BASELINE AQUATIC ECOLOGY ASSESSMENT FOR BAKUBUNG PLATINUM MINE

Prepared for:	Bakubung Minerals Proprietary Limited
Prepared by:	Knight Piésold (Pty) Ltd.
Project Number:	RI 301-00509/14
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Knight Piésold CONSULTING

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A	Issued in Final	03 April 2020
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Specialist Reports and Reports on Specialist Processes - Checklist		
	NEMA Regulations (2014) – Appendix 6	**Reference to section in report**
1	A specialist report or a report on a specialised process prepared in terms of these Regulations must contain -	
(a) i	The person who prepared the report; and	Section 0
(a) ii	The expertise of that specialist to compile a specialist reports including a curriculum vitae;	Annexure A
(b)	A declaration that the specialist is independent in a form as may be specified by the competent authority	Next page
(c)	An indication of the scope of, and the purpose for which the report was prepared	Section 1.4
(d)	Duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	Section 3.2
(e)	Description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	Section 3.0
(f)	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 2.1
(g)	An identification of any areas to be avoided, including buffers	Section 5.0
(h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	Figure 7
(i)	Description of any assumptions made and any uncertainties or gaps in knowledge	Section 4.0
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Section 7.0
(k)	any mitigation measures for inclusion in the EMPr	Section 7.0
(l)	any conditions for inclusion in the environmental authorisation;	Section 7.0
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 7.4
(n)	A reasoned opinion -	
(i)	whether the proposed activity, activities or portions thereof should be authorised;	Section 9.0
(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 9.0
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report	No consultation was undertaken as part of the study
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	No consultation undertaken as part of the study
(q)	any other information requested by the competent authority.	None

Declaration of Independence by Specialist

I, Neal Neervoort, in my capacity as specialist Aquatic Ecologist hereby declare that we –

- Act as independent consultants
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the Environmental Management Act, 2002 (No 5 of 2002);
- Have and will not have vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the Environmental Management Act, 2002 (No 5 of 2002);
- Will provide the competent authority with access to all information at our disposal regarding the application, whether such information is favourable to the applicant or not;
- Based on information provided to us by the project proponent and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of our professional ability; and
- Undertake to have our work peer reviewed on a regular basis by a competent specialist in the field of study for which we are registered.

17/04/2021

Neal Neervoort
Aquatic Ecologist
SACNASP Reg. No. 115316

Date

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1.0 INTRODUCTION

1.1 BACKGROUND

Wesizwe's core project is the Bakubung Platinum Mine (formerly known as the Frischgewaagd-Ledig project). The property consists of various portions of the farm Frischgewaagd 96 JQ and Ledig 909 JQ. The two farms are located directly south of the Pilanseberg complex. The project area falls within the Rustenburg and Moses Kotane Local Municipalities of the Bojanala District Municipality.

An Integrated Environmental Authorisation (IEA) was granted to Bakubung Minerals (Pty) Ltd in terms of Section 24L of National Environmental Management Act, 1998 (Act No. 107 of 1998) as amended read with regulation 27 of the Environmental Impact Assessment Regulations, 2014. Due to financial and time constraints Bakubung has proposed to change some of the approved infrastructure to ensure that the mine process can go ahead as planned. The following changes are proposed to the Bakubung Platinum Mine:

- A filtered tailings storage facility (TSF) able to contain an average tonnage profile of 1 Mtpa for a maximum period of 7 years
- The construction of a filtration plant and associated infrastructure
- Additional stormwater management dams.

Knight Piésold (Pty) Ltd was appointed to conduct the Amendment of the Environmental Management Programme and Environmental Authorisation and Water Use Licence Application for the above-mentioned project. The report forms part of the environmental baseline studies for the amended integrated environmental authorisation.

1.2 PROJECT DESCRIPTION

1.2.1 BAKUBUNG PLATINUM MINE

The project site is situated directly adjacent to the western side of the Royal Bafokeng Platinum Styldrift project and immediately north of Maseve's Project 1, owned in partnership with Canadian group Platinum Group Metals (PTM). These properties are all located on the Western Limb of the mineral-rich Bushveld Igneous Complex in the North West province of South Africa. The Bakubung Platinum Mine will comprise of an underground mine with a twin vertical shaft system – a main shaft and a ventilation shaft which will also function as the second escape route – and a process plant.

The main shaft is planned to have a hoisting capacity of 230 000 tonnes of ore plus 40 000 tonnes of waste per month. Initially the Merensky Reef ore will be mined at the rate of 180 000 tonnes and the UG2 ore will make up the balance of 50 000 tonnes per month. Once the Merensky has been depleted, the full 230 000 tonnes will be generated from UG2 ore. It is anticipated that the annual 4E (3 PGM + Au) production during steady state be around 420 000 ounces.

The Merensky Reef will be mined using conventional stoping methods and the UG2 using semi-mechanised methods, also known as hybrid methods. Crushing will be done underground from where the reefs will be separately conveyed to stockpiles at the concentrator plant. The concentrator design has emanated from the results of the test work conducted during the bankable feasibility study and is based on a standard PGM plant layout. Options for collaboration in developing a joint

concentrator plant with neighbours Maseve are being investigated to exploit benefits from economies of scale and sharing capital infrastructure costs.

1.2.2 TAILINGS FILTRATION

BPM is undertaking a project to design, build and operate a 1 MTPA capacity platinum ore concentrator plant and ramp it up to 2 MTPA over time. The concentrator plant is already authorised. An additional TSF is proposed. The Bakubung TSF consists of the following design elements:

- A 1 m high toe wall comprising of rockfill from the existing waste rock dump founded on the coarse residual norite providing containment during the early deposition into the facility.
- A Class C barrier system beneath the TSF, paddocks and evaporation ponds.
- A network of seepage collection drains constructed in the basin of the TSF and immediately upstream of the toe wall
- Toe paddocks to contain runoff and silt eroded from the outer slopes of the facility
- A concrete lined solution trench to channel filter discharge and runoff from the outer slopes to the evaporation pond.
- Two evaporation ponds with two compartments positioned at the lowest point of the solution trenches situated at the South Eastern side of the TSF to contain the seepage discharge.
- A perimeter access road to allow suitable access around site
- A stone pitched clean water diversion channel to divert clean stormwater around the TSF.

1.3 DETAILS OF SPECIALIST

Neal Neervoort is an Aquatic /Senior Environmental Scientist at Knight Piésold's Head Office in Rivonia. He has 10 years of working experience as a registered professional scientist in the Environmental Management and Aquatic Science fields. He has an aquatic ecology background as a Wetland Assessment Practitioner and DWS: SASS 5 Accredited Practitioner. Neal has been involved in various aquatic specialist studies as part of Environmental Processes and standalone projects. In the Environmental Management field, he has experience across Africa implementing Water Monitoring Programmes, Air Quality Monitoring Programmes, Environmental Compliance Audits, Water Use Licence Applications, Scoping Studies and Environmental Impact Assessments.

1.4 TERMS OF REFERENCE

The baseline aquatic and wetland ecology assessment report were compiled in order to:

- Provide a desktop and literature review of existing wetland and aquatic ecosystem information including aerial imagery and previous studies undertaken
- To provide feedback on the field visit undertaken on the 26th and 27th of February 2020 by a Pr.Sci.Nat. registered Aquatic Scientist
- To verify and confirm the watercourses assessed during the previous studies
- To delineate the watercourse systems identified and classify into appropriate hydrogeomorphic (HGM) units
- To determine the baseline aquatic health of the identified watercourses.
- To assess the Present Ecological State (PES) and the Ecological Importance and Sensitivity (EIS) of the identified watercourses

- Wetlands within 500 m of the proposed infrastructure was confirmed and delineated at a secondary level with a stronger desktop approach
- To identify possible impacts of the proposed project on the aquatic ecosystem and watercourses.

2.0 SITE DESCRIPTION

Bakubung Platinum Mine is located in the North West Province, Bojanala District, East of Phatsima village and approximately 7 km south-west of Sun City. Figure 1 below presents the locality of Bakubung Platinum Mine.

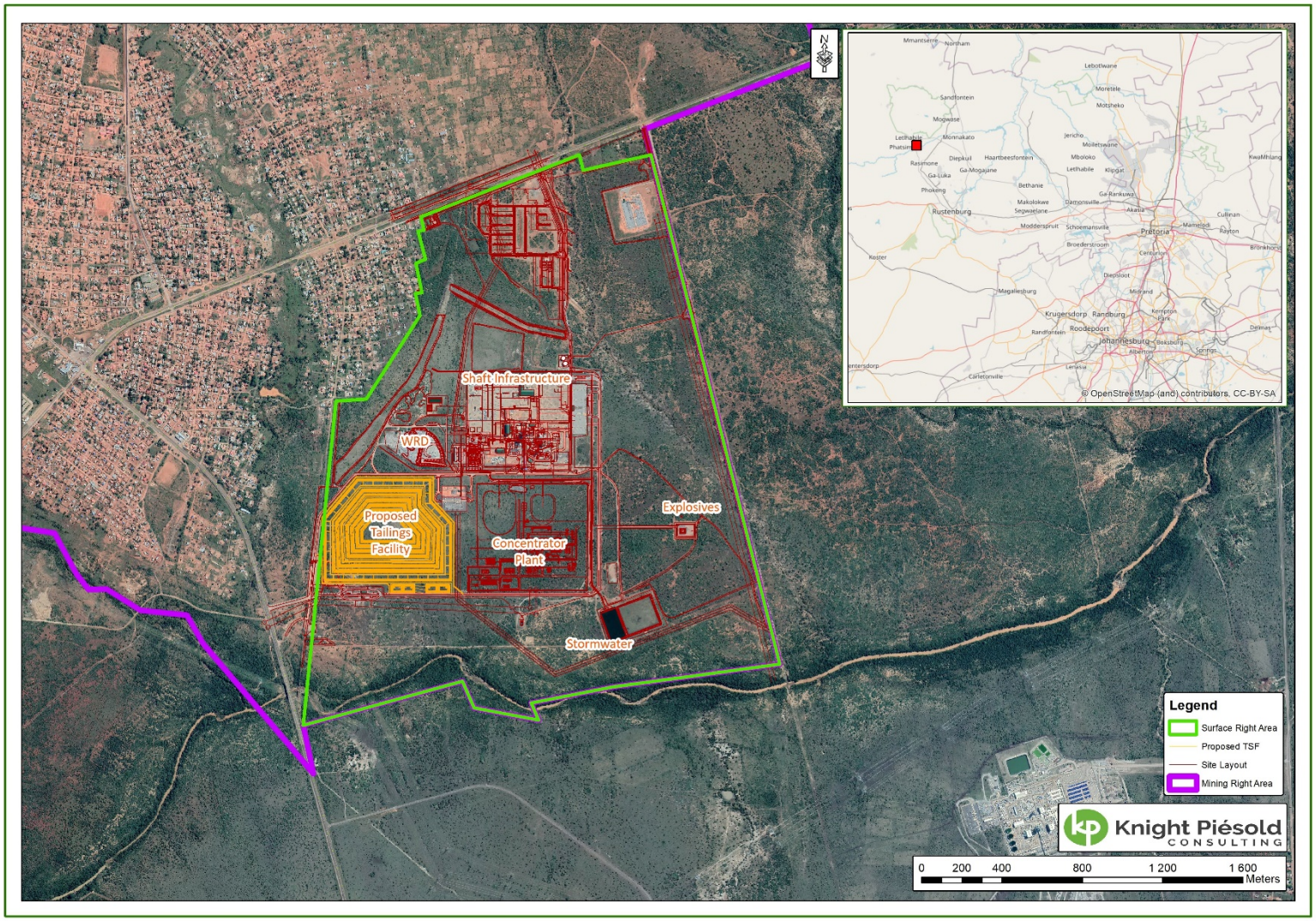

Figure 1: General Locality and Layout of Project Area

2.1 GENERAL SITE CHARACTERISTICS

2.1.1 CATCHMENT

The project area is located within the Crocodile (West) and Marico Water Management Area (WMA) and primary catchment A2, which falls within Quaternary Catchment A22F.

