irrigation, LARGE: Algal growth, MODERATE: Abstraction, Bed and Channel disturbance, Erosion, Alien aquatic macrophytes, Alien vegetation, Vegetation removal, SMALL: Overgrazing/trampling, Natural areas/nature reserves.

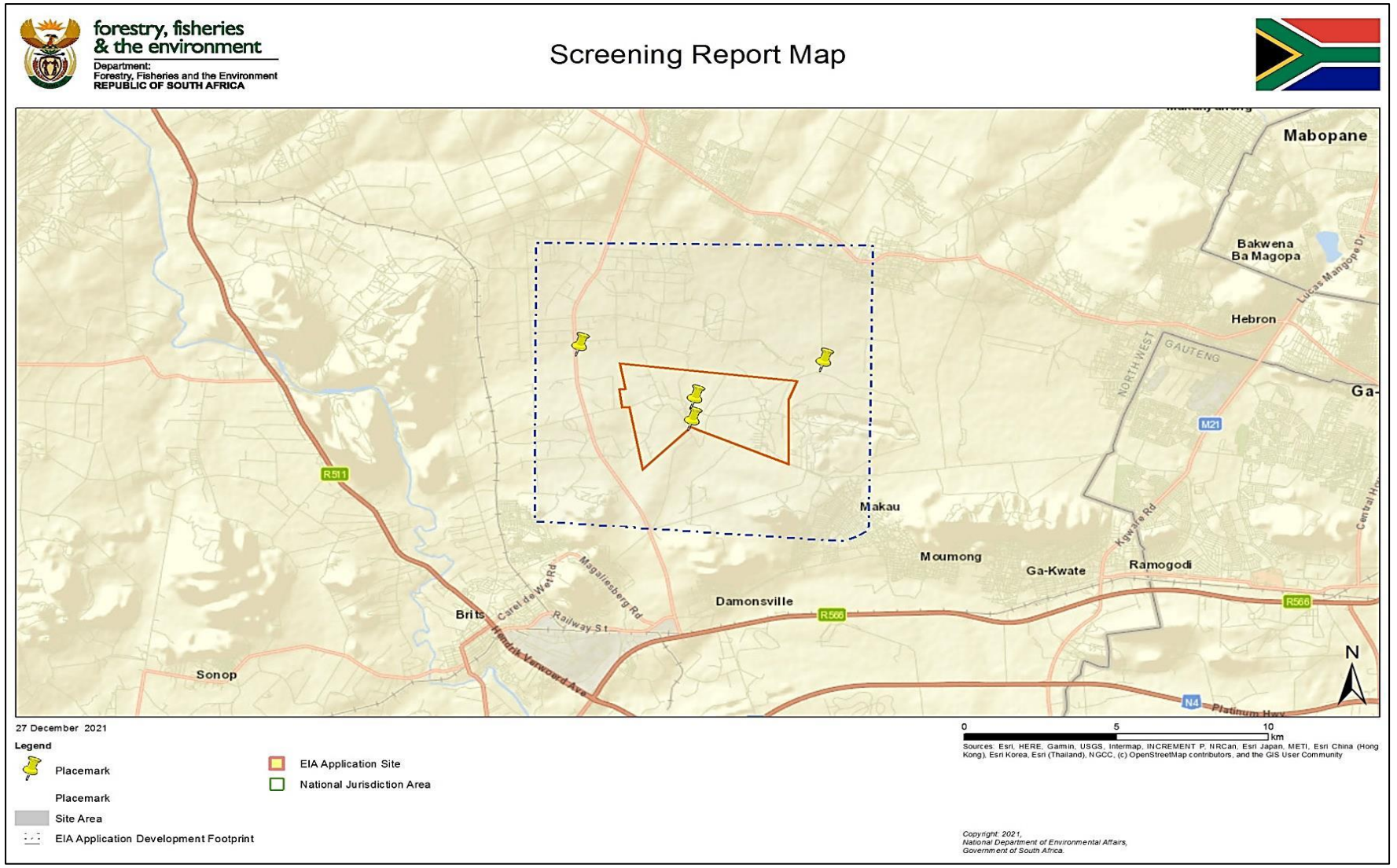

Figure 2: Combined aquatic sensitivity of the sampled site and surrounding areas

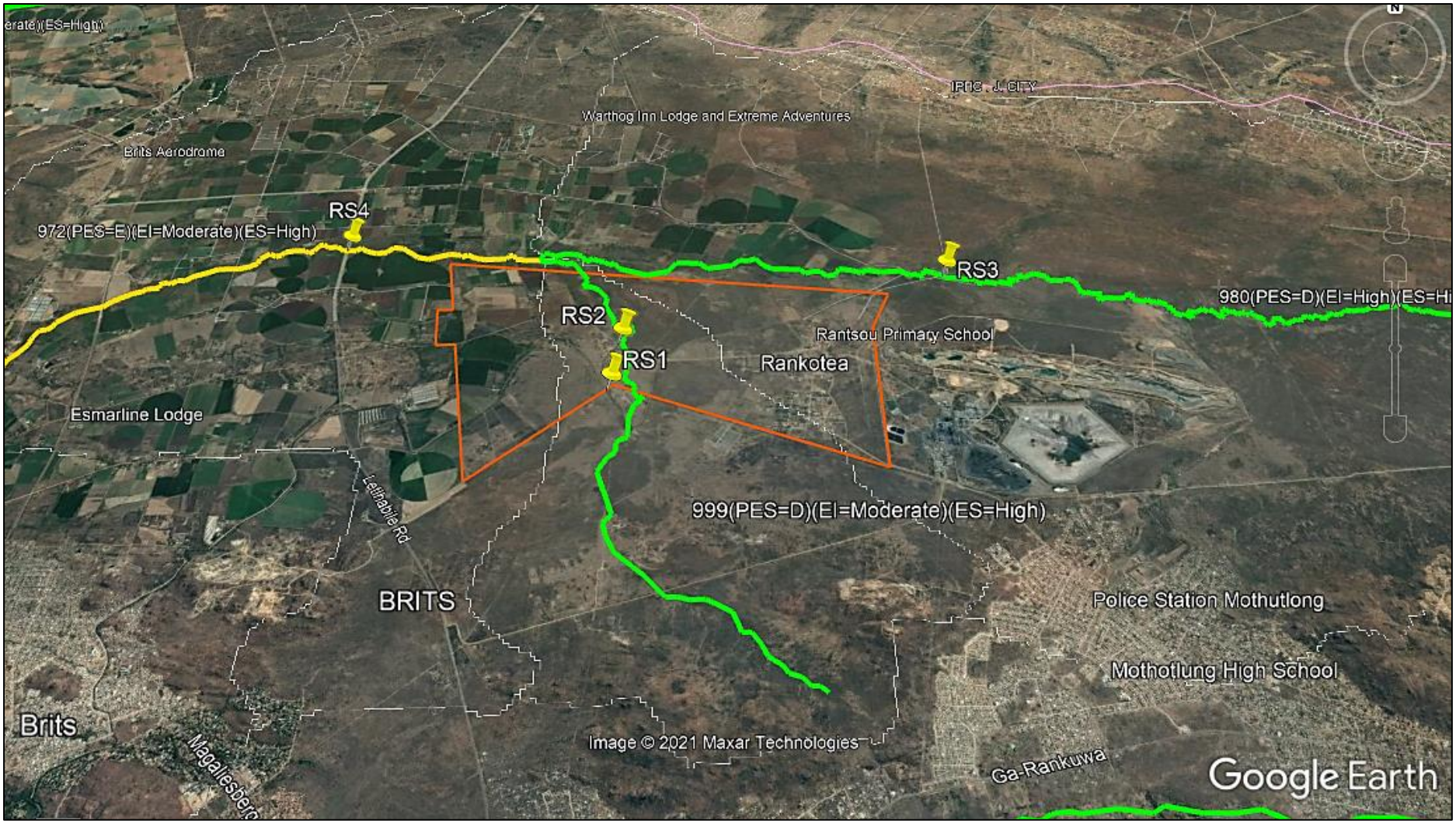

Figure 3: Sub Quaternary Reach associated with the sampled sites

Table 2: Present Ecological State, Ecological Importance and Sensitivity associated with the Rosespruit SQR A21J-00980 (DWS, 2014)

Present Ecological State		Ecological Importance				Ecological Sensitivity	
Instream Habitat Continuity Modifications	Small	Fish species /SQ	4	Invertebrate taxa / SQ	31	Fish physico-chemical sensitivity description	Low
Riparian/Wetland zone continuity modifications	Moderate	Fish average confidence	1	Invertebrate average confidence	2.81	Fish no-flow sensitivity description	Moderate
Potential instream habitat modifications	Moderate	Fish representatively per secondary class	Very Low	Invertebrate representatively per secondary class	Moderate	Invertebrate physico-chemical sensitivity description	Moderate
Riparian-wetland zone modifications	Moderate	Fish rarity per second class	Very Low	Invertebrate rarity per second class	Moderate	Invertebrate velocity sensitivity	Very High
Potential flow modifications	Large	Habitat diversity class	Low	Ecological importance riparian-wetland instream vertebrates	High	Riparian-wetland instream vertebrates (excluding fish) intolerance water level/ flow changes description	High
Potential physico-chemical modification activities	Moderate	Riparian-wetland natural vegetation rating based on % natural vegetation in 500m	Very High	Habitat Size Class	Low	Stream size sensitivity to modified flow/water level changes description	High
		Riparian-wetland natural vegetation importance based on expert rating	Low	Instream Migration Link Class	Very High	Riparian-wetland vegetation intolerance to water level changes	High
		Riparian-Wetland Zone Migration Link	High	Riparian -Wetland Zone habitat integrity class	High		
		Instream Habitat integrity Class	High				

Table 3: Present Ecological State, Ecological Importance and Sensitivity associated with the unnamed SQR A21J-00999 (DWS, 2014)

Present Ecological State		Ecological Importance				Ecological Sensitivity	
Instream Habitat Continuity Modifications	Small	Fish species /SQ	4	Invertebrate taxa / SQ	31	Fish physico-chemical sensitivity description	Low
Riparian/Wetland zone continuity modifications	Small	Fish average confidence	1	Invertebrate average confidence	2.81	Fish no-flow sensitivity description	Moderate
Potential instream habitat modifications	Moderate	Fish representatively per secondary class	Very Low	Invertebrate representatively per secondary class	Moderate	Invertebrate physico-chemical sensitivity description	Moderate
Riparian-wetland zone modifications	Small	Fish rarity per second class	Very Low	Invertebrate rarity per second class	Moderate	Invertebrate velocity sensitivity	Very High
Potential flow modifications	Moderate	Habitat diversity class	Low	Ecological importance riparian-wetland instream vertebrates	Low	Riparian-wetland instream vertebrates (excluding fish) intolerance water level/ flow changes description	Low
