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## Proposed Environmental Regulatory Process for the Middelrift Resources within the existing New Clydesdale Colliery Mining Right Area, Mpumalanga Province

### Aquatic Biodiversity and Impact Assessment

**Prepared for:**

Universal Coal (Pty) Ltd.

**Project Number:**

UCD6587

**DMRE Reference:**





MP30/5/1/2/2/492(EM)

June 2021



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- 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 48 and is punishable in terms of section 24F of the Act.



*Signature of the Specialist*

June 2021

*Date*

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## EXECUTIVE SUMMARY

### Introduction

Digby Wells Environmental (hereafter Digby Wells) has been requested by Universal Coal (hereafter Universal Coal) to undertake an Environmental Authorisation Application Process for the mining of the Middeldrift Resources within the Existing Universal Coal Development IV (UCDIV) New Clydesdale Colliery (NCC) Mine. The current Aquatic Ecology Impact Assessment report forms part of the required specialist studies to support the Environmental Application.

The proposed Project is in the Nkangala Magisterial District of the Mpumalanga Province. Universal Coal had identified coal resources within north of this existing Mining Right (MR) and as such is proposing to extend the proposed North Opencast Pit to the Middeldrift Resources (the Project). Middeldrift is a greenfield area. The intention is to exploit the resources through opencast mining methodologies.

The proposed new activities at the UCDIV NCC Mine to be authorised will entail:

- Mining of a pan;
- Construction of a bridge over the Steenkoolspruit to access the Middeldrift Resources;
- Diversion of the provincial road, which runs through the area of the Middeldrift site; and
- Construction of a new road (linked to the diversion) (approximately 4 km long).

### Scope of Work

The goal of the Aquatic Study was to describe the baseline conditions within the aquatic ecosystems associated with the proposed Project prior to the commencement of construction activities. Foreseeable aquatic-related impacts were also identified, and appropriate mitigation measures were provided for the preservation of the assessed aquatic ecosystems.

The main aquatic ecosystems of focus in the Aquatic Study fall within primary drainage region B of the Olifants Water Management Area (WMA), B11E quaternary catchment, and Sub-Quaternary Reaches (SQRs) B11E-01353 and B11E-01297 – the Rietspruit, which flows in the north west direction along the south west boundary of the proposed Project and the Steenkoolspruit which flows northwards along the east and north of the proposed Project.

The timing of the baseline aquatic survey coincided with the wet season (or high-flow; in May 2021) for the Project Area. At the time of the survey, instream channels along the Steenkoolspruit were too deep to sample without a boat and as such, these limitations may have negatively affected the sampling effort/efficacy. Suitable habitat for aquatic biota could not be accessed and sampling was limited to the marginal banks of the defined river channel, where it was deemed safe.

## Baseline Ecological Conditions

Amongst the water quality results, temperature values were recorded within typical summer season temperatures in South Africa. The pH values recorded exhibited close to neutral to slightly alkaline conditions, with two of the four assessed sites exceeding the recommended guideline. The recorded alkaline pH was likely attributed to the use of chemicals/fertilizers at the surrounding farms. Conductivity values were recorded above the recommended guideline at most of the sampled sites. The dissolved oxygen concentration levels were recorded above the recommended guideline at all sites; however, dissolved oxygen saturation levels were recorded below the recommended guideline at most of the sites. Most of the sampled sites were largely sedimented, smothering the substrates of the sites. The recorded *in situ* water quality was determined to be modified however was not expected to significantly impact on inhabiting indigenous aquatic biota. Only biota that are sensitive to high sediment loads (such as those that utilize gills for respiration) and those with high requirements for unmodified water quality may be deterred from colonising the sites.

The findings from the Index for Habitat Integrity assessments conducted during the current 2021 survey indicate that the habitat integrity along the assessed Rietspruit reach was *Largely Modified* (Ecological Category D) for the instream component and *Moderately Modified* (Ecological Category C) for the riparian component. Major impacts of the instream habitat included bed modification and the dominance of exotic fauna. At the assessed Steenkoolspruit reach, both instream and riparian components were determined to be in *Largely Modified* (Ecological Category D) conditions. Similarly, bed modification due to high sediment loads and the dominance of alien-invasive fauna were the major impacts of the instream habitat, whilst the removal of indigenous vegetation and the dominance of Bankrupt Bush (*Seriphium plumosum*) was the major impact of the riparian habitat.

The availability and integrity of aquatic macroinvertebrate biotopes were predominantly *Poor* across the sampled river reaches, only the upstream Site NC1 was determined to be in a *Good* state. The sampled systems were dominated by deep, slow to moderately flowing water and generally lacked the stones biotope. Marginal vegetation and sand were the common features throughout the sites. Similarly, the results of the South African Scoring System version 5 (SASS5) and Macroinvertebrate Response Assessment Index (MIRAI) indicate that conditions at the sampled reaches ranged between *Seriously Modified* (Ecological Category E) and *Largely Modified* (Ecological Category D) with macroinvertebrate community assemblages largely composed of taxa that have “Low” water quality requirements.

Results of the fish community assessment indicated that the sampled River Reaches ranged from *Seriously to Critically Modified* (Ecological Category E/F) to *Largely Modified* condition (Ecological Category D). A total of five fish species were collected (or observed), two of which were regarded as alien invasive species (*Gambusia affinis* and *Micropterus salmoides*). Of the three collected indigenous fish species, two are known to be tolerant to water quality modifications (*Pseudocrenilabrus philander* and *Tilapia sparrmanii*), whilst one (*Enteromius paludinosus*) is intolerant.

Following integration of the defined ecological conditions obtained for the instream biological integrity and the riparian component, it was determined that all assessed sites represented an integrated EcoStatus of *Largely Modified* (Ecological Category D).

### Impact Assessment and Mitigation Measures

Potential impacts on the aquatic ecosystems associated with the proposed Project were determined to be:

- **Minor** during construction of the road and **Negligible** upon adequate implementation of mitigation measures;
- **Major** for the construction of the bridge crossing at the Steenkoolspruit and **Moderate** upon adequate implementation of mitigation measures;
- **Minor** during the operational phase and **Negligible** upon adequate implementation of mitigation measures; and
- **Minor** during the Closure, Decommissioning and Rehabilitation Phase and also upon adequate implementation of mitigation measures.

An aquatic biomonitoring programme has been provided for the monitoring and preservation of the aquatic ecosystems associated with the proposed Project. This programme is aimed at better determining the ecological health of the ecosystems as well as to act as an early detection tool for impacts that might significantly affect aquatic biota.

### Reasoned Opinion Whether Project Should Proceed

Considering the *Seriously Modified* and *Largely Modified* Present Ecological State at the Rietspruit and Steenkoolspruit systems under study, highlighted foreseeable negative impacts are likely to exacerbate the ecological states. Furthermore, impacts of the proposed Project onto the associated watercourses are predicted to be *Negligible* upon implementation of mitigation measures.

No fatal flaws were identified during the current study, thus the proposed Project may proceed with the restriction that mitigation measures and the aquatic biomonitoring programme are implemented throughout the operation and Decommissioning phases to ensure no deterioration of the associated watercourses occur.

### Recommendations

Based on the results of the current study, the following recommendations are proposed:

- The depth of the Steenkoolspruit presents challenges in sampling the instream habitat, therefore, whole effluent toxicity assessments should be undertaken to provide a better indication of the Present Ecological State (PES) and determine the potential drivers of change;
- Sites NC1 and NC4 should be excluded from the monitoring programme due to the distance from the proposed project location and existing associated impacts. These sites were sampled due to their ease of accessibility. Additional sites, upstream and

downstream of the proposed project location should be sampled along the Steenkoolspruit to provide better representation of the biophysical integrity of the River; and

- The developed Aquatic Biomonitoring Programme must be adopted on an annual basis after commencement of the Establishment Phase of the Project. This programme should continue for the life of the Project and for at least three years post the Decommissioning Phase.



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## ACRONYMS, ABBREVIATIONS AND DEFINITION

ASPT	Average Score Per Taxa
CSIR	Council for Scientific and Industrial Research
DO	Dissolved Oxygen
DWS	Department of Water and Sanitation
EC	Ecological Category
FRAI	Fish Response Assessment Index
IHAS	Invertebrate Habitat Assessment System
IHI	Index for Habitat Integrity
MAP	Mean Annual Precipitation
MIRAI	Macro-Invertebrate Response Assessment Index
MRA	Mining Rights Area
NBA	National Biodiversity Assessment
NCC	New Clydesdale Colliery
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NFEPA	National Freshwater Ecosystem Priority Areas
PES	Present Ecological State
REMP	River EcoStatus Monitoring Programme
SAIAB	South African Institute of Aquatic Biodiversity
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SASS5	South African Scoring System version 5
SQR	Sub-Quaternary Reach
TWQR	Target Water Quality Range
UCDIV	Universal Coal Development IV
WMA	Water Management Area
WRC	Water Research Commission
WUL	Water Use License
WWF	Worldwide Fund for Nature

Legal Requirement		Section in Report
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Pages ii-iv
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Page iv
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	1.1
cA	And indication of the quality and age of the base data used for the specialist report;	6
cB	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	7.5
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	6
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	14
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternatives;	1
(g)	an identification of any areas to be avoided, including buffers;	N/A
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	2
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	1.3
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	10
(k)	any mitigation measures for inclusion in the EMPr;	8
(l)	any conditions/aspects for inclusion in the environmental authorisation;	9
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	9
(n)	a reasoned opinion (Environmental Impact Statement) -	12

Legal Requirement		Section in Report
	whether the proposed activity, activities or portions thereof should be authorised; and	
	if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMP, and where applicable, the closure plan;	12
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	N/A
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	N/A
(q)	any other information requested by the competent authority.	N/A



## 1. Introduction

Freshwater ecosystems provide habitat for a significant number of animal and plant species which constitute a valuable natural resource, in economic, cultural, aesthetic, scientific and educational terms (Schmeller *et al.*, 2018). In most parts of the world, these systems are experiencing declines in biodiversity and some of the well documented threats include: overexploitation; water pollution; flow modification; destruction or degradation of habitat; and invasion by exotic species (Dudgeon *et al.*, 2006; Skowno *et al.*, 2019). Mining is one of the major industrial sectors that alter and negatively impact the water quality of natural aquatic ecosystems (Dallas & Day, 2004). The conservation and management of these systems is thus essential for ensuring that the ecosystem diversity, functionality, and connectivity are maintained.

