Riverine Ecology Assessment for the Pure Source Sand Mining Operation

Free State Province, South Africa

November 2018

Reference

Pure Source Mine Aquatic Ecology Scoping Report V4

Prepared for:

Monte Cristo Commercial Park (Pty) Ltd

Prepared by:

The Biodiversity Company

420 Vale Ave. Ferndale, 2194

Cell: +27 81 319 1225

Fax: +27 86 527 1965

info@thebiodiversitycompany.com

www.thebiodiversitycompany

Report Name	**Riverine Ecology Assessment for the Pure Source Sand Mining Operation**	
Reference	**Pure Source Mine Aquatic Ecology Scoping Report V4**	
Submitted to	**Monte Cristo Commercial Park (Pty) Ltd**	
Report Writer (Aquatic Ecology)	**Russell Tate (Pr. Sci. Nat. 400089/15)**	
Report Reviewer	**Christian Fry (Pr. Sci. Nat. 119082)**	
Report Reviewer	**Andrew Husted (Pr. Sci. Nat. 400213/11)**	

Malachite Kingfisher, *Corythornis cristatus*, on the Vaal River (July 2018)

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DECLARATION

I, Russell Tate 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 Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other 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; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Russell Tate

Aquatic Specialist

The Biodiversity Company

20 July 2018

1 Introduction

The Biodiversity Company was commissioned by the Monte Cristo Commercial Pak (Pty) Ltd to conduct a riverine ecology assessment to support the Mining Right Application and Environmental Authorisation process for the proposed Pure Source Mine.

The proposed project will involve the development of an open pit mine, a processing plant and associated infrastructure. Commodities to be mined will include sand (silica), aggregate and diamonds (alluvial).

This report aims to provide a desktop scoping level assessment of the riverine ecology which may be potentially affected through the proposed mining operation. In addition, this report aims to provide delineated buffer zones for sensitive riverine landscapes identified. Furthermore, this report aims to identify potential fatal flaws for the proposed project and the methods which will be utilised in the field assessments. The overall aim of the riverine ecology study was to complete the following objectives:

- Determining the Present Ecological Status of the local watercourses;
- The delineation and assessment of riparian areas within 500 m of the project area;
- A risk assessment for the proposed development; and
- The prescription of mitigation measures and recommendations for identified risks.

2 Project Area

The proposed project is located approximately 23 km west of Sasolburg in the Free State Province. The project area is situated within the Vaal Water Management Area in the C23B quaternary catchment. The catchment of the project area drains into the C23B-01731 Sub Quaternary Reach (SQR) of the Vaal River system. The C23B-01731 SQR is 27.52 km in length and is within the Highveld Ecoregion. The gradient of the watercourse within the study area was determined to be a class F Geoclass which is indicative of a low gradient-gentle slope watercourse (DWS, 2018). The specific reach of the SQR is located downstream of the Vaal River Barrage and upstream of the Goosebay gauging weir near to the town of Vaal Oewer (Figure 1).

The catchment draining the project area consists of typical undulating, hygrophilous vegetation. Frost, fire and grazing maintain the dominance of grasslands in the region with the considered catchment being accurately defined by this broad description.

Aquatic fauna of the Vaal River system, particularly in this zone, are threatened by extensive agriculture, urban development and industrial activities in Vanderbijlpark/Vereeniging. These land uses have resulted in the sedimentation and modification of instream and wetland habitats associated with the Vaal River. In addition, the Ermelo Coal field is largely located within the overall source zone of the Vaal River basin which has resulted in several point source contaminants from coal mining and power generation activities. The Vaal River basin supports a critical commercial and industrial area in South Africa, supplying water for a multitude of activities and services.

According to Nel et al. (2011) the catchment of the watercourses in the study area are not National Freshwater Priority Areas (NFEPA). The Vredefort Dome World Heritage Site is

located approximately 33 km downstream of the proposed project area. The Vredefort Dome area presents unique instream habitat as a result of the geological formations in the area. The instream habitats include extensive cobbled substrate runs which support high quality spawning sites for the various Cyprinid species.