Potential physico-chemical modification activities	Small	Riparian-wetland natural vegetation rating based on % natural vegetation in 500m	Low	Habitat Size Class	Very Low	Stream size sensitivity to modified flow/water level changes description	High
		Riparian-wetland natural vegetation importance based on expert rating	Low	Instream Migration Link Class	Very High	Riparian-wetland vegetation intolerance to water level changes	High
		Riparian-Wetland Zone Migration Link	Very High	Riparian -Wetland Zone habitat integrity class	Very High		
		Instream Habitat integrity Class	High				

Table 4: Present Ecological State, Ecological Importance and Sensitivity associated with the Rosespruit SQR A21J-00972 (DWS, 2014)

Present Ecological State		Ecological Importance				Ecological Sensitivity	
Instream Habitat Continuity Modifications	Small	Fish species /SQ	9	Invertebrate taxa / SQ	35	Fish physico-chemical sensitivity description	High
Riparian/Wetland zone continuity modifications	Moderate	Fish average confidence	1.44	Invertebrate average confidence	3.97	Fish no-flow sensitivity description	High
Potential instream habitat modifications	Large	Fish representatively per secondary class	Low	Invertebrate representatively per secondary class	Moderate	Invertebrate physico-chemical sensitivity description	Moderate
Riparian-wetland zone modifications	Moderate	Fish rarity per second class	Low	Invertebrate rarity per second class	High	Invertebrate velocity sensitivity	Very High
Potential flow modifications	Large	Habitat diversity class	Low	Ecological importance riparian-wetland instream vertebrates	High	Riparian-wetland instream vertebrates (excluding fish) intolerance water level/ flow changes description	High
Potential physico-chemical modification activities	Large	Riparian-wetland natural vegetation rating based on % natural vegetation in 500m	Moderate	Habitat Size Class	Very Low	Stream size sensitivity to modified flow/water level changes description	Low
		Riparian-wetland natural vegetation importance based on expert rating	Low	Instream Migration Link Class	Very High	Riparian-wetland vegetation intolerance to water level changes	High
		Riparian-Wetland Zone Migration Link	High	Riparian -Wetland Zone habitat integrity class	High		
		Instream Habitat integrity Class	Moderate				

Table 5: Expected species historically recorded at the sub quaternary reaches (DWS, 2014)

Scientific Name	Common Name	IUCN Status			
Aplocheilichthys johnstoni	Johnstons topminnow	Least Concern			X
Clarias gariepinus	Sharptooth Catfish	Least Concern	X	X	X
Enteromius paludinosus	Straightfin Barb	Least Concern	X	X	X
Enteromius unitaeniatus	Longbeard barb	Least Concern			X
Labeo cylindricus	Redeye Labeo	Least Concern			X
Labeo molybdinus	Leaden Labeo	Least Concern			X
Labeobarbus marequensis	Lowveld Largescale Yellowfish	Least Concern			X
Pseudocrenilabrus philander	Southern Mouthbrooder	Least Concern	X	X	X
Tilapia sparmanii	Banded Tilapia	Least Concern	X	X	X
Total number of species		**9**	**4**	**4**	**9**

3.1.2 Ecoregion

The study area is located in the Bushveld Basin Ecoregion (Ecoregion 8), the ecoregion is generally characterised by plains of low relief with mixed bushveld being the definitive vegetation type. Perennial rivers associated with the ecoregion includes the Marico, Elands (West), Crocodile (West), Pienaars and Olifants Rivers.

