ECOLOGICAL ASSESSMENT OF THE AQUATIC RESOURCES IN THE VICINITY OF THE PROPOSED TAILINGS PIPELINE, ROAD CROSSING AND BERM CONSTRUCTION FOR THE BAKUBUNG PLATINUM MINE

PREPARED FOR

SLR Consulting

Prepared by:	**Scientific Aquatic Services**
Report author:	**L. Jonker**
Report reviewer:	**S. van Staden (Pr. Sci. Nat.)**
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Scientific Aquatic Services CC
CC Reg No 2003/078943/23
Vat Reg. No. 4020235273
PO Box 751779
Gardenview
2047
Tel: 011 616 7893
Fax: 086 724 3132
E-mail: admin@sasenvironmental.co.za

EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was requested to conduct a baseline aquatic ecological assessment in the vicinity of the Wesizwe Platinum: Bakubung Platinum Mine (BPM). The purpose of the report is to provide a summary of the ecological status of the aquatic resources of this area and to assess the potential impacts of the proposed tailings pipeline, road crossing and berm construction for the Wesizwe Platinum: Bakubung Platinum Mine. The field assessment took place on the 21st of July 2015.

The following general conclusions were drawn upon completion of the Aquatic Assessment:

Physico Chemical Water Quality Assessment:

- The Electrical Conductivity (EC) values observed at both the Sandspruit and unnamed tributary of the Elands River sites can be considered as largely elevated from expected natural conditions (between 10-30 mS/m);
- Spatially the EC decreased by 5.5% between the upstream and downstream sites of the Sandspruit, and decreased by 1.5% between the upstream and downstream sites of the unnamed tributary. These spatial changes comply with the Target Water Quality Recommendations (TWQR) (DWS formerly DWAF, 1996) for aquatic ecosystems, which advocate no change greater than 15% from spatial or temporal data;
- These data also indicate that currently there is no salt loading between the two points which provides a valuable indication of baseline conditions in the system;
- The pH values observed for both the Sandspruit and unnamed tributary sites can be regarded as largely natural (absolute values between 7-8) at the time of the assessment;
- Spatially the pH increased by 4.0% between the upstream and downstream sites of the Sandspruit, and increased by 3.1% between the upstream and downstream sites of the unnamed tributary. These spatial changes comply with the TWQR (DWS formerly DWAF, 1996) for aquatic ecosystems which advocate no change greater than 5% from spatial or temporal data. Close monitoring of these trends will be required in future;
- The Dissolved Oxygen (DO) concentrations observed within both the Sandspruit and unnamed tributary sites can be regarded as adequate for supporting a diverse and sensitive aquatic community at the time of the assessment;
- Spatially the DO concentration decreased by 12.1% between the upstream and downstream sites of the Sandspruit, and decreased by 0.1% between the upstream and downstream sites of the unnamed tributary;
- Temperatures can be regarded as normal for the time of year when sampling took place.

Aquatic assessment synopsis and conclusion:

Based on the findings of the aquatic study on the Sandspruit and unnamed tributary of the Elands River, the systems are characterized by seasonal flow variation and water abstraction for agricultural purposes. The desktop Ecological Importance and Sensitivity (EIS) and Present Ecological State (PES) assessment indicates the Sandspruit and Elands River PES classifications as a Class D, Ecological Importance (EI) classified as “moderate”, Ecological Sensitivity (ES) as “moderate” and default Ecological Category (ECat) as C. Indices employed, however, yielded the following classifications:

Summary of the aquatic assessment results for the assessment sites

Source	Site	IHAS	IHIA	SASS5		MIRAI	Diatom Cell Abnormalities
				Dickens and Graham (2001)	Dallas (2007)		
Sandspruit	Bak1	Inadequate	C	E	E/F	D	0.5
	Bak2	Inadequate		E	E/F	D	3.6
Unnamed tributary of the Elands River	Bak3	Inadequate	C	F	E/F	D	9.5
	Bak4	Adequate		E	E/F	D	1.0

The current assessments indicate that conditions in the project area is deteriorated from what could be expected based on the desktop assessment. The Sandspruit and unnamed tributary of the Elands River can thus be considered as systems of reduced Ecological Importance and Sensitivity due to the limited provision of refugia and the limited support it provides to the aquatic ecology of the area. The systems are however deemed important in terms of the provision of services to the terrestrial fauna of the area as well as fair significance from a socio-cultural point of view. It is deemed essential that all effort is made to ensure that impacts on the aquatic resources as a result of the proposed tailings pipeline, road crossing and berm development are minimised.

The following general conclusions were drawn upon completion of the Impact Assessment:

Based on the above assessment it is evident that there are three possible impacts that may have an effect on the overall aquatic integrity of the Elands River and its associated tributaries. The table below summarises the findings indicating the significance of the impacts before mitigation takes place as well as the significance of the impacts if appropriate management and mitigation takes place. In the consideration of mitigation it is assumed that a high level of mitigation takes place but which does not lead to prohibitive costs.

A summary of the impact significance of the construction phase on the Elands River and its associated tributaries.

Impact	Unmanaged	Managed
1: Loss of aquatic habitat	Medium Low	Very Low
2: Impacts on aquatic hydrological function and sediment balance	Medium Low	Low
3: Loss of aquatic biodiversity and sensitive taxa	Low	Very Low

A summary of the impact significance of the operational phase on the Elands River and its associated tributaries.

Impact	Unmanaged	Managed
1: Loss of aquatic habitat	Medium Low	Very Low
2: Impacts on aquatic hydrological function and sediment balance	Low	Very Low
3: Loss of aquatic biodiversity and sensitive taxa	Low	Very Low

A summary of the impact significance of the decommissioning and closure phase on the Elands River and its associated tributaries.

Impact	Unmanaged	Managed
1: Loss of aquatic habitat	Medium Low	Very Low
2: Impacts on aquatic hydrological function and sediment balance	Medium Low	Low
3: Loss of aquatic biodiversity and sensitive taxa	Low	Very Low

From the tables it is evident that prior to mitigation, impacts on the aquatic ecological integrity of the Elands River and its associated tributaries can be considered as Medium-Low to Low level impacts. Should mitigatory measures be implemented as recommended, impacts will be reduced to Low and Very Low level impacts.

Based on the findings of this study, it can be concluded that the study area has moderate levels of ecological integrity and sensitivity. The proposed tailings pipeline, road crossing and berm is therefore likely to result in a moderate transformation of important habitats, systems, and the loss of aquatic biodiversity should impact minimization measures not be implemented adequately. Adherence to the recommended mitigation measures will assist in reducing the impact on the aquatic resources on the subject property to an overall low level.

The following recommendations were drawn upon completion of the Aquatic Assessment:

After conclusion of this aquatic assessment, it is the opinion of the ecologists that the proposed tailings pipeline, road crossing and berm development be considered favourably, provided that the recommendations below are adhered to:

- It must be ensured that planning of the tailings pipeline, road crossing and berm includes consideration of adjacent drainage line areas to ensure that these areas are avoided as far as possible;
- Keep all demarcated sensitive zones outside of the construction area off limits during construction phase;
- Limit the footprint area of the proposed project and closure activity to what is absolutely essential in order to minimise environmental damage and loss of catchment yield;
- Planning for the proposed project should not lead to a reduction of stream flow or dewatering of any water source areas and connectivity of the riparian features should be maintained;
- Any damage to the drainage lines necessary to complete the work must be limited in extent;
- Tie-in points at riverbanks must be suitably safeguarded with gabion cut-off walls to prevent erosion;
- Permit only essential construction personnel within 32m of the riparian habitat, if absolutely necessary that they enter the buffer zone;
- All areas should be monitored for erosion and incision. Specific mention is made of sedimentation of riparian areas;
- To prevent the erosion of topsoils, management measures to minimise erosion should include installation of berms, silt traps, hessian curtains at erodible areas and stormwater diversion away from areas susceptible to erosion;
- Erosion berms may be installed in any areas where soil disturbances within the vicinity of the riparian features have occurred to prevent gully formation and siltation of the aquatic resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope greater than 15%, berms every 10m should be installed.
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 10% and 15%, berms every 20m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
- Sheet runoff from access roads should be slowed down by the strategic placement of berms;
- All soils compacted as a result of activities falling outside of project footprint areas should be ripped and profiled;
- Rehabilitate all drainage line and riparian habitat areas if required, in order to ensure that the ecology of these areas is re-instated during all phases;
- Edge effects of activities including erosion and alien/weed control need to be strictly managed in these areas;
- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the development / decommissioning footprint. Alien plant seed dispersal within the top layers of the soil within decommissioning areas, that will have an impact on future rehabilitation, has to be controlled;
- Alien and invasive vegetation control should take place throughout all phases of the development;
- All reseeding activities must be undertaken at the end of the dry season to ensure optimal conditions for germination and rapid vegetation establishment;
- Implement effective waste management in order to prevent construction related waste from entering the drainage line and riparian environments;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SANS standards to prevent leakage;
- No camp fires should be permitted in or near the riparian area;
- Appropriate sanitary facilities must be provided for the duration of the proposed development and all waste removed to an appropriate waste facility;
- During the operational phase of the tailings pipeline, ensure that operational and maintenance related activities are kept strictly within the development footprint;
- Regular monitoring of the tailings pipeline is recommended during the operational phase to prevent potential spills/leakages;
- All spills/leakages by the tailings pipeline should be immediately cleaned up and treated accordingly;

- All development footprint areas and areas affected by closure and decommissioning of the tailings pipeline should remain as small as possible and should not encroach onto surrounding riparian areas and their associated buffer zones;
- Upon closure and decommissioning, reseeding with indigenous grasses should be implemented in all affected areas;
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor during both the construction and operational phases;
- Post closure aquatic ecological monitoring is recommended to ensure that no impact on the aquatic resources in the area takes place after decommissioning and closure has taken place;
- Since the downstream sites in both the Sandspruit and unnamed tributary of the Elands River displayed higher SASS scores this spatial trend should not show a deterioration in the future once the proposed development takes place and this trend should be considered a Key Performance Indicator (KPI) for the project throughout the life of the infrastructure.

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1.(a) an indication of the scope of, and the purpose for which, the report was prepared

Scientific Aquatic Services was requested to conduct a baseline aquatic ecological assessment in the vicinity of the Wesizwe Platinum: Bakubung Platinum Mine. The purpose of the report is to provide a summary of the aquatic ecological status of this area and to assess the potential impacts of the proposed tailings pipeline, road crossing and berm construction for the Wesizwe Platinum: Bakubung Platinum Mine.

1.(b) the date and season of the site investigation and the relevance of the season to the outcome of the assessment

Site visit/investigation
Date: 21 July 2015
Season: Winter
Relevance of the season to the outcome of the assessment: Low flows experienced at the time of the assessment, this limits the diversity and sensitivity of the macro-invertebrate and diatom communities.

1.(c) A description of the methodology adopted in preparing the report or carrying out the specialised process

Please refer to Section 2 of the report.

1.(d) The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure

Please refer to Section 3.2 of the report.

1.(e) An identification of any areas to be avoided, including buffers

A minimum buffer of 32 meters around all riparian systems should be maintained in line with the requirements of the Environmental Impact Assessment (EIA) Regulations (GN R983, R984 and R 985) amended in December 2014 of the National Environmental Management Act (1998) in which non-essential activities should take place.

1.(f) 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

Please refer to Figure 1 in Section 1.1 of the report.

1.(g) A description of any assumptions made and any uncertainties or gaps in knowledge

Please refer to Section 2.9 of the report.

1.(h) A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment

Please refer to Section 4 for a discussion of the results pertaining to the study area, and to Section 6 for a discussion of the potential impacts of the proposed activity.

1.(i) Any mitigation measures for inclusion in the EMPr

Please refer to Section 6.1 and Section 7 of the report.

1.(j) Any conditions for inclusion in the environmental authorisation

The recommendations and mitigation measures discussed in the report must be adhered to.

1.(k) Any monitoring requirements for inclusion in the EMPr or environmental authorisation

On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited Assessor during the construction and operational phase of the project.

1.(l)(i) A reasoned opinion as to whether the proposed activity or portions thereof should be authorised

After conclusion of this aquatic assessment, it is the opinion of the ecologists that the proposed tailings pipeline, road crossing and berm development be considered favourably, provided that the recommendations and mitigation measures discussed in the report are adhered to.

1.(l)(ii) A reasoned opinion if the opinion is that the proposed activity 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

Please refer to Section 6.1 and Section 7 of the report.

1.(m) A description of any consultation process that was undertaken during the course of preparing the specialist report;

Consultation with interested and affected parties was undertaken as part of the environmental impact assessment and environmental management programme process conducted by SLR Consulting (Africa) (Pty) Ltd.

1.(n) A summary and copies of any comments received during any consultation process and where applicable all responses thereto

Comments and responses that were raised by interested and affected parties are included in the issues table, an Appendix of the EIA report.

1.(o) any other information requested by the competent authority.

No information requested

If you have any queries regarding the above, please do not hesitate to contact me.

Yours Sincerely

Stephen van Staden

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was requested to conduct a baseline aquatic ecological assessment in the vicinity of the Wesizwe Platinum: Bakubung Platinum Mine (BPM). The purpose of the report is to provide a summary of the ecological status of the aquatic resources of this area and to assess the potential impacts of the proposed tailings pipeline, road crossing and berm construction for the Wesizwe Platinum: Bakubung Platinum Mine. The field assessment took place on the 21st of July 2015.

The BPM is situated in the North West Province, South Africa. It is located south of the Pilansberg National Park. The Mining area is located approximately 20km from Boshoek on the R556. The mining area is located adjacent to the Elands River which is a tributary of the Crocodile River and forms part of the Limpopo River primary drainage system. The study area falls within the Bushveld-Basin Aquatic Ecoregion.

During this site visit a baseline aquatic ecological assessment was conducted in order to define the Present Ecological State (PES) and Ecostatus of the aquatic ecosystem. An impact assessment on the aquatic resources affected by the proposed pipeline, road crossing and berm construction was performed to determine the significance of the perceived impacts on the receiving environment. In addition, mitigatory measures were developed which aim to minimise the impacts, followed by an assessment of the significance of the impacts after mitigation, assuming that they are fully implemented.

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

Five sites were chosen in the vicinity of the proposed pipeline, road crossing and berm. Two sites are located on the Sandspruit, two sites located on the unnamed tributary of the Elands River as well as an ephemeral pan in the area of development. The co-ordinates for each of the sites assessed are presented in the table below.

Table 1: Co-ordinates of the sample sites.

Site	Description	GPS co-ordinates	
		South	East
Bak1	Located on the Sandspruit, upstream of the proposed pipeline crossing.	25°23'31.60"S	27° 4'2.99"E
Bak2	Located on the Sandspruit, downstream of the proposed pipeline crossing. Any impact on the aquatic ecology as a result of the pipeline construction will be evident at this point.	25°23'37.15"S	27° 4'7.78"E
Bak3	Located on the unnamed tributary of the Elands River, upstream of the proposed road crossing.	25°22'9.01"S	27° 5'4.22"E
Bak4	Located on the unnamed tributary, downstream of the proposed road crossing. Any impact on the aquatic ecology as a result of the pipeline construction will be evident at this point.	25°22'54.87"S	27° 5'26.66"E
*Bak5	This ephemeral pan is located within the area of the pipeline, road crossing and berm construction.	25°22'26.11"S	27° 4'41.33"E

* Site was dry at the time of assessment in July 2015.