Table 1: Catchment data

Water Management Area	Crocodile (West) and Marico
Quaternary catchment	A22F
Level 1 Ecoregion	Bushveld Basin
Level 2 Ecoregion	8.05
Rivers	Sandspruit; Elands River
Mean Annual Precipitation (MAP) mm	604
Mean Annual Run-off (MAR) in mm	16.3
Catchment Surface Area km^2	1688.3

2.1.2 NATIONAL FRESHWATER ECOSYSTEM PRIORITY AREAS (NFEPA)

The National Freshwater Ecosystem Priority Areas (NFEPA) was initiated by various project partners to identify and set implementation measures to protect freshwater ecosystems. The NFEPA project includes wetlands, rivers, lakes and estuaries.

The NFEPA project allowed for identifying various important freshwater ecosystems within South Africa. Theses ecosystems are categorised as Freshwater Ecosystem Priority Area (FEPA). The available spatial data for FEPA indicated two unchanneled valley bottom wetlands fall within the project area seen in Figure 2 below.

2.1.3 PRESENT ECOLOGICAL STATE, ECOLOGICAL IMPORTANCE AND SENSITIVITY

The Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) of the Sub-Quaternary Reach (SQRs) associated with the study area presented below in table and figure.

Table 2: PES, EIS and EI for the Elands River and Sandspruit (DWAF, 2012)

SQR	SQR Name	Present Ecological State	Ecological Importance	Ecological Sensitivity
A22F - 00869	Elands River	D (Largely Modified)	Moderate	Moderate
A 22F - 00822	Sandspruit	D (Largely Modified)	High	Moderate

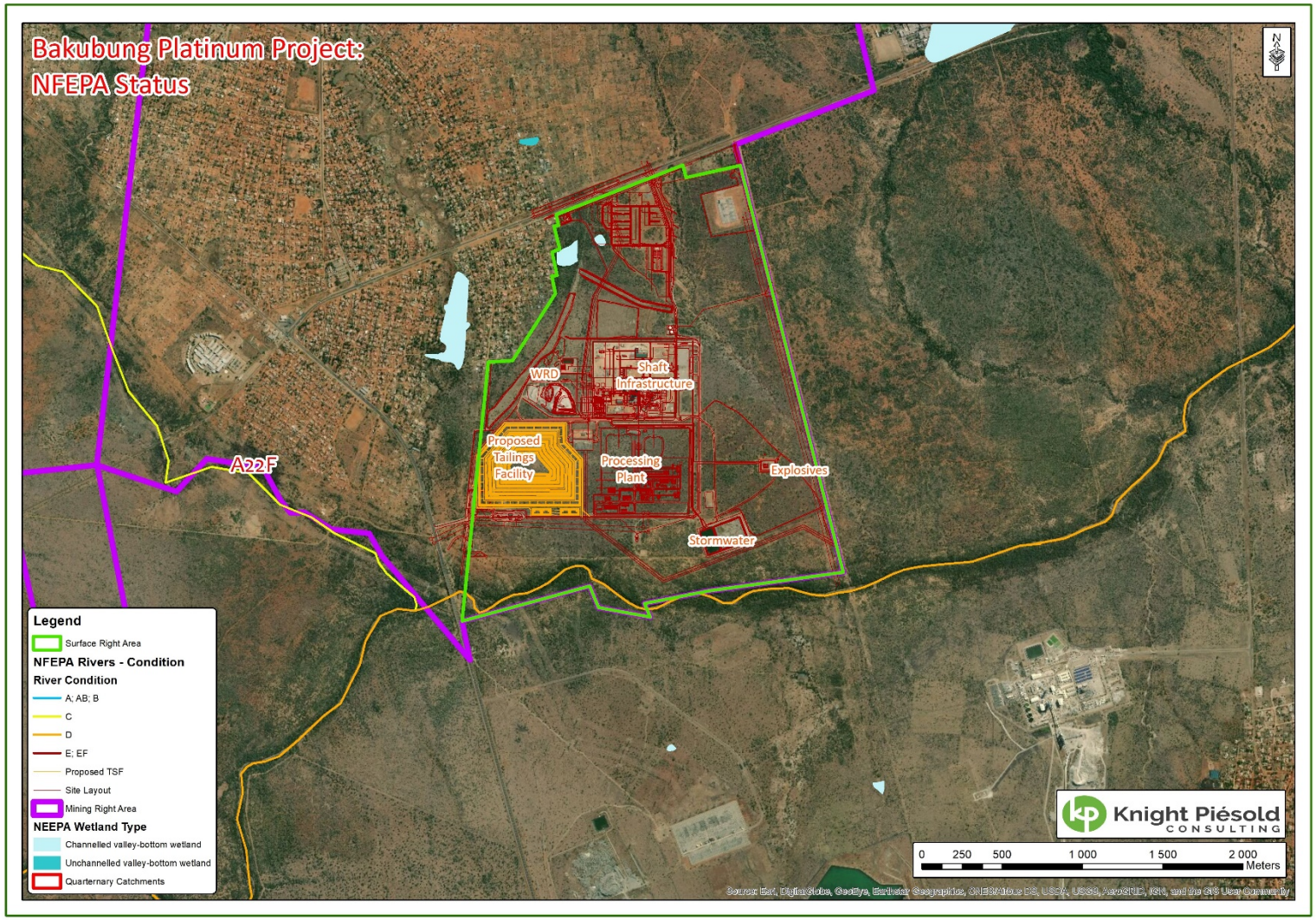

Figure 2: NFEPA Areas

2.2 AQUATIC SAMPLING SITES

Three possible monitoring sites were identified during the desktop survey. The GPS co-ordinates of each site were pre-assessed using GIS imagery and confirmed during the ground truth process. The monitoring sites were surveyed to assess the Present Ecological State (PES) and the possible impacts of the proposed Tailings Storage Facility (TSF) on the receiving aquatic environment.

The ground truth process indicated that only two of the three proposed sites were accessible and suitable for aquatic bio-monitoring. *In-situ* water quality, a visual assessment, bio-monitoring and electro-shocking were undertaken at the two chosen suitable sites located within the Elands River: upstream of the mine (BKB-U) and downstream of the mine (BKB-D).

The proposed aquatic assessment sites are illustrated in the Figure 3 and Table 3 below.

Table 3: Proposed Aquatic Assessment

Site Code	Description	Position UTM (WGS 84)
BKB-U	Located upstream of the Bakubung Platinum Mine. The site was accessed from the R565 which crosses the Elands river. The site is located underneath the bridge. The site provides suitable habitat for macro-invertebrates and fish species.	S 25.39255° E 27.07106°
BKB-D	The downstream monitoring point is located directly downstream of the project area. The site was accessed from the dirt road that runs along the water pipeline. The site will provide baseline conditions downstream of the mining area.	S 25.39259° E 27.09564°

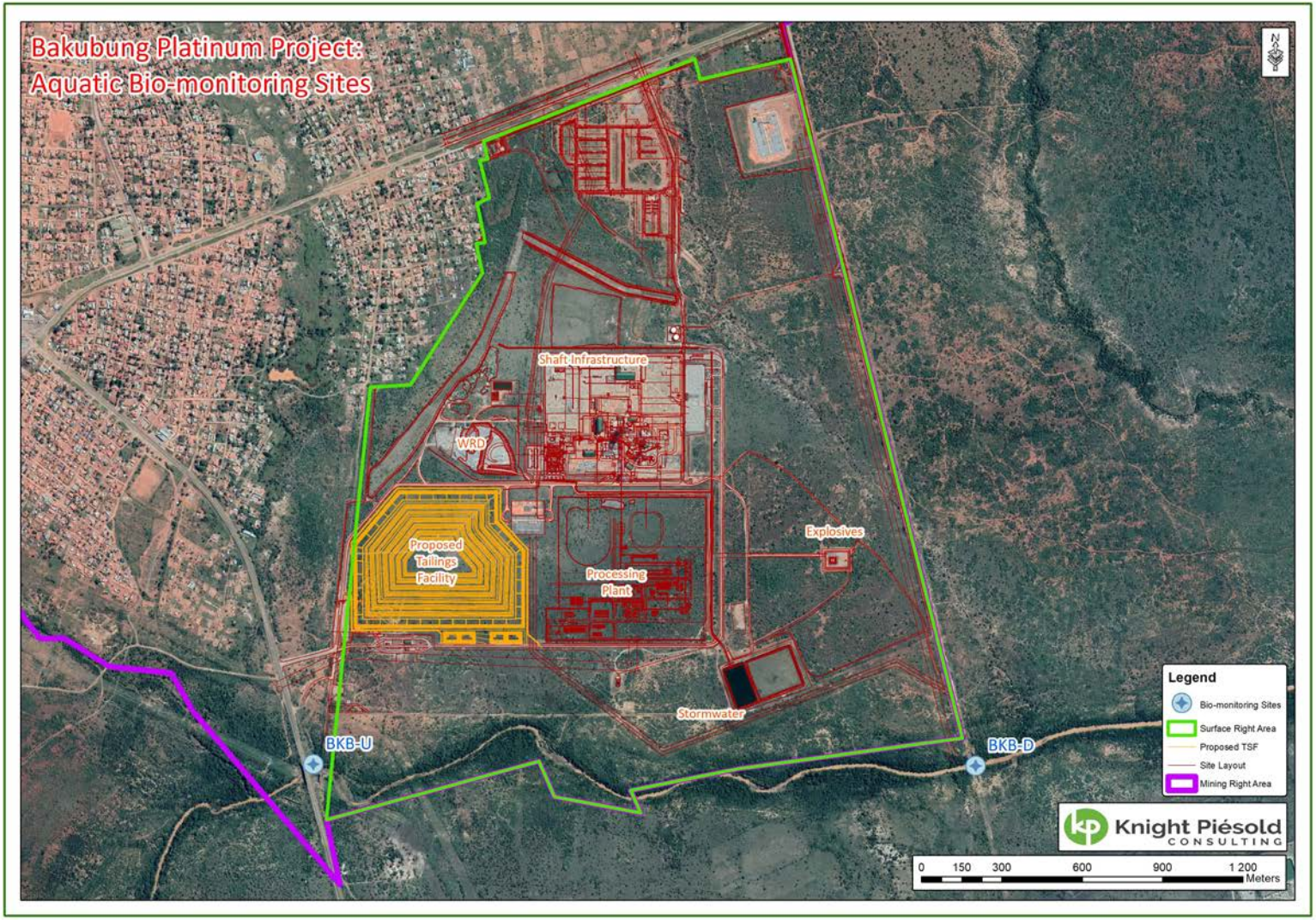

Figure 3: Aquatic monitoring sites

3.0 METHODOLOGY

The following methods was used to obtain the baseline information:

3.1 DESKTOP ASSESSMENT AND LITERATURE REVIEW

A comprehensive desktop assessment and literature review of all available information was conducted. Previous studies undertaken on the Elands River were used to provide baseline information.

3.2 FIELD SURVEY

A once off field survey was undertaken for this study during the period of 26 to the 27th of February 2020. Water levels were low with low to no flow within the river which could limit habitat availability for certain species.

3.3 AQUATIC ASSESSMENT

3.3.1 *IN-SITU* WATER QUALITY

Water quality is used to describe the physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses and for the protection of the health and integrity of aquatic ecosystems (DWAF, 1996).