This aquatic biodiversity assessment entailed identifying the potential impacts of the proposed open cast mine in surrounding water bodies. The standard River EcoStatus Monitoring Programme (REMP, previously referred to as the River Health Programme) techniques were used.

Digby Wells Environmental (hereafter Digby Wells) was appointed by Universal Coal (hereafter Universal Coal) to undertake an Environmental Application Process for the mining of the Middelrift resources within the Existing Universal Coal Development IV (UCDIV) New Clydesdale Colliery (NCC) (the Project). This Aquatic Biodiversity and Impact Assessment study forms part of the required specialist studies to support this Environmental Application.

### 1.1. Scope of Work

The methodology utilised in the current report/aquatic study can be distinguished into two separate components, namely a baseline assessment and an impact assessment. The current report served to update The goal of which was to establish the baseline aquatic conditions (i.e. prior to project commencement) and to identify, mitigate and avoid potential aquatic-related impacts associated with the proposed Project. This report updates the aquatic baseline conditions determined during the previous study (SAS, 2016) which was undertaken for the Roodekop Mining Area and the New Clydesdale Colliery along the Steenkoolspruit.

### 1.2. Details of the Specialist/s

The following specialists were involved in the compilation of this report.

Responsibility	Field Survey, Data Collation and Report Compilation
Full Name of Specialist	Tebogo Khoza
Highest Qualification	MSc. Biodiversity & Conservation
Years of experience in specialist field	3

<b>Registration(s):</b>	South African Council for Natural Scientific Professionals: <i>Candidate Natural Scientist</i> (Reg. No. 119651)
<b>Responsibility</b>	<b>Field Survey, Data Collation, Report Compilation and Technical Review</b>
<b>Full Name of Specialist</b>	Byron Bester
<b>Highest Qualification</b>	MSc Aquatic Health
<b>Years of experience in specialist field</b>	10
<b>Registration(s):</b>	South African Council for Natural Scientific Professionals: <i>Professional Natural Scientist</i> (Reg. No. 400662/15)

### 1.3. Assumptions, Limitations and Exclusions

In order to obtain a comprehensive understanding of the dynamics of the biota present within a watercourse (e.g. migratory pathways, seasonal prevalence, etc.), studies should include investigations conducted during different seasons, over a number of years and through extensive sampling efforts. Given the time constraints of the present study, such long-term research could not be conducted. Instead, conclusions provided within this report are based on data collected during a single late wet season sampling event, a literature review, and professional experience.

Some of the constraints observed during the current assessment include:

- The assessed Steenkoolspruit is an 18 km long, large river with wide and deep sections which were deemed unsafe to sample. Subsequently, this restricted sampling to the shallow marginal riverbanks, where it was deemed safer and accessible. Thus, the application of the selected assessment indices should be interpreted with caution, as each of the selected indices were primarily designed for application within typical riverine systems with a moderate hydrology and diverse habitat availability and not only along shallow marginal riverbanks. Therefore, the findings in this study are of low confidence and may not represent the 'natural' state of macroinvertebrate assemblage at the sampled Steenkoolspruit reach. Thus the addition of monitoring sites along the Steenkoolspruit is recommended for the continued monitoring activities.
- This Aquatic Biodiversity Impact Assessment Report does not assess potential impacts associated with the Pan proposed to be mined. Please refer to the Wetlands Impact Assessment Report (DWE, 2021).

## 2. Project Description

The proposed Project is in the Nkangala Magisterial District of the Mpumalanga Province. Universal Coal had identified coal resources within north of this existing Mining Right (MR) and as such is proposing to extend the proposed North Opencast Pit to the Middeldrift

Resources (the Project) Middeldrift is a greenfield area (Figure 2-1). The intention is to exploit the resources through opencast mining methodologies.

The proposed new activities at the UCDIV NCC Mine to be authorised will entail:

- Mining of a pan;
- Construction of a bridge over the Steenkoolspruit to access the Middeldrift Resources;
- Diversion of the provincial road, which runs through the area of the Middeldrift site; and
- Construction of a new road (linked to the diversion) (approximately 4 km long).



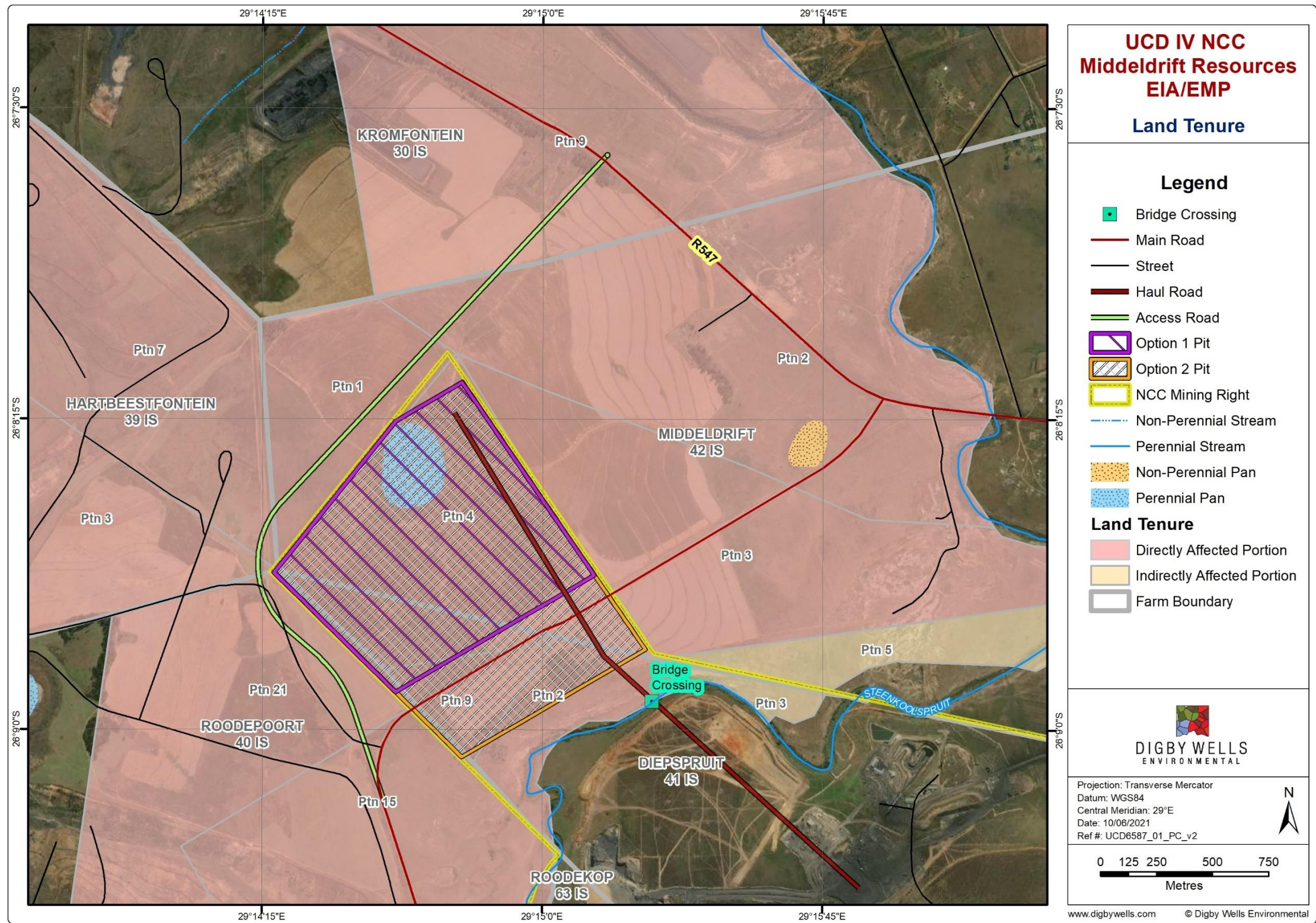


Figure 2-1: Land tenure at the UCD IV NCC



### 3. Relevant Legislation, Standards and Guidelines

Aquatic related legislation, standards and guidelines applicable to the Project are listed and briefly discussed below (Table 3-1).