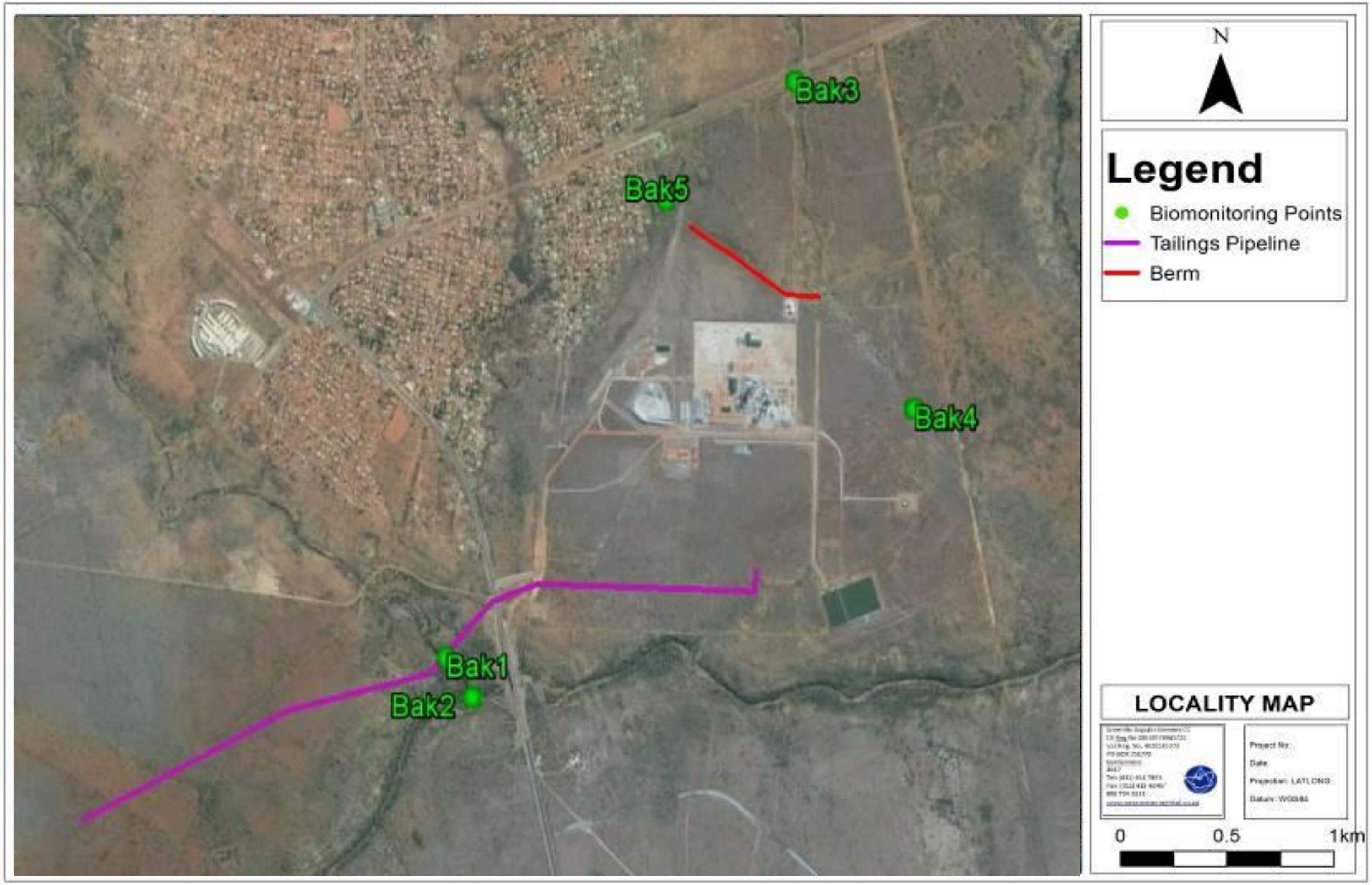


Figure 1: Aerial photograph depicting the assessment sites in the vicinity of the proposed project.

1.2 Legislative requirements

1.2.1 National Environmental Management Act, 1998

- The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations (GNR 982) as amended in 2014, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process (GNR 983) or the Environmental Impact Assessment (EIA) (GNR 984) process depending on the scale of the impact. Provincial regulations as set out in GNR 985 must also be considered.

1.2.2 National Water Act, 1998

- The National Water Act (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved.
- According to GN199 of the National Water Act all activities within 500m of a wetland must be authorised in terms of Section 21c and 21l of the National Water Act (Act 36 of 1998).
- No activity may therefore take place within a water course unless it is authorised by the Department of Water and Sanitation (DWS).
- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWS in terms of Section 21.

2 METHOD OF ASSESSMENT

The sections below describe the methodology used to assess the aquatic ecological integrity of the various sites based on water quality, instream and riparian habitat condition and biological impacts and integrity.

The Ecological Category (ECat) classification for each aspect of ecology and habitat analysis will be employed using the eco-status A to F continuum approach (Kleynhans and Louw 2007) where applicable. This approach allows for boundary categories denoted as B/C, C/D etc., as illustrated in Figure 2.

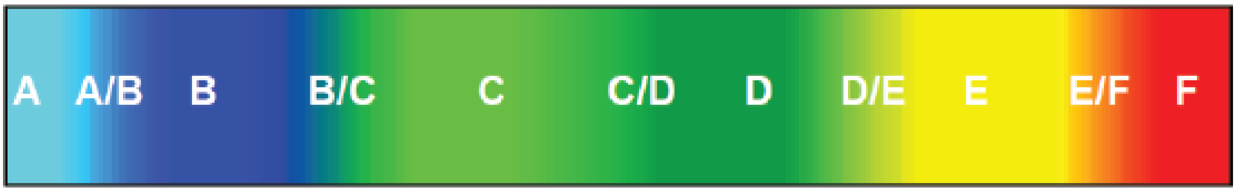


Figure 2: Ecological Categories (ECat) eco-status A to F continuum approach employed (Kleynhans and Louw 2007)

2.1 Visual Assessment

Each site was investigated in order to identify visible impacts on the site with specific reference to impacts from surrounding activities and possible effects from the proposed pipeline, road crossing and berm construction. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the system were assessed by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual indications of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area;
- Other life forms reliant on aquatic ecosystems and
- Signs of impact related to water quality.

2.2 Physico Chemical Water Quality Data

On-site testing of biota specific water quality variables took place. Parameters measured include pH, Electrical Conductivity (EC), Dissolved Oxygen (DO) and temperature. The results of on-site biota specific water quality analyses were used to aid in the interpretation of the data obtained by the biomonitoring. Results are discussed against the guideline water quality values for aquatic ecosystems as defined by the Department of Water and Sanitation (DWS) formerly known as the Department of Water Affairs and Forestry (DWAF 1996 vol 7).

2.3 Habitat Integrity

It is important to assess the habitat of each site, in order to aid in the interpretation of the results of the community integrity assessments by taking habitat conditions and impacts into consideration. The general habitat integrity of the site should be discussed based on the application of the Intermediate Habitat Integrity Assessment (IHIA) protocol, as described by Kemper (1999). This is a simplified procedure, which is based on the Habitat Integrity approach developed by Kleynhans (1996). The IHIA is conducted as a first level exercise, where a comprehensive exercise is not practical. The Habitat Integrity of each site should be scored according to 12 different criteria which represent the most important (and easily quantifiable) anthropogenically induced possible impacts on the system. The instream and riparian zones should be analyzed separately, and the final assessment should be made separately for each, in accordance with Kleynhans' (1999) approach to Habitat Integrity Assessment. Data for the riparian zone are, however, primarily interpreted in terms of the potential impact on the instream component. The assessment of the severity of impact of modifications is based on six descriptive categories with ratings. Analysis of the data should be carried out by weighting each of the criteria according to Kemper (1999). By calculating the mean of the instream and riparian Habitat Integrity scores, an overall Habitat Integrity score can be obtained for each site. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitats of the site. The method classifies Habitat Integrity into one of six classes, ranging from unmodified/natural (Class A), to critically modified (Class F).

Table 2: Classification of Present State Classes in terms of Habitat Integrity [Based on Kemper 1999]

Class	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural, with few modifications. A small change in natural habitats and biota may have taken place but the basic ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Extensively 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, basic ecosystem functions have been destroyed and the changes are irreversible.	<20

2.4 Habitat for Aquatic Macro-Invertebrates

The Invertebrate Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. Scores for the IHAS index were interpreted according to the guidelines of McMillan (1998) as follows:

- <65% inadequate for supporting a diverse aquatic macro-invertebrate community
- 65%-75% adequate for supporting a diverse aquatic macro-invertebrate community
- >75% highly suited for supporting a diverse aquatic macro-invertebrate community

2.5 Aquatic Macro-Invertebrates

Aquatic macro-invertebrate communities of the selected sites were investigated according to the method, which is specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter (1998). The assessment was undertaken according to the protocol as defined by Dickens & Graham (2001). All work was undertaken by an accredited SASS5 practitioner.

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

Classification of the system took place by comparing the present community status to reference conditions, which reflect the best conditions that can be expected in rivers and streams within a specific area and also reflect natural variation over time. The perceived reference state for the local streams was determined as a SASS5 score of 125 and an ASPT score of 5.5 based on general conditions of streams in the Bushveld Basin Eco-region. Interpretation of the results in relation to the reference scores was made according to the classification of SASS5 scores presented in the SASS5 methodologies published by both Dickens & Graham (2001) as well as Dallas (2007).

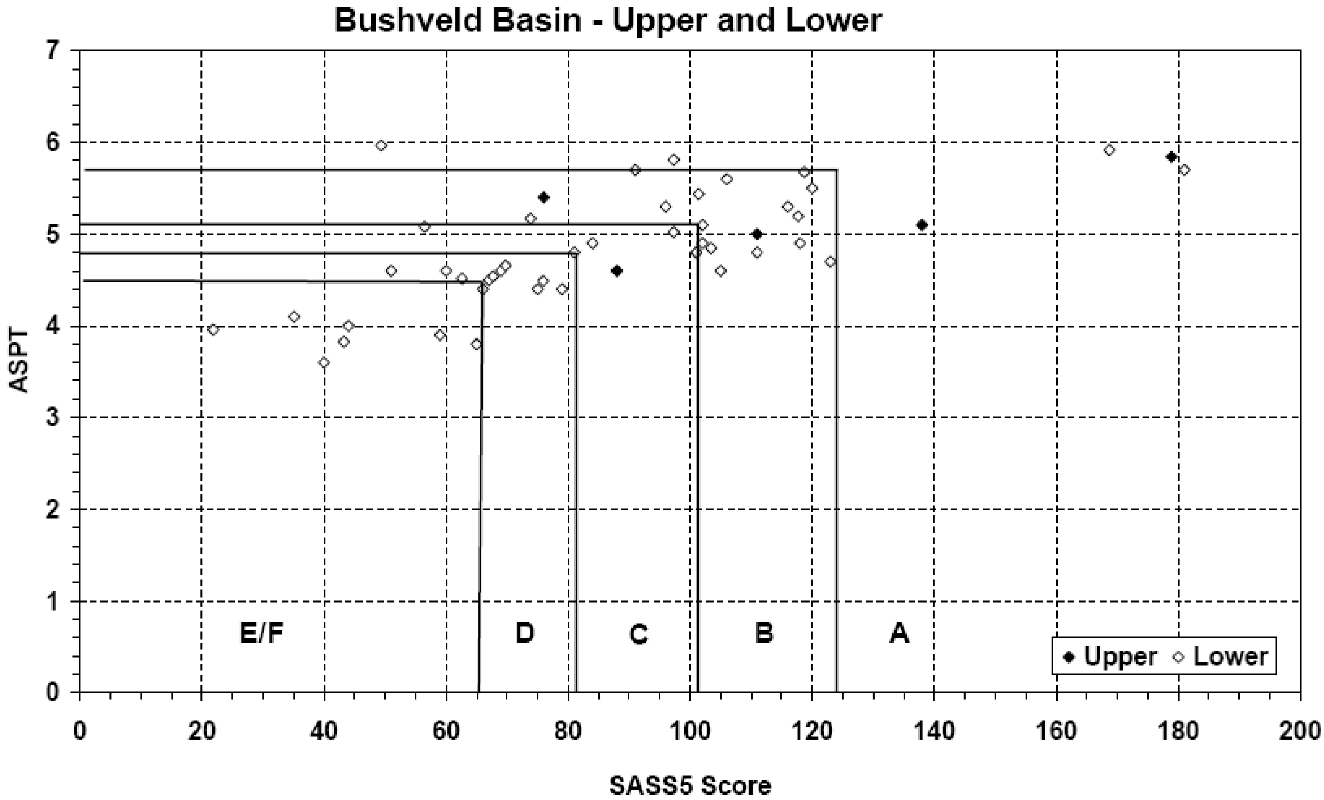


Figure 3: Biological Bands for the Bushveld basin – Upper and Lower zones, calculated using percentiles

Table 3: Definition of Present State Classes in terms of SASS scores as presented in Dickens & Graham (2001)

Class	Description	SASS5 Score%	ASPT
A	Unimpaired. High diversity of taxa with numerous sensitive taxa.	90-100 80-89	Variable >90
B	Slightly impaired. High diversity of taxa, but with fewer sensitive taxa.	80-89 70-79 70-89	<75 >90 76-90
C	Moderately impaired. Moderate diversity of taxa.	60-79 50-59 50-79	<60 >75 60-75
D	Largely impaired. Mostly tolerant taxa present.	50 – 59 40-49	<60 Variable
E	Severely impaired. Only tolerant taxa present.	20-39	Variable
F	Critically impaired. Very few tolerant taxa present.	0-19	Variable

Table 4: Description of the discussion points used for the discussion of data for each site

ASPECT	DEFINITION
Biotopes sampled	Refers to the various biotopes sampled for aquatic macro-invertebrates during the collection of the SASS5 samples.
Sensitive taxa present	A list of the taxa that were captured during SASS5 sampling regarded as being sensitive taxa relevant to the conditions in the area.
Sensitive taxa absent	A list of the taxa that were not captured during SASS5 sampling of the site but that were captured at other sites in the program and regarded as sensitive taxa.
Adjusted SASS5 score	The adjusted SASS5 value based on the adjustment figure in the IHAS index for variances in habitat conditions.
SASS5 % of reference score	The result compared to the reference SASS5 score of (125).
ASPT % of reference score	The result for the site compared to the reference ASPT score of (5.5)
Dallas; 2007 classification	The classification of the site into ecological bands/categories based on data from the Bushveld Basin.
Dickens and Graham, 2001 SASS5 classification	The classification of each site into one of five classes, based on the degree of impairment observed in the aquatic macro-invertebrate community.
McMillan, 1998 IHAS description	Description of the adequacy of habitat according to the guidelines of McMillan 1998
IHAS stones biotopes results	Discussion of the suitability of the stones biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS vegetation biotopes results	Discussion of the suitability of the vegetation biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS other biotopes results	Discussion of the suitability of the gravel, sand and mud biotopes of the site for supporting an aquatic macro-invertebrate community.
IHAS general stream characteristics	A summary of the notes made from the general stream characteristics section of the IHAS index.
Previous assessment IHAS score	The IHAS score obtained in the previous assessment.
Current IHAS score	The current score.
Current IHAS Adjustment score	The adjustment score from the IHAS index based on stream conditions.

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

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

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

Based on the three key requirements, the MIRAI provides an approach to deriving and interpreting aquatic invertebrate response to driver changes. The index has been applied to the monitoring sites following the methodology described by Thirion (2007). Aquatic macro-invertebrates expected at the sites were derived both from previous studies of rivers near the area as well as habitat, flow and water parameters (Thirion 2007).

2.7 Diatom Community Assessment

Macro-invertebrate communities are good indicators of localised conditions over the short-term. Fish, being long-lived, mobile and feeding on lower trophic levels, are considered to be good indicators of long-term influences and general habitat conditions.

However, the use of ecosystem faunal components (which includes both macro-invertebrates and fish) may in part be confounded by aspects like (De la Rey *et al*., 2004):

- complex, seasonal reproductive cycles;
- motility that may result in difficulties during sampling;
- different life stages and metamorphosis;
- specific habitat and niches;
- linked to flow conditions that may lead to uneven distributions;
- depth (i.e. if too deep to wade through) of the system limits meaningful evaluation.