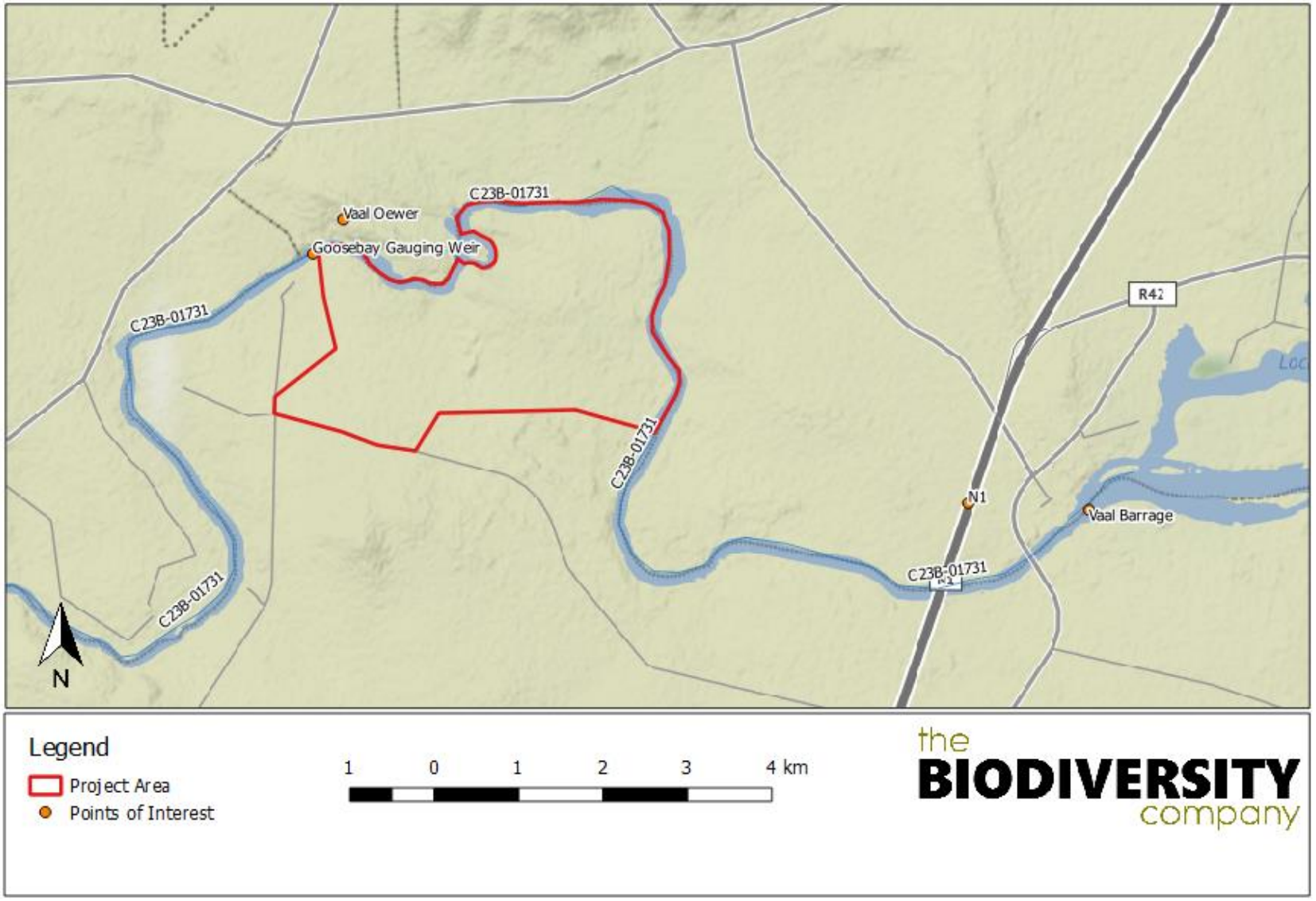

Figure 1: Location of the Proposed Project

3 Desktop Condition and Composition of the Aquatic Fauna

The study area considered in this assessment is located within the Southern Temperate Highveld Freshwater Ecoregion (Abel et al., 2008). In comparison to northern African river systems, the aquatic fauna of the considered ecoregion is “lacking in diversity” (Abel et al., 2008). This ecoregion is known to contain approximately 67-101 freshwater fish species of which 1-11 are known to be endemic (Figure 2). The ecoregion is known to have increased flow rates during the spring and summer seasons (September to March) and the indigenous fish species breed during this period.