**Table 3-1: Applicable legislation, regulations and guidelines**

Legislation, Regulation, Guideline or By-Law	Applicability
<p><b><u>National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEM:BA)</u></b></p> <p>The NEM:BA regulates the management and conservation of the biodiversity of South Africa within the framework provided under NEMA. This Act regulates the protection of species and ecosystems that require national protection and considers the management of alien and invasive species. The following regulations which have been promulgated in terms of the NEM:BA are also of relevance.</p>	<ul style="list-style-type: none"> <li>• An Aquatic Impact Assessment has been undertaken to identify species protected under this Act as well as the impacts posed to biodiversity; and</li> <li>• Required mitigation measures will be included in the Environmental Management Plan (EMP) as part of Environmental Authorisation process</li> </ul>
<p><b><u>National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).</u></b></p> <p>NEMA (as amended) was set in place under Section 24 of the Constitution. Certain environmental principles under NEMA must be adhered to, to inform decision making for issues affecting the environment.</p> <p>Section 24 (1)(a) and (b) of NEMA state that:</p> <p><i>The potential impact on the environment and socio-economic conditions of activities that require authorisation or permission by law and which may significantly affect the environment must be considered, investigated and assessed before their implementation and reported to the organ of state charged by law with authorizing, permitting, or otherwise allowing the implementation of an activity.</i></p> <p>The NEMA requires that pollution and degradation of the environment be avoided, or, where it cannot be avoided be minimised and treated.</p>	<p>The listed activities of the Project have the potential to impact on the environment, specifically the associated aquatic ecology. Therefore, requiring environmental authorisation before commencement.</p>
<p><b><u>The Mineral and Petroleum Resources Development Act (Act No.28 of 2002) (MPRDA) intends:</u></b></p> <ul style="list-style-type: none"> <li>• to make provision for equitable access to and sustainable development of the nation's mineral and petroleum resources; and</li> <li>• to provide for matters connected therewith.</li> </ul>	<ul style="list-style-type: none"> <li>• An aquatic ecology Impact Assessment was undertaken as part of the EIA Phase for the mining of the Middeldrift Resources;</li> <li>• Environmental Management Plan and Monitoring Program is included in the EIA Phase; and</li> </ul>

Legislation, Regulation, Guideline or By-Law	Applicability
	<ul style="list-style-type: none"> <li>Recommendations to prevent, avoid, and rehabilitate possible impacts were assessed.</li> </ul>
<p><b><u>South African National Biodiversity Institution (SANBI), National Biodiversity Assessment (NBA) 2018</u></b></p> <p>The NBA is a collaborative effort to synthesise the best available science on South Africa's biodiversity to inform policy and decision making in a range of sectors and contribute to national development priorities. It is used for the following:</p> <ul style="list-style-type: none"> <li>The NBA is used to inform policy in the biodiversity sector, such as the National Biodiversity Framework and the National Protected Area Expansion Strategy (NPAES), as well as informing policies and strategies of a range of other sectors that rely on natural resources, such as the water, agriculture and mining sectors.</li> <li>The NBA provides information to help prioritise the often limited resources for managing and conserving our biodiversity – actions can focus on preventing further loss and degradation of ecosystems and ecological infrastructure, on consolidating and expanding the protected areas network; and on interventions require to restore areas in bad condition so they become functional again.</li> <li>The NBA provides context and information that feeds into strategic planning processes such as strategic Environmental Assessments and bioregional planning.</li> </ul> <p>The NBA provides information for a range of national level reporting processes such as the South Africa Environment Outlook and ensures that the Department of Forestry, Fisheries and Environment (DFFE) has the necessary biodiversity information to meet the international reporting commitments to the Convention on Biological Diversity (CBD).</p>	<ul style="list-style-type: none"> <li>The guideline was used in this Aquatic Study for determining the current state of the biodiversity and ecosystem identified within the Project Area as well as providing indication of threat status and protection level for both species and ecosystems.</li> </ul>

## 4. Description of the Environment

The location of the proposed Project and biophysical features are described in the following sub-sections.

#### **4.1. Project Locality**

The Project Area is located in the Mpumalanga Province under the jurisdiction of the Emalahleni Local Municipality, which is in the Nkangala District Municipality (Figure 4-1). The site is located approximately 20 km north of Kriel and 27 km south-east from Ogies.