The following water quality parameters were determined during the field survey using a Hanna 9811-5 multi-parameter field instrument:

- pH
- Total Dissolved Solids (mg/l)
- Electrical Conductivity (mS/m)
- Temperature (°C)
- Dissolved Oxygen (DO) (mg/l).

The above-mentioned parameters provide a snapshot of the current water quality at the time of the survey and can be used as an early detection system for any water quality changes.

3.3.2 VISUAL ASSESSMENT

Each site was assessed by in-stream conditions such as morphology, hydrology and general site description. Photographic evidence was taken at each site as a representation of the conditions during the survey.

3.3.3 INVERTEBRATE HABITAT ASSESSMENT (IHAS)

IHAS evaluates the availability of suitable habitat for macro-invertebrates and expresses the availability and suitability as a percentage as described below. IHAS scores were interpreted according to the guidelines of McMillan 2002 as follows:

- <55% inadequate habitat
- 55-65% adequate habitat
- >65% good habitat.

The IHAS has been tested and found to be an unsatisfactory method of quantifying invertebrate habitat suitability (Ollis *et al*., 2006). As this study forms part of WUL conditions, IHAS will still be utilised and compared to a suitable simple five points scale as per the SASS 5 sheet.

Each habitat category was assigned weighted importance value that varied according to the geomorphological stream type. The weighted values were multiplied by the suitability rating (0-5), and the results were expressed as a percentage, where 100% = all habitats highly suitable.

3.3.4 AQUATIC INVERTEBRATES

The South African Scoring System Version 5 (SASS 5) (Dickens and Graham, 2002) is a rapid bio-assessment method to assess the integrity of macro-invertebrates in flowing aquatic ecosystems. Aquatic bio-monitoring utilises this index to detect the water quality of ecosystems. The index assigns each taxon with a sensitivity score that is used to indicate an overall average score per taxon (ASPT).

Benthic macro-invertebrates, in particular, are recognised as valuable organisms for bio-assessments, due largely to their visibility to the naked eye, ease of identification, rapid life cycle often based on the seasons and their largely sedentary habits (Dickens and Graham, 2002). Sampling was conducted using a standard size SASS net with mesh <1mm, dislodging macro invertebrates from their habitat substrates into the water column and catching the invertebrates in the net.

3.3.4.1 SASS ECOCLASSIFICATION

SASS Data Interpretation Guidelines (Dallas, 2007) were used to interpret the SASS 5 information collected during the survey. The guidelines method utilises natural variation in SASS 5 scores and ASPT to determine preliminary biological bands. The study area falls within the Level 1 Ecoregion for the Bushveld Basin and the SASS5 score and ASPT values were evaluated according to these bands.

3.3.4.2 MACROINVERTEBRATE RESPONSE ASSESSMENT INDEX (MIRAI)

Aquatic organisms have specific habitat conditions, water quality and flow that they prefer and MIRAI assesses the change from the reference condition to the current state within macroinvertebrate assemblages. The following four metric groups are ranked and weighted to provide the current Ecological Category (EC):

- Flow modification
- Habitat modification
- Water quality modification
- System connectivity and seasonality.

3.3.5 ICHTHYOFAUNA (FISH)

Fish were sampled using a portable, battery operated electro-fisher (Samus 725M). This is a standard method of sampling fish and is less prone to biased sampling of certain species than other methods of sampling. Sampling effort at each site varied between about 10 to 30 minutes, depending on the catch.

3.3.5.1 FISH ASSEMLABGE INTEGRITY INDEX (FAII)

The Present Ecological State of the fish assemblage was assessed using the species intolerance component of the Fish Assemblage Integrity Index (FAII) (Kleynhans, 1999). The species intolerance values for all species that were recorded at each site were added to obtain a total intolerance score (Kleynhans, 2003). The total scores were expressed as a percentage of the total intolerance scores for species that were expected.

3.3.5.2 FISH RESPONSE ASSESSMENT INDEX (FRAI)

The FRAI is an assessment index based on the environmental intolerances and preferences of the reference fish assemblage and the response of the constituent species of the assemblage to particular groups of environmental determinants or drivers.

Table 4: Main steps and procedure in the calculation of the FRAI (Kleynhans, 2007)

STEP	PROCEDURE
River section earmarked for assessment	As for study requirements and design
Determine reference fish assemblage: species and frequency of occurrence	• Use historical data & expert knowledge • Model: use ecoregional and other environmental information • Use expert fish reference frequency of occurrence database if available
Determine present state for drivers	• Hydrology • Physico-chemical • Geomorphology or • Index of habitat integrity
Select representative sampling sites	Field survey in combination with other survey activities
Determine fish habitat condition at site	• Assess fish habitat potential • Assess fish habitat condition
Representative fish sampling at site or in river section	• Sample all velocity depth classes per site if feasible • Sample at least three stream sections per site
Collate and analyze fish sampling data per site	Transform fish sampling data to frequency of occurrence ratings
Execute FRAI model	• Rate the FRAI metrics in each metric group • Enter species reference frequency of occurrence data • Enter species observed frequency of occurrence data • Determine weights for the metric groups • Obtain FRAI value and category • Present both modelled FRAI & adjusted FRAI.

3.3.5.3 EXPECTED FISH SPECIES AND CONSERVATION STATUS

The expected fish species was derived from the river database of fish species recorded within the Elands River and Freshwater Fishes of Southern Africa (Skelton, 2001) based on their habitat preferences. The conservation status of the indigenous fish species was assessed in terms of the IUCN Red List of Threatened Species (IUCN, 2015).

Table 5: Expected Fish Species (DWAF, 2012)

Species	Common Name	IUCN Status	Habitat
Labeobarbus marequensis	Lowveld Largescale Yellowfish	LC	Occurs in flowing water of larger streams and rivers
Enteromius trimaculatus	Threespot Barb	LC	Main channels of large rivers, penetrates high into tributary systems and may also be present in isolated floodplain pools.
Clarias gariepinus	Sharptooth Catfish	LC	Migratory species living and feeding near the bottom as well as in midwaters
Labeo molybdinus	Leaden Labeo	LC	Rocky habitats of main river channels
Schilbe Intermedius	Silver Catfish	LC	Generally abundant in open water, in both lacustrine and fluviatile conditions, often showing shoaling habits (De Vos, 1995). Prefers large or rather large rivers and dams
Oreochromis mossambicus	Mozambique Tilapia	VU	Occurs in all but fast-flowing waters
Mesobola brevianalis	River Sardine	LC	Prefers well-aerated, open water of flowing rivers
Pseudocrenilabrus philander	Southern Mouthbrooder	LC	Occurs in a wide variety of habitats from flowing waters to lakes and isolated sinkholes usually favouring vegetated areas where the current is not too strong
Tilapia sparmanii	Banded Tilapia	LC	Occurs in a widely diverse habitat, it favours areas where plant cover exists along the edges of rivers, lakes or swamps and prefers shallow sheltered water and does not colonize the open water of large dams.
Enteromius mattozi	Papermouth	LC	Inhabits large pools of cooler perennial rivers; thrives in man-made impoundments
Enteromius paludinosus	Straightfin Barb	LC	Hardy species, preferring quiet, well-vegetated waters in lakes and marshes or marginal areas of larger rivers and slow-flowing streams. It is more tolerant of degraded stream conditions than other barbs

3.4 WETLAND ASSESSMENT

3.4.1 WETLAND DELINEATION AND CLASSIFICATION

During the field investigation, wetlands were identified and delineated according to the delineation procedure set out by "*A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas*", described by the Department of Water Affairs and Forestry (DWAF), 2003.

The delineation of the actual wetland boundaries used indirect indicators of prolonged saturation such as wetland plants (hydrophytes) and wetland soils (hydromorphic soils) with emphasis on the hydromorphic soils. According to the DWAF 2003 field procedure, soils at 50 cm from the surface should indicate signs of wetness (mottling and gleying).

To determine the boundaries of the wetland, soil samples were taken starting with the wettest part of the wetland and proceeding outwards at regular intervals to check for the soil wetness and vegetation indicators. Each sampling point was sampled at a depth of 0-10 cm and at 40-50 cm.

Wetlands were classified using a Munsell Soil Colour Chart, including the use of soil and vegetation characteristics used in the delineation of wetlands and the determination of wetland zones (Kotze *et al*., 1994).

The information recorded in the field was used as input into the Wetland Assessment Tools:

- WET-Health is an Excel based tool that formulates the appropriate information to determine the health of the wetland system. A score is provided for hydrology, geomorphology and vegetation to present the wetland with a Present Ecological State (PES) based on the scoring as per Table 6 below
- Ephemeral channels and ephemeral drainage lines will be assessed based on the application of the Intermediate Habitat Integrity (IHI) assessment for use of the rapid habitat assessment (Kemper, 1999). The assessment was based on the severity of the impacts associated with the modifications within the in-stream and riparian area. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each system

Table 6: Summary of impact scores and health category associated with changes

Description	Impact Score Range	Health Category
Unmodified, natural	0-0.9	A

Largely Natural. Slight change from natural	1-1.9	B
Moderately modified.	2-3.9	C
Largely modified	4-5.9	D
Greatly / Seriously modified	6-7.9	E
Critically modified	8-10	F

3.4.2 ECOLOGICAL IMPORTANCE AND SENSITIVITY

The Ecological Importance and Sensitivity (EIS) score was formulated according to the guidelines (DWAF, 1999). The EIS provides a guideline for the determination of the Ecological Management Class (EMC), Table 7 below. A series of 10 determinants were assessed for the EIS on a scale of 0 to 4, where 0 indicates no importance and 4, a high importance.

Table 7: Interpretation of Median Scores for the Ecological Importance and Sensitivity Categories

Ecological Importance and Sensitivity Category (EIS)	Range of Median	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. They play a major role in moderating the quantity and quality of water of major rivers.	>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. They play a role in moderating the quantity and quality of water of major rivers.	>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. They play a	>1 and <=2	C

small role in moderating the quantity and quality of water of major rivers.		
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. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

3.5 PRESENT ECOLOGICAL STATE (PES)

The results will be interpreted in accordance to the table below providing each component with a present ecological state.

Table 8: Ecological Categories (Kleynhans, 2007)

Class	Ecological Category	Description
A	Unmodified or approximate natural conditions.	High diversity of taxa with numerous sensitive taxa.
B	Largely natural with few modifications.	A change in community characteristics may have taken place but species richness and presence of intolerant species indicate little modification
C	Moderately Modified.	A lower than expected species richness and presence of most intolerant species. Some impairment of health may be evident at the lower limit of this class.
D	Largely Modified.	A clearly lower than expected species richness and absence or much lowered presence of intolerant and moderately intolerant species. Impairment of health may become more evident at the lower limit of this class.
E	Seriously Modified.	A strikingly lower than expected species richness and general absence of intolerant and moderately intolerant species. Impairment of health may become very evident.
F	Critically Modified.	An extremely lowered species richness and absence of intolerant species. Only tolerant species may be present with a complete loss of species at the lower limit of the class. Impairment of health generally very evident

4.0 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations were applicable to the study:

- A once off survey was undertaken during February 2020
- The wetland assessment was based on the previous study conducted to confirm if the wetland areas were still available
- All watercourses within a 500 m of the project area were assessed
- Watercourses in proximity of the project area were classified using WET-Health and watercourses further from the project area and potentially less impacted on a desktop basis
- DWS Risk Assessment was based on the impacts associated with wetlands within 500m of the mining infrastructure
- Construction of certain infrastructure has commenced based on prior IEA
- High rainfall was received prior to the site visit
- The report is based on information obtained prior to the site visit.

5.0 AQUATIC BASELINE ASSESSMENT

A detailed site visit was undertaken in February 2020 to determine the baseline ecological state of the aquatic ecosystems and identify any potential impacts associated with the proposed development.