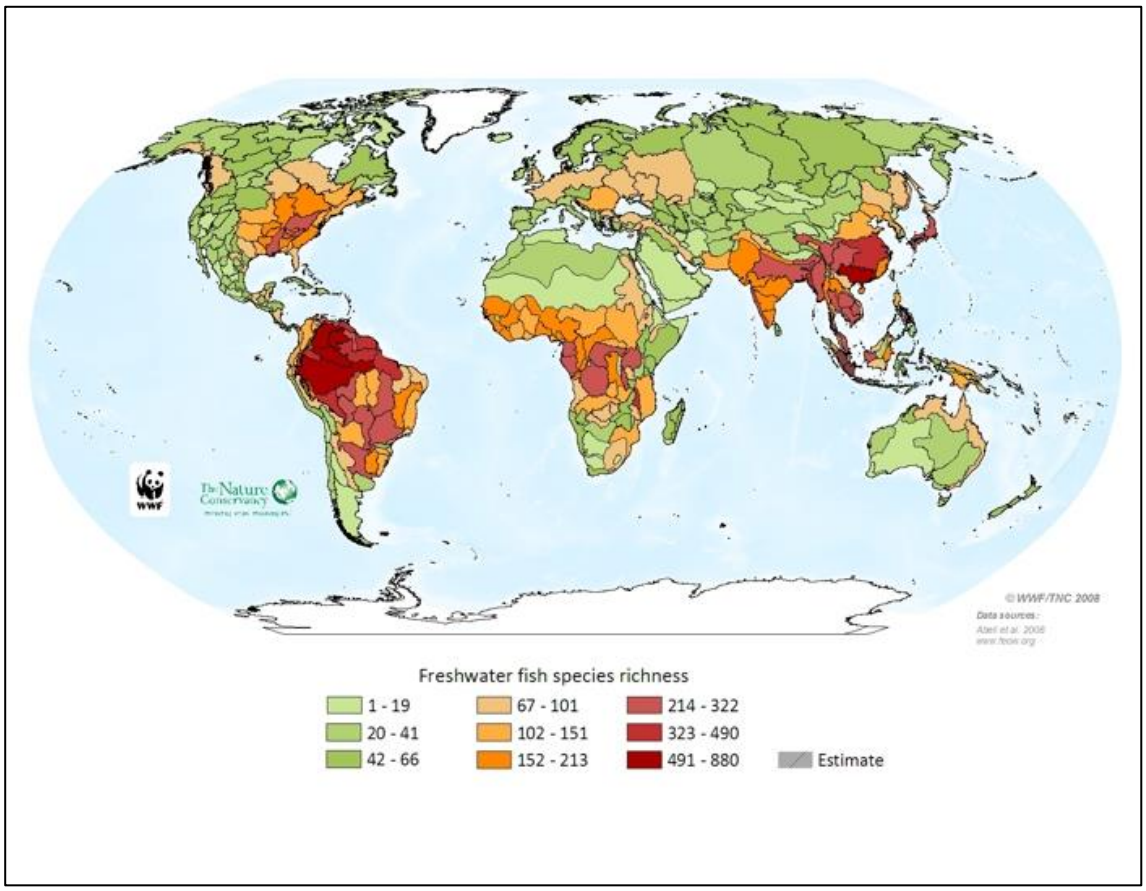

Figure 2: Freshwater Fish Species Richness of the Freshwater Ecoregions of the World (Abel et al., 2008)

Notable aquatic ecology in the Vaal River basin are the several endemic Cyprinid species such as *Labeo capensis* (Least Concern), *L. umbratus* (Least Concern), *Labeobarbus kimberleyensis* (Near Threatened), *Labeobarbus aeneus* (Least Concern) and the Rock Catlet, *Austroglanis sclateri* (Least Concern). In addition to the above species, *Enteromius cf. palidus* is undergoing systematic revision and likely represents several species. In the case of this assessment, *E. cf. palidus* is regarded as a listed species as a precautionary approach. The desktop ecological status of the C23B-01731 SQR is presented in Table 1.