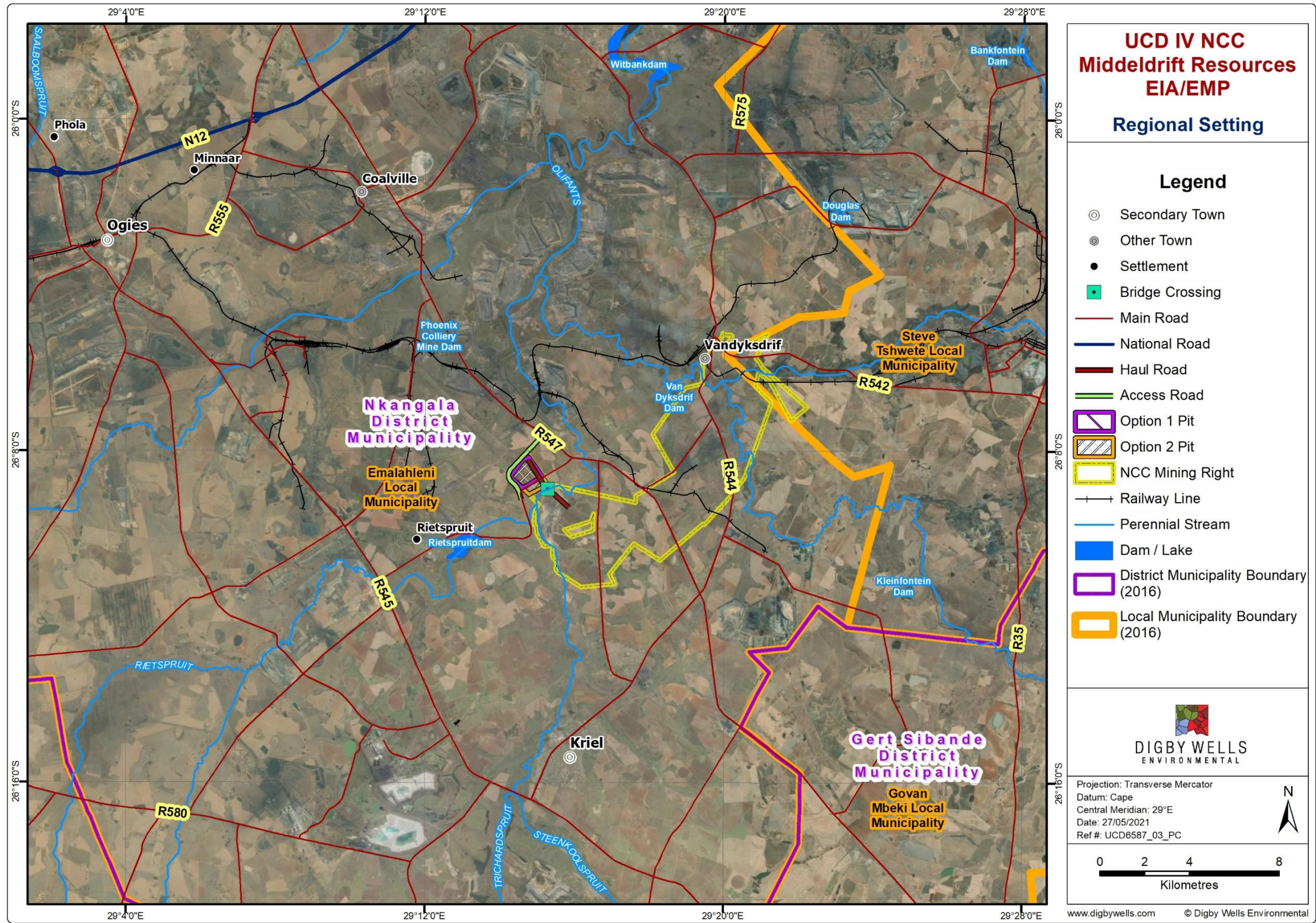


Figure 4-1: Map showing the regional setting for UCDIV NCC



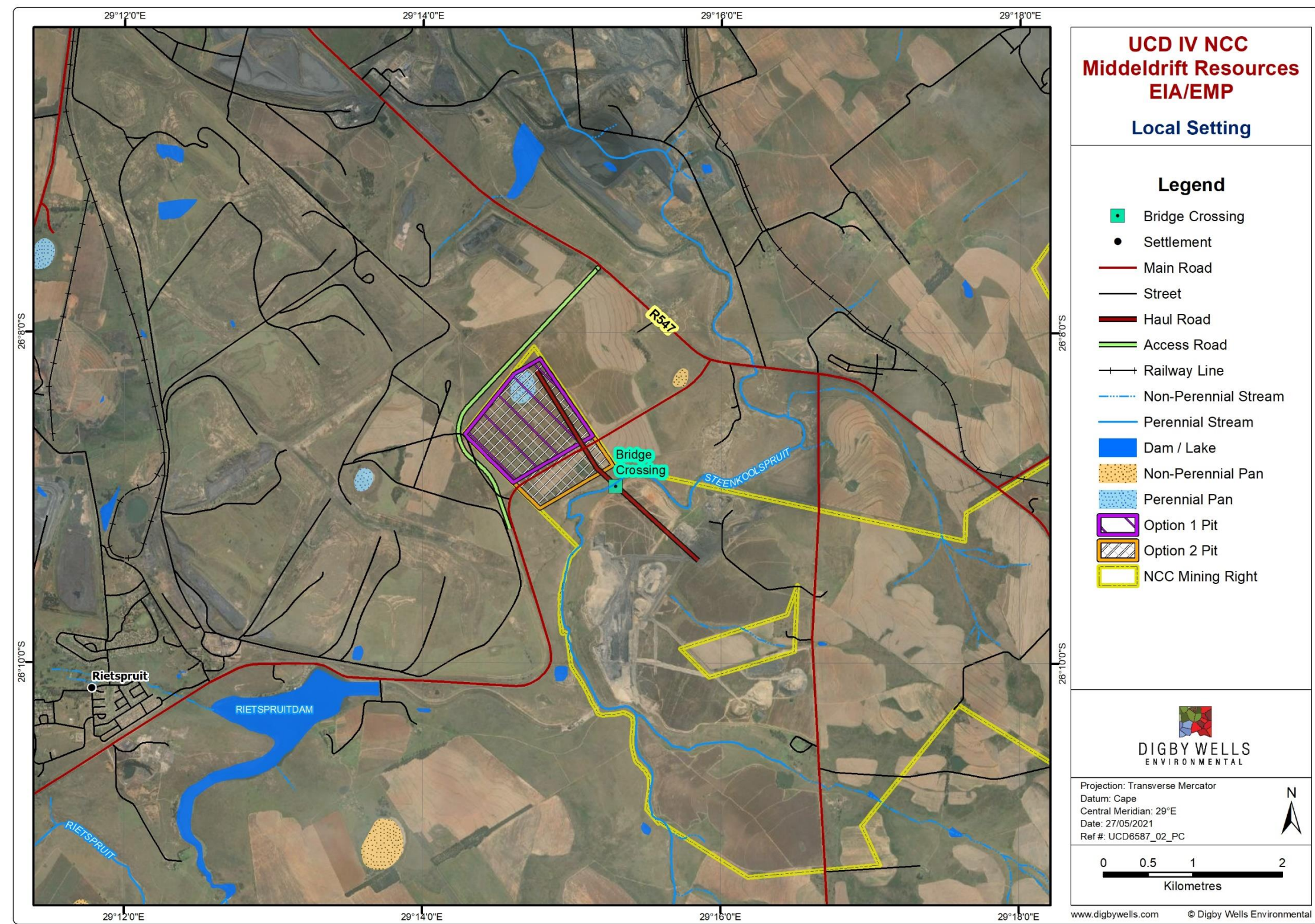


Figure 4-2: Local Setting of UCDIV NCC



## 4.2. Biophysical Description

The following sections will briefly describe the biophysical attributes associated with watercourses and provide a regional context for the proposed Project.

### 4.2.1. Associated Watercourses

The water resources of South Africa are divided into quaternary catchments, which are regarded as the principal water management units in the country (Department of Water Affairs and Forestry, 2011). These catchments represent the fourth order of the hierarchical classification system, in which the primary catchments are the major units. The primary drainages are further grouped into or fall under Water Management Areas (WMA). The Department of Water and Sanitation (DWS) has established nine WMAs as contained in the National Water Resource Strategy 2 (2013) in terms of Section 5 subsection 5 (1) of the National Water Act, 1998 (Act No. 36 of 1998) (NWA, 1998).

The proposed coal mine falls within primary drainage region B of the Olifants WMA and the B11E quaternary catchment, Sub-Quaternary Reaches (SQRs) B11E-01353 and B11E-01297 (the Rietspruit and Steenkoolspruit). The Rietspruit SQR is a second order stream approximately 24 km in length, which drains from south-west along the Project Area and joins the Steenkoolspruit SQR east of the Project Area boundary. The Steenkoolspruit SQR is a third order stream, approximately 18 km in length and flows along the east and north of the Project Area before joining the Olifants River, a major river which flows in a north-easterly direction into Mozambique and then joins the Limpopo River which drains into the Indian Ocean.

Figure 4-3 indicates the Quaternary Catchment and freshwater resources associated with the study area.



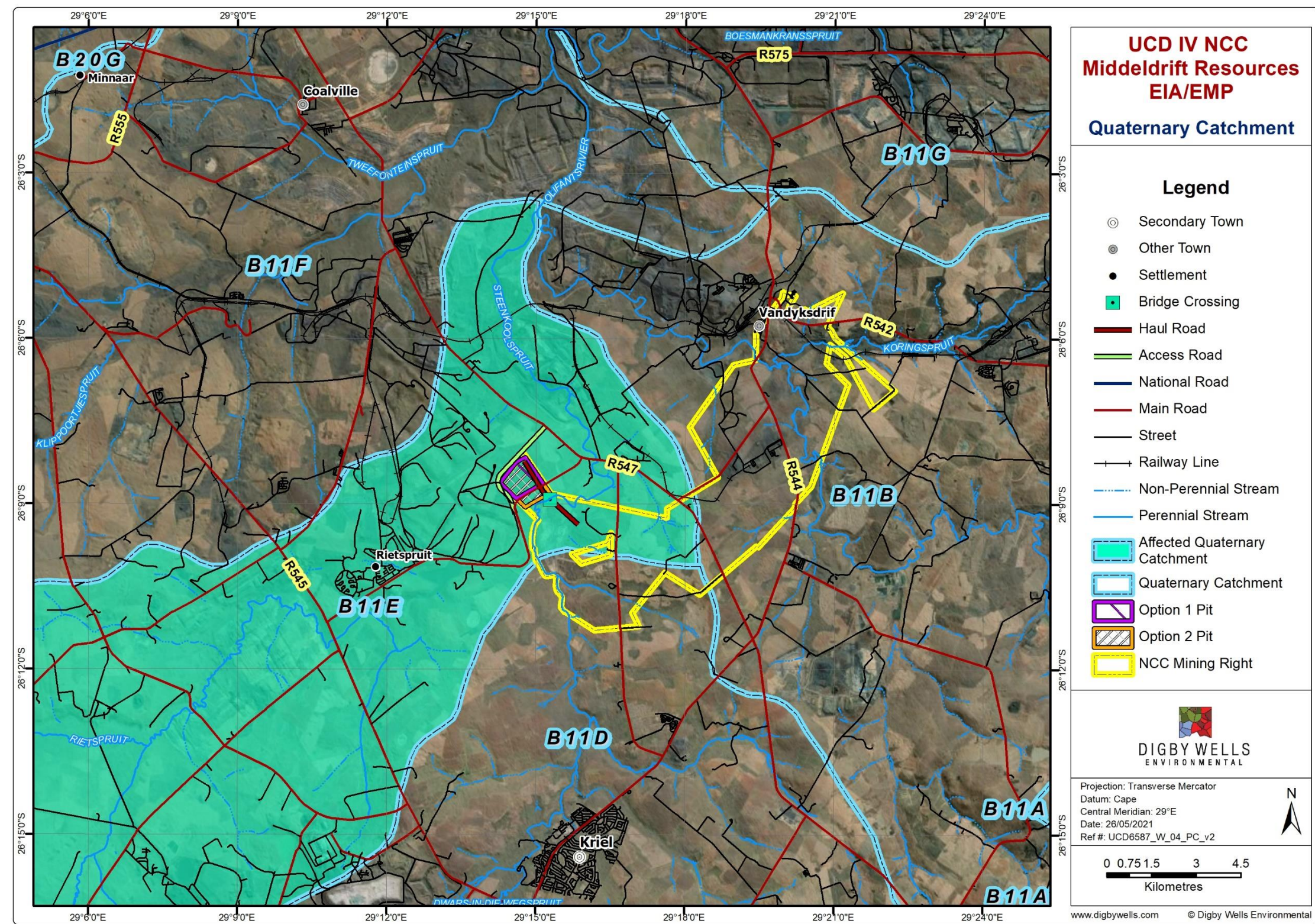


Figure 4-3: Quaternary Catchments associated with the study area



### 4.3. Regional Biodiversity Importance.

#### 4.3.1. Freshwater Ecoregions

Ecoregions are regions characterised by a relative similarity in the type of ecosystems and ecosystem components, i.e. biotic and abiotic. The Project Area is located within the Southern Temperate Highveld freshwater ecoregion, which combines headwaters of coastal basins that drain to the Indian Ocean with those of the Atlantic-draining Orange basin (Abell *et al.* 2008; Darwall *et al.* 2009).

#### 4.3.2. National Freshwater Ecosystem Priority Areas

The National Freshwater Ecosystem Priority Areas (NFEPA) project represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA; now Department of Water and Sanitation, or DWS), Department of Forestry, Fisheries and Environment (DFFE), World Wide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). More specifically, the NFEPA project aims to:

- Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems;
  - This aim is to accomplish systematic biodiversity planning to identify priorities for conserving South Africa's freshwater biodiversity within the context of equitable social and economic development.
- Develop a basis for effective implementation of measures to protect FEPAs, including free-flowing rivers. This aim comprises of two separate components:
  - National component aimed to align DWA (or currently the DWS) and DFFE policy mechanisms and tools for managing and conserving freshwater ecosystems; and
  - Sub-national component which is aimed to use three case studies to demonstrate how NFEPA products should be implemented to influence land and water resource decision-making processes.
- Maximize synergies and alignment with other national level initiatives, including the NBA and the Cross-Sector Policy Objectives for Inland Water Conservation (Driver *et al.*, 2011).