The main characteristics associated with this ecoregion are listed in 6, the dominant types are illustrated in **bold**.

Table 6: Main attributes associated with the Highveld Ecoregion (Ecoregion 11)

Attribute	Highveld
Terrain Morphology: Broad division	**Plains; Low Relief;** Plains: Moderate Relief; Lowlands, Hills and Mountains; Moderate and High Relief; Open Hills: Lowlands Mountains; Moderate to High Relief; Closed Hills. Mountains; Moderate and High Relief
Vegetation Types	**Mixed Bushveld;** Clay thorn Bushveld; Waterberg Moist Mountain Bushveld (Limited)
Altitude (m.a.s.l)	700-1700
Mean annual precipitation	400 to 600
Coefficient of Variation (% of annual precipitation)	25 to 35
Rainfall concentration index	55 to >65
Rainfall seasonality	Early to mid Summer
Mean annual temperature	14 to 22

3.1.3 Vegetation

The proposed prospecting area is situated in the Marikana Thornveld Vegetation Type (Figure 4). The vegetation type is distributed within the North West and Gauteng Provinces. Generally associated with open *Vachelia karroo* woodland occurring in valleys ad slightly undulating plains with scattered lowland hills. The vegetation type is characterised by summer rainfall with very dry winters and a mean annual precipitation of 600 to 700 mm. This vegetation type is rated endangered with less than 1% of the vegetation type statutorily conserved in the Magaliesburg and De Onderstepoort Nature reserves.

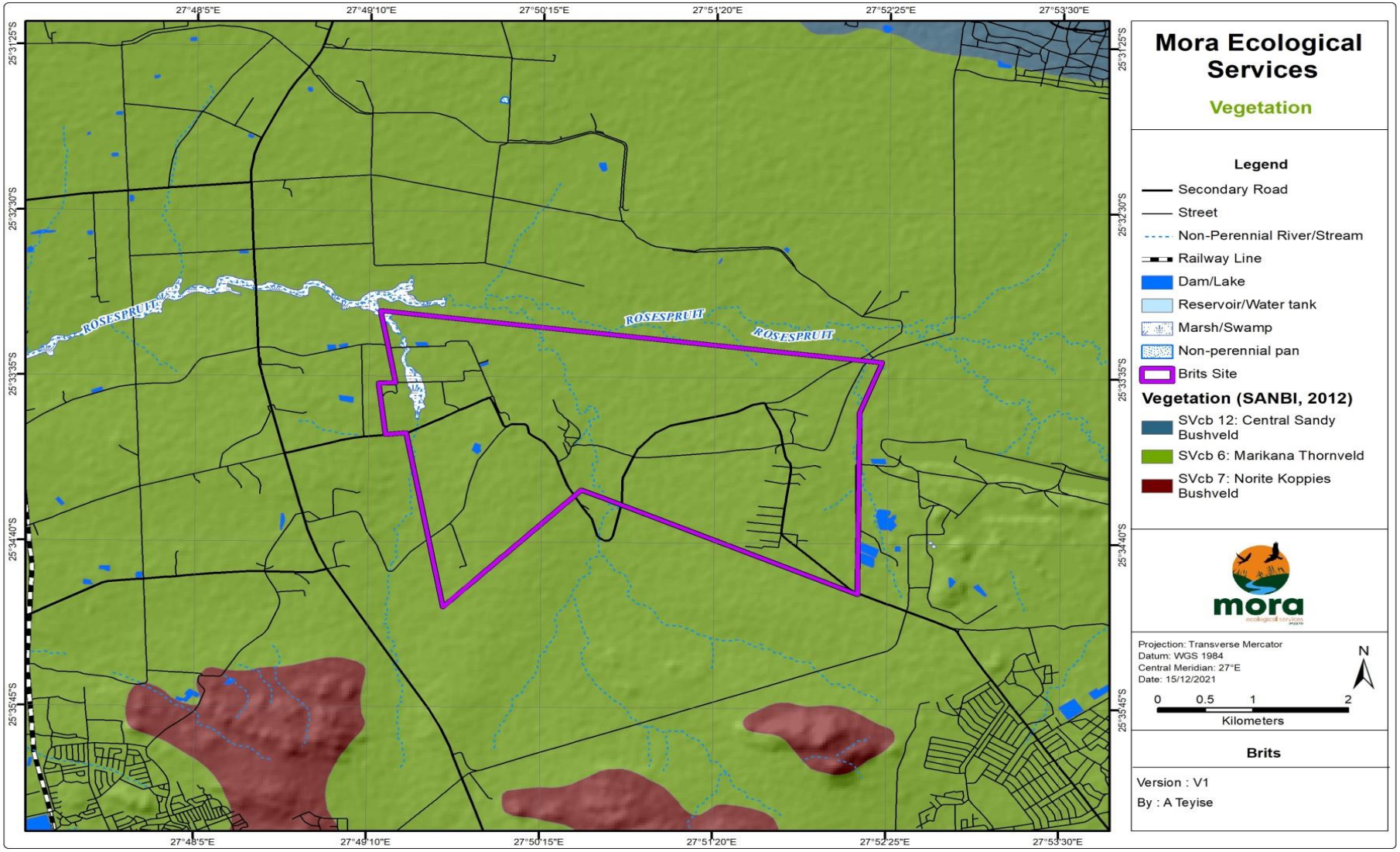

Figure 4: Vegetation the associated with the proposed prospecting area

3.2 Field Assessment

3.2.1 Sampled Sites

Table 7: Description of associated aquatic systems

Sample Site	RS1 (Sampled 19/12/2021)
	
Located in the proposed prospecting area upstream, a river converted into a channel for irrigation purposes. The reach has been completely transformed.	
Sample Site	**RS2 (Sampled 19/12/2021)**
	
Located downstream of point RS1 which was once a river transformed into a channel for irrigation purposes. The reach has been completely transformed	
Sample Site	**RS3 (Sampled 19/12/2021)**
	
Located upstream of the proposed prospecting area, serious changes in the natural flow regime have occurred within the reach, where flow would only occur at times of heavy rains. The wetland	

upstream was inspected for approximately 100 meters from the point where gravel sand and mud was the main biotope. Vegetation was restricted to inundated grasses.	
Sample Site	**RS4 (Sampled 19/12/2021)**
	
Located downstream of the proposed prospecting area, the reach was characterised by wetland properties with no defined channel observed at the time of sampling. Which was dry at the time of the assessment, the reach was inspected for approximately 100 meters up and downstream of the point. Gravel, sand and Mud was the dominant biotope observed throughout the reach with vegetation restricted to reeds.	