In comparison, the use of diatoms (a unicellular algal group) as biological indicators is desirable for the following reasons (De la Rey *et al.* 2004):

- occurrence in all types of aquatic ecosystems;
- the group collectively exhibits a broad range of tolerance (i.e. a wide range of specific water chemistry requirements);
- they exhibit very short generation times and hence respond rapidly to act as an “early warning system”;
- they not only respond to pollutants but are sensitive to changes in nutrient concentrations such as phosphate and nitrogen;
- because of the above-mentioned sensitivity, short generation time, rapid immigration rates and the lack of physical dispersal barriers they respond rapidly to perturbations and eutrophication;
- the population assemblages are usually diverse and hence contain much ecological information;
- large numbers of individuals can easily be collected making robust statistical and multivariate procedures possible if required;

- taxonomy of the group (identification based on frustules morphology) are well documented;
- they can be sampled at most times of the year as they can even be found on substrata in dry streambeds.

Diatoms thus provide a rapid response to specific physico-chemical conditions in water and are often the first indication of change. The presence or absence of indicator taxa can be used to detect specific changes in environmental conditions such as eutrophication, organic enrichment, salinisation and changes in pH. They are therefore useful for providing an overall picture of trends within an aquatic system.

The use of diatoms in South Africa is considered a published, scientifically sound and relevant tool for water quality assessments, providing a fine level of diagnostic resolution (Harding, Archibald and Taylor 2007; Taylor, Janse van Vuuren and Pieterse 2007a). It has been extensively compared to established indices such as SASS5 (De la Rey *et al.* 2004; De la Rey *et al.,* 2008). Results indicated that diatom indices were more affected by water quality than SASS5 (De la Rey *et al.* 2008) reflecting certain elements of water quality with a higher degree of accuracy (De la Rey *et al.* 2004), whilst SASS5 displayed a higher dependency on habitat quality as measured by IHAS (De la Rey *et al.* 2008). The conclusion was that both indices should be utilized as complementary indicators, resulting in the publication of numerous methods and manuals on the use of diatom indices (e.g. Taylor, de la Rey and van Rensburg 2005; Taylor, Kriel and van Rensburg 2006; Taylor, Harding and Archibold 2007b; Koekemoer and Taylor 2009; Matlala, Taylor and Harding 2011).

Sampling of diatom communities were performed within moderate flowing waters according to methodology described by Taylor *et al.* (2007b) and Taylor *et al.* (2005). Diatoms were sampled from colonised substrata, the latter identified either by a slimy or mucilaginous feel or a visible golden-brown film. Substrata may include cobbles, small boulders, man-made objects, as well as emergent or submerged macrophytes.

Following collection, samples were submitted to a laboratory for **slide preparation, identification** and **enumeration**. Diatom slides were prepared by acid oxidation using hydrochloric acid and potassium permanganate. Clean diatom frustules were mounted onto a glass slide ready for analysis. Taxa were identified mainly according to standard floras (Krammer and Lange- Bertalot, 2000). The aim of the **data analysis** was to identify and count diatom valves (400 counts) to produce semi-quantitative data, from which ecological conclusions can be drawn. Diatoms were sampled within moderate flowing waters, hence the use of the diatom software package OMNIDIA to infer water quality conditions at these sites was applicable. Index values were calculated in OMNIDIA for epilation data (attached to rocks) (Lecointe *et al.* 1993). In general, each diatom species used in the calculation of the index is assigned two values; the first value reflects the tolerance or affinity of the particular diatom species to a certain water quality (good or bad) while the second value indicates how strong (or weak) the relationship is. These values are then weighted by the abundance of the particular diatom species in the sample. The general water quality indices (integrating impacts from organic material, electrolytes, pH and nutrients), used in the assessment, are:

- the Specific Pollution sensitivity Index (SPI), one of the most extensively tested indices in Europe; and
- the percentage of (organic) Pollution Tolerant Valves (%PTV).

The interpretation of the SPI scores applied in this study is displayed in Table 5.

Table 5: Class limit boundaries for the Specific Pollution sensitivity Index (SPI) (Koekemoer and Taylor, 2011).

SPI Score	Class	Ecological Category
>17.3	High Quality	A
16.8 – 17.2		A/B
13.3 – 16.7	Good Quality	B
12.9 – 13.2		B/C
9.2 – 12.8	Moderate Quality	C
8.9 – 9.1		C/D
5.3 – 8.8	Poor Quality	D
4.8 – 5.2		D/E
<4.8	Bad Quality	E

Table 6: Ecological indicator value classification (Van Dam *et al.,* 1994)

Ecological indicator value classification (Van Dam *et al.,* 1994)		
pH		
1 - acidobiontic	optimal occurrence at pH <5.5	
2 - acidophilous	mainly occurring at pH <7	
3 - circumneutral	mainly occurring at pH-values about 7	
4 - alkaliphilous	mainly occurring at pH >7	
5 - alkalibiontic	exclusively occurring at pH >7	
6 - indifferent	no apparent optimum	
Salinity		
	Cl- (mg/l)	***Salinity (%)***
1 - fresh	<100	<0.2
2 - fresh brackish	<500	<0.9
3 - brackish fresh	500 - 1000	0.9 - 1.8
4 - brackish	1000 - 5000	1.8 - 9.0
Nitrogen uptake metabolism		
1 - nitrogen-autotrophic taxa. Tolerating very small concentrations of organically bound nitrogen		
2 - nitrogen-autotrophic taxa, tolerating elevated concentrations of organically bound nitrogen		
3 - facultatively nitrogen-heterotrophic taxa, needing periodically elevated concentrations of organically bound nitrogen		
4 - obligately nitrogen-heterotrophic taxa, needing continuously elevated concentrations of organically bound nitrogen		
Oxygen requirements		
1 - continuously high (about 100% saturation)		
2 - fairly high (above 75% saturation)		
3 - moderate (above 50% saturation)		
4 - low (above 30% saturation)		
5 - very low (about 10% saturation)		
Trophic state		
1 - oligotraphentic	4 - meso-eutraphentic	
2 - oligo-mesotraphentic	5 - eutraphentic	
3 - mesotraphentic	6 - hypereutraphentic	
7 - oligo- to eutraphentic (hypereutraphentic)		

2.8 Impact Assessment

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

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

The definitions used in the impact assessment are presented below:

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation;
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[1]. The interaction of an aspect with the environment may result in an impact;
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is;
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems;
- **Resources** include components of the biophysical environment;
- **Frequency of activity** refers to how often the proposed activity will take place;
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor;
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards;
- **Spatial extent** refers to the geographical scale of the impact; and
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

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

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria. Refer to the table below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[2].

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

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

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

Table 7: Criteria for assessing significance of impacts.

LIKELIHOOD DESCRIPTORS

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

CONSEQUENCE DESCRIPTORS

Severity of impact	**RATING**
Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function Largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	**RATING**
Activity specific/ < 5 ha impacted / linear features affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / linear features affected < 500m	2
Local area/ within 1 km of the site boundary / < 5000ha impacted / linear features affected < 1000m	3
Regional within 5 km of the site boundary / < 2000ha impacted / linear features affected < 3000m	4
Entire habitat unit / Entire system/ > 2000ha impacted / linear features affected > 3000m	5
Duration of impact	**RATING**
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5

Table 8: Significance rating matrix

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

Table 9: Positive/Negative Mitigation Ratings

Significance Rating	Value	Negative Impact management recommendation	Positive Impact management recommendation
Very High	126 - 150	Consider the viability of the project. Very strict measures to be implemented to mitigate impacts according to the impact mitigation hierarchy	Actively promote the project
High	101 - 125	Consider alternatives in terms of project execution and location. Ensure designs take environmental sensitivities into account and Ensure management and housekeeping is maintained and attention to impact minimisation is paid according to the impact mitigation hierarchy	Promote the project and monitor ecological performance
Medium High	76 – 100	Consider alternatives in terms of project execution and Ensure management and housekeeping is maintained and attention to impact minimisation is paid according to the impact mitigation hierarchy	Implement measures to enhance the ecologically positive aspects of the project while managing any negative impacts
Medium Low	51 - 75	Ensure management and housekeeping is maintained and attention to impact minimisation is paid	Implement measures to enhance the ecologically positive aspects of the project while actively managing any negative impacts
Low	26 - 50	Promote the project and ensure management and housekeeping is maintained	Monitor ecological performance and pay extensive attention to minimising potential negative environmental impacts
Low Very	1 - 25	Promote the project	Actively seek measures to implement impact minimisation according to the impact mitigation hierarchy and identify positive ecological aspects to be promoted

The following points were considered when undertaking the assessment:

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

2.9 Assumptions and limitations

The following points serve to indicate the assumptions and limitations of this study.

- ***Reference conditions are unknown:*** The composition of aquatic biota in the study area prior to regional disturbance is unknown. For this reason, reference conditions are hypothetical, and are based on professional judgement and/or inferred from the baseline environmental data collected as part of the Environmental Impact Assessment process for the BPM.
- ***Lack of suitable habitat:*** Limited SASS5 biotopes present at the various sites which is likely to limit the diversity and sensitivity of the macro-invertebrate community.
- ***Lack of strong flowing water:*** The diatom samples for Sites Bak1 and Bak2 were taken within stagnant waters which may be subject to strong fluctuations in their condition, specifically salinity, organic and nutrient levels. Any attempt to use existing diatom indices suitable for freshwater ecosystems to determine the biological integrity of such systems will likely result in misleading conclusions.

3 GENERAL IMPORTANCE OF THE STUDY AREA

3.1 Ecoregions

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

The study area is located all along the Elands River which is a tributary of the Crocodile River and forms part of the Limpopo River primary drainage system. The study area falls within the Bushveld-Basin Aquatic Ecoregion. The biomonitoring site Bak3 falls just within the Western Bankenveld Ecoregion, but will be discussed according to the Bushveld-Basin Ecoregion for comparative reasons.

3.2 Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) PES/EIS database

The PES/EIS database, as developed by the DWS RQIS department, was utilised to obtain additional background information on the project area. The PES/EIS database has been made available to consultants since mid-August 2014.

The information from this database is based on information at a sub-quaternary catchment reach (SQR) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as South African River Health Program (SA RHP) sites, Environmental Water Requirement (EWR) sites and Hydro Water Management (WM) sites.

In this regard information for sub-quaternary catchment reaches (SQR) A22F-00822 for the Sandspruit and A22F-00869 for the Elands River represent the SQR closest to the sites assessed. Key information on background conditions within the study area, as contained in this database and pertaining to the Present Ecological State (PES), ecological importance and ecological sensitivity for the study area, is tabulated in Table 10 and Table 11.

From the assessment of the PES/EIS data, the following points are highlighted which summarise the data:

The invertebrate data list which is available for the Elands River (A2ELAN-HOOGE) is considered to be representative of the larger study area. However, this SQR specifically represents the larger Elands River. Because the Sandspruit and unnamed tributary of the Elands River assessed are much smaller systems, all the families listed below may not necessarily occur there due to natural limitations caused by lower flows and limited habitat:

- Oligochaeta
- Heptageniidae
- Chlorolestidae
- Libellulidae
- Gerridae
- Baetidae 1 sp
- Coenagrionidae
- Notonectidae
- Caenidae
- Vellidae
- Lymnaeidae
- Ceratopogonidae
- Chironomidae
- Hydrophilidae
- Naucoridae
- Culicidae
- Simuliidae
- Corixidae
- Ancylidae
- Gomphidae

Fish data on the Elands River in the larger study area is considered to be representative of what may be expected in the study area:

- *Barbus trimaculatus*
- *Clarias gariepinus*
- *Labeo molybdinus*
- *Pseudocrenilabrus philander*
- *Tilapia sparrmanii*

According to the ecological importance classification for the quaternary catchment, the Sandspruit and unnamed Tributary of the Elands River can be classified as moderately sensitive systems of low ecological importance which, in their present state, can be considered as Class D streams according to the PES classification. In terms of the default ECat classification, these systems have the potential to attain Class C conditions.

Table 10: Summary of the ecological status of the sub-quaternary catchment reach (SQR) A22F-00822 (Sandspruit) based on the DWS RQIS PES/EIS database

Synopsis (SQ reach A22F-00822)					
PES[1] category median	**Mean EI[2] class**	**Mean ES[3] class**	**Length (km)**	**Stream order**	**Default ECat[4]**
D	Moderate	Moderate	27.10	1.0	C
PES details					
Instream habitat continuity MOD		Moderate	**Riparian/wetland zone MOD**		Large
RIP/wetland zone continuity MOD		Large	**Potential flow MOD activities**		Moderate
Potential instream habitat MOD activities		Serious	**Potential physico-chemical MOD activities**		Large
EI details					
Invertebrate taxa/SQ		36.00	**Invertebrate average confidence**		2.56
Invertebrate representivity per secondary class		High	**Invertebrate rarity per secondary class**		Very High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		Low	**Habitat diversity class**		Moderate
Habitat size (length) class		Low	**Instream migration link class**		High
Riparian-wetland zone migration link		Moderate	**Riparian-wetland zone habitat integrity class**		Moderate
Instream habitat integrity class		Low	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**		Very High
Riparian-wetland natural vegetation rating based on expert rating					Low
Fish spp./SQ		7.00	**Fish: Average confidence**		1.00
Fish representivity per secondary per secondary class		Low	**Fish rarity per secondary per secondary class**		Low
ES details					
Fish physical-chemical sensitivity description		Moderate	**Fish no-flow sensitivity description**		Moderate
Invertebrates physical-chemical sensitivity description		Moderate	**Invertebrates velocity sensitivity**		Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					Low
Stream size sensitivity to modified flow/water level changes description					Low
Riparian-wetland vegetation intolerance to water level changes description					Low

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

Table 11: Summary of the ecological status of the sub-quaternary catchment reach (SQR) A22F-00869 (Elands River) based on the DWS RQIS PES/EIS database

Synopsis (SQ reach A22F-00869)					
PES[1] category median	**Mean EI[2] class**	**Mean ES[3] class**	**Length (km)**	**Stream order**	**Default ECat[4]**
D	Moderate	Moderate	16.07	3.0	C
PES details					
Instream habitat continuity MOD		Moderate	**Riparian/wetland zone MOD**		Large
RIP/wetland zone continuity MOD		Moderate	**Potential flow MOD activities**		Large
Potential instream habitat MOD activities		Large	**Potential physico-chemical MOD activities**		Large
EI details					
Invertebrate taxa/SQ		44.00	**Invertebrate average confidence**		4.55
Invertebrate representivity per secondary class		High	**Invertebrate rarity per secondary class**		Very High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating		Very High	**Habitat diversity class**		Very Low
Habitat size (length) class		Low	**Instream migration link class**		High
Riparian-wetland zone migration link		High	**Riparian-wetland zone habitat integrity class**		Moderate
Instream habitat integrity class		Moderate	**Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m**		Very High
Riparian-wetland natural vegetation rating based on expert rating					Low
Fish spp./SQ		12.00	**Fish: Average confidence**		5.00
Fish representivity per secondary per secondary class		Moderate	**Fish rarity per secondary per secondary class**		Very High
ES details					
Fish physical-chemical sensitivity description		High	**Fish no-flow sensitivity description**		High
Invertebrates physical-chemical sensitivity description		High	**Invertebrates velocity sensitivity**		Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description					High
Stream size sensitivity to modified flow/water level changes description					Low
Riparian-wetland vegetation intolerance to water level changes description					Low