Based on the current outputs of the NFEPA project (Nel *et al.*, 2011), the sub-quaternary catchment (B11E) within which the proposed Project lies is not considered a NFEPA Water Management Area, however, River FEPA and Upstream Management Area occur south west of the project area within the C12D sub-quaternary catchment (Figure 4-4).



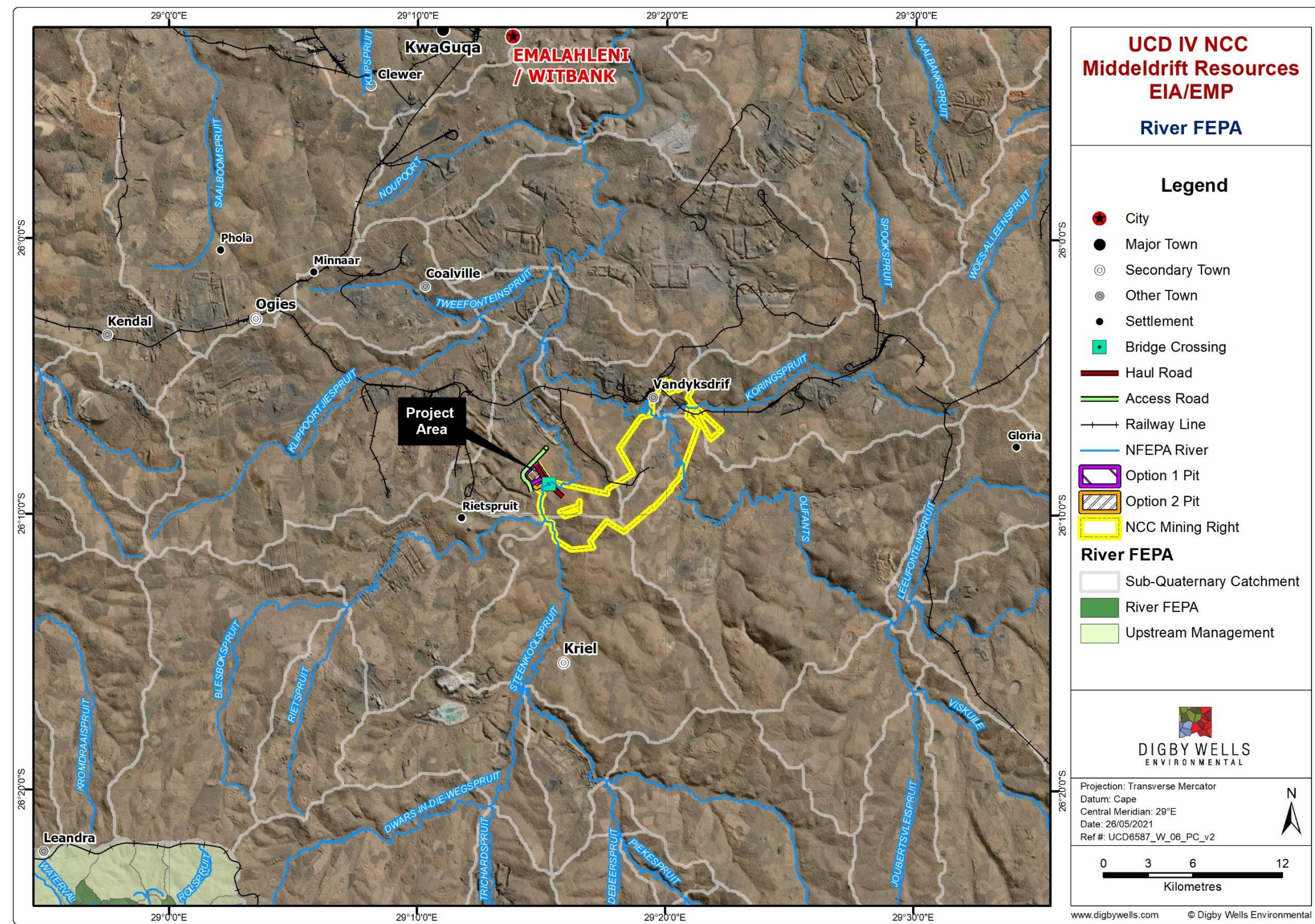


Figure 4-4: NFEPA Rivers Associated with the Project Area



#### 4.4. Mpumalanga Biodiversity Sector Plan

The Mpumalanga Biodiversity Sector Plan (MBSP) is a spatial tool that forms part of the national biodiversity planning tools and initiatives that are provided for national legislation and policy. The MBSP was published in 2014 by the Mpumalanga Tourism and Parks Agency (MTPA) and comprises a set of maps of biodiversity priority areas accompanied by contextual information and land-use guidelines for use in land-use and development planning, environmental assessment and regulation, and natural resource management. Strategically the MBSP enables the province to:

- Implement the NEM:BA, 2004 provincially, and comply with requirements of the National Biodiversity Framework, 2009 (NBF) and certain international conventions;
- Identify those areas of highest biodiversity that need to be considered in provincial planning initiatives; and
- Address threat of climate change (ecosystem-based adaptation).

The publication includes terrestrial and freshwater biodiversity areas that are mapped and classified in Protected Areas (PAs), Critical Biodiversity Areas (CBAs), Ecological Support Areas (ESAs) or Other Natural Areas (ONAs) (Figure 4-5).

CBAs with a bioregion are the portfolio of areas (i.e. map of CBAs for Mpumalanga Province), which if maintained in the appropriate respective condition (i.e. Land-use Guidelines) would meet the pattern targets for all biodiversity features, as well as ensure that areas necessary for supporting critical ecological processes remain functional. Based on these primary outputs, **Moderately Modified – Old Lands** and **ONAs** areas occur at the east, south and west portions along the edge of the Project Area. Additionally, the Steenkoolspruit is categorised as an **ESA** (Table 4-1).

**Table 4-1: Mpumalanga Biodiversity Sector Plan Categories Associated with the proposed open-cast mine, as well as recommended Land Management Objectives**

Category*	Description	Land Management Objective
<b>ESA</b>	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of protected areas or CBAs and for delivering ecosystem services.	Maintain in a functional, near-natural state, but some habitat loss is acceptable. A greater range of land-uses over wider areas is appropriate, subject to an authorization process that ensures the underlying biodiversity objectives are not compromised.
<b>ONAs</b>	Areas that have not been identified as a priority in the current systematic biodiversity plan but retain most of their natural character and perform a range of biodiversity and ecological infrastructural functions. Although they have not been	An overall management objective should be to minimise habitat and species loss and ensure ecosystem functionality through strategic landscape planning. These areas offer the greatest flexibility in terms of management objectives and permissible land-uses, but some

Category*	Description	Land Management Objective
	prioritized for biodiversity, they are still an important part of the natural ecosystem.	authorisation may still be required for high-impact land-uses.
<b>Heavily or Moderately Modified Areas</b>	Areas that have been modified by human activity to the extent that they are no longer natural, and do not contribute to biodiversity targets. These areas may still provide limited biodiversity and ecological infrastructural functions, even if they are never prioritized for conservation action.	Such areas offer the most flexibility regarding potential land-uses, but these should be managed in a biodiversity-sensitive manner, aiming to maximize ecological functionality and authorization is still required for high-impact land-uses. Moderately modified areas (old lands) should be stabilized and restored where possible, especially for soil carbon and water-related functionality.