3.2.2 Water Quality

3.2.2.1 In situ Water Quality

This section provides the In situ measurements observed at the time of sampling, although this does not represent the permanent water quality of the sampled sites, it does provide context of potential issues which may be present within the sampled reach (Table 8). In situ water quality assessment could only be performed at sample sites RS1-RS3.

Table 8: In situ measurements observed during the sample period (19/12/2021)

Parameter	**Target Water Quality Range Aquatic Ecosystems (DWAF, 1996)**	**Sample Site**		
		RS1	**RS2**	**RS3**
Temperature (°C)	5-30	22.7	23.1	22.8
pH	6.5-9.0	8.23	8.02	7.64
Dissolved Oxygen (mg/l)	5-12	7.20	7.06	5.42
Dissolved Oxygen Saturation (%)	80-120	83.0	90.7	90.7
Electrical Conductivity (*µs*/cm)	No change more than 15%	475	528	525

Based on the measurements observed at the time of sampling no exceedances of the target water quality ranges as set out by the DWS (DWAF, 1996) were observed, and is not deemed to be a limiting factor to aquatic biota at the time of the assessment.

3.2.3 Biotic assessments

No macroinvertebrate or fish community assessment could be conducted at the time of the assessment due to the seriously transformed state of the aquatic systems observed and the reach being dry at sample site RS4.

3.2.4 Habitat Assessment

The instream integrity of the associated reaches have undergone severe modifications due to the installation of the irrigation channel used for agricultural activities. The riparian integrity of the unnamed tributary was also classed seriously modified due extensive clearing for agricultural lands.

Table 9: Instream IHI scores associated with the sampled sites

Modification	RS1-RS4
Water abstraction	25
Flow modification	25
Bed modification	25
Channel	25
Physico-chemistry	5
Inundation	10
Alien macrophytes	0
Alien aquatic fauna	10
Rubbish dumping	10
IHI score[1]	**37.8**

Table 10: Riparian IHI scores associated with the sampled sites

Modification	RS1-RS4
Vegetation removal	25
Invasive vegetation	15
Bank erosion	0
Channel modification	25
Water abstraction	25
Inundation	10
Flow modification	25
Physico-chemistry	5
IHI Score[1]	**35.8**

4. Impact Assessment

The impact assessment for the proposed prospecting prior to mitigation was classified as Medium. Largest impacts arise from potential clearing for the prospecting which may destabilise banks and lead to an element of sedimentation downstream of the Rosespruit. These impacts will likely only take place during and post drilling activities. A buffer of 100 m has been applied to all water resources (see figure 5 below), in order to protect these water resources from further deterioration.

With the implementation of the proposed rehabilitation measures all impacts associated with the rehabilitation process will be lowered to Low significance, attributing positive change in the long term when rehabilitation is completed.

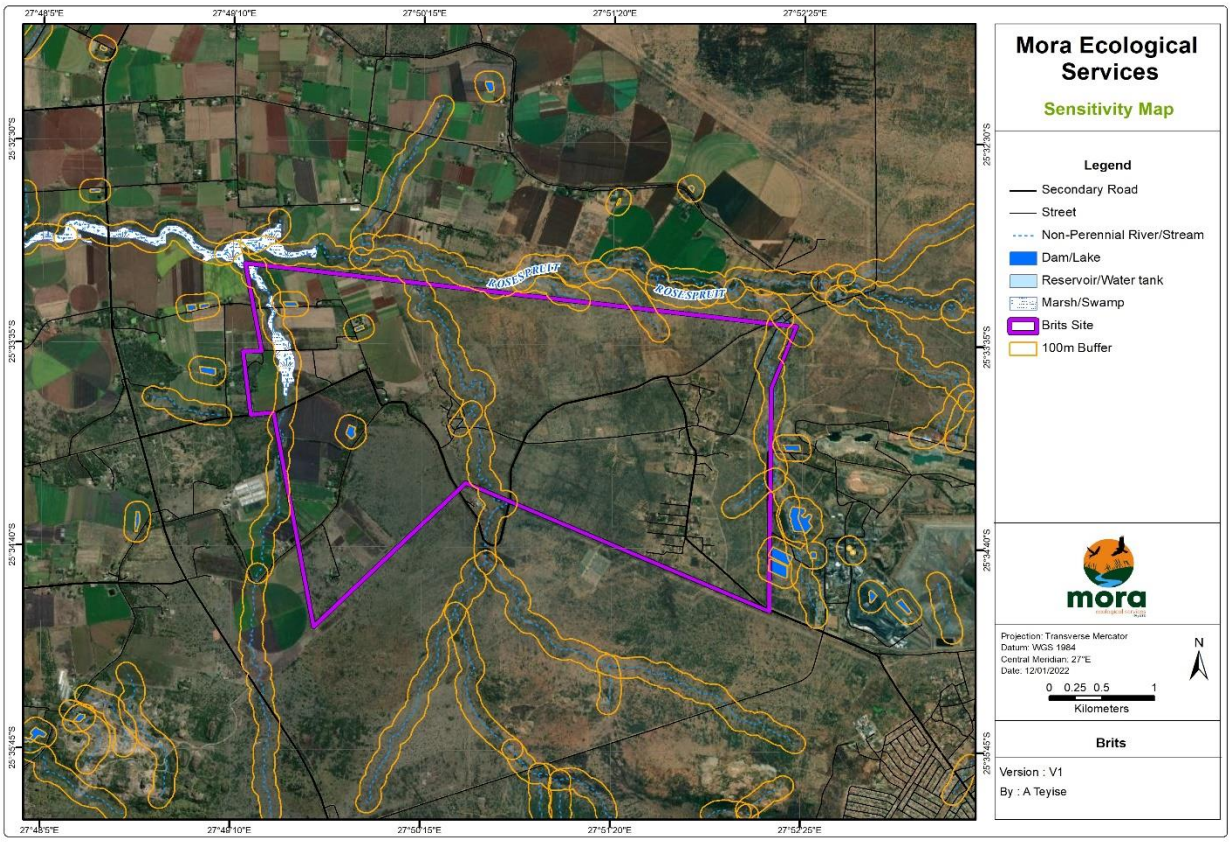

Figure 5: Vegetation the associated with the proposed prospecting area.