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

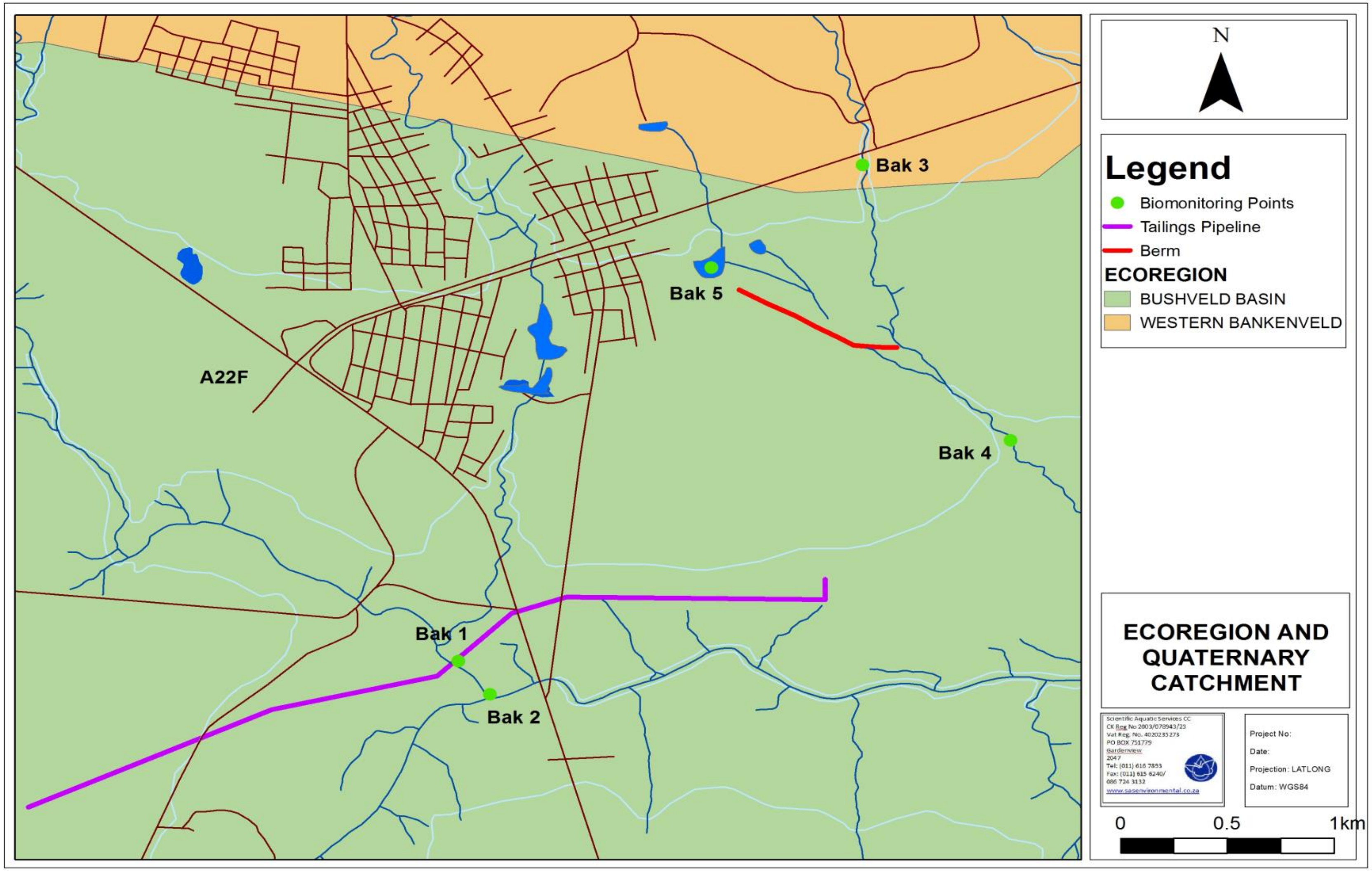


Figure 4: **The Ecoregion and Quaternary Catchment applicable to the study area**

4 RESULTS

Four aquatic ecological assessment points were assessed on the 21st of July 2015; two sites located on the Sandspruit (Bak1 and Bak2), two sites located on the unnamed tributary of the Elands River (Bak3 and Bak4). An ephemeral pan (Bak5) in the area of development was also visited, which was dry at the time of the assessment.

4.1 Visual Assessment

A photographic record of each site was made in order to provide a visual record of the condition of each assessment site as observed during the field assessment. The photographs taken at each site are presented in the sections below. The tables in each section summarise the observations for the various criteria made during the visual assessment undertaken at each site.

The Sandspruit

Figure 5: Upstream view of the Bak1 site on the Sandspruit.

Figure 6: Downstream view of the Bak1 site on the Sandspruit.

 **Figure 7: Upstream view of the Bak2 site on the Sandspruit.**	 **Figure 8: Local view of the Bak2 site on the Sandspruit.**

Unnamed tributary of the Elands River

 **Figure 9: Upstream view of the Bak3 site on the unnamed tributary.**	 **Figure 10: Downstream view of the Bak3 site on the unnamed tributary.**
 **Figure 11: Upstream view of the Bak4 site on the unnamed tributary.**	 **Figure 12: Local view of the Bak4 site on the unnamed tributary.**

Ephemeral Pan

Figure 13: Local view of the pan (Bak5) at the time of the assessment.

Figure 14: Local view of the pan (Bak5) at the time of the assessment.

Table 12: Description of the assessment sites.

SITE	Bak1	Bak2	Bak3	Bak4	Bak5
Upstream features	This point is located on the Sandspruit, upstream of the proposed tailings pipeline crossing. This point is fairly remote with only gravel roads present to gain access to the area.	This point is located on the Sandspruit, downstream of the proposed tailings pipeline. The site is located just before the confluence with the Elands River. This point is fairly remote with only gravel roads present to gain access to the area.	This site is located on the unnamed tributary of the Elands River. It is located downstream of the R556 bridge crossing within the BPM property. This site is located upstream of the proposed road crossing.	This site is located on the unnamed tributary of the Elands River, downstream of the proposed road crossing. The site is located within the BPM property.	This point is located within the BPM property. Adjacent to a rural settlement with only gravel roads present to gain access to the area.
Downstream significance	Located upstream of the Bak2 site. This site will be used as the upstream reference point for site Bak2.	Any impact on the aquatic resources as a result of the proposed tailings pipeline will be evident at this site.	The site is located upstream of the Bak4 site. This site will be used as the upstream reference point for Bak4.	Any impact on the aquatic resources as a result of the proposed road crossing will be evident at this site.	This point is located upstream of the BPM activities.
Riparian zone characteristics	The riparian zone is relatively narrow due to the incised nature of the active-channel. The riparian zone is dominated by trees, grass and shrubs. No inundated bankside vegetation was present at the site.	The riparian zone is relatively narrow due to the incised nature of the active-channel. The riparian zone is dominated by trees, grass and shrubs. No inundated bankside vegetation was present at the site.	The riparian zone is relatively narrow due to the incised nature of the active-channel. The riparian zone is dominated by grass, shrubs and some trees. Limited inundated bankside vegetation was present.	The riparian zone is relatively narrow due to the shallow nature of the active-channel. The riparian zone is dominated by grass. Limited inundated bankside vegetation was present.	The wetland zone can be divided into permanent and seasonal wetness zones. Both of which were dry at the time of the assessment. The wetland area was dominated by grass and trees.
Algal presence	No algal proliferation was evident at the time of the assessment.				The site was dry at the time of the assessment.
Visual indication of and impact on aquatic fauna	Sedimentation present on rocks. This will have some limit on the diversity and sensitivity of the aquatic community. Lack of connectivity in the system.	Loss of connectivity in the system.	Severe sedimentation present further upstream of the site due to a collapsed road crossing. This will have some limit on the diversity and sensitivity of the aquatic community.	Extremely shallow flows at the time of the assessment.	
Depth characteristics	The system at this point is dominated by a wide shallow pool habitat.	The system at this point is dominated by both shallow and deep pools.	The system at this point was dominated by a narrow, shallow run.	The system at this point was dominated by very shallow runs.	
Flow condition	There is no diversity of flow; generally the water can be considered as still. This will have some limit on the diversity and sensitivity of the aquatic community.	There is no diversity of flow; generally the water can be considered as still. This will have some limit on the diversity and sensitivity of the aquatic community.	The site had a limited diversity of flow at this point; including faster flowing riffles and slower flowing runs.	The site had no diversity of flow; and is dominated by slow flowing runs.	
Water clarity	Water was clear at the time of the assessment.	Water was discoloured at the time of the assessment.	Water was discoloured at the time of the assessment.	Water was clear at the time of the assessment.	
Water odour	No odors were evident at the time of the assessment.				

SITE	Bak1	Bak2	Bak3	Bak4	Bak5
Erosion potential	There is a moderate to high potential for erosion due to the presence of steep banks. During flood condition erosion may occur.	There is a moderate to high potential for erosion due to the presence of steep banks. During flood condition erosion may occur.	There is a moderate to high potential for erosion due to the presence of incised banks, and the collapsed road crossing further upstream. During flood condition erosion may occur.	There is a low potential for erosion due to the presence of well vegetated banks. During flood condition limited erosion may occur.	There is a moderate potential for erosion due to the limited vegetation cover at the time of the assessment. During flood condition erosion may occur.

4.2 Biota specific water quality

Table 13 below records the biota specific water quality of the assessment sites.

Table 13: Biota specific water quality variables

Site	Conductivity mS/m	pH	Dissolved Oxygen mg/l	% Dissolved Oxygen Saturation	Temp °C
Bak1	73.0	7.27	9.68	83.8	9.5
Bak2	69.0	7.56	8.51	79.1	12.8
Bak3	65.0	7.66	7.68	81.3	18.4
Bak4	64.0	7.90	7.67	86.2	21.6

- The Electrical Conductivity (EC) values observed at both the Sandspruit and unnamed tributary sites can be considered as largely elevated from the expected natural conditions (between 10-30 mS/m). This suggests that additional impacts in the catchment may be occurring which lead to salinization of the system although the local geology may also form a natural source of elevated salts in these systems;
- Spatially the EC decreased by 5.5% between the upstream and downstream sites of the Sandspruit, and decreased by 1.5% between the upstream and downstream sites of the unnamed tributary. These spatial changes comply with the Target Water Quality Recommendations (TWQR) (DWS formerly DWAF, 1996) for aquatic ecosystems, which advocate no change greater than 15% from spatial or temporal data;
- These data serve as an indication that no salinization occurs within this segment of the system prior to the proposed activities taking place;
- The pH values observed at both the Sandspruit and unnamed tributary sites can be regarded as largely natural (absolute values between 7-8) at the time of the assessment;
- Spatially the pH increased by 4.0% between the upstream and downstream sites of the Sandspruit, and increased by 3.1% between the upstream and downstream sites of the unnamed tributary. These spatial changes comply with the TWQR (DWS formerly DWAF, 1996) for aquatic ecosystems which advocate no change greater than 5% from spatial or temporal data. This trend will need to be closely monitored in future;
- The Dissolved Oxygen (DO) concentrations observed at both the Sandspruit and unnamed tributary sites can be regarded as adequate in supporting a diverse and sensitive aquatic community at the time of the assessment;
- Spatially the DO concentration decreased by 12.1% between the upstream and downstream sites of the Sandspruit, and decreased by 0.1% between the upstream and downstream sites of the unnamed tributary;

- Temperatures can be regarded as normal for the time of year when sampling took place.

Table 14: Spatial deviation of the biota specific water quality variables according to the Target Water Quality Recommendations (TWQR) (DWS formerly DWAF, 1996)

Parameter	The Sandspruit (Bak1 and Bak2)	The Unnamed Tributary (Bak3 and Bak4)
Conductivity mS/m	-5.5%	-1.5%
pH	+4.0%	+3.1%
Dissolved Oxygen mg/l	-12.1%	-0.1%
Guidelines: (DWAF, 1996)	EC: No change greater than 15% from spatial and temporal data. pH: No change greater than 5% from spatial or temporal data. DO: At least 80% of saturation.	
Key: Negative value = decrease; Positive value = increase. Normal text = No significant change; Red text = Temporal and Spatial changes exceed the TWQR in a negative fashion; Blue text = Significant temporal and Spatial changes but change considered positive.		
Notes: For DO trends are expressed in terms of actual concentration values as measured in mg/L and not in percentage saturation values. Classification of "deterioration"/ improvement" were thus not evaluated in terms of the guideline, but a change exceeding 15% was considered significant.		

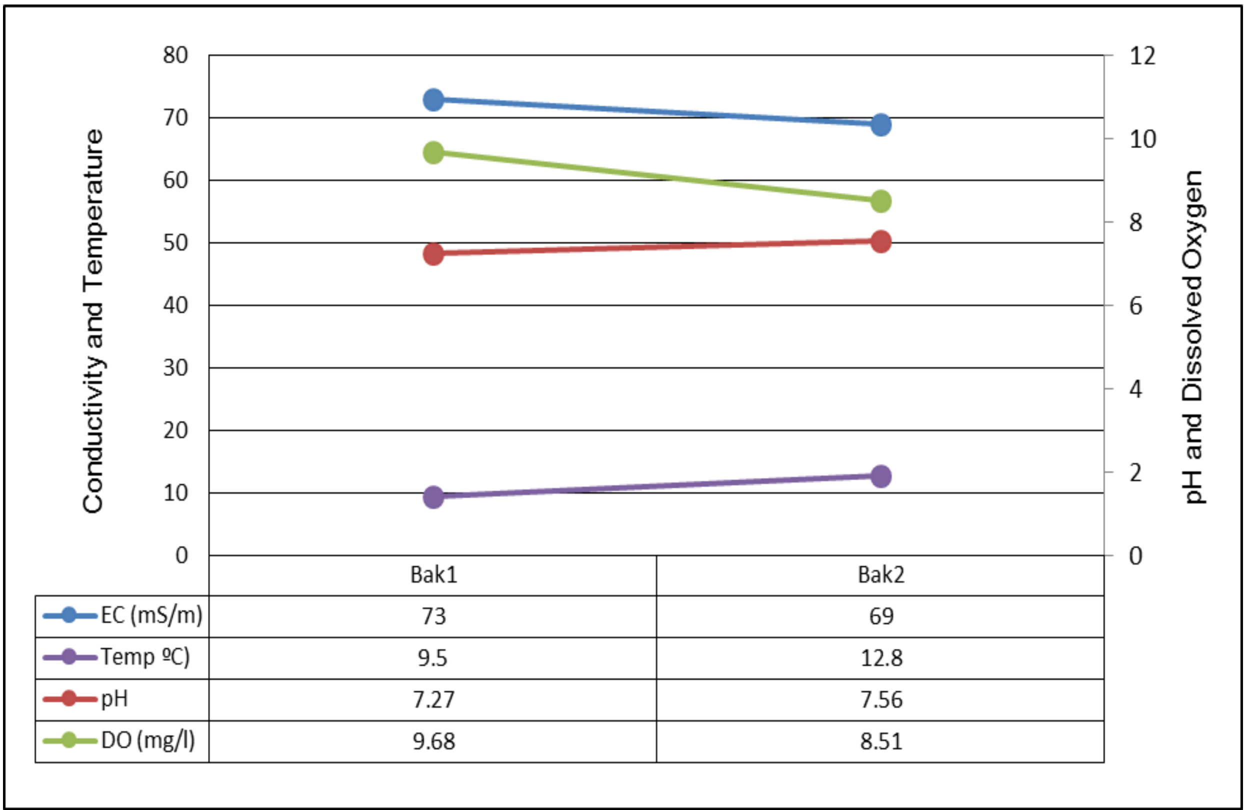


Figure 15: Biota specific water quality variation of the Sandspruit between the upstream and downstream sites.