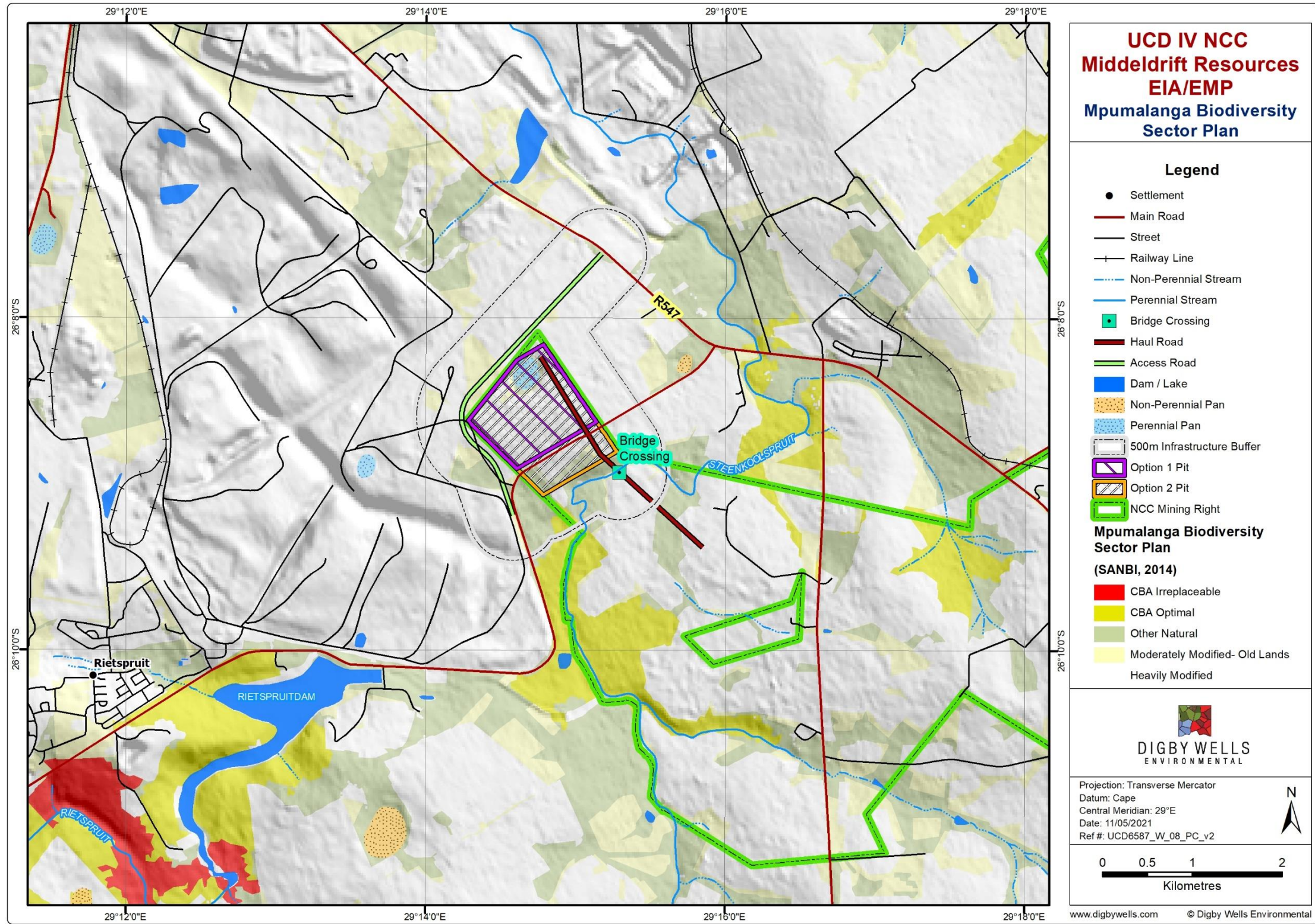


Figure 4-5: Mpumalanga Biodiversity Sector Plan (MBSP)



#### 4.5. Mining and Biodiversity Guideline

The Mining and Biodiversity Guideline was developed collaboratively by SANBI, DFFE, the Department of Mineral Resources and Energy (DMRE), the Chamber of Mines and the South African Mining and Biodiversity Forum (2013). The purpose of the guideline was to provide the mining sector with a manual to integrate biodiversity into the planning process thereby encouraging informed decision-making around mining development and environmental authorizations. The aim of the guideline is to explain the value for mining companies to consider biodiversity management throughout the planning process. The guideline highlights the importance of biodiversity in managing the social, economic and environmental risk of the proposed mining Project. The country has been mapped into biodiversity priority areas including the four categories each with associated risks and implications (Department of Environmental Affairs, Department of Mineral Resources, Chamber of Mines, South African Mining and Biodiversity Forum, & South African National Biodiversity Institute, 2013) (Table 4-2).

**Table 4-2: Mining and Biodiversity Guideline Categories (DEA *et al.*, 2013)**

Category	Risk and Implications for Mining
Legally Protected	Mining prohibited; unless authorised by ministers of both the DFFE and DMRE.
Highest Biodiversity Importance	Highest Risk for Mining: the EIA process must confirm significance of the biodiversity features that may be a fatal flaw to the proposed Project. Specialists must provide site-specific recommendations for the application of the mitigation hierarchy that informs the decision-making processes of mining licences, water use licences and environmental authorisations. If granted, authorisations should set limits on allowed activities and specify biodiversity related management outcomes.
High Biodiversity Importance	High Risk for Mining: the EIA process must confirm the significance of the biodiversity features for the conservation of biodiversity priority areas. Significance of impacts must be discussed as mining options are possible but must be limited. Authorisations may set limits and specify biodiversity related management outcomes.
Moderate Biodiversity Importance	Moderate Risk for Mining: the EIA process must confirm the significance of the biodiversity features and the potential impacts as mining options must be limited but are possible. Authorisations may set limits and specify biodiversity related management outcomes.

Two of the categories are found within the Project Area i.e. **Moderate Biodiversity Importance – Moderate Risk for Mining** (Figure 4-6).



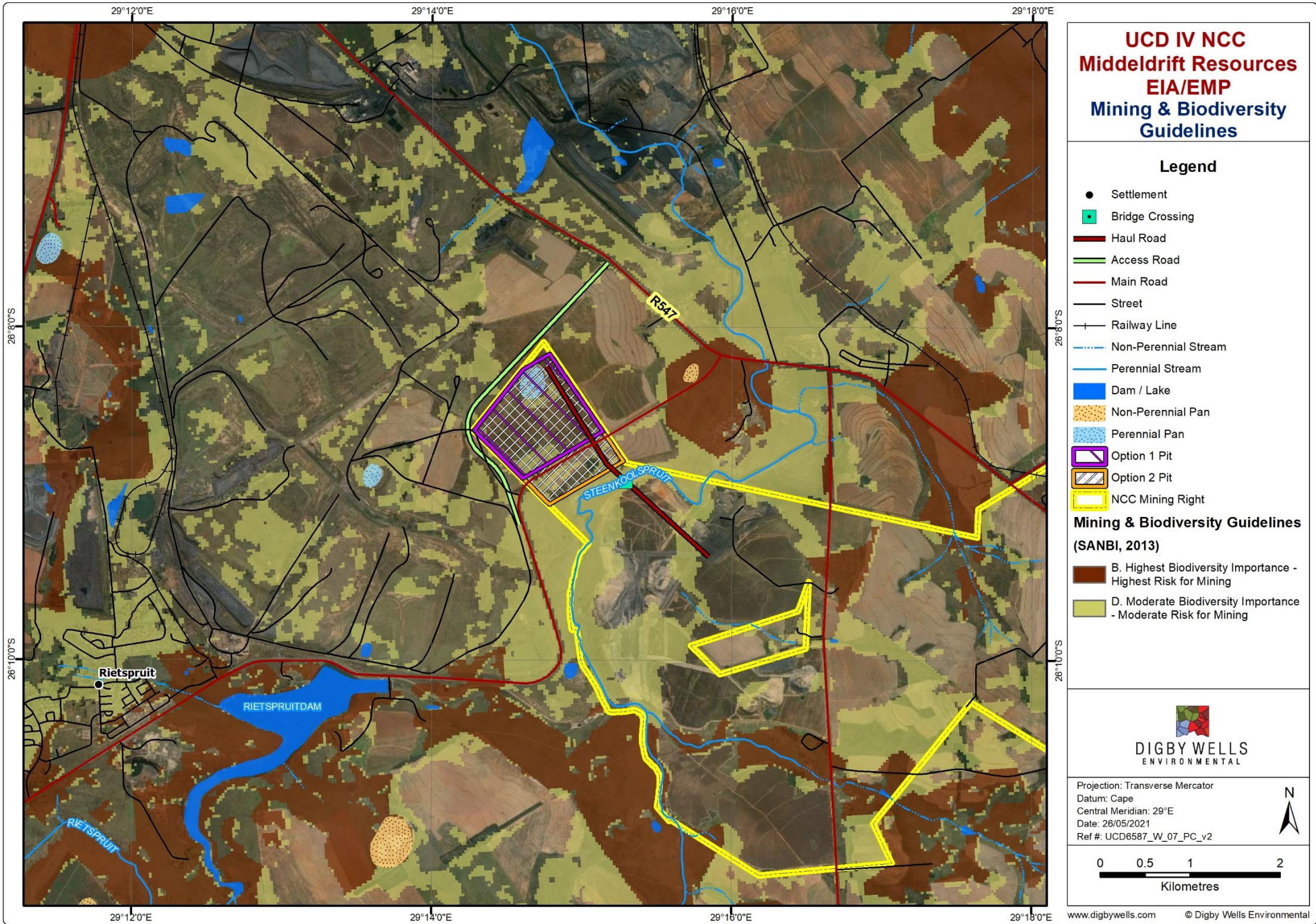


Figure 4-6: Mining and Biodiversity Guideline for Associated Project Area



This section provides a summary of the approach to the study, including each of the respective bioassessment indices utilised at each of the selected monitoring sites.

#### 4.6. Approach to Study

In order to enable an adequate description of the aquatic environment and the determination of the present ecological state, the following stressor, habitat and response indicators were evaluated:

- **Stressor indicators:**
  - *In situ* water quality assessment (Temperature, pH, Electrical Conductivity, and Dissolved Oxygen), including comparison to applicable guideline values (if any) and identification of parameters of potential concern; and
- **Habitat indicator:**
  - Instream and riparian habitat conditions, utilising the Index for Habitat Integrity (IHI, version 2); and
  - Aquatic macroinvertebrate biotope evaluation through the Adapted Invertebrate Habitat Assessment System (IHAS, Version 2.2).
- **Response indicators:**
  - Aquatic macroinvertebrate assessment, including the determination of ecological condition through Version 5 of the South African Scoring System (SASS5) and the Macro-Invertebrate Response Assessment Index (MIRAI);
  - Ichthyological assessment, including the evaluation of reference conditions and determination ecological condition through the Fish Response Assessment Index (FRAI); and
  - Determination of the integrated EcoStatus (EcoStatus 4, Version 1.02).

A detailed description of each index/approach utilised in the baseline determination has been outlined in Appendix A.