Table 11: Impact ratings associated with the proposed rehabilitation

POTENTIAL ENVIRONMENTAL IMPACT	APPLICABLE AREA	ACTIVITY	Significance Before Mitigation								Significance After Mitigation							
			S	P	F	SE	I	D	Total	Rating	S	P	F	SE	I	D	Total	Rating
Removal of indigenous vegetation	Unnamed tributary	Earthworks and drilling	-1	3	0.5	2	3	4	-12.5	Medium	-1	1	0.2	1	1	1	4.2	Low(-)
Disturbance of the natural soil profile resulting in the proliferation of invasive alien plant species	Unnamed Tributary	Earthworks and drilling	-1	4	0.5	2	2	1	-9.5	Medium	-1	2	0.2	1	1	1	5.2	Low(-)
Potential sedimentation due to drilling	Unnamed Tributary	Earthworks and drilling	-1	3	0.5	2	3	4	-12.5	Medium	-1	1	0.2	1	1	1	4.2	Low(-)
Potential sedimentation due to drilling	Rosespruit	Earthworks and drilling	-1	3	0.5	2	2	1	-8.5	Medium	-1	1	0.2	1	1	1	4.2	Low(-)

	Unnamed Tributary	Earthworks and drilling	-1	3	0.5	2	2	1	-8.5	Medium	-1	1	0.2	1	1	1	4.2	Low(-)
Change in species composition due to potential sedimentation	Unnamed Tributary	Earthworks and drilling	-1	3	0.5	2	3	1	-9.5	Medium	-1	1	0.2	1	1	1	4.2	Low(-)
Physiochemical changes in water quality because of changes in flow-water quality relationships such as increase in salts and other chemical concentrations due to runoff	Unnamed tributary and Rosespruit	Earthworks and drilling	-1	3	0.5	2	2	4	-11.5	Medium	-1	1	0.2	1	1	1	4.2	Low(-)

5. Proposed Rehabilitation Mitigation

Herewith follows the key rehabilitation aims of the proposed prospecting sand recommended mitigation.

- To control the proliferation of alien invasive plant species;
- To manage stormwater and reduce the extent of soil erosion; and
- To promote continued water flow throughout the rehabilitated area.

5.1 Rehabilitation specifications

Emphasis must be placed towards potential impacts of construction activities within the riparian area to promote the success of the rehabilitation plan. It is required that a method statement be provided by the contractors involved for approval by the appointed Environmental Control Officer (ECO) and engineer.

- A suitably qualified professional registered scientist must be appointed prior to any activities taking place where potential plants of conservation importance to undertake a plant rescue if protected species are present;
- Vegetation to be stripped should be restricted to the rehabilitation footprint area to reduce the risk of erosion during times of heavy rain, this should additionally be undertaken in phases to limit the total area of exposed soil on site;
- When soils are removed, topsoil and associated sub soil must be stockpiled appropriately in low heaps as recommended by the appointed engineers;
- Spoiled or stockpiled materials should not be placed within riparian areas;
- The location of appropriate toilet facilities should be present, chemical toilets must be provided which should be serviced and spaced as per the occupational health and safety regulations. These chemical toilets should be located outside the 1 :100 year flood line or 50 meters from the unnamed tributary;
- Spill kits should be kept on site, in the event of accidental oil/petroleum or other chemical spillage. Absorbent materials should be available to ensure quick remediation of potential spills;
- Plant machinery should not be stored or left unattended within close proximity of the unnamed tributary;
- Frequent inspections of the unnamed tributary should be undertaken to ensure no harmful practices occur on site; and
- Fixed point photographic monitoring should take place to record any improvement or potential impact to the unnamed tributary.

5.1.1 Alien Invasive Plant Management

Before clearing commences, it is important to understand that when an alien invasive plant management programme starts it must be implemented until completion. Failure to do so will have no value to the status of the area. According to the Conservation of Agricultural Resources Act (CARA), invasive alien vegetation must be removed from environmentally sensitive areas with the least amount of damage to indigenous vegetation.

Herewith follows best practice management actions:

- The extent of proliferation should be mapped with density and approximate height specified;

- Costs and priorities should be determined and a plan for initial operations , follow up control, and maintenance of the area should be drafted;
- Clearing should be prioritized in areas that are minimally proliferated first;
- Emphasis should be placed that all alien invasives are removed before blocks can be burnt;
- Follow up clearing must be practiced in the first wet season after the initial burn;
- Restoration of the rehabilitated areas can then take place; and
- Record should be kept of clearing operations and stands.

When using herbicides during clearing:

- A registered pest control officer must be appointed to oversee and conduct the removal of alien invasive species with herbicides;
- Plants should be sprayed when actively growing;
- The appropriate personal protective equipment should be worn whenever handing herbicides;
- The application area must be established prior to any use of herbicides;
- Herbicides must be stored in a drip sheet in a demarcated area in the veld out of direct sunlight;
- A wetting agent should be added to the herbicide to allow for better absorption;
- Herbicides should not be used during strong winds or rain events to limit potential drift; and
- All storage facilities should comply with the Association of Veterinary and Crop Associations of South Africa (AVCASA) requirements.

6. Conclusion

MORA Ecological Services (Pty) Ltd was appointed by Archean Resources (Pty) Ltd to conduct a baseline aquatic assessment as part of the proposed prospecting for a new chrome mine in close vicinity of the Bushveld Vametco Mine, Brits. Four sample sites were established., however due to the largescale transformation of the unnamed tributary and the changes in natural flow regimes the biotic integrity could not be assessed at the time of sampling

No exceedances of the target water quality guidelines as set out by the Department of Water and sanitation was observed at the time of sampling (DWAF, 1996).

The habitat analysis of the unnamed tributary and Rosespruit, associated with the proposed prospecting area was classed seriously modified. Large-scale instream modifications have occurred with the construction of the channel within the unnamed tributary and within the flow path of the wetland associated with the RS3 sample site.

The impact assessment for the proposed prospecting calculated the impact to the unnamed tributary and Rosespruit prior to mitigation as Medium. This is primarily due to the potential sedimentation and clearing of the riparian. Although no fish species of conservation concern is expected within the reach, impacts to aquatic biota, the riparian characteristics and water quality will likely occur if mitigation is not appropriately applied as recommended.

With the implementation of the proposed rehabilitation measures all impacts associated with the rehabilitation process will be lowered to Low significance, attributing positive change in the long term when rehabilitation is completed.

It is recommended that a follow up assessment be conducted prior to any mining activities later in the wet season to establish the biotic integrity of the Rosespruit. It is the opinion of the specialist that if the recommended mitigation measures are implemented the prospecting may be considered favourably.

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8. Appendices

Appendix 1: Methodology

In situ Water Quality

At each assessment sites where water was present, a hand-held multiparameter water meter was used to measure dissolved oxygen (DO; mg/L), electrical conductivity (EC; µS/cm), temperature (°C) and pH

South African Scoring System version 5

At each site where flowing water was present the assessment included bio-monitoring of aquatic macroinvertebrates using the South African Scoring System version 5 (SASS5) based on the method developed by Dickens and Graham (2002). In brief, the method involves the collection of macroinvertebrates from different riverine habitats (stones, vegetation, gravel, sand and mud). Each of the taxa have been allocated a sensitivity score based on their ability to tolerate degradation of water quality or habitat. Samples from each of the habitats are identified and their abundance is scored for 15 minutes. The combined sensitivity scores of all the taxa are summed to provide the SASS score which gives an indication of the ecological state of the river. The SASS score divided by the number of taxa recorded, gives the Average Score Per Taxon (ASPT) which gives a good indication of the state of the stream

Macroinvertebrate Response Assessment Index (MIRAI)

The three major requirements of a stream system that is associated with productivity is flow regime, physical habitat structure and water quality. The MIRAI index developed by Thirion (2007) incorporates these three key requirements to determine aquatic invertebrate responses to driver changes. Expected macroinvertebrates for each assessment sites were derived from the Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) database.