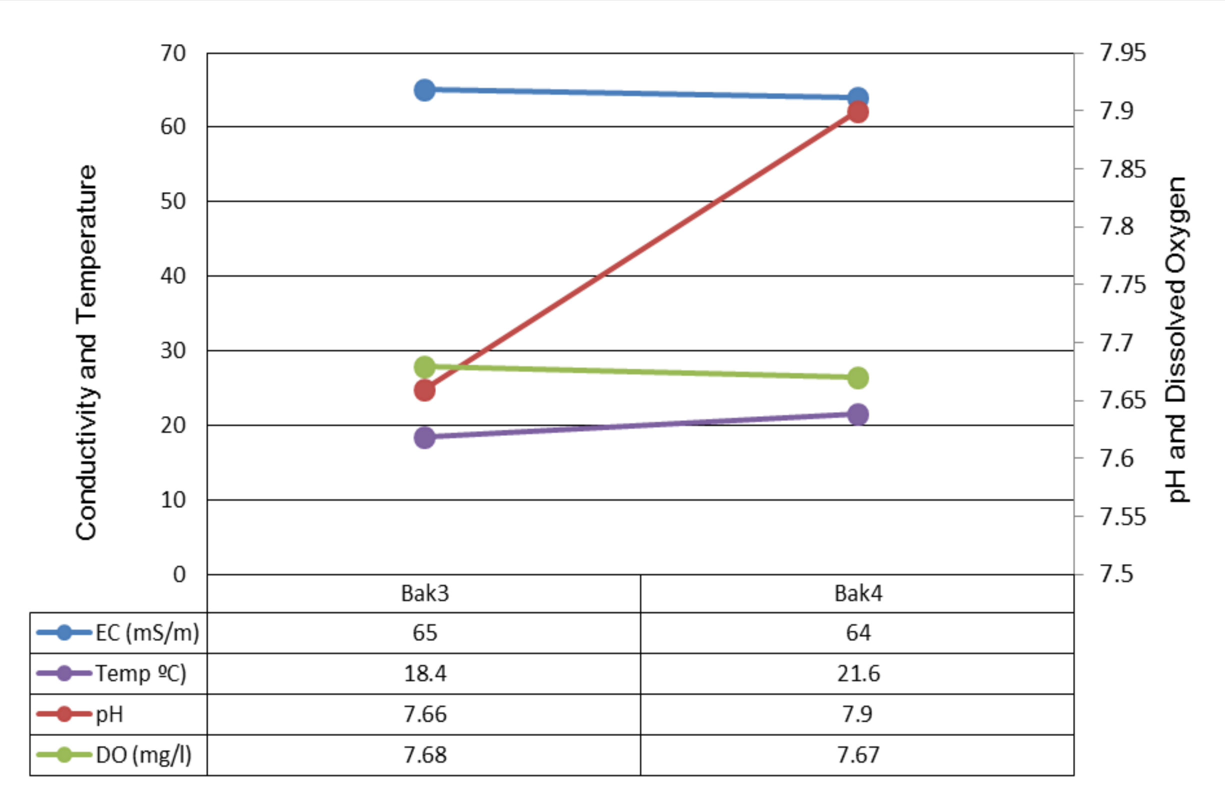


Figure 16: Biota specific water quality variation of the unnamed tributary of the Elands River between the upstream and downstream sites.

4.3 Habitat Assessment

The Integrated Habitat Integrity Assessment (IHIA) was applied to the Sandspruit and unnamed tributary of the Elands River as a whole system and not per site. The results are presented below:

The Sandspruit:

- From the results of the application of the IHIA to the Sandspruit, it is evident that there are some impacts at the present time;
- Instream impacts included large impacts from flow modifications and water quality modifications. Moderate impacts include water abstraction, bed modification and channel modifications. Overall, the Sandspruit achieved a 62.3% score for instream integrity;
- The largest riparian zone impacts included bank erosion, indigenous vegetation removal, flow modification and water abstraction. The Sandspruit achieved a 67.3% score for riparian zone integrity;

- The Sandspruit obtained an overall IHIA rating of 64.8%, which indicates moderately modified (Class C conditions). The site, therefore, falls within the Default Ecological Category for the sub-quaternary catchment reach in terms of habitat integrity.

Unnamed tributary of the Elands River:

- From the results of the application of the IHIA to the unnamed tributary, it is evident that there are some impacts at the present time;
- Instream impacts included large impacts from flow modifications and water quality modifications. Moderate impacts include water abstraction, bed modification and channel modifications. Overall, the unnamed tributary achieved a 65.9% score for instream integrity;
- The largest riparian zone impacts included bank erosion, indigenous vegetation removal and water abstraction. The unnamed tributary achieved a 73.0% score for riparian zone integrity;
- The unnamed tributary obtained an overall IHIA rating of 69.4%, which indicates moderately modified (Class C conditions). The site, therefore, falls within the Default Ecological Category for the sub-quaternary catchment reach in terms of habitat integrity.

Table 15 provides a summary of the results obtained from the application of the IHAS Index to the four assessment sites. This index determines habitat suitability with particular reference to the requirements of aquatic macro-invertebrates. The results obtained from this assessment will aid in interpreting the SASS data.

Table 15: A summary of the results obtained from the application of an IHAS index to the assessment sites

Type of Result	Bak1	Bak2	Bak3	Bak4
McMillan, 1998 IHAS description	Habitat structure and diversity was inadequate for supporting a diverse aquatic macro-invertebrate community.	Habitat structure and diversity was inadequate for supporting a diverse aquatic macro-invertebrate community.	Habitat structure and diversity was inadequate for supporting a diverse aquatic macro-invertebrate community.	Habitat structure and diversity was adequate for supporting a diverse aquatic macro-invertebrate community.
IHAS stones biotopes results	There was excellent rocky substrate available at this point.	There was good rocky substrate available at this point.	There was adequate rocky substrate available at this point.	Limited rocky substrate present at the site.
IHAS vegetation biotopes results	No inundated marginal vegetation was present due to the incised nature of the stream. No aquatic vegetation was present at the site.	No inundated marginal vegetation was present due to the incised nature of the stream. No aquatic vegetation was present at the site.	Limited marginal vegetation was present to provide habitat for aquatic macro-invertebrates.	Adequate marginal vegetation was present to provide habitat for aquatic macro-invertebrates.
IHAS other biotopes results	Adequate sand, mud and gravel deposits were present at this point.	Adequate sand, mud and gravel deposits were present at this point.	Adequate sand, mud and gravel deposits were present at this point.	Adequate sand, mud and gravel deposits were present at this point.
IHAS general stream characteristics	A relatively wide stream consisting of shallow pool habitat. The water was clear at this point.	A relatively wide stream consisting of deep and shallow pool habitat. The water was discoloured at this point.	A relatively narrow stream consisting of shallow riffles and runs. The water was discoloured at this point.	A relatively narrow stream consisting of shallow runs. The water was clear at this point.
IHAS score	60%	55%	58%	65%
Current IHAS Adjustment score	+25	+27	+21	+21

- Habitat conditions at both sites of the Sandspruit (Bak1 and Bak2) can be regarded as inadequate for supporting a diverse and sensitive aquatic macro-invertebrate community. This is due to the lack of strong flowing water and the absence of marginal vegetation due to the incised nature of the stream;
- Habitat conditions at the upstream site (Bak3) of the unnamed tributary can be regarded as inadequate for supporting a diverse and sensitive aquatic macro-invertebrate community while the downstream site (Bak4) can be regarded as adequate. The inadequate IHAS score at site Bak3 is due to the sedimentation present at the site as a result of the collapsed road crossing further upstream in the system;
- Habitat conditions are largely similar at all of the sites at the time of the assessment, limited variation in macro-invertebrate community diversity and sensitivity is expected between the sites.

4.4 Aquatic macro-invertebrate community assessment

Tables 16 and 17 provide a summary of the results obtained from the application of the SASS5 and IHAS indices to the sites.

Table 16: Biotope specific summary of the results obtained from the application of the SASS5 index to the assessment sites

PARAMETER	SITE	STONES	VEGETATION	GRAVEL, SAND AND MUD	TOTAL
SASS5 Score	Bak1	34	-	27	39
	Bak2	32	-	23	40
	Bak3	14	18	9	20
	Bak4	13	24	25	30
Taxa	Bak1	8	-	8	10
	Bak2	9	-	7	11
	Bak3	5	5	4	7
	Bak4	4	6	7	8
ASPT	Bak1	4.3	-	3.4	3.9
	Bak2	3.6	-	3.3	3.6
	Bak3	2.8	3.6	2.3	2.9
	Bak4	3.3	4.0	3.6	3.8

Table 17: A summary of the results obtained from the application of the SASS5 and IHAS indices to the assessment sites

Type of Result	Bak1	Bak2	Bak3	Bak4
Biotopes sampled	Stones out of current, gravel, sand, mud and marginal vegetation.	Stones out of current, gravel, sand, mud and marginal vegetation.	Stones out of current, gravel, sand, mud and marginal vegetation.	Gravel, sand, mud and marginal vegetation.
Sensitive taxa present	*Caenidae; Corduliidae*	*Caenidae*	*None*	*Caenidae*
Sensitive taxa absent	*Heptageniidae; Chlorolestidae; Naucoridae; Ancylidae; Gomphidae*	*Heptageniidae; Chlorolestidae; Naucoridae; Ancylidae; Gomphidae; Corduliidae*	*Heptageniidae; Chlorolestidae; Naucoridae; Ancylidae; Gomphidae; Caenidae; Corduliidae*	*Heptageniidae; Chlorolestidae; Naucoridae; Ancylidae; Gomphidae; Corduliidae*
Adjusted SASS5 score	64	67	41	51
SASS% of upstream reference	NA	102.6%	NA	150.0%
ASPT% of upstream reference	Not Applicable	92.3%	Not Applicable	131.0%
***SASS5 % of reference score**	31.2%	32.0%	16.0%	24.0%
****ASPT % of reference score**	70.9%	65.5%	52.7%	69.1%

Type of Result	Bak1	Bak2	Bak3	Bak4
Dallas, 2007 classification	Class E/F	Class E/F	Class E/F	Class E/F
Dickens and Graham, 2001 SASS5 classification	Class E (Seriously impaired)	Class E (Seriously impaired)	Class F (Critically impaired)	Class E (Seriously impaired)

*SASS5 Reference Score= 125
**ASPT Reference Score= 5.5

- The aquatic macro-invertebrate community integrity of the Sandspruit at both the Bak1 and Bak2 sites may be considered to be in a seriously impaired (Class E) condition according to the Dickens and Graham (2001) classification system. Both sites may also be considered as seriously to critically impaired according to the Dallas (2007) classification system;
- The aquatic macro-invertebrate community integrity of the unnamed tributary may be considered as critically impaired (Class F) at the upstream Bak3 site, and as seriously impaired (Class E) at the downstream Bak4 site according to the Dickens and Graham (2001) classification system. Both sites may be considered as seriously to critically impaired according to the Dallas (2007) classification system;
- Spatially, the SASS5 score of the Sandspruit increases negligibly in a downstream direction between the Bak1 and Bak2 sites by 2.6%, while the ASPT score decreases slightly in a downstream direction by 7.7%. This is likely as a result of the decreased habitat score at the downstream Bak2 site and the lack of connectivity between the sites;
- Spatially, the SASS5 score of the unnamed tributary increases significantly in a downstream direction between the Bak3 and Bak4 sites by 50.0%, while the ASPT score increased by 12.1%. This is likely as a result of the improved habitat conditions and the slight decrease of EC at the downstream Bak4 site; and
- These observations provide valuable indications of baseline trends. Since in both instances the downstream sites displayed higher SASS scores this spatial trend should not show a deterioration in the future once the proposed development takes place and this trend should be considered a Key Performance Indicator (KPI) for the project throughout the life of the infrastructure.

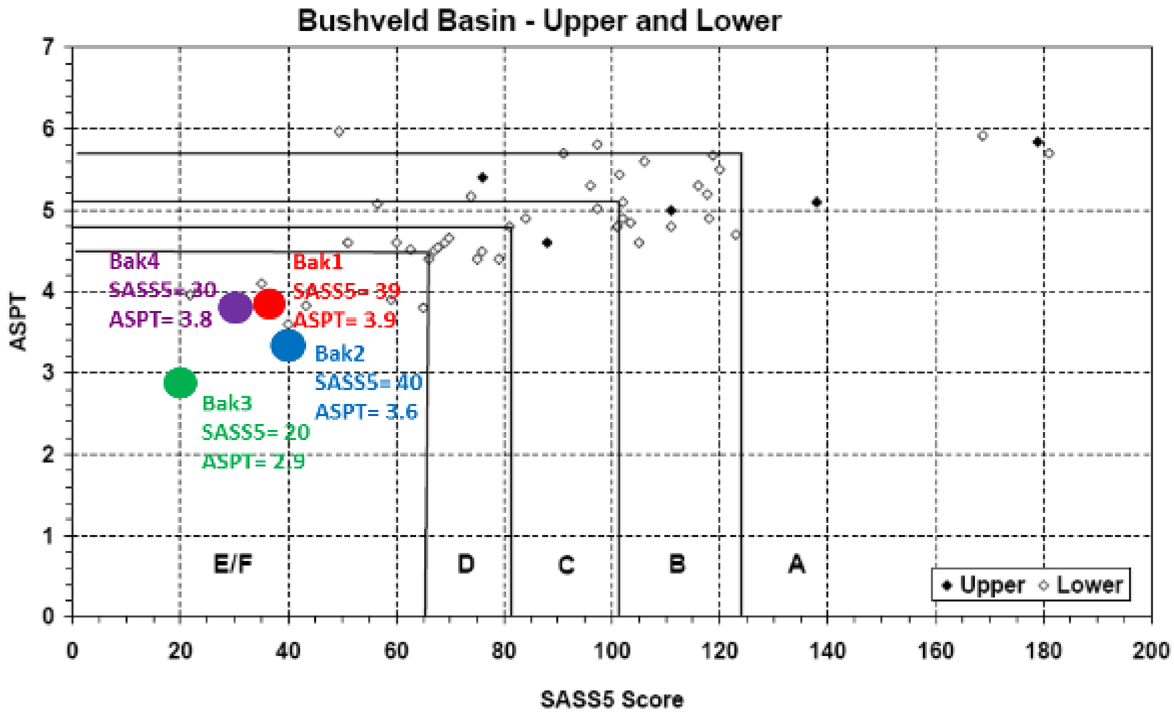
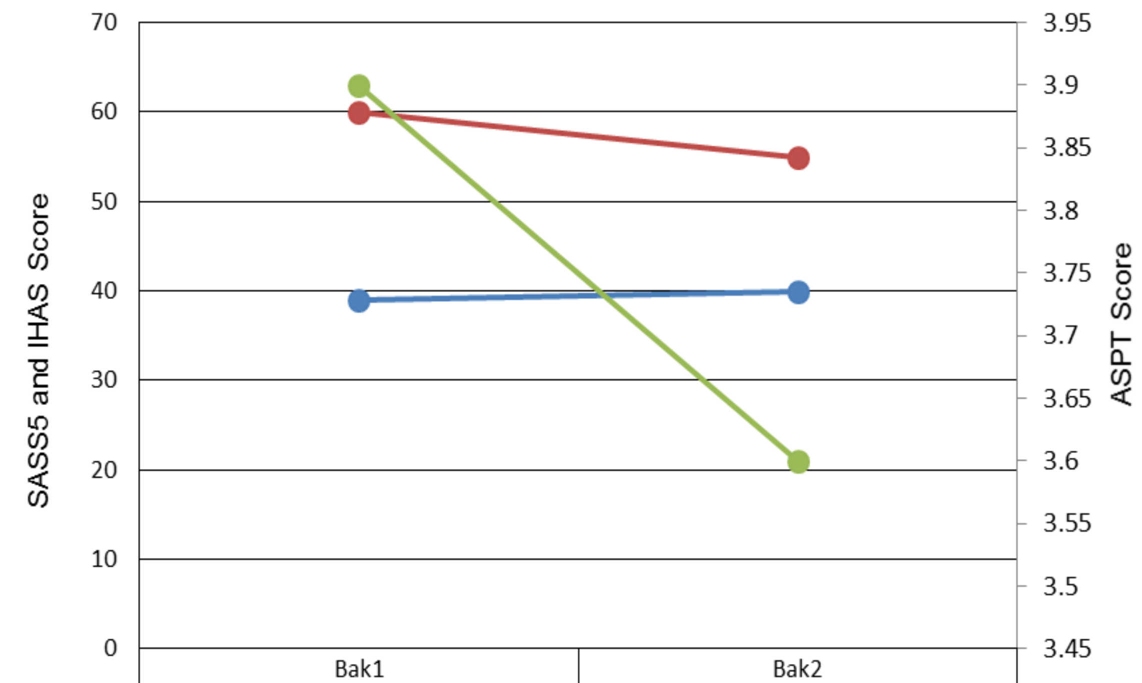


Figure 17: SASS5 results according to the Dallas (2007) classification system for the biomonitoring sites located on the Sandspruit and unnamed tributary.

Table 18: Spatial deviation of the aquatic macro-invertebrate community integrity.

Parameter	The Sandspruit (Bak1 and Bak2)	The Unnamed Tributary (Bak3 and Bak4)
SASS5 Score	+2.6%	+50.0%
ASPT Score	-7.7%	+12.1%
IHAS Score	-8.3%	+31.0%



	Bak1	Bak2
SASS5	39	40
IHAS	60	55
ASPT	3.9	3.6

Figure 18: SASS5, ASPT and IHAS score variation between the upstream and downstream sites located on the Sandspruit.