#### 4.7. Selected Monitoring Sites

Aquatic Ecology monitoring sites were selected based on the location of the proposed Project infrastructure, the MRA and areas suspected to inhabit sensitive/conservationally important aquatic species (Table 4-3; Figure 4-7). See Appendix B for Site Photographs.

**Table 4-3: Aquatic Biomonitoring sampling sites within the study area**

Site/Point	Coordinates	Description
<b>Rietspruit</b>		
<b>NC1</b>	26°11'30.25"S 29°10'57.88"E	Located along the Rietspruit at the R545 crossing, upstream of the Rietspruit Dam. Site serves as a reference site
<b>Steenkoolspruit</b>		
<b>NC2</b>	26° 9'55.17"S	Located along the Steenkoolspruit approximately 1.8 km South of UCDIV NCC. Sites served as a reference site along the Steenkoolspruit.

Site/Point	Coordinates	Description
	29°14'58.40"E	
<b>NC3</b>	26° 8'13.97"S 29°16'11.73"E	Located along the Steenkoolspruit at the R547 crossing, approximately 1.9 km East of UCDIV NCC
<b>NC4</b>	26° 7'15.59"S 29°14'28.10"E	Located at a tributary of the Steenkoolspruit adjacent to the R547 road, approximately 1.7 km North of UCDIV NCC



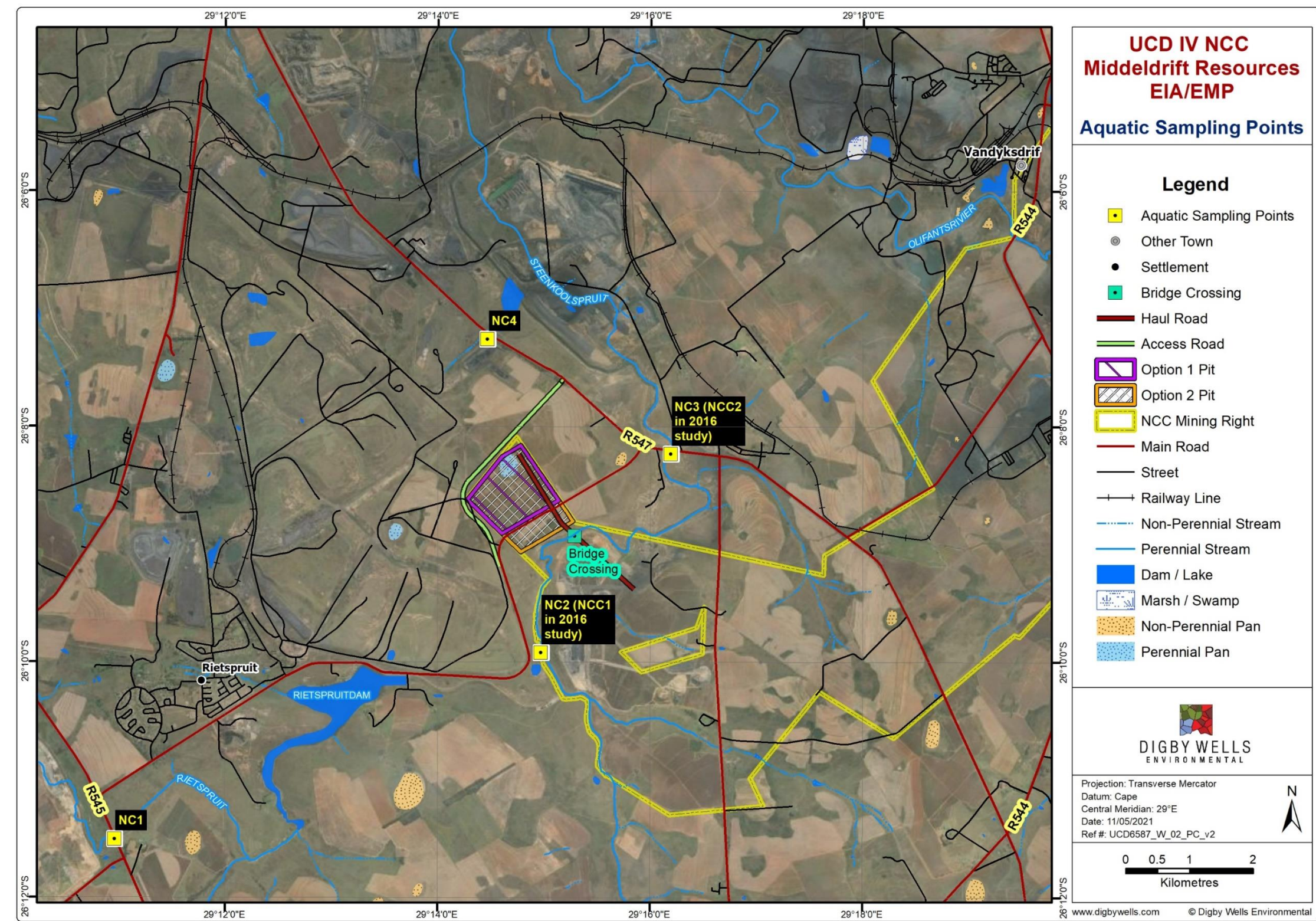


Figure 4-7: Selected Aquatic Sampling Points



## 5. Desktop Present Ecological State, Importance and Sensitivity

Of the two SQR's occurring within the focus quaternary catchment, only the Steenkoolspruit B11E-01297 SQR is expected to be potentially impacted by the proposed mining activities, the Rietspruit B11E-01353 SQR, which joins the Steenkoolspruit upstream of the Project Area will therefore be included as a reference site for the current assessment.

Table 5-1 outlines the desktop aquatic-related data obtained for both the Rietspruit B11E-01353 and Steenkoolspruit B11E-01297 SQR (DWS, 2014). Figure 4-3 displays the potentially affected Quaternary Catchment B11E.

**Table 5-1: Desktop Aquatic Data pertaining to the Rietspruit and Steenkoolspruit**

SQR Code/Aquatic Component	B11E-01353	B11E-01297
Ecological Category	<b>E</b>	<b>D</b>
Category Description	Seriously Modified	Largely Modified
Ecological Importance (EI)	Moderate	Moderate
Ecological Sensitivity (ES)	High	High

According to the desktop data obtained for the Rietspruit B11E-01353 (DWS, 2014), the 24 km long SQR appears to be in a *Seriously Modified State* (i.e. Ecological Category E), whilst the ~18 km Steenkoolspruit B11E-01297 SQR appears to be in a *Largely Modified* state (i.e. Ecological Category D). Land uses associated with these SQRs include mining, residential and agricultural activities. According to the DWS (2014), impacts associated with these land uses include low water crossings, algal growth (eutrophication), water abstraction, increased flows, erosion, sedimentation, vegetation removal, alien vegetation encroachment, canalization, mine effluent discharge and run-off.

The Ecological Importance (EI) and Ecological Sensitivity (ES) of both SQRs have been classified as "moderate" and "high" respectively. A total of 46 macroinvertebrate taxa and 7 indigenous fish species are expected to occur at the Rietspruit whilst 38 macroinvertebrate taxa 6 fish species are expected at the Steenkoolspruit.

The "high" ES for both SQRs is mainly due to the large number of macroinvertebrate taxa that have a *very high* sensitivity towards water quality and velocity modifications as well as fish species with *moderate* sensitivity towards water quality modifications and high sensitivity towards no-flow conditions.

### 5.1. Expected Aquatic Macroinvertebrates

The expected aquatic macroinvertebrate taxa for the associated Steenkoolspruit SQR are presented in Table 5-2.

**Table 5-2: Expected Macroinvertebrate Taxa in the Watercourses Associated with the proposed Project**

Family Names		
Porifera	Corixidae	Elmidae

Family Names		
Turbellaria	Gerridae	Gyrinidae
Oligochaeta	Hydrometridae	Halipidae
Hirudinea	Naucoridae	Hydrophilidae
Potamonautidae	Nepidae	Ceratopogonidae
Atyidae	Notonectidae	Chironomidae
Hydracarina	Pleidae	Culicidae
Baetidae > 2 sp	Veliidae/Mesoveliidae	Muscidae
Caenidae	Ecnomidae	Simuliidae
Coenagrionidae	Hydropsychidae 1 sp	Lymnaeidae
Aeshnidae	Hydroptilidae	Physidae
Libellulidae	Leptoceridae	Planorbinae
Belostomatidae	Dytiscidae	
Blue shading = high dependence for fast-flowing water; Green shading = dependence for both fast-flowing water and moderate water quality		

The expected aquatic macroinvertebrate assemblage is largely composed of taxa (families) with preference for slow-flowing to moderately-flowing water and low water quality dependence, only five of the expected 38 species have preference for fast-flowing water and only three taxa are dependent on both fast-flowing water and moderately-flowing water (DWS, 2014).

No aquatic macroinvertebrate species of commercial or economic value identified were listed on the original NEM:BA (2004) Threatened and Protected Species (ToPS) regulations.

## 5.2. Expected Fish Species

The fish species expected in the reaches associated with the Project Area have been provided for in Table 5-3 (DWS, 2014). A total of seven species are expected, however, one of the species (*Enteromius cf. neefi* or Sidespot Barb) is currently under assessment within South Africa, as the population is distinct to the true *E. neefi* population occurring in Angola, Zambia and the Democratic Republic of Congo (Moelants & Tweddle, 2018). This species is therefore excluded from the list of expected species for the Project Area.