Table 1: Desktop Ecological Status of the Vaal River within the C23B-01731 Sub Quaternary Reach (DWS, 2018)

Present Ecological Status	**Largely Modified (class D)**
Ecological Importance	**Moderate**
Ecological Sensitivity	**High**
Default Ecological Category	**Largely Natural (Class B)**

The desktop data for the Vaal River SQR considered in this assessment indicates that the PES of the watercourse is Largely Modified (class D). The central factors negatively effecting the PES were water quality deterioration, in the form of excessive sewerage input compounded by industrial, agricultural and urban runoff, habitat quality degradation, in the form of extensive flow regulation and riparian habitat modification. The ecological importance of the watercourse at a desktop level was determined to be moderate. The moderate rated level of importance can be attributed to the wide distribution of aquatic fauna throughout the Orange-Vaal River Basins. The ecological sensitivity was derived to be high. The presence of flow and water quality sensitive taxa renders the fauna sensitive to changes to the physical components of the watercourse. The default ecological category was rated as Largely Natural (class B). Management of landuse must be completed in a manner which aims to improve the PES class of the watercourse. However, the extensive and permanent nature of the existing impacts renders the management of the watercourse to this level implausible. The default ecological category should therefore be revised.

4 Methodology and Terms of Reference

Standard methods used in the River Ecosystem Monitoring Programme will be used to determine the PES of the considered watercourse. The various sections provided below elaborate on the various methods/indexes which will be applied for this study.

4.1 Water Quality

Water quality will be measured *in situ* using a handheld calibrated Extech ExStik II meter. The constituents considered that will be measured included: pH, conductivity (µS/cm), temperature (°C) and Dissolved Oxygen (DO) in mg/l.

4.2 Aquatic Habitat Integrity and Riparian Zone Delineation

The Intermediate Habitat Assessment Index (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), 1999 will be used to define the ecological status of the river reach.

The area to be covered in this assessment includes a 10 km reach of the Vaal River. This habitat assessment model compares current conditions with reference conditions that are expected to have been present.

The IHIA model will be used to assess the integrity of the habitats from a riparian and instream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996).

The criteria and ratings utilised in the assessment of habitat integrity in the current study are presented in Table 2 and Table 3.

Table 2: Criteria used in the Assessment of Habitat Integrity (Kleynhans, 1996)

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or alternatively agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments.
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also, a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 3: Descriptions used for the Ratings of the Various Habitat Criteria

Impact Category	Description	Score
None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16-20

Impact Category	Description	Score
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

The riparian delineation will be completed according to Department of Water Affairs and Forestry (DWAF, 2005). Typical riparian cross sections and structures are provided in Figure 3. Indicators such as topography and vegetation will be the primary indicators used to define the riparian zone. One metre contour data obtained from topography spatial data was also utilised to support the infield assessment.