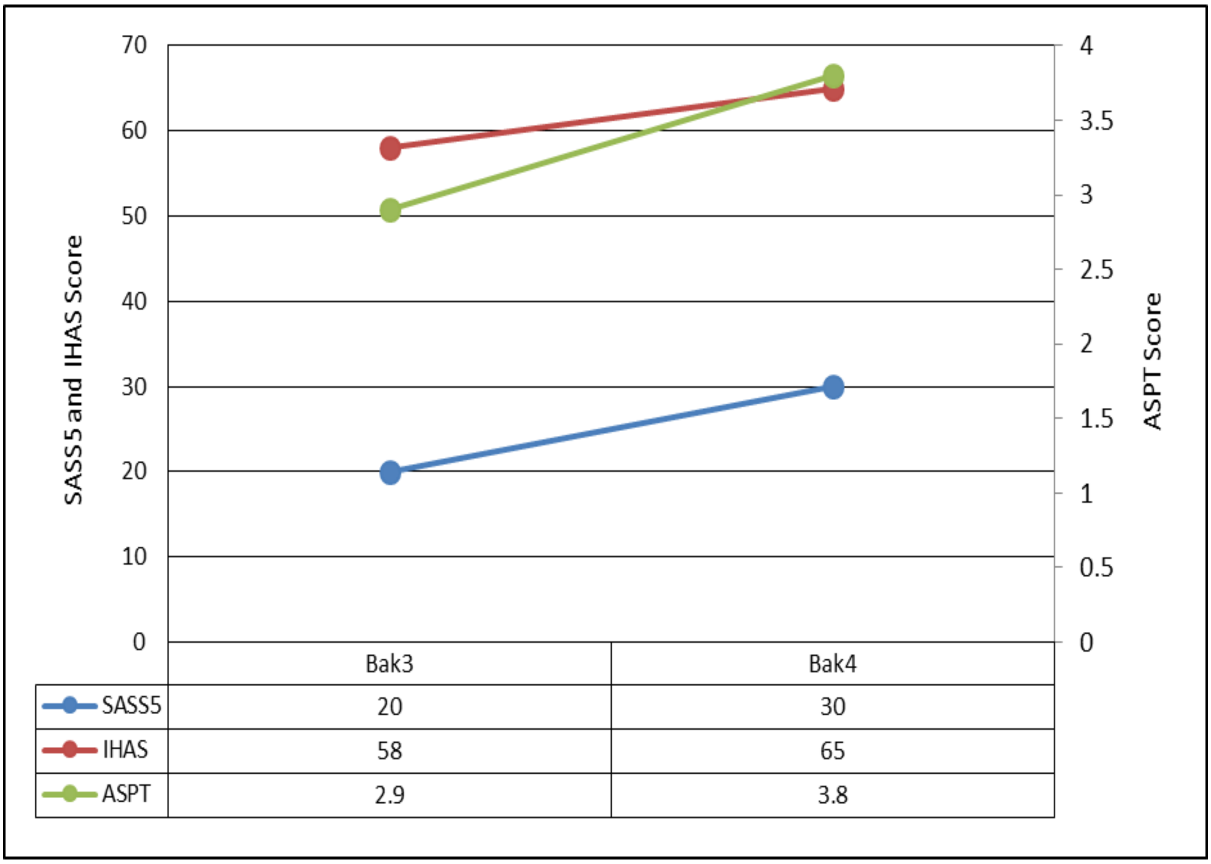


Figure 19: SASS and IHAS score variation between the upstream and downstream sites located on the unnamed tributary of the Elands River.

4.5 Macro-invertebrate Response Assessment Index (MIRAI)

The results obtained after employing the MIRAI are summarised below. For ease of comparison the classifications obtained using SASS5 are also presented in this section.

Table 19: Summary of the results (ecological categories) obtained from the application of the MIRAI to the assessment sites, compared to classes awarded using SASS5.

Variable / Index	Bak1	Bak2	Bak3	Bak4
Ecological category (MIRAI)	Class D (49.0%)	Class D (51.9%)	Class D (42.6%)	Class D (50.8%)
Dickens and Graham (SASS5)	Class E	Class E	Class F	Class E
Dallas (SASS5)	Class E/F	Class E/F	Class E/F	Class E/F

From the table above it is clear that the MIRAI results in terms of Ecological Category classification is slightly higher than the classification awarded by the SASS5 assessment, and is in accordance with the desktop assessment for the Sandspruit and Elands River PES. The key ecological drivers of systems are the lack of strong flowing water within the Sandspruit, the loss of connectivity within the system and the absence of inundated marginal vegetation due to the incised nature of the stream. The key ecological drivers within the unnamed tributary is likely the extremely low flow conditions present at these sites and the limited habitat availability accessible at the biomonitoring sites.

4.6 Diatom Community Assessment

Appendix 4 displays a list of species and abundances recorded for each of the sites. The table below indicates the results of the various Pollution Indexes applied to the biomonitoring sites.

Table 20: Pollution indices for the biomonitoring sites

Pollution Indices				
Site	TDI	%PTV	SPI	Diversity (Shannon – Weaver)
Bak1	9,8	35,7	14,7	3,55
Bak2	5,8	28,5	13,1	3,58
Bak3	3,8	29,5	11,6	3,17
Bak4	3,7	3,6	6,1	1,29
TDI (Trophic Diatom Index): *1 = Clean water, 20 = Grossly polluted water* %PTV: Percentage of organic Pollution Tolerant Valves SPI (Specific Pollution sensitivity Index): *1 = Heavy pollution, 20 = Negligible pollution*				

Table 21: Ecological indicators for the biomonitoring sites

Ecological Indicators					
Site	pH	Salinity	Nitrogen	Oxygen	Trophic state
Bak1	4	2	3	2	5
Bak2	3	2	1	2	5
Bak3	3	2	2	2	4
Bak4	3	2	3	2	5

Table 22: Diatom deformations for the biomonitoring sites

Diatom cell abnormalities (%)			
Bak1	Bak2	Bak3	Bak4
0.5	3.6	9.5	1.0
*Further water analysis recommended for abnormalities over 2%. Test for pesticides and metals recommended.			

- Twenty-one species were identified at the upstream site Bak1 and a total of 375 valves counted during the analysis. *Gomphonema parvulum* was the dominant species, which is considered typical of eutrophic conditions (Van Dam et al., 1994) and highly tolerant of organic pollution (Lange-Bertalot, 1979);

- Twenty species were identified at the downstream site Bak2 and a total of 301 valves counted during the analysis. *Fragilaria tenera* was the dominant species which may point to inorganic nutrient inputs in the system (Lange-Bertalot, 1980);
- Sixteen species were identified at the upstream site Bak3 of the unnamed tributary with only 226 valves counted during the analysis. *Navicula radiosa* was the dominant species at the time of the assessment;
- Only seven species were identified at the downstream site Bak4 of the unnamed tributary, with 302 valves counted during the analysis. *Craticula buderi* was the dominant species which is often found in freshwaters with an average to higher electrolyte content, often in saline waters and can occur in mining effluent (Lange-Bertalot, 2001);
- According to the results of the Pollution Indices, the diatom community structures found at the biomonitoring sites can be described as follows;
  - % Organic Pollution Tolerant Diatoms
    - Both the sites on the Sandspruit presented high values of pollution tolerant diatoms, 35.7% at the upstream Bak1 site and 28.5% at the downstream Bak2 site. This is indicative of artificial inputs of organic material all along the Sandspruit.
    - The upstream Bak3 site of the unnamed tributary presented a high number of pollution tolerant diatoms (29.5%), while the downstream Bak4 site had a relatively low percentage of organic pollution tolerant diatoms (3.6%). This indicates that organic pollution is entering the unnamed tributary at the upper reaches of the system. This is likely due to the locality of the site close to the R556 and downstream of a rural settlement.
  - The Specific Pollution sensitivity Index
    - The Sandspruit upstream Bak1 site can be regarded as being in a Class B condition, and the downstream Bak2 site in a Class B/C condition. This is indicative of good water quality at the time of the assessment.
    - The unnamed tributary Bak3 site can be regarded as being in a Class C condition, and the downstream Bak4 site in a Class D condition. The deteriorated condition at site Bak4 is likely due to anthropogenic and mining related activities which is supported by the presence of *Craticula buderi* as the dominant taxa at the site. This is indicative of moderately modified to poor water quality at the time of the assessment.
- According to the Ecological Indicators, the diatom community structures found at the sites are dependent on circumneutral to alkaliphilous pH values as well as fresh brackish water with a percentage salinity of <0.9%;

- The nitrogen uptake metabolism of diatoms found at sites Bak1 and Bak4 can be described as nitrogen-heterotrophic taxa which need continuously elevated concentrations of organically bound nitrogen, while the diatoms found at sites Bak2 and Bak3 can be described as nitrogen-autotrophic taxa which can tolerate elevated concentrations of organically bound nitrogen;
- The diatom communities present at the biomonitoring sites prefer fairly high dissolved oxygen saturation (>75%);
- The diatom community structures present at sites Bak1, Bak2, and Bak4 can be classified as Eutraphentic, diatoms are adapted for strongly polluted water at the time of the assessment, while the diatom community structure at site Bak3 can be classified as Meso-eutraphentic meaning the diatoms are adapted for slightly polluted water; and
- Diatom cell abnormalities were calculated at 3.6% at site Bak2 and 9.5% at site Bak3. Further water analysis is recommended for abnormalities over 2%. It is recommended to test for pesticides and heavy metals within the system in an attempt to clarify point and/or diffuse sources within the larger study area.

5 SYNTHESIS

Based on the findings of the aquatic study on the Sandspruit and unnamed tributary of the Elands River, the systems are characterized by seasonal flow variation and water abstraction for agricultural purposes. The desktop EIS/PES assessment indicates the Sandspruit and Elands River PES classifications as a Class D, EI classified as “moderate”, ES as “moderate” and default ECat as C. Indices employed, however, yielded the following classifications:

Table 23: Summary of the aquatic assessment results for the assessment sites

Source	Site	IHAS	IHIA	SASS5		MIRAI	Diatom Cell Abnormalities
				Dickens and Graham (2001)	Dallas (2007)		
Sandspruit	Bak1	Inadequate	C	E	E/F	D	0.5
	Bak2	Inadequate		E	E/F	D	3.6
Unnamed tributary of the Elands River	Bak3	Inadequate	C	F	E/F	D	9.5
	Bak4	Adequate		E	E/F	D	1.0

The current assessments indicate that conditions in the project area is deteriorated from what could be expected based on the desktop assessment. The Sandspruit and unnamed tributary of the Elands River can thus be considered as systems of reduced Ecological Importance and Sensitivity due to the limited provision of refugia and the limited support it provides to the aquatic ecology of the area. The systems are however deemed important in terms of the provision of services to the terrestrial fauna of the area as well as fair significance from a socio-cultural point of view. It is deemed essential that all effort is made to ensure that impacts on the aquatic resources as a result of the proposed tailings pipeline, road crossing and berm development are minimised.

6 IMPACT ASSESSMENT

6.1 General Management and Good Housekeeping Practices

The following essential mitigation measures are considered to be standard best practice measures applicable to a development of this nature, and must be implemented during all phases of the proposed tailings pipeline, road crossing and berm construction activities, in conjunction with those stipulated in the individual tables pertaining to specific impacts in the following sections which define the mitigatory measures specific to the minimisation of impacts on aquatic resources.

Development and construction footprint

- Sensitivity maps should be considered during all phases of the development to aid in the conservation of aquatic habitat and resources within the study area;
- All development footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive areas with specific mention of riparian areas. It must be ensured that the riparian and drainage line systems, and their associated buffer zones are off-limits to construction vehicles and personnel;
- A minimum buffer of 32 meters around all riparian systems should be maintained in line with the requirements of the Environmental Impact Assessment (EIA) Regulations (GN R983, R984 and R 985) amended in December 2014 of the National Environmental Management Act (1998) in which non-essential activities should take place;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas in order to minimise environmental damage; and
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration.

Vehicle access

- All areas of increased ecological sensitivity should be marked as such and kept off limits to all unauthorised construction and maintenance vehicles as well as personnel;
- Planning of temporary roads and access routes should take the site sensitivity plan into consideration;
- Vehicles and construction equipment are only allowed to cross drainage lines when using the temporary access roads;
- Drip trays must be provided for stationary or parked machinery or vehicles;
- No washing of machinery and vehicles on site; and
- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil. All spills should they occur, should be immediately cleaned up and treated accordingly.

Alien plant species

- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the project footprint. Alien plant seed dispersal within the top layers of the soil within footprint areas that will have an impact on future rehabilitation has to be controlled;
- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998);
- For species specific and area specific eradication, care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used, and footprint areas should be kept as small as possible when removing alien plant species*;* and
- No vehicles should be allowed to drive through designated sensitive drainage line and riparian areas during the eradication of alien and weed species.

Riparian and drainage line habitat

- A minimum buffer of 32 meters around all riparian systems should be maintained in line with the requirements of the Environmental Impact Assessment (EIA) Regulations (GN R983, R984 and R 985) amended in December 2014 of the National Environmental Management Act (1998) in which non-essential activities should take place;

- Any damage to the drainage lines necessary to complete the work must be limited in extent;
- Tie-in points at riverbanks must be suitably safeguarded with gabion cut-off walls to prevent erosion;
- Construction activities may not permanently alter the surface or subsurface flow;
- No rocks from any water resource may be used as erosion or sedimentation control;
- Permit only essential construction personnel within 32m of the riparian habitat, if absolutely necessary that they enter the buffer zone;
- Implement effective waste management in order to prevent construction related waste from entering the drainage line and riparian environments; and
- The fishing or capturing of any biota should be prohibited.

Soils

- In areas to be affected by construction activities a minimum of 300mm topsoil should be removed and stockpiled separately. On completion of the pipeline construction and after backfilling of the trenches, the topsoil should be replaced as the final layer prior to reseeding;
- All areas should be monitored for erosion and incision. Specific mention is made of sedimentation of riparian areas;
- To prevent the erosion of topsoils, management measures to minimise erosion should include installation of berms, silt traps, hessian curtains at erodible areas and stormwater diversion away from areas susceptible to erosion;
- Berms every 50m should be installed where any disturbed soils have a slope of less than 2%, every 25m where the track slopes between 2% and 10%, every 20m where the track slopes between 10% and 15% and every 10m where the track slope is greater than 15% to prevent gully formation;
- Sheet runoff from access roads should be slowed down by the strategic placement of berms; and
- All soils compacted as a result of activities falling outside of project footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas.

Waste Management

- Implement effective waste management in order to prevent construction-related waste from entering the drainage line and riparian environments;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SANS standards to prevent leakage;

- All spills, should they occur, should be immediately cleaned up and treated accordingly;
- Appropriate sanitary facilities must be provided for the life of the construction activity and all waste removed to an appropriate waste facility;
- All hazardous chemicals should be stored on bunded surfaces and all hazardous waste should be removed to a licenced hazardous landfill site;
- No camp fires should be permitted in or near the riparian area; and
- Ensure that litter does not affect the riparian areas and associated buffer zones. Ensure that an adequate number of rubbish and 'spill' bins are provided to prevent litter and ensure the proper disposal of waste and spills.

Rehabilitation

- All soils compacted as a result of activities falling outside of project footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas;
- Rehabilitate all drainage line and riparian habitat areas if required, in order to ensure that the ecology of these areas is re-instated during all phases of the project;
- Edge effects of activities including erosion and alien/weed control need to be strictly managed in these areas;
- All reseeding activities must be undertaken at the end of the dry season to ensure optimal conditions for germination and rapid vegetation establishment; and
- As much vegetation growth as possible should be promoted within the proposed development area in order to protect soils.