5.1 IN-SITU WATER QUALITY

In-situ water quality was recorded on-site during the field survey. All parameters were within the guideline values except for the electrical conductivity (EC) at both sites (BKB-U and BKB-D). The elevated EC levels could be due to the increase in TDS within the river as the high rainfall has caused sediment to wash down the river.

Table 9: *In-situ* Water Quality data

Site	Date	Time	pH	Temp	EC	Salinity	DO (mg/L)
DWAF Ecosystem Guideline			**6.5 -9.0**		**<154**		**>5.0**
BKB – U	27/02/2020	10:40	7,5	26,6	320	5,43	66,5
BKB – D	27/02/2020	14:01	7,1	26,4	170	4,41	56,5

The water clarity was very low at both sites due to excessive siltation. The sampled sites are also impacted by livestock which were observed during the site visit.

5.2 INVERTEBRATE HABITAT ASSESSMENT (IHAS)

The Elands river has a variety of habitat and biotopes available for macro-invertebrates. The sampled river reach had shallow slow flowing water at the upstream point, and shallow to deep slow flowing water at the downstream point.

The most dominant biotope upstream (BKB-U) was stones in and out of current, bedrock and boulders along with limited marginal vegetation and GSM, with no aquatic vegetation. The downstream point (BKB-D) was dominated by GSM, stones out of current and marginal vegetation. There was no aquatic vegetation or stones in current. Both sites had slow flowing runs and pools, with no significant riffles or rapids observed.

Both BKB-U and BKB-D had all three biotopes (stones, vegetation, Gravel Sand and Mud (GSM)) available for sampling. BKB-D did not have stones in current, only stones out of current were sampled for the stones biotope.

5.2.1 BKB-U

The habitat assessment provides information on the habitat availability for macro invertebrates within an aquatic ecosystem. The IHAS score indicates that adequate habitat was available at the site, as it had an IHAS score of 58%. Sampling was limited to a stones and bedrock dominated shallow reach of the Elands River. There was sufficient GSM and limited marginal vegetation present at the site. The low flow exposed some sections of the bedrock-dominated site, leaving them exposed and dried out.

5.2.2 BKB-D

BKB-D had an IHAS score of 44%, indicating that there was inadequate habitat available for macro-invertebrates within the aquatic ecosystem. The downstream site was dominated by sand and marginal vegetation out of current. It also had limited stones out of current, gravel and mud. The site had shallow and deep sections which were accessible for sampling.

5.3 AQUATIC INVERTEBRATES

The proposed Ecological Category (EC) for the reach of the Elands River is a category D (Largely Modified). The SASS 5 protocol was used to sample macro-invertebrate assemblages of both BKB-U and BKB-D. Although the water levels and flow were low, the sampling sites provided sufficient habitat to allow for the sampling of macro-invertebrates.

5.3.1 BKB-U

The macro-invertebrate assemblage recorded from the SASS5 sampling protocol that was used indicated that there were 22 taxa. The assemblage had a SASS score of 89 and an Average Score per Taxa (ASPT) of 4.0. The most sensitive taxa recorded were Atyidae (Freshwater Shrimps) and Elmidae/Dryopidae (Riffle beetles).

The habitat available was limited and the water was shallow and had an almost constant slow to no flow throughout the sampled area. The SASS score and ASPT categorises the site in an ecological category C (Moderately Modified) with some pollutant intolerant taxa available.

The Macroinvertebrate Response Assessment Index (MIRAI) was used to provide a habitat-based cause and affect foundation to interpret the deviation of the aquatic community from the reference condition. The results from MIRAI categorise the Ecological category of the Elands River as a Category D) Largely Modified.

Table 10: Invertebrate EC: Based on weights of metric groups

INVERTEBRATE EC METRIC GROUP	METRIC GROUP CALCULATED SCORE

FLOW MODIFICATION	**FM**	50.6
HABITAT	**H**	54.6
WATER QUALITY	**WQ**	53.7
CONNECTIVITY & SEASONALITY	**CS**	60
INVERTEBRATE EC		54.4
INVERTEBRATE EC CATEGORY		**D**

5.3.2 BKB-D

The macroinvertebrate assemblage sampled using the SASS5 sampling protocol indicated that there were 22 taxa. The assemblage had a SASS score of 94 and an Average Score per Taxa (ASPT) of 4.3. The most sensitive taxa recorded were Atyidae (freshwater shrimps), hydracarina (mites) and Lestidae (emerald damselflies/spreadwings).

The available habitat was dominated by marginal vegetation and sand (both out of current). The other biotopes were limited (stones out of current (SOOC), gravel and mud). However, stones in current (SIC), bedrock, aquatic vegetation and marginal vegetation in current were not available. The sampled area had shallow and deep portions, but the water velocity was slow throughout.

The SASS score and ASPT categorises the site in an ecological category C (Moderately Modified) which indicates that there is a presence of pollution intolerant and moderately intolerant species. This ecological category is higher than the recommended ecological category set out for this stretch of river which is Category D – Largely Modified.

The Macroinvertebrate Response Assessment Index (MIRAI) was used to provide a habitat-based cause and affect foundation to interpret the deviation of the aquatic community from the reference condition. The results from MIRAI categorise the Ecological category of the Elands River as a Category D) Largely Modified.

Table 11: Invertebrate EC: Based on weights of metric groups

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE
FLOW MODIFICATION	**FM**	50.6
HABITAT	**H**	54.6
WATER QUALITY	**WQ**	53.7
CONNECTIVITY & SEASONALITY	**CS**	60
INVERTEBRATE EC		54.4
INVERTEBRATE EC CATEGORY		**D**

5.4 ICHTYOFUANA (FISH)

Fish sampling was done by electro shocking which was limited to accessible areas within the stretch of river. Water clarity also played a role in sampling, as visibility was limited. The ecological category for the reach of the Elands River was a category D.

5.4.1 BKB-U

Three of the eleven expected fish species within the reach of the Elands River was recorded during the survey. The reference condition fish species was based on previous studies done on the Elands River as well as the DWS database. *Enteromius paludinosus* was the most abundant of the species recorded. Only one expected species within the river reach, *Oreochromis mossambicus,* was of conservation importance according to the IUCN red data list being listed as Vulnerable. All other expected fish species were of Least Concern. Very low abundance of fish was recorded during the survey as water levels were low and slow. The water was also very turbid with high suspended solids within the water column. The fish assemblage index categorised the site as a Category E (Seriously Modified).

The FRAI results categorised the river reach in a Category D (Largely Modified) which is the same as the reference condition for the Elands River.

5.4.2 BKB-D

Four of the eleven expected fish species within the reach of the Elands River was recorded during the survey. The reference condition fish species was based on previous studies done on the Elands River as well as the DWS database. *Enteromius paludinosus* was the most abundant of the species recorded. The invasive species *Gambusia affinis* (Mosquito Fish) was recorded at the site. *G. affinis* occurs in most habitats, being most abundant in shallow water with vegetation. The fish assemblage index categorised the site as a Category E (Seriously Modified).

The FRAI results categorised the river reach in a Category D (Largely Modified) which is the same as the reference condition for the Elands River.

6.0 WETLAND BASELINE ASSESSMENT

The National Water Act, Act 36 of 1998, defines wetlands as follows:

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

A baseline wetland and watercourse delineation study was undertaken by De Castro & Brits Ecological Consultants in March 2016 as part of the integrated environmental authorisation process. As part of the current study these identified wetland and water courses were confirmed and assessed during the survey as all water courses within 500 m of the project area will require a Section 21 (c) and (i) water use licence (WUL).

Three HGM units were identified during the survey as illustrated in the figures below.

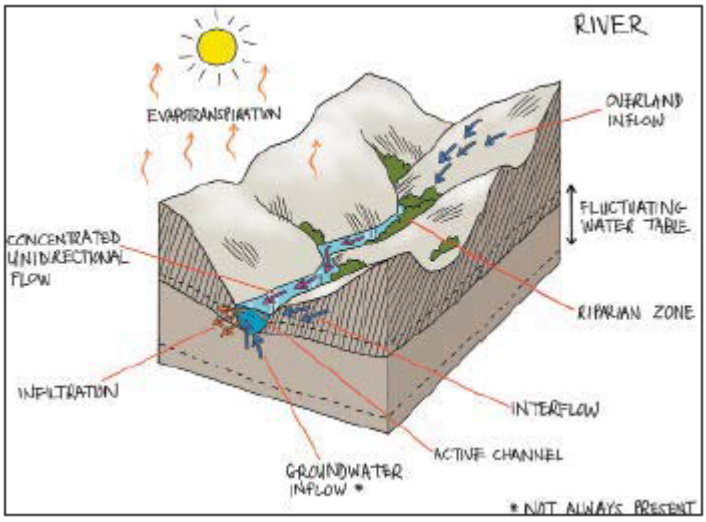

Figure 4: Conceptual illustration of a river (SANBI, 2013)

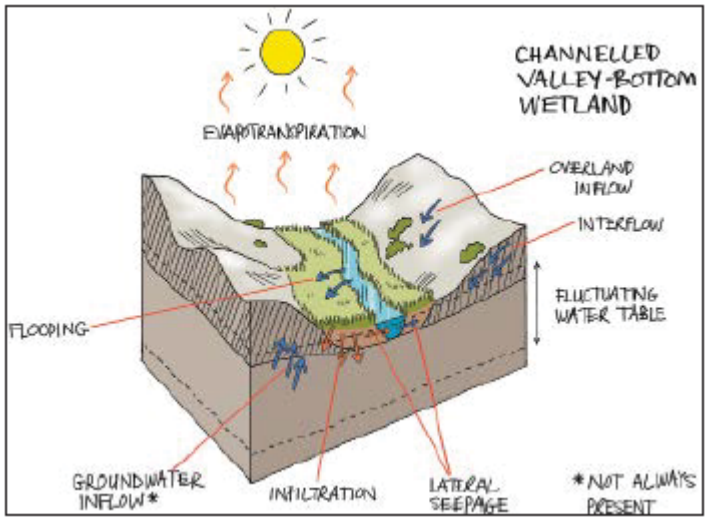

Figure 5: Conceptual illustration of a channeled valley-bottom wetland (SANBI, 2013)

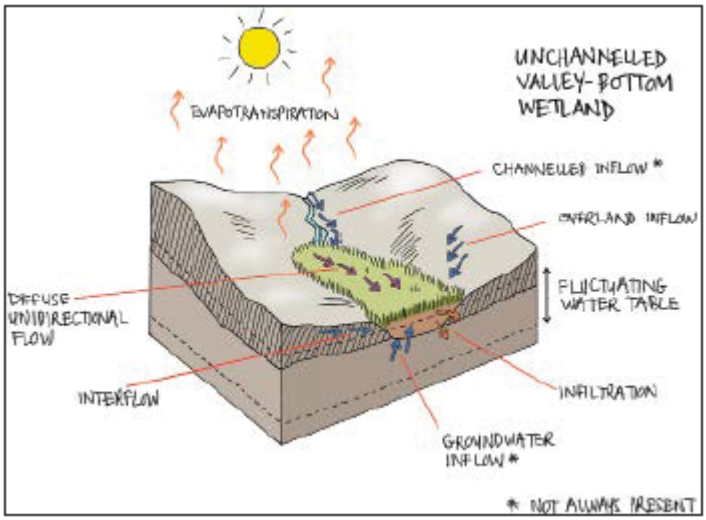

Figure 6: Conceptual illustration of a unchanneled valley-bottom wetland (SANBI, 2013)

The table below indicate the watercourses identified during the site survey:

Table 12: HGM units identified during the survey numbered in accordance to Figure 7