Vegetation Response Assessment Index (VEGRAI)

Developed by Kleynhans et al (2007) the VEGRAI model is designed for the qualitative assessment of the responses of riparian vegetation to impacts. The calculated results are defensible due to an outlined process (rules that convert the assessors estimates into ratings which convert these ratings into ecological categories.

Descriptions of the A-F ecological Categories

Ecological Category	Description	Score %
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

WATERCOURSE HABITAT ASSESSMENT

At each of the assessment site, and particularly where flowing water wasn't present, the instream and riparian habitat was assessed. Critical factors that influence the structure and function of aquatic communities is the condition of the surrounding physico-chemical habitat. Habitat loss, alteration, or degradation generally results in a decline in species diversity. The Index of Habitat Integrity (IHI) was developed by Kleynhans (1996) as a rapid assessment of the severity of impacts affecting habitat integrity within a river reach. It can be applied to both perennial and non-perennial watercourses. The following instream impacts were assessed in this study: water abstraction; flow modification; bed modification; channel modification; physico-chemical modification; inundation; alien macrophytes; and rubbish dumping. The riparian impacts assessed were: vegetation removal; exotic vegetation; bank erosion; channel modification; water abstraction; inundation; flow modification; physico-chemistry. Each of the impacts are given a score based on their degree of modification (1-25), along with a confidence rating based on the level of confidence in the score. The scores were determined after walking upstream and downstream along the watercourse for approximately 150m.

Descriptive classes for the assessment of habitat modifications

Impact Class	Description	Score
None	No discernible impact, or the modification is located in a way that has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality ,diversity, size and variability are also very small	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is limited	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat	11-15

	quality, diversity, size and variability. Large areas are, however, not influenced.	
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not affected.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally	21-25

An IHI class is then determined based on the resulting score. These results provide an indication of the present ecological state (PES) as observed at the site compared to that determined in the desktop PESEIS (DWS, 2014).

The methodology used to rate all potential and identified environmental impacts: Impact risk or significance was determined using a quantitative ranking technique, and ultimately expressed as a Low (0-6.9), Moderate (7-12.9) or High (13-18) significance. The predicted impacts are rated before and after mitigation measures are applied. Regarding the cases where mitigation requires time to establish, the consequential impact is based on the situation after establishment of the mitigation measures.

Index of Habitat Integrity (IHI) classes and descriptions

Integrity Class	Description	Score
A	Natural	>90
B	Largely Natural	80-90
C	Moderately Modified	60-79
D	Largely Modified	40-59
E	Seriously Modified	20-39
F	Critically Modified	0-19

Impact Assessment Methodology

Each impact identified was assessed in terms of the following aspects:

- Status of the Impact (i.e. positive or negative).
- Probability of the Impact.
- Frequency of the Impact.
- Spatial Extent of the Impact.
- Intensity of the Impact
- Duration of the Impact

The significance of the impact upon each environmental factor is rated according to its quantitative evaluation. This rating, however, is not a reflection of the environmental risk or severity of impact. In certain instances, a specific factor may have been permanently altered, but the impact of that factor on the environment (natural, cultural, social) is marginal or even inconsequential. It is therefore important to analyze the entire scope of the impact and its context and not assess it entirely on the significance of the rating alone.

Impact Assessment Scoring

Rating	Description	Quantitative Rating
Status (S)		
Positive	A benefit to the holistic environment	1
Negative	A detriment to the holistic environment	-1
Probability (P)		
Improbable	In all likelihood the impact will not occur	1
Low Probability	Possibility of the impacts to materialise is very low	2
Probable	A distinct possibility that the impact will occur	3
Highly Probable	Most likely that the impact will occur	4
Definite	The impact will occur regardless of any prevention measures	5
Frequency (F)		
Continuous	Daily	1
Frequent	Less than daily (hours)	0.8
Infrequent	Moderate frequency (weekly)	0.5
Occasional	Less than weekly (once or twice per month)	0.2
Spatial Extent (SE)		
Site Specific	Effects occur within the site/servitude boundary	1
Local	Effects extend beyond the site boundary	2
	Affects immediate surrounding areas	
Regional	Widespread	3
	Extends far beyond the site boundary	
	Effects felt within a 50km radius of the surface lease area	
National	Effects felt beyond the 50km radius	4
Intensity (I)		
Very Severe	Substantial deterioration/improvement	4
	Irreversible or permanent	
	Cannot be mitigated	
Very Beneficial	Permanent improvement and benefit	4
Severe	Marked deterioration	3

Rating	Description	Quantitative Rating
-	Long term duration Serious and severe impacts Mitigation is very expensive, difficult or time consuming	
Beneficial	Large improvement Long term duration	3
Moderately Severe	Moderate deterioration Medium term to long term duration Fairly easily mitigated	2
Moderately Beneficial	Moderate improvement Medium to long term duration	2
Slight	Minor deterioration Short to medium term duration Mitigation is easy, cheap or quick	1
Beneficial	Minor improvement Short to medium term duration	1
Duration (D)		
Short Term	0 - 5 years Less than the project life span	1
Medium Term	5 - 10 years	2
Long Term	15 - 40 years Life of project	3
Permanent	Where the impact will be irreversible and will remain	4
Significance		
NEGATIVE		
High	Negative long term/permanent change to the natural and social environment	13 - 18
Medium	Medium or long term effects to natural and social environment These effects are real and mitigation is possible, difficult and often costly	7 - 12.9
Low	Short term effects on the natural environment	0 - 6.9

Rating	Description	Quantitative Rating
	Effects are not substantial and are often viewed as unimportant	
	Mitigation is cheap, easy, quick or seldom required	
POSITIVE		
Low	No real benefit to the holistic environment	0 - 6.9
Medium	A benefit to the holistic environment	7 - 12.9
	Monitoring is needed	
	Some mitigation is needed	
High	To the greater benefit of the social and/or natural environment	13 - 18
	No mitigation or monitoring needed	

Appendix 2: Specialist CV

Jacobus Johannes du Plessis

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B.Sc Hons (Zoology)

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South African National

PROFILE SUMMARY

Baseline Biodiversity Assessments (Aquatic and Fauna);

Providing aquatic ecological expertise for the assessment and management of freshwater systems;

Conducted training at the South African Wildlife College for the Department of Rural development and African Field Ranger Training Services (AFRTS); and

Sales: Lenton Scientific.