6.2 Impact 1: Loss of aquatic habitat and ecological structure in the Elands River and associated tributaries

Activities leading to impact

Pre-Construction Phase	Construction Phase	Operational Phase	Decommissioning and Closure Phase
Possible poor planning leading to an increased footprint in the vicinity of the Elands River and its tributaries.	Obstacles in the riparian zone obstructing flow and causing build-up of sediment.	Spillages and seepage of tailings material into the groundwater and receiving environment.	Ineffective decommissioning and rehabilitation may lead to instream habitat transformation and alien vegetation encroachment.
Potential inappropriate design of infrastructure leading to changes to aquatic habitat.	Site clearing and the removal of vegetation leading to increased runoff and erosion.	Ongoing disturbance of soils as a result of general operational and maintenance activities.	Disturbance of soils as part of decommissioning and rehabilitation activities leading to sedimentation in the receiving environment.
	The disturbance of soils and sediment leading to increased turbidity in the system.		Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management.
	Earthworks in the vicinity of riparian areas leading to increased loss of habitat.		Potential contamination of riparian areas from the decommissioning of tailings infrastructure.
	Runoff from construction areas leading to contaminated water and soil.		
	Incision of riparian areas leading to erosion and sediment deposition.		
	Dumping of construction-related waste material within the aquatic resources or in the vicinity of the aquatic resources.		
	Potential contamination of soil and water from the oil or fuel of construction equipment and vehicles.		
	The disturbance or removal of vegetation during site access leading to increased erosion and runoff into the aquatic resources.		

Construction related activities, such as the removal of the topsoil and disturbance of vegetation, will lead to habitat destruction and overall loss of biodiversity within the riparian areas. All these activities may result in permanent impact on the features and may extend to downstream areas as well. In addition the edge effects from the development could lead to the introduction of alien species.

Operational activities such as leaks and spillages from the tailings pipeline will result in the contamination of riparian soils and water, which will lead to the alteration or loss of habitat for aquatic species.

If left unmitigated, impacts on the riparian features will lead to significant impacts on riparian habitat and ecological structure, however with the implementation of mitigation measures the severity and spatial scale of the impact can be reduced.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	2	4	4	3	6	11	66 (Medium-Low)
Operational phase	4	2	4	4	4	6	12	72 (Medium Low)
Decommissioning phase	3	2	2	2	2	5	6	36 (Low)

Essential construction mitigation measures:

- Any damage to the drainage lines necessary to complete the work must be limited in extent;
- Tie-in points at riverbanks must be suitably safeguarded with gabion cut-off walls to prevent erosion;
- Permit only essential construction personnel within 32m of the riparian habitat, if absolutely necessary that they enter the buffer zone;
- All areas should be monitored for erosion and incision. Specific mention is made of sedimentation of riparian areas;
- To prevent the erosion of topsoils, management measures to minimise erosion should include installation of berms, silt traps, hessian curtains at erodible areas and stormwater diversion away from areas susceptible to erosion;
- Erosion berms may be installed in any areas where soil disturbances within the vicinity of the riparian features have occurred to prevent gully formation and siltation of the aquatic resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10% and 15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.
- Sheet runoff from access roads should be slowed down by the strategic placement of berms;
- All soils compacted as a result of activities falling outside of project footprint areas should be ripped and profiled;
- Rehabilitate all drainage line and riparian habitat areas if required, in order to ensure that the ecology of these areas is re-instated during all phases;
- Edge effects of activities including erosion and alien/weed control need to be strictly managed in these areas;
- Alien and invasive vegetation control should take place throughout all phases of the development;;
- All reseeding activities must be undertaken at the end of the dry season to ensure optimal conditions for germination and rapid vegetation establishment; and
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor during the construction phase.

Essential operation phase mitigation measures:

- Ensure that operational and maintenance related activities are kept strictly within the development footprint;
- Regular monitoring of the tailings pipeline is recommended to prevent potential spills/leakages;
- All spills/leakages by the tailings pipeline should be immediately cleaned up and treated accordingly;
- Alien and invasive vegetation control should take place throughout all phases of the development; and
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor during the operational phase.

Essential decommissioning and closure phase mitigation measures:

- All development footprint areas and areas affected by closure and decommissioning of the tailings infrastructure should remain as small as possible and should not encroach onto surrounding riparian areas and their associated buffer zones;
- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the development / decommissioning footprint. Alien plant seed dispersal within the top layers of the soil within decommissioning areas, that will have an impact on future rehabilitation, has to be controlled;
- Upon closure and decommissioning, reseeding with indigenous grasses should be implemented in all affected areas;
- Post closure aquatic ecological monitoring is recommended to ensure that no impact on the aquatic resources in the area takes place after closure has taken place.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	2	2	2	2	4	6	24 (Very Low)
Operational phase	2	2	2	2	4	4	8	32 (Low)
Decommissioning phase	1	2	1	1	1	3	3	9 (Very Low)

Probable latent impacts:

- Sedimentation of the system as a result of erosion may lead to altered instream habitat;
- Some changes to the hydrology of the system may occur due to increased runoff affecting downstream habitat.
- Seepage or drainage through the soil leading to contaminated water and soil.

6.3 Impact 2: Impacts on aquatic hydrological function and sediment balance

Activities leading to impact

Pre-Construction	Construction Phase	Operational Phase	Decommissioning and Closure Phase
Possible poor planning leading to an increased footprint in the vicinity of the Elands River and its tributaries.	Site clearing and the removal of vegetation leading to increased runoff and erosion.	Ongoing disturbance of soils as a result of general operational and maintenance activities.	Ineffective decommissioning and rehabilitation may lead to instream habitat transformation and alien vegetation encroachment.
Potential inappropriate design of infrastructure leading to changes in hydrological function and sediment control capacity.	Stockpiling adjacent to riparian areas and runoff from stockpiles leading to sedimentation of the riparian areas.		Disturbance of soils as part of decommissioning and rehabilitation activities leading to sedimentation in the receiving environment.
	Earthworks in the vicinity of riparian areas leading to altered runoff patterns.		Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management.
	Movement of construction vehicles within riparian areas leading to soil compaction which results in increased runoff.		Potential contamination of riparian areas from the decommissioning of tailings infrastructure.
	Concentration of flow and incision of riparian areas.		

Construction activities such as vegetation removal and excavations may alter the hydrology and sediment balance of the riparian features. An increase in runoff from disturbed areas may also alter flow patterns and may result in the severity of floods downstream. In addition, sediment deposition as a result of the disturbance of soils and increased sediment runoff during the construction phase may result in an impact on the sediment balance of the features.

During the operational phase, compacted soils due to access roads will increase surface runoff, which then alter the hydrology of the features. Ongoing operational and maintenance activities will result in the sedimentation and possible contamination of riparian habitat, leading to the reduction of water quality.

If left unmitigated, impacts on the riparian features will lead to significant impacts on riparian habitat and ecological structure, however with the implementation of mitigation measures the severity and spatial scale of the impact can be reduced.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	2	3	3	3	6	9	54 (Medium-Low)
Operational phase	3	2	2	2	4	5	8	40 (Low)
Decommissioning phase	3	2	2	2	2	5	6	30 (Low)

Essential construction mitigation measures:

- It must be ensured that planning of the tailings pipeline, road crossing and berm includes consideration of adjacent drainage line areas to ensure that these areas are avoided as far as possible;
- Keep all demarcated sensitive zones outside of the construction area off limits during construction phase;
- Limit the footprint area of the proposed project and closure activity to what is absolutely essential in order to minimise environmental damage and loss of catchment yield;
- Planning for the proposed project should not lead to a reduction of stream flow or dewatering of any water source areas and connectivity of the riparian features should be maintained;
- Erosion berms may be installed in any areas where soil disturbances within the vicinity of the riparian features have occurred to prevent gully formation and siltation of the aquatic resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope of less than 2%, berms every 50m should be installed.
  - Where the track slopes between 2% and 10%, berms every 25m should be installed.
  - Where the track slopes between 10% and 15%, berms every 20m should be installed.
  - Where the track has slope greater than 15%, berms every 10m should be installed.
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor during the construction phase.

Essential operational mitigation measures

- Ensure that operational and maintenance related activities are kept strictly within the development footprint;
- Regular monitoring of the tailings pipeline is recommended to prevent potential spills/leakages;
- All spills/leakages by the tailings pipeline should be immediately cleaned up and treated accordingly;
- Alien and invasive vegetation control should take place throughout all phases of the development; and
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor during the operational phase.

Essential decommissioning and closure phase mitigation measures

- Post closure aquatic ecological monitoring is recommended to ensure that no impact on the aquatic resources in the area takes place after closure has taken place;
- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the development / decommissioning footprint. Alien plant seed dispersal within the top layers of the soil within decommissioning areas, that will have an impact on future rehabilitation, has to be controlled; and
- Upon closure and decommissioning, reseeding with indigenous grasses should be implemented in all affected areas.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	2	2	2	2	4	6	24 (Very Low)
Operational	2	2	1	1	4	4	6	24

phase								**(Very Low)**
Decommissioning phase	**1**	**2**	**1**	**1**	**1**	**3**	**3**	**9 (Very Low)**

Probable latent impacts:

- Loss of catchment yield;
- Sedimentation of the features may lead to altered riparian habitats;
- Ineffective rehabilitation may lead to the permanent transformation of the riparian habitat; and
- Proliferation of alien weed species in disturbed areas will lead to altered vegetation communities.

6.4 Impact 3: Loss of aquatic biodiversity and sensitive taxa in the Elands River and associated tributaries

Activities leading to impact

Pre-Construction Phase	Construction Phase	Operational Phase	Decommissioning and Closure Phase
Possible poor planning leading to an increased footprint in the vicinity of the Elands River and its tributaries.	The disturbance of soils and sediment leading to increased turbidity in the system.	Spillages and seepage of tailings material into the groundwater and receiving environment.	Ineffective decommissioning and rehabilitation may lead to instream habitat transformation and alien vegetation encroachment.
Potential inappropriate design of infrastructure leading to changes in hydrological function and sediment control capacity.	Dumping of construction-related waste material within the aquatic resources or in the vicinity of the aquatic resources.	Ongoing disturbance of soils as a result of general operational and maintenance activities.	Disturbance of soils as part of decommissioning and rehabilitation activities leading to sedimentation in the receiving environment.
	Disturbance or removal of vegetation and stones during site access leading to increased runoff and erosion.		Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation due to poor management.
	Potential contamination of soil and water from the oil or fuel of construction equipment and vehicles.		Potential contamination of riparian areas from the decommissioning of tailings infrastructure.
	Earthworks in the vicinity of riparian areas leading to altered runoff patterns.		
	Stockpiling adjacent to riparian areas and runoff from stockpiles leading to sedimentation of the riparian areas.		
	Movement of construction equipment or vehicles and personnel in the vicinity of the aquatic resources.		

Construction activities such as vegetation removal, earthworks and stockpiling around the riparian area may alter the hydrology and sediment balance of the features. An increase in runoff from disturbed areas may also alter flow patterns. In addition, sediment deposition as a result of the disturbance of soils and increased sediment runoff during the construction may result in an impact on the sediment balance of the features. Which can lead to an inability to support biotic biodiversity as a result of changes to water quality, increased sedimentation and alteration of natural hydrological regimes.

During the operational phase, possible spillages/leakages of the tailings pipeline will result in contamination of the receiving environment, leading to the reduction of water quality.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	2	4	3	3	6	10	60 (Medium-Low)
Operational phase	4	2	4	3	4	6	11	66 (Medium Low)
Decommissioning phase	3	2	2	2	2	5	6	30 (Low)

Essential construction mitigation measures:

- Implement effective waste management measures in order to prevent construction related waste from entering the drainage line and riparian environments;
- Appropriate sanitary facilities must be provided for the duration of the proposed development and all waste removed to an appropriate waste facility;
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SANS standards to prevent leakage;
- All spills, should they occur, should be immediately cleaned up and treated accordingly;
- No camp fires should be permitted in or near the riparian area; and
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor during the construction phase.

Essential operational mitigation measures

- Ensure that operational and maintenance related activities are kept strictly within the development footprint;
- Regular monitoring of the tailings pipeline is recommended to prevent potential spills/leakages;
- All spills/leakages by the tailings pipeline should be immediately cleaned up and treated accordingly;
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor during the operational phase.

Essential decommissioning and closure phase mitigation measures

- Post closure aquatic ecological monitoring is recommended to ensure that no impact on the aquatic resources in the area takes place after closure has taken place.

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	2	2	2	2	4	6	24 (Very Low)
Operational phase	2	2	2	2	4	4	8	32 (Low)
Decommissioning phase	1	2	1	1	1	3	3	9 (Very Low)

Probable latent impacts:

- Sedimentation of the features may lead to altered riparian habitats;
- Ineffective rehabilitation may lead to the permanent transformation of the riparian habitat;
- Proliferation of alien weed species in disturbed areas will lead to altered vegetation communities; and
- Impairment to water quality as a result of possible spillage/leakage leading to the loss of sensitive taxa.

6.5 Impact Assessment Conclusion

Based on the above assessment it is evident that there are three possible impacts that may have an effect on the overall aquatic integrity of the Elands River and its associated tributaries. The table below summarises the findings indicating the significance of the impacts before mitigation takes place as well as the significance of the impacts if appropriate management and mitigation takes place. In the consideration of mitigation it is assumed that a high level of mitigation takes place but which does not lead to prohibitive costs.

Table 24: A summary of the impact significance of the construction phase on the Elands River and its associated tributaries.

Impact	Unmanaged	Managed
1: Loss of aquatic habitat	Medium Low	Very Low
2: Impacts on aquatic hydrological function and sediment balance	Medium Low	Low
3: Loss of aquatic biodiversity and sensitive taxa	Low	Very Low

Table 25: A summary of the impact significance of the operational phase on the Elands River and its associated tributaries.

Impact	Unmanaged	Managed
1: Loss of aquatic habitat	Medium Low	Very Low
2: Impacts on aquatic hydrological function and sediment balance	Low	Very Low
3: Loss of aquatic biodiversity and sensitive taxa	Low	Very Low

Table 26: A summary of the impact significance of the decommissioning and closure phase on the Elands River and its associated tributaries.

Impact	Unmanaged	Managed
1: Loss of aquatic habitat	Medium Low	Very Low
2: Impacts on aquatic hydrological function and sediment balance	Medium Low	Low
3: Loss of aquatic biodiversity and sensitive taxa	Low	Very Low

From the tables it is evident that prior to mitigation, impacts on the aquatic ecological integrity of the Elands River and its associated tributaries can be considered as Medium-Low to Low level impacts. Should mitigatory measures be implemented as recommended, impacts will be reduced to Low and Very Low level impacts.

Based on the findings of this study, it can be concluded that the study area has moderate levels of ecological integrity and sensitivity; and the proposed tailings pipeline, road crossing and berm is therefore likely to result in a moderate transformation of important habitats and systems, and the loss of biodiversity should impact minimization measures not be implemented adequately. Adherence to the recommended mitigation measures will assist in reducing the impact on the aquatic resources on the subject property to an overall low level.

7 RECOMMENDATIONS

After conclusion of this aquatic assessment, it is the opinion of the ecologists that the proposed tailings pipeline, road crossing and berm development be considered favourably, provided that the recommendations below are adhered to:

- It must be ensured that planning of the tailings pipeline, road crossing and berm includes consideration of adjacent drainage line areas to ensure that these areas are avoided as far as possible;
- Keep all demarcated sensitive zones outside of the construction area off limits during construction phase;
- Limit the footprint area of the proposed project and closure activity to what is absolutely essential in order to minimise environmental damage and loss of catchment yield;
- Planning for the proposed project should not lead to a reduction of stream flow or dewatering of any water source areas and connectivity of the riparian features should be maintained;
- Any damage to the drainage lines necessary to complete the work must be limited in extent;
- Tie-in points at riverbanks must be suitably safeguarded with gabion cut-off walls to prevent erosion;
- Permit only essential construction personnel within 32m of the riparian habitat, if absolutely necessary that they enter the buffer zone;
- All areas should be monitored for erosion and incision. Specific mention is made of sedimentation of riparian areas;
- To prevent the erosion of topsoils, management measures to minimise erosion should include installation of berms, silt traps, hessian curtains at erodible areas and stormwater diversion away from areas susceptible to erosion;
- Erosion berms may be installed in any areas where soil disturbances within the vicinity of the riparian features have occurred to prevent gully formation and siltation of the aquatic resources. The following points should serve to guide the placement of erosion berms:
  - Where the track has slope greater than 15%, berms every 10m should be installed.