No	HGM Unit	Description	Size (Ha)
1	Ephemeral Channel	Located north west of project area and drains into small dam	0.52
2	Ephemeral Channel	North of project area channel that receives storm water run-off from the R556 and surrounding areas. Drains into an ephemeral dam	0.3
3	Ephemeral Channel	North of project area channel that receives storm water run-off from the R556 and surrounding areas. Drains into an ephemeral dam	0.25
4	Ephemeral Channel	The channel drains from the dam south towards the project area. The channel feeds the valley bottom wetland.	0.99
5	Ephemeral Channel	The channel originates to the north towards the Pilanesberg and receives surface water run-off from the catchment draining south adjacent to the project area where it joins the Elands River downstream of the mine.	11.97
6	Ephemeral Channel	Located to the south the channel drains into the Elands River	0.20
7	Ephemeral Channel	Channel towards the south west of the project area that drains south	1.45
8	Unchanneled Valley Bottom	Wetland located north of the project area, receives water from the upstream catchment. Due to some construction activities the wetland has been divided in two parts.	5.16
9	Channelled Valley Bottom	Drains south into the Sandspruit. The channel flows under the R565.	1.32
10	Ephemeral Drainage Channel	Drainage channel draining the mining area. The channel receives run-off from the cleared areas within the project area.	0.13
11	Ephemeral Drainage Channel	Drainage channel draining the mining area. The channel receives run-off from the cleared areas within the project area.	0.70
12	Ephemeral Drainage Channel	Located on the southern bank of the Elands River. The drainage channels was assessed as it falls within the 500 m buffer zone	0.28

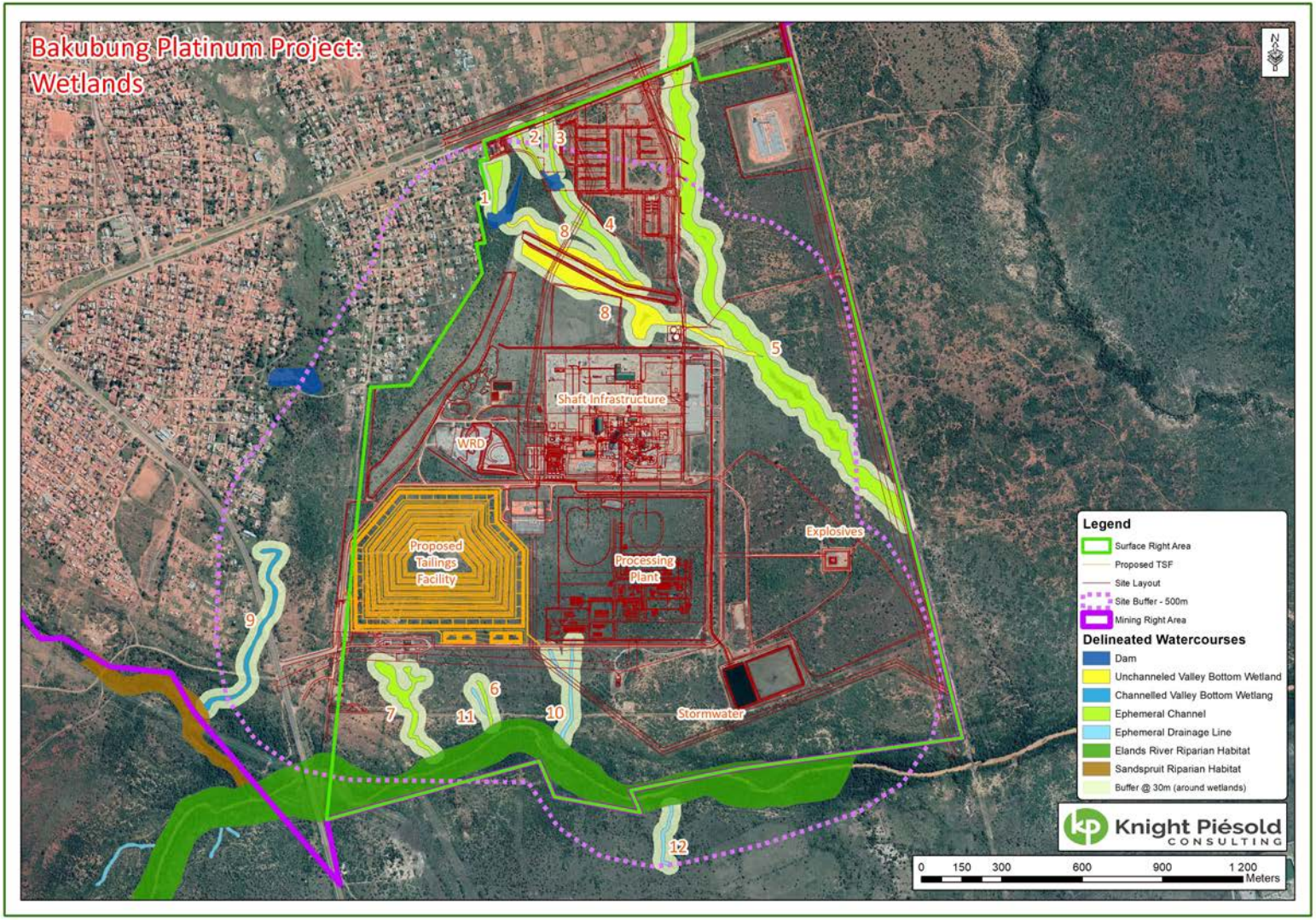

Figure 7: Delineated watercourse areas and associated buffers

6.1 EPHEMERAL CHANNELS

Seven ephemeral channels were identified during the site survey. Ephemeral channels only flow during rainfall periods and the flow is short lived as it is dependent on the inflow of water. Each channel was assessed based on the in-stream characteristics using the IHI method to determine the PES. According to the National Water Act, 1998 the instream habitat “includes the physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse”.

The IHI method is a rapid method to assess the PES for such channels as these wetlands are difficult to assess using the WET-Health tools. The table below show the PES for each of these channels.

Table 13: Present Ecological State of Ephemeral Channels assessed during site visit

Instream Criteria	Ephemeral Channel 1	Ephemeral Channel 2	Ephemeral Channel 3	Ephemeral Channel 4	Ephemeral Channel 5	Ephemeral Channel 6	Ephemeral Channel 7
Water Abstraction	0.0	0.0	0.0	0.0	3.2	0.0	0.0
Flow Modification	10.0	10.0	10.0	11.2	6.0	3.2	10.0
Bed Modification	3.6	4.0	4.0	6.7	3.6	4.0	3.6
Channel Modification	2.8	4.0	4.0	5.6	6.0	4.0	2.8
Extent of inundation	0.0	0.0	0.0	0.0	4.0	0.0	0.0
Water Quality	4.0	2.0	4.0	2.8	6.0	8.0	4.0
Presence Exotic macrophytes	5.2	4.0	4.0	4.5	0.0	4.0	6.0
Presence of Exotic fauna	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Presence of Solid Waste Disposal	0.0	2.0	3.2	0.0	4.0	0.0	2.0
Total Score (%) IHI	**74.4**	**74.0**	**70.8**	**69.2**	**67.2**	**76.8**	**71.6**
Classification	**C**	**C**	**C**	**C**	**C**	**C**	**C**

6.2 UNCHANNELED VALLEY BOTTOM WETLAND

Wetland 8 (Figure 7) was classified as a unchanneled valley bottom wetland that drains into the ephemeral channel to the east of the project area. As stated in the previous baseline report, the wetland area has been separated in two due to mining activities, as a noise berm was constructed. The construction of the area for the water tanks and road to the staff accommodation has also altered the flow of water within the wetland. No culvert has been created for the water to flow under the road and has caused water to dam on the western section. The valley bottom wetland receives water from all the ephemeral channels that flow south and flows through the wetland.

Plate 1: Unchanneled Valley Bottom Wetland looking towards the water tanks

6.2.1 PRESENT ECOLOGICAL STATE

A series of tools were designed to assist and standardise the assessment of wetland systems across South Africa. To determine the PES of the wetland, the WET-Health tool was used. Wet-Health comprises three modules: a hydrological, geomorphological and vegetation module; each one providing indicators that collectively contribute to determining the PES.

6.2.1.1 YDROLOGY

The hydrological change associated with the wetland would be the changes to water input from hardened surfaces in the catchment and the retention patterns as the wetland hydrology has been altered due to construction of certain infrastructure.

The change to the hydrology (the deviation at this site compared to a pristine site) is detrimental with a total impact score of 5.0 suggesting a health category of D, as seen in Table 14 below.

Table 14: Hydrology PES

HGM Unit	HGM Type	Impact Score	Health Category
1	valley bottom without a channel	5.0	D

6.2.1.2 GEOMORPHOLOGY

The change in geomorphology is limited to surface run off from the upstream drainage catchment and sub-surface drainage that will slightly increase the sediment load within the hydrogeomorphic (HGM) unit. The wetland has a general slope of 0.6 % that gives it a protected state of erodibility.

The impact of the modifications on the geomorphological integrity is small, with an impact score of 1.0 and a health category of B as seen in the table below.

Table 15: Geomorphology PES

HGM Unit	HGM Type	Impact Score	Health Category
1	Valley Bottom without a channel	1.0	B

6.2.1.3 VEGETATION

The valley bottom without channel located to the north of the project area is dominated by vegetation within the valley due to some sedimentation washing down from the catchment. Vegetation is dominated by grasses and sedges to the middle of the wetland area. Very little shrubs were recorded in the project area. An overall impact score of 3.0 was obtained, categorising the vegetation PES as category C as seen in Table 16 below.

Table 16: Vegetation PES

HGM Unit	HGM Type	Impact Score	Health Category
1	Valley Bottom without a channel	3.0	C

6.2.1.4 OVERALL HEALTH FOR THE WETLAND

The overall WET Health for the HGM unit within the project area, given its relative contributions from each component, indicates a health category of C. The wetland presents good vegetation cover which minimises soil erodibility and sedimentation during rainfall events. The category C wetland indicates that the wetland is in a moderately modified state.

6.3 CHANNELED VALLEY BOTTOM WETLAND

A channeled valley bottom wetland was identified to the west of the project area. The wetland drains towards the south into the Sandspruit. The wetland was confirmed during the survey but was not assessed as the mine should not have an impact on the wetland though it is located within the 500 m radius of the mining area.

6.3.1.1 DESKTOP BASED PES

A level 1 WET-Health assessment was undertaken for the channeled valley bottom wetland. The results are presented below in Table 17.

Table 17: Desktop based PES assessment (WET-Health Level 1)

Module	Impact Score	Category
Hydrology	2.1	C
Geomorphology	2.2	C
Vegetation	1.8	B
Overall Health score for wetland	**2.0**	**C**

6.4 EPHEMERAL DRAINAGE LINE

There is currently no prescribed method for the determination of the PES for drainage lines but for the purpose of the survey the IHI method will be adapted to use the in-stream assessment. The drainage lines are located to the south of the project area draining into the Elands river. The drainage lines might be impacted due to surface water run-off from the mining area. The table below indicate the PES associated with the three drainage lines.

Table 18: PES for delineated drainage lines based

Instream Criteria	Ephemeral Drainage Line 10	Ephemeral Drainage Line 11	Ephemeral Drainage Line 12
Water Abstraction	0.0	0.0	0.0
Flow Modification	4.8	6.0	5.6
Bed Modification	4.0	4.0	3.2
Channel Modification	4.0	4.0	4.0
Extent of inundation	0.0	0.0	0.0
Water Quality	2.0	4.0	2.0
Presence Exotic macrophytes	4.0	4.0	3.2
Presence of Exotic fauna	0.0	0.0	0.0
Presence of Solid Waste Disposal	0.0	0.0	0.0
Total Score (%) IHI	**81.2**	**78.0**	**82.0**
Classification	**B**	**C**	**B**

The overall ecological state for the drainage lines are a Category B (Largely Natural) with the current impacts associated. The drainage lines might deteriorate in future as the surface run-off might increase or the drainage lines be lost due to construction of additional surface infrastructure.