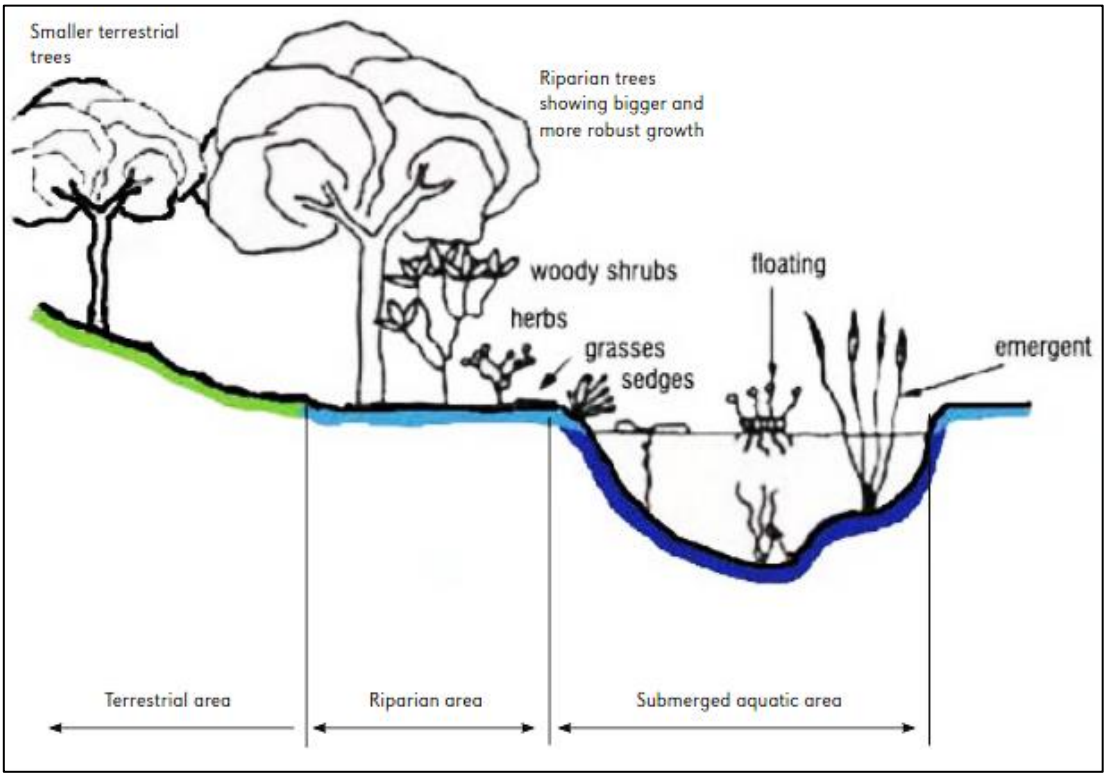

Figure 3: Riparian Habitat Delineations (DWAF, 2005)

4.3 Aquatic Macroinvertebrate Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al.,* 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al.,* 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

4.3.1 South African Scoring System

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the

perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).

Sampled invertebrates will be identified using the "Aquatic Invertebrates of South African Rivers" Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion *et al.,* 1995; Dickens and Graham, 2002; Gerber and Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the North Eastern Coastal Belt - upper ecoregion (Figure 4). This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database.