- Where the track has slope of less than 2%, berms every 50m should be installed.
- Where the track slopes between 10% and 15%, berms every 20m should be installed.
- Where the track slopes between 2% and 10%, berms every 25m should be installed.

➢ Sheet runoff from access roads should be slowed down by the strategic placement of berms;

➢ All soils compacted as a result of activities falling outside of project footprint areas should be ripped and profiled;

➢ Rehabilitate all drainage line and riparian habitat areas if required, in order to ensure that the ecology of these areas is re-instated during all phases;

➢ Edge effects of activities including erosion and alien/weed control need to be strictly managed in these areas;

➢ Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the development / decommissioning footprint. Alien plant seed dispersal within the top layers of the soil within decommissioning areas, that will have an impact on future rehabilitation, has to be controlled;

➢ Alien and invasive vegetation control should take place throughout all phases of the development;

➢ All reseeding activities must be undertaken at the end of the dry season to ensure optimal conditions for germination and rapid vegetation establishment;

➢ Implement effective waste management in order to prevent construction related waste from entering the drainage line and riparian environments;

➢ It must be ensured that all hazardous storage containers and storage areas comply with the relevant SANS standards to prevent leakage;

➢ No camp fires should be permitted in or near the riparian area;

➢ Appropriate sanitary facilities must be provided for the duration of the proposed development and all waste removed to an appropriate waste facility;

➢ During the operational phase of the tailings pipeline, ensure that operational and maintenance related activities are kept strictly within the development footprint;

➢ Regular monitoring of the tailings pipeline is recommended during the operational phase to prevent potential spills/leakages;

➢ All spills/leakages by the tailings pipeline should be immediately cleaned up and treated accordingly;

- All development footprint areas and areas affected by closure and decommissioning of the tailings pipeline should remain as small as possible and should not encroach onto surrounding riparian areas and their associated buffer zones;
- Upon closure and decommissioning, reseeding with indigenous grasses should be implemented in all affected areas;
- On-going aquatic ecological monitoring must take place on a 6 monthly basis by an SA RHP Accredited assessor during both the construction and operational phases;
- Post closure aquatic ecological monitoring is recommended to ensure that no impact on the aquatic resources in the area takes place after decommissioning and closure has taken place;
- Since the downstream sites in both the Sandspruit and unnamed tributary of the Elands River displayed higher SASS scores this spatial trend should not show a deterioration in the future once the proposed development takes place and this trend should be considered a Key Performance Indicator (KPI) for the project throughout the life of the infrastructure.

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APPENDIX 1: SASS5 Scoresheets

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 21/07/2015	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: BAK PIPE 1	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5	A		A	A
RIVER:	Oligochaeta	1			A	A	Hydrometridae*	6					Chironomidae	2	B		A	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1	A		A	A
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 9.5 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.27	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 9.68 mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1				
Cond: 73.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4	B			B	Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6	A		A	B	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3	A		A	A
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		34	0	27	39
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		8	0	8	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		4	0.0	3	3.9
	Chlorolestidae	8					Pisuliidae	10					IHAS:		60%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						TADPOLES					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5	A		A	A	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					STONES + GSM ONLY					
	Zygoptera juvs.	6					Gyrinidae*	5										
	Aeshnidae	8					Halipidae*	5										
	Corduliidae	8	1			1	Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4			A	A	Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 21/07/2015	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**	**TAXON**		**S**	**VG**	**GSM**	**TOT**
GRID REFERENCE:	**PORIFERA**	5					**HEMIPTERA:**						**DIPTERA:**					
S:°	**COELENTERATA**	1					Belostomatidae*	3					Athericidae	10				
E:°	**TURBELLARIA**	3					Corixidae*	3			B	B	Blepharoceridae	15				
SITE CODE: BAK PIPE 2	**ANNELIDA:**						Gerridae*	5					Ceratopogonidae	5	1		A	A
RIVER:	Oligochaeta	1	A		A	A	Hydrometridae*	6					Chironomidae	2	A		B	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1	1		A	A
WEATHER CONDITION:	**CRUSTACEA:**						Nepidae*	3					Dixidae*	10				
TEMP: 12.8 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.56	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 8.51 mg/l	Atyidae	8					Veliidae/M..veliidae*	5	A			A	Muscidae	1				
Cond: 69.0 mS/m	Palaemonidae	10					**MEGALOPTERA:**						Psychodidae	1				
BIOTOPES SAMPLED:	**HYDRACARINA**	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	**PLECOPTERA:**						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					**TRICHOPTERA**						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	**EPHEMEROPTERA**						Ecnomidae	8					**GASTROPODA**					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6	1		A	A	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					**CASED CADDIS:**						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					**PELECYPODA**					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3	1			1
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					**SASS SCORE:**		32	0	23	40
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					**NO OF TAXA:**		9	0	7	11
	Chlorocyphidae	10					Petrothrincidae SWC	11					**ASPT:**		4	0.0	3	3.6
	Chlorolestidae	8					Pisuliidae	10					**IHAS**:		55%			
	Coenagrionidae	4	1			1	Sericostomatidae SWC	13					**OTHER BIOTA**:					
	Lestidae	8					**COLEOPTERA:**						TILLAPIA, TADPOLE					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5			1	1	**COMMENTS**:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					STONES + GSM ONLY					
	Zygoptera juvs.	6					Gyrinidae*	5	1			1	HIGH RIVER BANKS					
	Aeshnidae	8					Halipidae*	5										
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 21/07/2015	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: BAK PIPE 3	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5	A	1		A
RIVER:	Oligochaeta	1	1		A	A	Hydrometridae*	6					Chironomidae	2	A	A	A	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1	A			A
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 18.4 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.66	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 7.68 mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1		1	A	A
Cond: 65.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	1	A	A	B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		14	18	9	20
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		5	5	4	7
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		3	3.6	2	2.9
	Chlorolestidae	8					Pisuliidae	10					IHAS:		58%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						SEVERE SEDIMENTATION					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5		1		1	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					LIMITED VEG					
	Zygoptera juvs.	6					Gyrinidae*	5					MUD					
	Aeshnidae	8					Halipidae*	5										
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 21/07/2015	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: BAK PIPE 4	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5	A		A	A
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	A	A	A	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1	1	1	A	A
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 216 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 7.90	Potamonautidae*	3					Pleidae*	4					Ephydridae	3				
DO: 7.67 mg/l	Atyidae	8					Veliidae/M..veliidae*	5					Muscidae	1			1	1
Cond: 64.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	A	B	A	B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6		A	A	A	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		13	24	25	30
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		4	6	7	8
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		3	4.0	4	3.8
	Chlorolestidae	8					Pisuliidae	10					IHAS:	65%				
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5		1	1	A	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					VERY LOW FLOW					
	Zygoptera juvs.	6					Gyrinidae*	5					STONES + VEG + GSM					
	Aeshnidae	8					Halipidae*	5										
	Corduliidae	8					Helodidae	12					* = airbreathers					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					SWC = South Western Cape T = Tropical					
	Libellulidae	4					Hydrophilidae*	5		1		1	VG = all vegetation ST = Sub-tropical					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud S = Stone & rock					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

APPENDIX 2: IHAS Scoresheets

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: BAK PIPE 1	**Date**: 21/07/2015					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			13		
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				0	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m²' = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				17	
	HABITAT TOTAL (MAX 55):				30	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					30
	TOTAL IHAS SCORE (%):				60	

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name:

Site Name: BAKPIPE 2 — **Date**: 21/07/2015

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(*NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			14		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				0	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m^2 = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m^2	rocks	1-2m^2	<1m^2	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				14	
	HABITAT TOTAL (MAX 55):				28	
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX				27	
	TOTAL IHAS SCORE (%):				55	

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name:						
Site Name: BAK PIPE 3	**Date**: 21/0/2015					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			13		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				8	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				13	
	HABITAT TOTAL (MAX 55):				34	
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX					24
	TOTAL IHAS SCORE (%):				58	

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)

River Name:

Site Name: BAK PIPE 4

Date: 21/07/2015

SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):			13		
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none	0	1-25	26-50	51-75	>75
	Vegetation Score (max 15):				8	
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				13	
	HABITAT TOTAL (MAX 55):				34	
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>2	>1-2	1	>½-1	½	<½
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	flood	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45):					31
	TOTAL IHAS SCORE (%):				65	

APPENDIX 3: IHIA Scoresheets

Instream Habitat Integrity

Weights	14	13	13	13	14	10	9	8	6		
SITE	Water abstraction	Flow modification	Bed modification	Channel modification	Water quality	Inundation	Exotic macrophytes	Exotic fauna	Solid waste disposal	Total Score (%)	Classification
Sandspruit	9	11	9	9	11	3	3	0	1	62.3	C Moderately modified
Unnamed Tributary	9	11	6	8	11	2	2	0	2	65.9	C Moderately modified

None (0)	Small (1-5)	Moderate (6 – 10)	Large (11 – 15)	Serious (16 – 20)	Critical (21 – 25)

Riparian Zone Habitat Integrity

Weights	13	12	14	12	13	11	12	13		
SITE	Vegetation removal	Alien encroachment	Bank erosion	Water abstraction	Flow modification	Channel modification	Water quality	Inundation	Total Score (%)	Classification
Sandspruit	6	5	11	8	6	5	3	3	67.3	C Moderately modified
Unnamed Tributary	6	5	11	8	5	4	3	2	73.0	C Moderately modified

None (0)	Small (1-5)	Moderate (6 – 10)	Large (11 – 15)	Serious (16 – 20)	Critical (21 – 25)

Combined Habitat Integrity (Kemper, 1999)

SITE	*INSTREAM HABITAT*	*RIPARIAN ZONE*	*IHI SCORE*	*CLASS*
Sandspruit	62.3	67.3	64.8	C Moderately modified
Unnamed Tributary	65.9	73.0	69.4	C Moderately modified

APPENDIX 3: Specialist Declaration

SPECIALIST REPORTING REQUIREMENTS AS PER APPENDIX 6 OF THE EIA REGULATIONS 2014

This letter has been prepared to report on the compliance of _(Stephen van Staden and Scientific Aquatic Services)_as part of the specialist reporting requirements listed in Appendix 6 of the Environmental Impact Assessment Regulations, 2014 from the National Environmental Management Act, 1998 (Act no. 107 of 1999).

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

Stephen van Staden, M.Sc. Environmental Management. (Pr. Sci. Nat.)

Leandra Jonker, M.Sc. Aquatic Health

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

Refer to relevant section in report or complete section below

Company of Specialist:	Scientific Aquatic Services		
Name / Contact person:	Stephen van Staden		
Postal address:	PO Box 751779, Garden View		
Postal code:	2047	Cell:	083 415 2356
Telephone:	011 616 7893	Fax:	086 311 4878
E-mail:	stephen@sasenvironmental.co.za		
Qualifications	MSc (Environmental Management) (University of Johannesburg) BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg) BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)		
Registration / Associations	Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP) Accredited River Health practitioner by the South African River Health Program (RHP) Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum		

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF STEPHEN VAN STADEN
PERSONAL DETAILS

Position in Company	Managing member, Ecologist, Aquatic Ecologist

Date of Birth	13 July 1979
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

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

EDUCATION

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

COUNTRIES OF WORK EXPERIENCE

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

SELECTED PROJECT EXAMPLES

Development compliance studies

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

Specialist studies and project management

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

Aquatic and water quality monitoring and compliance reporting

- Development of the Resource quality Objective framework for Water Use licensing in the Crocodile West Marico Water management Area.

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

Wetland delineation and wetland function assessment

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

Terrestrial ecological studies and biodiversity studies

- Development of a biodiversity offset plan for Xstrata Alloys Rustenburg Operations.
- Biodiversity Action plans for numerous mining operations of Anglo Platinum throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Assmang Chrome throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plans for numerous mining operations of Xstrata Alloys and Mining throughout South Africa in line with the NEMBA requirements.
- Biodiversity Action plan for the Nkomati Nickel and Chrome Mine Joint Venture.
- Terrestrial and wetland biodiversity studies for three copper mines on the copperbelt in the Democratic Republic of the Congo.
- Terrestrial and wetland biodiversity studies for proposed mining projects in Guinea Bissau, Liberia and Angola in West Africa.
- Numerous terrestrial ecological assessments for proposed platinum and coal mining projects.
- Numerous terrestrial ecological assessments for proposed residential and commercial property developments throughout most of South Africa.
- Specialist Giant bullfrog (*Pyxicephalus adspersus*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist Marsh sylph (*Metisella meninx*) studies for several proposed residential and commercial development projects in Gauteng, South Africa.
- Project management of several Red Data Listed (RDL) bird studies with special mention of African grass owl (*Tyto capensis*).
- Project management of several studies for RDL Scorpions, spiders and beetles for proposed residential and commercial development projects in Gauteng, South Africa.
- Specialist assessments of terrestrial ecosystems for the potential occurrence of RDL spiders and owls.
- Project management and site specific assessment on numerous terrestrial ecological surveys including numerous studies in the Johannesburg-Pretoria area, Witbank area, and the Vredefort dome complex.
- Biodiversity assessments of estuarine areas in the Kwa-Zulu Natal and Eastern Cape provinces.
- Impact assessment of a spill event on a commercial maize farm including soil impact assessments.

Fisheries management studies

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

SCIENTIFIC AQUATIC SERVICES (SAS) – SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF LEANDRA JONKER
PERSONAL DETAILS

Position in Company	Aquatic Ecologist
Date of Birth	6 September 1988
Nationality	South African
Languages	English, Afrikaans
Joined SAS	2012

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Accredited River Health practitioner by the South African River Health Program (RHP)

EDUCATION

Qualifications

MSc Aquatic Health (University of Johannesburg)	2015
BSc Environmental Management (Hons) (University of South Africa)	2011
BSc Botany and Zoology (North-West University)	2009

COUNTRIES OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo

SELECTED PROJECT EXAMPLES

Aquatic Biomonitoring
- Aquatic biomonitoring programs for several Xstrata Alloys Mines and Smelters.
- Aquatic biomonitoring programs for several Anglo Platinum Mines.
- Aquatic biomonitoring programs for several Assmang Chrome Operations.
- Aquatic biomonitoring programs for Petra Diamonds.
- Aquatic biomonitoring programs for Harmony Gold.
- Aquatic biomonitoring programs for industrial clients in the paper production and energy generation industries.
- Aquatic biomonitoring programs for selected North-West Waste Water Treatment Works.

Water Quality and Toxicity Monitoring
- Annual and Quarterly Water Monitoring and Management for the Bokoni Platinum Mine.
- Toxicological monitoring programs for several Xstrata Alloys Mines and Smelters.
- Toxicological monitoring programs for several Anglo Platinum Mines.
- Toxicological monitoring programs for several Assmang Chrome Operations.
- Toxicological monitoring programs for several Samancor Chrome Operations.

Water Use License Applications (WULA)
- A Water Use License Application for the construction of a box culvert bridge to provide access to the approved Olievenhoutbosch Shopping Centre, located on a portion of portion 123 of the farm Olievenhoutbosch 389 JR.
- A Water Use License Application for the proposed construction of a filling station on Erf 121 Laezonia Agricultural Holdings, Tshwane.
- A Water Use License Application for the proposed residential township establishment on portions 25 and 26 of the farm Swartkop 383 JR, (Celtisdal X 65 & 66), Raslouw Agricultural Holdings, City of Tshwane, Gauteng.

Rehabilitation Projects
- Riparian Rehabilitation and Management Plan for the Rustenburg Rapid Transport bridge upgrades, Rustenburg.
- Riparian Habitat Integrity Assessment and Rehabilitation Action Plan for the Pilanesberg Platinum Mine Stream Diversion.

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

I, Stephen van Staden, declare that -

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

Signature of the Specialist

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

I, Leandra Jonker, declare that -

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

Signature of the Specialist