6.5 ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS) ASSESSMENTS

According to the DWAF 1999, “ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system’s ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity provides a guideline for determination of the Ecological Management Class (EMC).

The EIS was conducted according to the DWAF guidelines (1999) for the one HGM unit found in the wetland system. Results for the EIS are presented in Table 19 below.

6.6 BAKUBUNG INFRASTRUCTURE

The North West Agriculture, Conservation and Environment do not have specific buffer zones pertaining to wetlands and as such the Gauteng Department of Agriculture and Rural Development (GDARD) requirements for biodiversity assessments guidelines were applied. The guidelines require a 30 m buffer zone for wetlands inside urban areas and were applied to the delineated wetlands. Although surface infrastructure has already commenced at Bakubung, it is recommended that a 30 m buffer zone (Figure 7) around the wetland areas be implemented.

Table 19: Interpretation of median scores for biotic and habitat determinants to determine the EIS

Determinant	Ephemeral Channel (1)	Ephemeral Channel (2)	Ephemeral Channel (3)	Ephemeral Channel (4)	Ephemeral Channel (5)	Ephemeral Channel (6)	Ephemeral Channel (7)	Valley Bottom without a Channel (8)	Valley Bottom with a Channel (9)	Ephemeral Drainage Line (10)	Ephemeral Drainage Line (11)	Ephemeral Drainage Line (12)
PRIMARY DETERMINANTS												
Rare & Endangered Species	1	1	1	1	1	1	1	1	1	0	0	0
Populations of Unique Species	1	1	1	1	1	1	1	1	1	0	0	0
Species/taxon Richness	0	0	0	0	2	0	0	2	2	0	0	0
Diversity of Habitat Types or Features	1	1	1	1	2	1	1	2	2	1	1	1
Migration route/breeding and feeding site for wetland species	1	1	1	1	1	1	1	1	1	1	1	1
Sensitivity to Changes in the Natural Hydrological Regime	2	2	2	2	3	2	2	2	2	2	2	2
Sensitivity to Water Quality Changes	2	2	2	2	4	2	2	4	4	1	1	1
Flood Storage, Energy Dissipation & Particulate/Element Removal	3	3	3	3	3	3	1	3	3	3	3	3
MODIFYING DETERMINANTS												
Protected Status	0	0	0	0	0	0	0	0	0	0	0	0
Ecological Integrity	1	1	1	1	3	1	1	3	3	1	1	1
TOTAL	12	12	12	12	20	12	10	19	19	9	9	9
MEDIAN	1	1	1	1	2	1	1	2	2	1	1	1
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**Low/Marginal**	**Low/Marginal**	**Low/Marginal**	**Low/Marginal**	**Moderate**	**Low/Marginal**	**Low/Marginal**	**Moderate**	**Moderate**	**Low/Marginal**	**Low/Marginal**	**Low/Marginal**
Ecological Management Class	**D**	**D**	**D**	**D**	**C**	**D**	**D**	**C**	**C**	**D**	**D**	**D**

7.0 IMPACT ASSESSMENT AND PROPOSED MITIGATIONS

The impact rating system was adopted by Knight Piésold (Pty) Ltd and the same system will be used to standardise the impact ratings.

7.1 DEFINING THE NATURE OF THE IMPACT

An impact is essentially any change to a resource or receptor brought about by the presence of the proposed project component or by the execution of a proposed project related activity. The terminology used to define the nature of an impact is detailed in below.

Table 20: Impact Nature

Term	Definition
Positive (+)	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative (-)	An impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor.
Direct impact (D)	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (e.g. between occupation of a site and the pre-existing habitats or between an effluent discharge and receiving water quality).
Indirect impact (I)	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (e.g. in-migration for employment placing a demand on resources).
Cumulative impact (C)	Impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project.

7.2 ASSESSING SIGNIFICANCE

The Knight Piésold impact significance rating system is based on the following equation:

Significance of Environmental / Social Impact = Consequence x Probability

The consequence of an impact can be derived from the following factors:

Severity / Magnitude – the degree of change brought about in the environment

Reversibility - the ability of the receptor to recover after an impact has occurred

Duration - how long the impact may be prevalent

Spatial Extent - the physical area which could be affected by an impact.

The severity, reversibility, duration, and spatial extent are ranked using the criteria indicated in Table 21 and then the overall consequence is determined by adding up the individual scores and multiplying it by the overall probability (the likelihood of such an impact occurring). Once a score has been determined, this is checked against the significance descriptions indicated in Table 22.

Table 21: Ranking Criteria

Severity / magnitude (M)	Reversibility (R)	Duration (D)	Spatial extent (S)	Probability (P)
5 – Very high – The impact causes the characteristics of the receiving environment/ social receptor to be altered by a factor of 80 – 100 %	**5 – Irreversible** – *Environmental* - where natural functions or ecological processes are altered to the extent that it will permanently cease. *Social* - Those affected will not be able to adapt to changes and continue to maintain-pre impact livelihoods.	**5 – Permanent** - Impacts that cause a permanent change in the affected receptor or resource (e.g. removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.	**5 – International** - Impacts that affect internationally important resources such as areas protected by international conventions, international waters etc.	**5 – Definite** - The impact will occur.
4 – High – The impact alters the characteristics of the receiving environment/ social receptor by a factor of 60 – 80 %		**4 – Long term** - impacts that will continue for the life of the Project, but ceases when the Project stops operating.	**4 – National** - Impacts that affect nationally important environmental resources or affect an area that is nationally important/ or have macro-economic consequences.	**4 – High probability** – 80% likelihood that the impact will occur
3 – Moderate – The impact alters the characteristics of the receiving environment/ social receptor by a factor of 40 – 60 %	**3 – Recoverable** *Environmental* - where the affected environment is altered but natural functions and ecological processes may continue or recover with human input. *Social* - Able to adapt with some difficulty and maintain pre-impact livelihoods but only with a degree of support or intervention.	**3 – Medium term** - Impacts are predicted to be of medium duration (5 – 15 years)	**3 – Regional** - Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries, habitat type/ecosystem.	**3 – Medium probability** – 60% likelihood that the impact will occur u

Severity / magnitude (M)	Reversibility (R)	Duration (D)	Spatial extent (S)	Probability (P)
2 – Low – The impact alters the characteristics of the receiving environment/ social receptor by a factor of 20 – 40 %		**2 – Short term** - Impacts are predicted to be of short duration (0 – 5 years)	**2 – Local** - Impacts that affect an area in a radius of 2 km around the site.	**2 – Low probability** - 40% likelihood that the impact will occur
1 – Minor – The impact causes very little change to the characteristics of the receiving environment/ social receptor and the alteration is less than 20 %	**1 – Reversible** *Environmental* - The impact affects the environment in such a way that natural functions and ecological processes are able to regenerate naturally. *Social* - People/ communities are able to adapt with relative ease and maintain pre-impact livelihoods.	**1 – Temporary -** Impacts are predicted to intermittent/ occasional over a short period.	**1 – Site only** - Impacts that are limited to the site boundaries.	**1 – Improbable** - 20% likelihood that the impact will occur

Table 22: Significance Definitions

Score According to Impact Assessment Matrix	Significance Definitions	Colour Scale Ratings	
		Negative Ratings	Positive Ratings
Between 0 and 29 significance points indicate **Low Significance**	An impact of low significance is one where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value.	**Low**	**Low**
Between 30 and 59 significance points indicate **Moderate Significance**	An impact of moderate significance is one within accepted limits and standards. The impact on the receptor will be noticeable and the normal functioning is altered, but the baseline condition prevail, albeit in a modified state. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is As Low As Reasonably Practicable (ALARP). This does not necessarily mean that "moderate" impacts have to be reduced to "low" impacts, but that moderate impacts are being managed effectively and efficiently to not exceed accepted standards.	**Moderate**	**Moderate**
60 to 100 significance points indicate **High Significance**	An impact of high significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An impact with high significance will completely modify the baseline conditions. A goal of the ESIA process is to get to a position where the Project does not have any high negative residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be high residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors, such as employment, in coming to a decision on the Project.	**High**	**High**

7.3 IMPACT RATING AND MITIGATION MEASURES

7.3.1 LOSS OF WATERCOURSE HABITATS

The construction of surface infrastructure on the mining area could impact on the watercourse habitat. The site layout indicates some overlap into the delineated watercourse areas as well as linear infrastructure that will cross the watercourses. The significance of the impact is deemed to be High before mitigation and Moderate with mitigation measures implemented.

Magnitude

The watercourses within the project area range from a class B to a class C with a moderate EIS thus the magnitude of the habitat loss is Very High. The impact will alter the watercourse permanently as wetland habitat will be lost.

Reversibility

The impact will not be reversible as wetland habitat will be permanently lost.

Duration

The impact of watercourse habitat loss will start during the construction phase until decommissioning and therefore seen as a long-term impact.

Spatial extent

The clearing of watercourse habitat will be confined to the mining area and thus the spatial extent will be site only.

Probability

The valley bottom wetland without a channel has already been altered by the construction of a noise berm. The site layout plans indicate that certain infrastructure will overlap into the delineated watercourse areas which will lead to further habitat loss. The probability of habitat loss is therefore scored as a high probability as this impact will most likely occur.

Significance

The significance of the impact is deemed to be High before mitigation and Moderate with mitigation measures implemented.

7.3.1.1 MITIGATION MEASURES

- Proposed infrastructure that overlap with the delineated watercourses should be re-aligned or design alternatives should be considered to avoid the watercourse areas
- The proposed 30 m buffer zone around the watercourses should implemented
- Proposed linear infrastructure should be designed to limit the habitat loss
- If the wetland areas can not be avoided by the proposed roads or pipelines, design alternatives should be considered to not impact or alter the functionality or ecological state of the wetlands
- The wetland areas should be demarcated during construction to ensure that no construction activities occur within these areas
- A watercourse rehabilitation programme should be implemented

7.3.2 SEDIMENT MOBILISATION

The increase surface water runoff from stockpiles, hardened surfaces and areas cleared of vegetation could lead to the deposition of sediment and increase erosion within the watercourses. The ecological and hydrological integrity of the watercourses will be altered.

Magnitude

The magnitude of the impact is scored as very high before mitigation as the increase in run-off and sediment within the watercourses will alter the ecological and hydrological integrity of the system. Post mitigation the magnitude will be moderate as the impact can be mitigated.

Reversibility

The impact is reversible, as human input can assist to recover the ecological functionality of the system if impacted.

Duration

Sediment mobilisation is scored as a medium-term impact as the system will recover or change its function within 5 – 15 years. The impact is expected during the construction and operation phase but should minimise during closure or decommissioning.

Spatial extent

The spatial extent will be regional as the deposition of sediment within the watercourses could impact on the Elands River further downstream as the sediment build up or the increase in erosion will wash down during high rainfall events.

Probability

The construction of the infrastructure will require vegetation to be cleared and additional hardened surfaces to be constructed that will increase the surface run-off and sediment to be washed into the watercourses. The impact is scored as a high probability in this regard.

Significance

The significance of the impact is scored Moderate pre and post mitigation measures.

7.3.2.1 MITIGATION MEASURES

- A stormwater management system will be required to attenuate flood peak events
- Stormwater outflows should not be allowed to enter directly into watercourses but be attenuated before they are released
- A watercourse rehabilitation plan should be developed for impacts not successfully mitigated
- Buffer zones should be implemented.