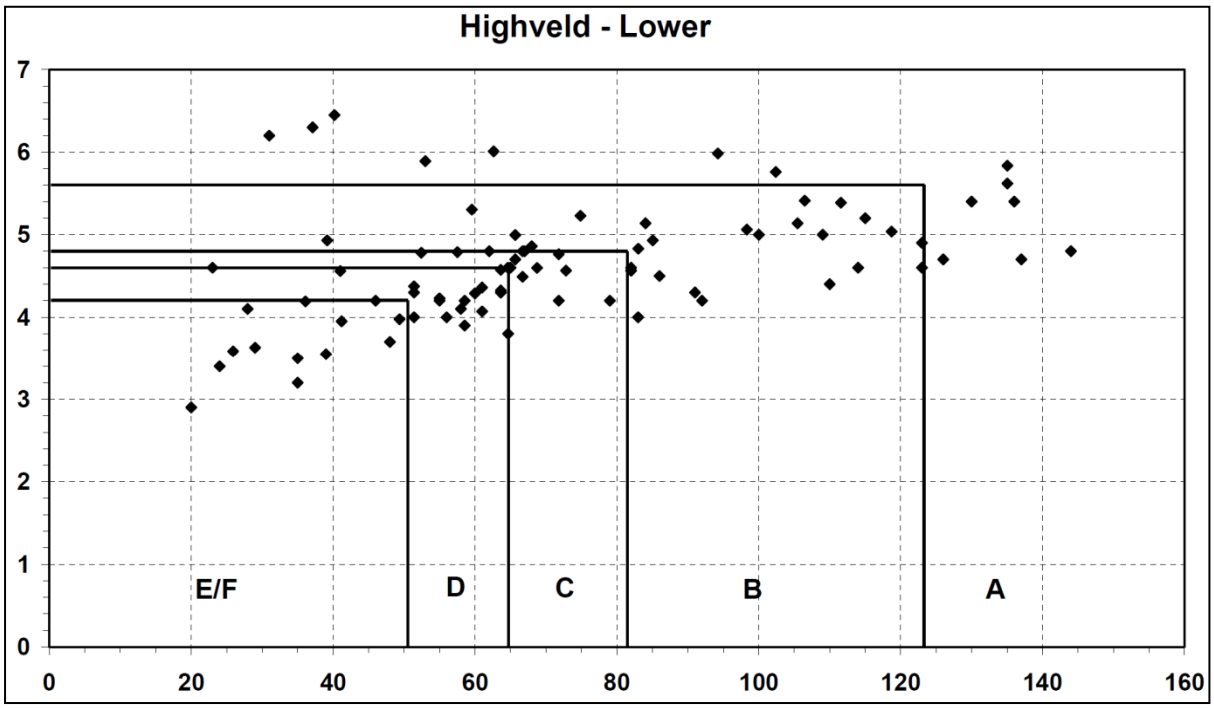

Figure 4: Biological Bands for the Highveld Lower Ecoregion (Dallas, 2007)

The assessment of the watercourse will be completed using standard invertebrate sampling methods which have been adapted to suit the nature of the considered watercourse. In the case of this study, the wide and deep nature of the Vaal River system presents poor invertebrate biotopes. In order to compensate for this and provide a high level assessment of the current conditions, an adapted overall statistical analysis will be conducted in this study. This involves the selection of four sampling points which represent a single site. Standard SASS5 sampling methods will be completed at a total of four sites which represent the larger macro site. This data will be presented in the final report.

4.3.2 Macroinvertebrate Response Assessment Index

The Macroinvertebrate Response Assessment Index (MIRAI) will be used to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community from the calculated reference conditions for the SQR. This does not preclude the

calculation of SASS5 scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic macroinvertebrates are as follows:

- Flow regime;
- Physical habitat structure;
- Water quality;
- Energy inputs from the watershed; and
- Riparian vegetation assessment.

The results of the MIRAI will provide an indication of the current ecological category and therefore assist in the determination of the PES.

4.4 Fish Community Assessment

A standard qualitative fish assessment will be completed for this study. Electrofishing techniques, fyke and cast netting methods will be applied to determine the reach based fish community during the survey for comparative purposes and interpretation. The Fish Response Assessment Index will be applied for this study.

4.5 Present Ecological Status

Ecological classification refers to the determination and categorisation of the integrity of the various selected biophysical attributes of ecosystems compared to the natural or close to natural reference conditions (Kleynhans and Louw, 2007). For the purpose of this study ecological classifications have been determined for biophysical attributes for the associated water course. This was completed using the river ecoclassification manual by Kleynhans and Louw (2007).

4.6 Determining Buffer Requirements

The “Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries” (Macfarlane et al. 2014) will be used to determine the appropriate buffer zone for the proposed activity.

5 Potential Impacts from the Proposed Project

The layout of the proposed project is presented in Figure 5. As can be seen in the figure, the layout of the proposed project is largely outside the delineated riparian and buffer zones. Considering this, no direct impacts to the riparian habitat of the Vaal River can be anticipated. However, several indirect impacts can be expected as a result of the proposed project.

The proposed project activities were determined to have two primary potential impacts to the associated riverine ecology. The first was determined to be related to the conditions within the physical make-up of the considered river reaches. This includes the riverine substrates, banks, riparian vegetation and water column. These physical components of a water course determine the quality of the aquatic habitats. Therefore, modification of these physical components would result in a habitat quality impact. The second impact was determined to be related to the chemical properties of water. Considering aquatic biota have requirements for

habitat, as well as sensitivity to changes in water chemistry, a change to water quality is anticipated to have negative impacts to local aquatic biota.