KEY EXPERIENCE

Baseline biodiversity studies (terrestrial & aquatic ecosystems);

Impact Assessments (terrestrial & aquatic ecosystems);
Aquatic bio-monitoring; and
Sales,
Qualifications

B. Hons. Zoology (University of Johannesburg) 2017;
BSc (University of South Africa) – Zoology and Botany 2015.

COUNTRIES OF WORK

South Africa;
Namibia;
Uganda;
Liberia; and
Malawi.

Skills

- Aquatic macroinvertebrate and fish community studies;
- Risk assessment for proposed developments;
- Recommending appropriate mitigations to reduce environmental impacts;
- Conducting aquatic biomonitoring;
- Small mammal and herpetofauna field surveys including the use of various traps (camera, sherman and pitfall);
- Sales
- Basic GIS mapping using ARC GIS; and
- Equipment maintenance and manufacture.

PREVIOUS EMPLOYMENT

Independent consultant October 2019 - Present

- Sales representative at Lenton Scientific (January 2020- March 2021);
- Ecologist at Scientific Aquatic Services October 2018 – October 2019;
- Head of Aquatics at Environmental Assurance (ENVASS) – October 2017-October 2018;
- Intern at The Biodiversity Company January 2016 to June 2017; and
- Assessor/trainer at the South African Wildlife College for several short term contracts 2012-2014.

ACHIEVEMENTS

Placed top 3 with research project of honours class, gaining access to an international student exchange program with the Hong Kong University 2016.

ACADEMIC QUALIFICATIONS

- B.Sc Hons in Zoology (University of Johannesburg) 2016; and
- B.Sc Zoology and Botany (University of South Africa) 2014.

ACCREDITATIONS AND COURSES

- Professional Scientist (Aquatic Science): 118234
- SASS5 accredited;
- Venomous snake handling (Africa Snakebite Institute) 2017;
- Fish Identification course with Roger Bills 2016;
- FGASA level 1;
- Assessors certification (CATHSSETA);
- Trails guide (Theory);

- Use of a Semi-automatic Carbine for Business purposes – NSN shooting Academy 2018; and
- Grade E PSIRA registration – Inkwe Training Services 2018.

PUBLICATIONS

TS Bengu, J du Plessis, LS Modley & JC van Dyk (2017) Health effects in fish from the polluted Orlando Dam and Klipspruit wetland system, Soweto, South Africa. African Journal of Aquatic Science.

Recent Project Experience

For further details please contact me directly at: jaco@rmpd.co.za

Time span	Nature of project	Capacity	Industry / Sector	Client / Developer	Country (Province)
2021	Pollution screening of the Ncandu River, Newcastle.	Aquatic Specialist	Civil	ActionSA	KwaZulu-Natal
2021	Aquatic Screening for the proposed extraction from the Bua River.	Aquatic Scientist	Mining	Enviro-Insight	Malawi
2021	High Flow Aquatic Baseline Assessment for proposed concessions	Aquatic Scientist	Mining	Avesoro	Liberia
2021	Baseline Aquatic assessment for the proposed Bismarck Dam	Aquatic Scientist	Agriculture	Ages Limpopo	Limpopo
2021	Low flow Aquatic Baseline Assessment for the proposed concessions	Aquatic Scientist	Mining	Avesoro	Liberia
2020	Aquatic Baseline Assessment for the proposed Donora Hydroelectric Plant	Report compilation and impact assessment	Hydroelectric Dam Development	Enviro-Elements	Mpumalanga
2020	Bi-annual aquatic biomonitoring for the Booysendal Contractors Camp	Aquatic Specialist	Mining	GCS	Limpopo
2020	Aquatic biomonitoring for the Thaba Cronimet Chrome mine	Aquatic Specialist	Mining	Enviro-insight	North-West
2020	Aquatic biomonitoring for Delmas Coal Mine	Aquatic Specialist	Mining	Iggdrasil Scientific Services	Mpumalanga

2020	Aquatic screening assessment for the proposed Luongo Hydropower Project	Report Compilation and Impact assessment	Hydroelectric Dam Development	Armitage Environmental and Social Consulting	Luapulu Province, Zambia
2020	Aquatic biomonitoring for the Wonderstone Stone Quarry	Aquatic Specialist	Mining	Iggdrasil Scientific Services	North-West
2020	Aquatic biomonitoring for the Gollfview, Coal Mine	SASS5 Assessor	Mining	The Biodiversity Company	Mpumalanga
2020	Aquatic biomonitoring for the Dama Coal Mine	SASS5 Assessor	Mining	The Biodiversity Company	KwaZulu-Natal
2020	Baseline Aquatic Assessment for the Moreleta Spruit	Aquatic Specialist	Civil Development	Enviro-Insight	Gauteng
2019	Avifaunal Assessment for the Insa Coal Mine	Avifaunal Specialist	Mining	Insa Coal	KwaZulu-Natal
2019	Fish community assessment for two proposed Hydro-electric schemes	Fish Specialist	Hydroelectric Dam Development	EnviRoss	Gulu, Uganda
2019	Aquatic assessment for the extension of the Maquasa East Coal Mine	Aquatic Specialist	Mining	Kangra Coal	Piet Retief, Mpumalanga
2019	Baseline Aquatic Assessment for the proposed Twyfelhoek Coal Mine	Aquatic Specialist	Mining	Kangra Coal	Piet Retief, Mpumalanga
2019	Baseline Aquatic Assessment for the proposed Barlgathen Coal MIne	Aquatic Specialist	Mining	Kangra Coal	Piet Retief, Mpumalanga
2019	Baseline Aquatic Assessment for the proposed Donkerhoek Coal MIne	Aquatic Specialist	Mining	Kangra Coal	Piet Retief, Mpumalanga
2019	State of the Rivers Assessment – Olifants System	Fish Specialist	Agriculture	Olifants Irrigation Board	Mpumalanga
2019	Aquatic Baseline Assessment for the proposed Royal Sheba Mine	Aquatic Specialist	Mining	Jacana Environmental	Baberton, Mpumalanga
2019	Aquatic Baseline Assessment for the proposed The Dual Coal Mine	Aquatic Specialist	Mining	Jacana Environmental	Musina, Limpopo
2019	Aquatic Biomonitoring for the Hernic Chrome Mine	Aquatic Specialist	Mining	Hernic Ferrochrome	Brits, North West