7.3.3 SURFACE WATER POLLUTION

Water quality in the watercourses could be impacted by sedimentation or by project related impacts such as spills and surface run-off from stockpile areas and the TSF.

Magnitude

The magnitude of the alteration of water quality within the watercourse is scored as being high as a spill could have a severe impact on the natural receiving environment.

Reversibility

The impact on the watercourses will be recoverable over time.

Duration

The duration will be medium term as the functionality will return.

Spatial extent

The alteration in water quality depending on the severity will have a regional impact as the watercourses all drain into the Elands River. Such impacts should be contained.

Probability

The probability of a hazardous spill is deemed to be low, although possible. The impact is deemed to be improbable during the closure phase

Significance

The significance of the impact is deemed to be Low before and after mitigation.

7.3.3.1 MITIGATION MEASURES

- Stormwater measures should be implemented around stockpile areas
- Pipelines should be designed to contain any possible spillages as emergency measures
- Routine monitoring of pipelines should be conducted
- Internal TSF inspections should be done quarterly to ensure safety and stability
- Stockpiles should be designed to contain and prevent erosion during high rainfall events
- No refuelling should occur in close proximity to any watercourse. A designed re-fuelling area should be constructed
- Hazardous products should be stored in hazardous material zone with a bunded area.

7.3.4 ENCROACHMENT OF ALIEN VEGETATION

The establishment and encroachment of alien plant species in watercourses, specifically after construction activities have created disturbances within watercourse habitats that opportunistic alien species can utilise.

Magnitude

The encroachment of alien vegetation is rated as high as alien vegetation was observed during the site survey.

Reversibility

The impact is recoverable through human input.

Duration

The duration will be short term as it can be mitigated and prevented. The impact will only be during the construction phase as mitigation and monitoring measures should be implemented during operation.

Spatial extent

The encroachment of alien vegetation will be local as the impact will only affect the direct watercourse.

Probability

The impact is ranked as a medium probability as construction within the watercourses could be avoided or minimised.

Significance

The significance of alien encroachment is ranked as being a Moderate impact before and after mitigation as the impact can be mitigated and controlled.

7.3.4.1 MITIGATION MEASURES

- Develop and implement an alien vegetation control plan to limit and manage the spread of alien vegetation within watercourses.

7.4 MONITORING RECOMMENDATIONS

During the construction and operational phase of the mining activities the following monitoring recommendations are made to monitor and ensure implementation of the proposed mitigation measures:

- Weekly monitoring by an Environmental Control Officer (ECO) during the construction phase to ensure construction activities are restricted to infrastructure footprints
- Sediment and storm water control measures should be monitored and maintained especially during the wet season
- ECO to ensure that wetlands and buffer zones are identified and visibly marked during the construction phase
- Proposed alien vegetation control plan should include a monitoring phase or protocol to ensure the encroachment of alien vegetation is monitored
- Annual inspections should be conducted by the Engineer of Record on the TSF and stockpiles

8.0 WATER USE LICENCE

The construction of the new TSF that falls within 500 m of delineated wetlands triggers a *Section 21 (c): impeding or diverting the flow of water in a watercourse and 21 (i): altering bed, banks, course or characteristics of a watercourse* according to the National Water Act, 1998. The proposed activities associated with the delineated aquatic systems, due to the nature of the system and the impacts associated with the development, could be Generally Authorised by the Department of Water and Sanitation (DWS). In this regard a DWS 23 Risk Assessment Matrix was compiled on activities in delineated aquatic systems that could require water use licence authorisation. The Risk Matrix will assist DWS to determine if the activity can be Generally Authorised (GA) according to Notice 509 of 2016 (Government Gazette No. 40229).

8.1 DWS 23 RISK ASSESSMENT

The prescribed risk matrix in terms of Notice 509 is presented in Annexure A and summarised in the table below. The risk matrix indicates that the risks identified are categorised as Low after mitigation measures. The nature of the aquatic ecosystems is of such a nature that the impact of the TSF is seen as Low, as long as the impact on the systems is mitigated. The author of this report is of the professional opinion that the wetlands within 500m from the mine infrastructure can obtain a General Authorisation in terms of the National Water Act Section 21.

Table 23: Summarised DWS Risk Matrix

Nr.	Phases	Activity	Aspect	Impact	Significance	Risk Rating	Control Measures	Borderline LOW MODERATE Rating Classes	Type Watercourse
1	Construction Phase	Construction of Tailings Storage Facility (TSF)	Construction of TSF within 500 m of delineated watercourse	Sedimentation build up within the wetland	**40**	**M**	* Manage sediment and surface water run off to ensure that no sediment build up occur within the aquatic ecosystems *Stormwater management plan and measure should be implemented	15	Ephemeral Channel 7 (Class C) Ephemeral Channel 6 (Class C) Ephemeral Drainage Line 10 (Class B) Ephemeral Drainage Line 11 (Class C)
2				Surface Water Pollution	**40**	**M**	* Stormwater plan and measure should be put in place * TSF inspections should be done quarterly * TSF should be monitored during high rainfall events	15	Ephemeral Channel 7 (Class C) Ephemeral Channel 6 (Class C) Ephemeral Drainage Line 10 (Class B) Ephemeral Drainage Line 11 (Class C)
3	Operational Phase	Operation of Tailings Storage Facility (TSF)	Operation of TSF within 500m of delineated watercourse	Low water quality inputs	**40**	**M**	* Monitor TSF * Ensure storm water management plan is implemented * Run-off from TSF should be contained * Ensure freeboard on TSF and RWD	15	Ephemeral Channel 7 (Class C) Ephemeral Channel 6 (Class C) Ephemeral Drainage Line 10 (Class B) Ephemeral Drainage Line 11 (Class C)

9.0 CONCLUSION

Knight Piésold (Pty) Ltd was appointed by Bakubung Platinum Mine to undertake the aquatic assessment for the proposed amendment of the IEA. A comprehensive site visit was undertaken during February 2020 by the professional Aquatic Scientists of Knight Piésold. Table 24 below provides a summary of the delineated wetlands and assessed watercourses.

The following impacts were identified based on the proposed change in project description and delineated watercourses. The impacts are deemed to be applicable during the construction, operation and closure phase:

- Loss of watercourse habitat
- Sediment mobilisation: deposition and erosion in watercourses
- Surface water pollution
- Encroachment of alien species into watercourse.

By implementing the appropriate mitigation measures, the impacts can be reduced to acceptable levels. The specialist is therefore of the opinion that the development should be approved, and the water uses may receive a General Authorisation by the DWS.

Table 24: Summary of Results

No	HGM Unit	Description	Size (Ha)	EIS	PES
1	Ephemeral Channel	Located north west of project area and drains into small dam	0.52	D	Class C
2	Ephemeral Channel	North of project area channel that receives storm water run-off from the R556 and surrounding areas. Drains into an ephemeral dam.	0.3	D	Class C
3	Ephemeral Channel	North of project area channel that receives storm water run-off from the R556 and surrounding areas. Drains into an ephemeral dam.	0.25	D	Class C
4	Ephemeral Channel	The channel drains from the dam south towards the project area. The channel feeds the valley bottom wetland.	0.99	D	Class C
5	Ephemeral Channel	The channel originates to the North towards the Pilanesberg and receives surface water run-off from the catchment draining south adjacent to the project area where it joins the Elands River downstream of the mine.	11.97	C	Class C
6	Ephemeral Channel	Located to the south the channel drains into the Elands river	0.20	D	Class C
7	Ephemeral Channel	Channel towards the south west of the project area that drains south	1.45	D	Class C
8	Unchanneled Valley Bottom	Wetland located north of the project area receives water from the upstream catchment. Due to some construction activities the wetland has been divided in two parts.	5.16	C	Class C
9	Channelled Valley Bottom	Drains south into the Sandspruit. The channel flows under the R565.	1.32	C	Class C
10	Ephemeral Drainage Channel	Drainage channel draining the mining area. The channel receives run-off from the cleared areas within the project area.	0.13	D	Class B
11	Ephemeral Drainage Channel	Drainage channel draining the mining area. The channel receives run-off from the cleared areas within the project area.	0.70	D	Class C
12	Ephemeral Drainage Channel	Located on the southern bank of the Elands River the drainage channels were assessed as it falls within the 500m buffer zone	0.28	D	Class B
BKB-U	Upstream Monitoring site	Upstream of Bakubung	-	-	Class D

No	HGM Unit	Description	Size (Ha)	EIS	PES
	Elands River				
BKB-D	Downstream Monitoring Site Elands River	Downstream of Bakubung	-	-	Class D

10.0 REFERENCES

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Certification

This report was prepared and reviewed by the undersigned.

Prepared:

Neal Neervoort, Pr.Sci.Nat.
Snr. Aquatic Scientist

Reviewed:

Amelia Briel, Pr.Sci.Nat.
Section Manager: Environment

Approval that this document adheres to Knight Piésold Quality Systems: AB

APPENDIX A1

Curriculum Vitae

NEAL NEERVOORT (Pr. Sci. Nat.)

SENIOR AQUATIC ECOLOGIST

Neal Neervoort is a Senior Aquatic Ecologist /Senior Environmental Scientist with eleven years of working experience as a registered professional scientist in the Environmental Management and Aquatic Science fields. He is based in the Rivonia KP South Africa branch with vast experience across Africa. He has an aquatic ecology background as a Wetland Assessment Practitioner and DWS: SASS 5 Accredited Practitioner. Neal has been involved in various aquatic specialist studies as part of Environmental Processes and standalone projects. In the Environmental Management field, he has experience across Africa implementing Water Monitoring Programmes, Air Quality Monitoring Programmes, Environmental Compliance Audits, Water Use Licence Applications, Scoping Studies and Environmental Impact Assessments.

Knight Piésold (Pty) Ltd.
South Africa

REGISTRATIONS / CERTIFICATIONS

- SACNASP, South African Council of Natural Scientific Professions, Pr.Sci.Nat No 115316
- Department of Water and Sanitation: SASS 5 Accredited Practitioner
- Certificate of Competence: Tools for Wetland Assessment Course

SPECIFIC RELEVANT EXPERIENCE

- **Johannesburg Water Aquatic Monitoring of Waste Water Treatment Works:** Conduct bi-annual aquatic bio-monitoring, monthly water sampling, bi-monthly diatom sampling and bi-monthly toxicity testing at various WWTW.
- **Mutanda Mine, DRC:** Responsible for the project management and update of the Environmental and Social Impact Study (ESIS).
- **Lufubu Hydropower Scheme, Zambia:** Amendment of the ESIA and undertake the EWR study associated with the hydropower.
- **Kinsevere Copper Mine, DRC:** Responsible for the design and implementation of an extensive groundwater and potable water monitoring programme, including analysis of laboratory results and reporting as well as conducting Bi-annual aquatic bio-monitoring.
- **Ethemba Dam Environmental and Social Impact Assessment, Swaziland:** Project manager and compilation of the ESIA associated with the Dam.
- **ERWAT Aquatic Monitoring:** Conduct quarterly aquatic monitoring including toxicity and diatom analysis at 19 water care works within the Ekurhuleni area.
- **Aquatic Assessment of Olushandja Dam:** Aquatic screening and bio-accumulation study for the Olushandja Bulk Water Supply project.
- **Nampower Water Quality Monitoring:** Develop water monitoring programme for three power stations in Namibia.
- **City of Johannesburg State of Rivers:** Manage and conduct the annual State of Rivers project for the City of Johannesburg.
- **Bronkhorstspruit Aquatic Assessment:** Conduct aquatic and wetland assessment for proposed development in Bronkhorstspruit.
- **Umshwathi Bulk Water Supply Aquatic Assessment:** Conduct aquatic assessment for the proposed bulk water supply in Umshwathi, KZN.
- **Initial Environmental Evaluation (IEE) for Ezulwini Sustainable Water Supply Project, Swaziland:** Compile and management the IEE for the Ezulwini Sustainable Water Supply Project.
- **Khorixas to Uis Environmental Scoping Report, Namibia:** Compile the Scoping Report and facilitate the public participation process for the proposed road upgrade in Namibia.