The central anticipated impacts associated with the proposed project are related to increased suspended solids and sedimentation within the drainage lines leading into the Vaal River. The proposed open pit mining methods, without mitigation, will strip vegetation resulting in increased runoff velocities and subsequent erosion, sedimentation and increased suspended solids. This may have an impact to aquatic habitat and to fine sediment sensitive instream aquatic ecology. The proposed project will alter the topography of the catchment feeding the C23B-01731 SQR and can result in the alteration of the hydrology within the considered river reach.

The weathered nature of the commodities being mined will likely result in the negligible leaching of water contaminants. Nonetheless, it can be anticipated that salt content within the mineral resources will become exposed to further weathering. This subsequently may result in the increase of dissolved solid content downstream of the proposed project should runoff/seepage from the mineral resources enter into the watercourse. It is therefore recommended that a leachate test is completed for the mineral resource to define the potential contaminants which may emanate from this source.

The proposed project will potentially utilise water from the Vaal River for the processing of the mineral resources. The utilisation of water will inevitably have impacts to the immediate local hydrology and this may subsequently have a negative impact on local instream biology. The volumes of water which are proposed to be extracted have not been provided and therefore the significance of this impact cannot be defined.

Further, no detailed activities and layout for the proposed closure/decommission phase have been provided. Thus, no risk assessment for this component could be effectively assessed.

A detailed risk and impact matrix must be completed to fully determine the significance and likelihood of all associated impacts. Recommendations will be made to avoid impacts where possible, and mitigation measures will then be prescribed in order to reduce the significance of unavoidable impacts. These mitigation measures may also be considered to reduce the extent of the initial buffer width of 102 m.