2019	Aquatic Biomonitoring for the Rietvlei Colliery	Aquatic Specialist	Mining	JacoK Consulting	Delmas, Mpumalanga
2019	Aquatic Biomonitoring for the Ngagane Coal Siding	Aquatic Specialist	Mining	Osho (Pty) Ltd	Newcastle, KwaZulu-Natal
2019	Aquatic Baseline Assessment for the proposed Zimpande Coal Mine	Aquatic Specialist	Mining	EXM	Newcastle, KwaZulu-Natal
2019	Aquatic Biomonitoring for the Ikwezi Coal MIne	Aquatic Specialist	Mining	Osho (Pty) Ltd	Newcastle, KwaZulu-Natal
2019	Aquatic Baseline Assessment for the Unauthorized Dieter Hinze Dam (Section 24G)	Aquatic Specialist	Agriculture	Enprocon	Paulpietersburg, KwaZulu-Natal
2019	Aquatic Baseline Assessment for the Unauthorized Heine Hinze Dam (Section 24G)	Aquatic Specialist	Agriculture	Enprocon	Paulpietersburg, KwaZulu-Natal
2019	Faunal assessment for the proposed extension of the Anglo American Lifex Coal Mines	Faunal Specialist	Mining	SRK	Emalahleni, Mpumalanga
2019	Bald Ibis Monitoring for the Ikwezi Coal MIne	Faunal Specialist	Mining	Osho (Pty) Ltd	Newcastle, KwaZulu-Natal
2019	Faunal assessment for the extension of the Maquasa East Coal Mine	Faunal Specialist	Mining	Kangra Coal	Piet Retief, Mpumalanga
2019	Faunal Assessment for the proposed Twyfelhoek Coal Mine	Faunal Specialist	Mining	Kangra Coal	Piet Retief, Mpumalanga
2019	Faunal Assessment for the proposed Barlgathen Coal Mine	Faunal Specialist	Mining	Kangra Coal	Piet Retief, Mpumalanga
2019	Faunal Assessment for the proposed Donkerhoek Coal Mine	Faunal Specialist	Mining	Kangra Coal	Piet Retief, Mpumalanga
2019	Faunal assessment for the proposed Royal Sheba Mine	Faunal Specialist	Mining	Jacana Environmental	Baberton, Mpumalanga

2019	Faunal assessment for the proposed the Dual Coal Mine	Faunal Specialist	Mining	Jacana Environmental	Musina, Limpopo
2018	Faunal assessment for the proposed Zimpande Coal Mine	Faunal Specialist	Mining	EXM	Newcastle, KwaZulu-Natal
2018	Faunal Assessment for the proposed extension of the Overlooked Colliery	Faunal Specialist	Mining	Cabanga Environemental	Delmas, Mpumalanga
2018	Biodiversity Assessment for the proposed R101 interchange	Terrestrial Specialist	Civil Development	RHDHV	Mokopane, Limpopo
2018	Aquatic Biomonitoring for the Lydenburg Smelter	Aquatic Specialist	Mining	Environmental Assurance	Mpumalanga
2017-2018	Aquatic Biomonitoring for the Vele Coal Mine	Aquatic Specialist	Mining	Environmental Assurance	Limpopo
2017-2018	Estuary Assessment for the Fairbreeze Titanium Mine	Aquatic Specialist	Mining	Tronox	KwaZulu-Natal
2017-2018	Quarterly aquatic biomonitoring for the Fairbreeze Titanium Mine	Aquatic Specialist	Mining	Tronox	KwaZulu-Natal
2017-2018	Quarterly aquatic biomonitoring for the rehabilitated Hillendale Titanium Mine	Aquatic Specialist	Mining	Tronox	KwaZulu-Natal
2017-2018	Quarterly aquatic biomonitoring for the Tronox Central Processing Plant	Aquatic Specialist	Mining	Tronox	KwaZulu-Natal
2017-2018	Aquatic Baseline assessment for the reapplication of a water use license, Umlabu Coal	Aquatic Specialist	Mining	Environmental Assurance	Mpumalanga
2017-2018	Aquatic Biomonitoring for the Voorslag Siding	Aquatic Specialist	Mining	Environmental Assurance	Mpumalanga
2017-2018	Aquatic Biomonitoring for the Zululand Anthracite Colliery	Aquatic Specialist	Mining	Zululand Anthracite Colliery	KwaZulu-Natal
2017-2018	Aquatic Biomonitoring for the Mooinooi Chrome	Aquatic Specialist	Mining	Samancor	North-West

	Mine				
2017-2018	Aquatic biomonitoring for the Buffelsfontein Chrome Mine	Aquatic Specialist	Mining	Samancor	North-West
2017-2018	Aquatic biomonitoring for the Spitzkop Chrome Mine	Aquatic Specialist	Mining	Samancor Eastern Chrome	Mpumalanga
2017-2018	Aquatic biomonitoring for the Kennedysvale Chrome mine	Aquatic Specialist	Mining	Samancor Eastern Chrome	Mpumalanga
2017-2018	Aquatic biomonitoring for the Mareesburg Chrome Mine	Aquatic Specialist	Mining	Samancor Eastern Chrome	Mpumalanga
2017-2018	Aquatic biomonitoring for the Mooiplaats Coal MIne	Aquatic Specialist	Mining	Environmnetal Assurance	Mpumalanga
2017-2018	Aquatic biomonitoring for the Crocodile River Chrome MIne	Aquatic Specialist	Mining	Eastplats	North-West
2017	Aquatic Screening Assessment for the proposed Elysium Dessalinisation Plant	Aquatic Specialist	Civil Development	Afzelia	KwaZulu-Natal
2017	Aquatic Baseline Assessment for the P483 Road Upgrade	Aquatic Specialist	Civil Development	Afzelia	KwaZulu-Natal
2017	Aquatic biomonitoring for the Boikarabelo Coal Mine	Aquatic Specialist	Mining	The Biodiversity Company	Limpopo
2017	Baseline Fish Community Studies for a proposed Tented Camp in the Rhenosterkop Dam Nature Reserve	Fish Specialist	Civil Development	Iggdrasil Scientific Services	Limpopo
2016	SASS sample preservation for the River Eco-Status Monitoring Program	Aquatic Assistant	Water	UKZN	KwaZulu-Natal
2016-2017	Relocation of three protected floral species for the development of a train manufucturing starion	Floral Specialist	Civil Development	Aecom	Gauteng
2016	Baseline Aquatic Assessment for the	Aquatic Assistant	Civil Development	The Biodiversity	Gauteng

	Moloto Road Upgrade			Company	
2016	Aquatic Baseline Assessment for the proposed D1126 Culvert Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the Gumede Road Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the proposed Hlope Road Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the proposed Khanjana Road Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the proposed Luhane Bridge	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the proposed Nkomo road Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the proposed Polokwane Road upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the Sbongmuso Road Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the Leandra Dam	Aquatic Assistant	Civil Development	The Biodiversity Company	Mpumalanga
2016	Aqautic Baseline Assessment for the proposed Creche Road Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the proposed Edrayini Road Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the proposed Bombay Road Upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal
2016	Aquatic Baseline Assessment for the proposed D661 causeway upgrade	Aquatic Assistant	Civil Development	Enviropro	KwaZulu-Natal

2016	Faunal Baseline Assessment for the proposed expansion of the Polokwane Smelter	Faunal Assistant	Mining	The Biodiversity Company	Limpopo

REPORT COMPILED BY:

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