WORK HISTORY

Company Name	Position	Dates
Knight Piésold Consulting, South Africa	Senior Environmental Scientist/Environmental Scientist	2009-Date

EDUCATION

- B.Sc. Hons. Biodiversity and Conservation (University of Johannesburg), 2007
- B.Sc. Zoology & Botany (University of Johannesburg), 2006

SPECIALIZATIONS

- Aquatic and Wetland Ecology
- Environmental Management
- Water Use Licence Applications
- Ecological Water Requirements

COUNTRIES OF WORK EXPERIENCE

- South Africa
- Democratic Republic of Congo
- Swaziland
- Namibia
- Ghana
- Zambia

APPENDIX A2

Photo Report

Plate 2: Bakubung Upstream Sampling Site

Plate 3: Bakubung Downstream Monitoring Point

Plate 4: *Schilbe intermedius*

(Silver Catfish)

Plate 5: *Enteromius paludinosus*

(Straightfin Barb)

APPENDIX A3

Aquatic Macroinvertebrates

Date (dd:mm:yr):	27/02/2020				(dd.ddddd)
Site Code:	BKB - U	Grid reference (dd mm ss.s) Lat:	S	#REF!	#REF!
Collector/Sampler:	Neal Neervoort	Long:	E	#REF!	#REF!
River:		Datum (WGS84/Cape):		WGS 84	
Level 1 Ecoregion:	11: HIGHVELD	Altitude (m):			
Quaternary Catchment:		Zonation:		E: Lower Foothills	

Temp (°C):	26.40	Routine or Project? (circle one)		Flow:	
pH:	7.10	Project Name:		Clarity (cm):	2
DO (mg/L):	56.50	ERWAT		Turbidity:	
Cond (mS/m):	170.00			Colour:	
Riparian Disturbance:					
Instream Disturbance:					

Site Description:

Biotopes Sampled (tick & rate)	Rating	Weight
Stones In Current (SIC)	0	4,0
Stones Out Of Current (SOOC)	3	4,0
Bedrock	2	1,5
Aquatic Veg	0	1,0
MargVeg In Current	0	2,0
MargVeg Out Of Current	3	2,0
Gravel	0	4,0
Sand	3	2,0
Mud	2	1,0
Hand picking/Visual observation	Y	

OVERALL BIOTOPE SUITABILITY		Category
	27%	F

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1	A			A
Hirudinea (Leeches)	3		1		1
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3				
Atyidae (Freshwater Shrimps)	8	B	A	A	B
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8				
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4	A		1	A
Baetidae 2 sp	6				
Baetidae > 2 sp	12				
Caenidae (Squaregills/Cainflies)	6	A			A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9				
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9				
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10				
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		B	1	B
Lestidae (Emerald Damselflies/Spreadwing	8				
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6	1			1
Libellulidae (Darters/Skimmers)	4	1		1	A
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3		A		A
Corixidae* (Water boatmen)	3	A	A	A	B
Gerridae* (Pond skaters/Water striders)	5	A	A		B
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3		A		A
Notonectidae* (Backswimmers)	3	1	A	A	B
Pleidae* (Pygmy backswimmers)	4		1		1
Veliidae/M...veliidae* (Ripple bugs)	5		A	1	A
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6				
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5		1		1
Elmidae/Dryopidae* (Riffle beetles)	8		1		1
Gyrinidae* (Whirligig beetles)	5				A
Haliplidae* (Crawling water beetles)	5				
Helodidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles	5				
Limnichidae (Marsh-Loving Beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10				
Blepharoceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5	A			A
Chironomidae (Midges)	2	A		1	A
Culicidae* (Mosquitoes)	1		1		1
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1		1		1
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5				
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3				
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3				
Physidae* (Pouch snails)	3				
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3				
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					89
No. of Taxa					22
ASPT					4.0

Other biota:

Comments/Observations:

Date (dd:mm:yr):	27/02/2020				(dd.ddddd)	**Biotopes Sampled (tick & rate)**	**Rating**	**Weight**
Site Code:	BKB-D	**Grid reference (dd mm ss.s) Lat:**	S	#REF!	#REF!	Stones In Current (SIC)	0	4,0
Collector/Sampler:	Neal Neervoort	**Long:**	E	#REF!	#REF!	Stones Out Of Current (SOOC)	2	4,0
River:		**Datum (WGS84/Cape):**		WGS 84		Bedrock	0	1,5
Level 1 Ecoregion:	11: HIGHVELD	**Altitude (m):**				Aquatic Veg	0	1,0
Quaternary Catchment:		**Zonation:**		E: Lower Foothills		MargVeg In Current	0	2,0
	Temp (°C): 0.00	**Routine or Project? (circle one)**	Flow:			MargVeg Out Of Current	3	2,0
Site Description:	pH: 0.00	Project Name:	Clarity (cm):			Gravel	2	4,0
	DO (mg/L): 0.00	ERWAT	Turbidity:	2.5		Sand	3	2,0
	Cond (mS/m): 0.00		Colour:			Mud	2	1,0
	Riparian Disturbance:					Hand picking/Visual observation	Y	Category
	Instream Disturbance:					OVERALL BIOTOPE SUITABILITY	28%	F

Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5				
COELENTERATA (Cnidaria)	1				
TURBELLARIA (Flatworms)	3				
ANNELIDA					
Oligochaeta (Earthworms)	1			A	A
Hirudinea (Leeches)	3		1		1
CRUSTACEA					
Amphipoda (Scuds)	13				
Potamonautidae* (Crabs)	3				
Atyidae (Freshwater Shrimps)	8	1	B	1	B
Palaemonidae (Freshwater Prawns)	10				
HYDRACARINA (Mites)	8		1		1
PLECOPTERA (Stoneflies)					
Notonemouridae	14				
Perlidae	12				
EPHEMEROPTERA (Mayflies)					
Baetidae 1sp	4		1		1
Baetidae 2 sp	6				
Baetidae > 2 sp	12				
Caenidae (Squaregills/Cainflies)	6		1	A	A
Ephemeridae	15				
Heptageniidae (Flatheaded mayflies)	13				
Leptophlebiidae (Prongills)	9				
Oligoneuridae (Brushlegged mayflies)	15				
Polymitarcyidae (Pale Burrowers)	10				
Prosopistomatidae (Water specs)	15				
Teloganodidae SWC (Spiny Crawlers)	12				
Tricorythidae (Stout Crawlers)	9				
ODONATA (Dragonflies & Damselflies)					
Calopterygidae ST,T (Demoiselles)	10				
Chlorocyphidae (Jewels)	10				
Synlestidae (Chlorolestidae)(Sylphs)	8				
Coenagrionidae (Sprites and blues)	4		B	1	B
Lestidae (Emerald Damselflies/Spreadwing	8		1		1
Platycnemidae (Stream Damselflies)	10				
Protoneuridae (Threadwings)	8				
Aeshnidae (Hawkers & Emperors)	8				
Corduliidae (Cruisers)	8				
Gomphidae (Clubtails)	6	A			A
Libellulidae (Darters/Skimmers)	4		1	1	A
LEPIDOPTERA (Aquatic Caterpillars/Moths)					
Crambidae (Pyralidae)	12				

Taxon	QV	S	Veg	GSM	TOT
HEMIPTERA (Bugs)					
Belostomatidae* (Giant water bugs)	3		A		A
Corixidae* (Water boatmen)	3	1	1	A	A
Gerridae* (Pond skaters/Water striders)	5				A
Hydrometridae* (Water measurers)	6				
Naucoridae* (Creeping water bugs)	7				
Nepidae* (Water scorpions)	3		A		A
Notonectidae* (Backswimmers)	3		B	A	B
Pleidae* (Pygmy backswimmers)	4				
Veliidae/M...veliidae* (Ripple bugs)	5				
MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)					
Corydalidae (Fishflies & Dobsonflies)	8				
Sialidae (Alderflies)	6				
TRICHOPTERA (Caddisflies)					
Dipseudopsidae	10				
Ecnomidae	8				
Hydropsychidae 1 sp	4				
Hydropsychidae 2 sp	6				
Hydropsychidae > 2 sp	12				
Philopotamidae	10				
Polycentropodidae	12				
Psychomyiidae/Xiphocentronidae	8				
Cased caddis:					
Barbarochthonidae SWC	13				
Calamoceratidae ST	11				
Glossosomatidae SWC	11				
Hydroptilidae	6				
Hydrosalpingidae SWC	15				
Lepidostomatidae	10				
Leptoceridae	6		1		1
Petrothrincidae SWC	11				
Pisuliidae	10				
Sericostomatidae SWC	13				
COLEOPTERA (Beetles)					
Dytiscidae/Noteridae* (Diving beetles)	5		B		B
Elmidae/Dryopidae* (Riffle beetles)	8				
Gyrinidae* (Whirligig beetles)	5				
Haliplidae* (Crawling water beetles)	5				
Helodidae (Marsh beetles)	12				
Hydraenidae* (Minute moss beetles)	8				
Hydrophilidae* (Water scavenger beetles	5				
Limnichidae (Marsh-Loving Beetles)	10				
Psephenidae (Water Pennies)	10				

Taxon	QV	S	Veg	GSM	TOT
DIPTERA (Flies)					
Athericidae (Snipe flies)	10				
Blepharoceridae (Mountain midges)	15				
Ceratopogonidae (Biting midges)	5				
Chironomidae (Midges)	2		1		1
Culicidae* (Mosquitoes)	1				
Dixidae* (Dixid midge)	10				
Empididae (Dance flies)	6				
Ephydridae (Shore flies)	3				
Muscidae (House flies, Stable flies)	1				
Psychodidae (Moth flies)	1				
Simuliidae (Blackflies)	5				
Syrphidae* (Rat tailed maggots)	1				
Tabanidae (Horse flies)	5				
Tipulidae (Crane flies)	5				
GASTROPODA (Snails)					
Ancylidae (Limpets)	6				
Bulininae*	3		A		A
Hydrobiidae*	3				
Lymnaeidae* (Pond snails)	3		1		1
Physidae* (Pouch snails)	3		1		1
Planorbinae* (Orb snails)	3				
Thiaridae* (=Melanidae)	3			A	A
Viviparidae* ST	5				
PELECYPODA (Bivalves)					
Corbiculidae (Clams)	5				
Sphaeriidae (Pill clams)	3				
Unionidae (Perly mussels)	6				
SASS Score					94
No. of Taxa					22
ASPT					4.3

Other biota:

Comments/Observations:

APPENDIX A4

Ichthyofauna (Fish)

Expected Fish Species			
		BKB-U	BKB-D
Species Name	**Common Name**		
Enteromius trimaculatus	Threespot barb		
Clarias gariepinus	Sharptooth catfish		
Labeo molybdinus	Leaden Labeo		
Pseudocrenilabrus philander	Southern mouthbrooder		
Tilapia sparrmanii	Banded tilapia		
Enteromius marequensis	Largescale yellowfish		
Enteromius paludinosus	Straightfin barb	5	3
Oreochromis mossambicus	Mozambique tilapia		2
Enteromius mattozi	Papermouth	4	2
Mesobola brevianalis	River sardine		
Schilbe intermedius	Silver catfish	1	
Gambusia affinis	Mosquitofish		1
Time Sampled		38	
Number of fish		48	8
Number of Species		3	4
FAII Score		31.4	35.7
FAII EC		**E**	**E**
FRAI EC		**D**	**D**