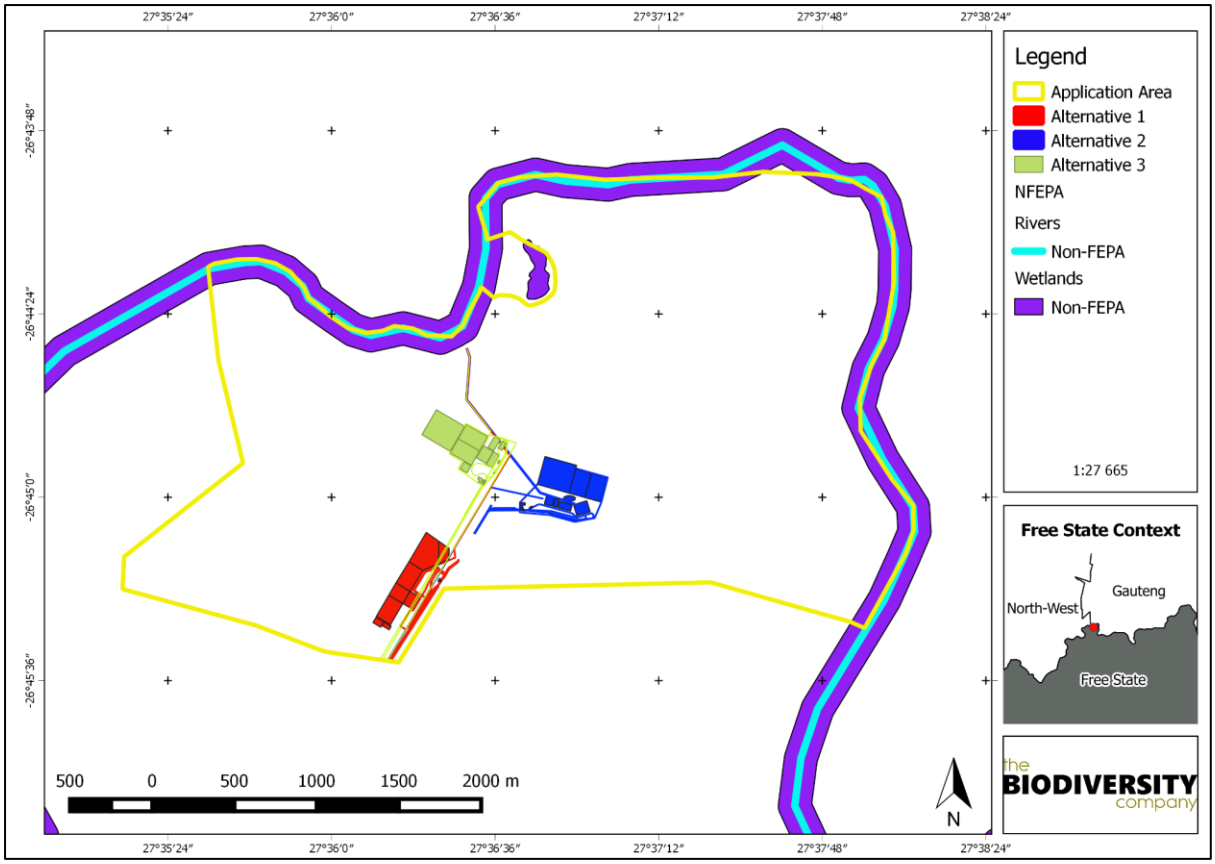

Figure 5: Project Infrastructure and Alternatives

Table 4: Aquatic Ecology Risk Assessment for the Proposed Project

Activity	Impact Description	Significance Pre- Mitigation	Mitigation measures / Recommendations	Significance Post-Mitigation
Construction Phase				
Clearing of vegetation	Alteration of catchment drainage resulting in increased runoff velocity and erosion.	Medium	Maintain buffer zones to wetlands and riparian areas. Implement storm-water management plan.	Low
Construction of infrastructure and minor earthworks	Alteration of catchment drainage and exposure of un weathered materials resulting in increased dissolved solid concentrations in local water bodies.	Medium	Maintain buffer zones to wetlands and riparian areas. Implement storm-water management plan. Design and implement passive dirty water retention processes.	Low
Placement of infrastructure within the catchment area	Alteration of catchment drainage resulting in erosion and sedimentation.	Medium	Maintain buffer zones to wetlands and riparian areas. Implement storm-water management plan.	Low
Operation Phase				
Operation of open pit	Alteration of catchment drainage and exposure of un weathered materials resulting in increased dissolved solid concentrations in local water bodies.	Medium	Maintain buffer zones to wetlands and riparian areas. Implement storm-water management plan. Design and implement passive/active dirty water retention and clean water discharge processes.	Low

Activity	Impact Description	Significance Pre- Mitigation	Mitigation measures / Recommendations	Significance Post-Mitigation
Operation of the processing plant	The use and storage of dirty water may result in diffuse or point source contamination via seepage and direct runoff. This may result in the increased suspended and dissolved solids within the Vaal River and subsequent ecological impact.	Medium	Maintain buffer zones to wetlands and riparian areas. Implement storm-water management plan. Design and implement passive/active dirty water retention and clean water discharge processes.	Low
Operation of active Run of Mine stockpiles	Runoff of materials from stockpiles resulting in increased suspended and dissolved solids within the Vaal River and subsequent ecological impact.	Medium	Maintain buffer zones to wetlands and riparian areas. Implement storm-water management plan. Design and implement passive/active dirty water retention and clean water discharge processes.	Low
Operation of the supporting infrastructure	Increased in suspended/dissolved solid concentrations and erosion from drainage alteration.	Medium	Maintain buffer zones to wetlands and riparian areas. Implement storm-water management plan. Design and implement passive/active dirty water retention and clean water discharge processes.	Low
Operation of open pit	The dewatering of the open pit may result in the discharge of dirty water resulting in increased suspended and dissolve solids in local water bodies.	Medium	Maintain buffer zones to wetlands and riparian areas. Implement storm-water management plan. Design and implement passive/active dirty water retention and clean water discharge processes.	Low

6 Conclusion

The outcomes of this scoping assessment have not identified any significant fatal flaws for the proposed project. However, further investigation will be made during the Environmental Impact Assessment process.

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