Additionally, each species sensitivity ratings towards physio-chemical and no-flow conditions (DWS, 2014) have been provided for, together with their conservation status according to the IUCN Red List of Threatened Species (2021).

**Table 5-3: Expected Fish Species in the Reaches Associated with the Project Area**

Fish Species	Common Name	Tolerance/Preference		Conservation Status
		Modified Water Quality	No-flow	
<i>Clarias gariepinus</i>	Sharptooth Catfish	1	1.7	LC
<i>Enteromius anoplus</i>	Chubbyhead Barb	2.6	2.3	LC

Fish Species	Common Name	Tolerance/Preference		Conservation Status
		Modified Water Quality	No-flow	
<i>Enteromius paludinosus</i>	Straightfin Barb	2.3	1.8	LC
<i>Labeobarbus polylepis</i>	Bushveld Smallscale Yellowfish	3.3	2.9	LC
<i>Pseudocrenilabrus philander</i>	Southern Mouthbrooder	1.4	1	LC
<i>Tilapia sparrmanii</i>	Banded Tilapia	1.4	0.9	LC
Tolerance: 1-2 = tolerant, 3-4 moderately tolerant; 4-5 = Intolerant; <b>Red</b> Shading = intolerant, <b>Green</b> shading = tolerant, Conservation Status: LC=Least Concern				

Following a review of available collection records of fish species occurring within the watercourses associated with the study area, a total of six (6) fish species are expected to occur within the B11AE and B11D catchments. Three (3) of the six (6) species are regarded as tolerant to modified water quality and no flow conditions (DWS, 2014). According to Skelton (2001), all the species are indigenous to South Africa and their conservation status is regarded as Least Concern

## 6. Findings and Discussion

Each of the assessment indicators applied at the time of the present survey (on the 2<sup>nd</sup> March 2021) are discussed below and where possible, compared against data collected during a previous survey undertaken in 2016 (SAS, 2016).

### 6.1. Water Quality

For the purposes of the assessment, each of the values recorded during the survey were compared against various water quality guidelines originating from the following sources:

- pH and saturation percentage guidelines obtained from Department of Water Affairs and Forestry (1996a);
- Conductivity guideline value of 500 µS/cm stipulated in U.S. Environmental Protection Agency (2010); and
- Dissolved oxygen concentration guideline for macroinvertebrates from Nebeker et al. (1996). And dissolved oxygen saturation for aquatic biota from Department of Water Affairs and Forestry (1996).

The *in-situ* water quality results of the 2021 late wet season survey for the watercourses associated with the proposed Project are presented in Table 6-1 and further discussed in the below sections.

**Table 6-1: *In situ* Water Quality Results for Watercourses Associated with the proposed Project**

Monitoring Site	Riet-spruit	Steenkoolspruit			Guideline
	NC1	NC2	NC3	NC4	
Time	08h40	9h52	11h26	12h12	-



Monitoring Site	Riet-spruit	Steenkoolspruit			Guideline
	NC1	NC2	NC3	NC4	
Temperature (°C)	19.4	21.2	22.7	23.1	5-30
pH	8.74	7.98	8.46	7.68	6-8
Conductivity (µS/cm)	524	564	487	3570	≤500
Dissolved oxygen (mg/l)	6.24	6.63	8.12	7.13	>5
Dissolved oxygen (Saturation %)	74.1	76.3	80.3	68.5	80-120
Clarity (cm)	41	22	10	5	-

**\*Red values indicate constituents exceeding recommended guideline values**

### 6.1.1. *In situ* Temperature

Water temperature is an important abiotic factor in aquatic ecosystems, it influences organisms' growth, feeding and metabolic rates, emergence, fecundity, and behaviour. Thus all organisms have an optimum temperature range within which they survive. The temperatures of inland waters in South Africa generally range from 5-30 °C, which is the range within which most aquatic invertebrates in southern Africa thrive (DWAF, 1996). Human-induced changes in temperature include (amongst others), water abstraction, heated return-flows of irrigation water; and discharge of water from impoundments (Department Of Water Affairs And Forestry, 1996).

Temperature values recorded at monitoring sites associated with the proposed Project ranged from 19.4 °C to 23.1 °C, typical of the summer season temperatures in South Africa. Therefore, all recordings were within the normal temperature of inland waters in the country, thus all sites were not expected to deter occurring aquatic biota due to temperature influences.

### 6.1.2. *In situ* pH

The pH value is a measure of hydrogen (H<sup>+</sup>), hydroxyl (OH<sup>-</sup>), bicarbonate (HCO<sub>3</sub><sup>-</sup>) and carbonate (CO<sub>3</sub><sup>2-</sup>) ions in water (Dallas & Day, 2004). The pH of natural water is determined by geological and atmospheric influences and may also vary both diurnally and seasonally. Diurnal fluctuations occur in productive systems where the relative rates of photosynthesis and respiration vary over a 24-hour period because photosynthesis alters the carbonate/bicarbonate equilibrium by removing CO from the water, thus elevated pH levels may be a characteristic of eutrophic systems where biological activity is increased. The toxicity of many elements in water is determined by pH, aluminium for example, is mobilized in acidic waters (DWAF, 1996).

The pH values recorded exhibited close to neutral to slightly alkaline conditions, ranging from 7.68 pH units to 8.74 pH units during the present study. The DWAF (1996) guideline upper limit of 8 pH units was exceeded at sites NC1 and NC3 only. The recorded pH levels were likely influenced by natural processes such as photosynthesis.

### 6.1.3. *In situ* Electrical Conductivity

Electrical conductivity (conductivity) is a measure of the ability of water to conduct an electrical current. This ability is a result of the presence of total dissolved salts or dissolved compounds that carry an electrical charge. Conductivity in natural waters varies in part on the characteristics of geological formations which the water has been in contact with and the dissolution of minerals in soils and plant matter. Anthropogenic sources of increased dissolved salts include domestic and industrial effluent discharges and surface runoff from urban, industrial and cultivated areas (DWAF, 1996).

Conductivity values were recorded above the recommended guideline of 500  $\mu\text{S}/\text{cm}$  (USEPA, 2010) at all the sites except at Site NC3. The conductivity at sites NC1 and NC2 were however only slightly above the recommended guideline (i.e. 524  $\mu\text{S}/\text{cm}$  and 564  $\mu\text{S}/\text{cm}$ ), whilst an elevated conductivity level was recorded at Site NC4 (3570  $\mu\text{S}/\text{cm}$ ). Lying directly below a wetland system (Figure 6-1), this elevated conductivity was suspected to be attributed to the accumulation of contaminants stemming from the surrounding land uses which were carried through surface and sub-surface flows (Dallas & Day, 2004; Tuladhar & Iqbal, 2020).



**Figure 6-1: Photo showing wetland system (indicated by a red arrow) lying above Site NC4**



**Figure 6-2: Photo showing high sediment loads observed at Site NC4**

#### **6.1.4. *In situ* Dissolved Oxygen**

Gaseous oxygen ( $O_2$ ) from the atmosphere dissolves in water and is also produced in water by aquatic plants and phytoplankton. The maintenance of adequate dissolved oxygen (DO) concentrations is critical for the survival and functioning of the aquatic biota because it is required for the respiration of all aerobic organisms. Therefore, the DO concentration provides a useful measure of the health of an aquatic ecosystem.

Sampled sites generally lacked primary drivers of dissolved oxygen in river systems, that is instream aquatic vegetation and rapids, with the exception of site NC3 where rapids were present at the time of the survey. Despite this, DO concentration levels were recorded above the recommended guideline of 5 mg/l (Nebeker *et al.*, 1996) at all sites. Site NC3 recorded the highest dissolved oxygen concentration (8.12 mg/l), this was likely attributed to the rapids at this site, i.e. the turbulence facilitates the diffusion of oxygen from the surrounding air (Dallas & Day, 2004).

#### **6.1.5. Water Clarity/Turbidity**

Most of the sampled sites were largely sedimented, smothering the substrates of the sites. A wide variety of water clarity measurements were recorded ranging from 5 cm at Site NC4 to 41 cm at Site NC1. Despite the high clarity at Site NC1, this site contained high sediment loads which had settled at the surface. This site lies downstream of intensive mining areas and agriculture fields thus the high sediment content was likely attributed to associated land uses



such as the clearing of vegetation leading to soil erosion. High sediment composition in water bodies directly impacts on aquatic organisms by smothering and blocking the gills (and other respiratory apparatus) in fish and aquatic invertebrates and indirectly by reducing the amount of available food as the vegetation gets covered and trapped in fine particles. It is therefore important to avoid land use activities that result in surface runoff of soil into these watercourses.

## 6.2. Aquatic and Riparian Habitat

Assessment of aquatic habitat within the study area was based largely on the application of recognised assessment indices at each of the selected sampling points, as well as associated reach) within the assessed watercourses, namely the IHI and the IHAS. The IHI is a rapid, field-based, visual assessment of modifications to a number of pre-selected biophysical drivers (i.e. semi-quantitative) used to determine the Ecological Category of associated instream and riparian habitats.

### 6.2.1. Index for Habitat Integrity

The IHI was completed at a desktop level for each aquatic ecosystem considered in the present survey and populated with observations recorded during the field survey (Table 6-2).

It should be noted that this assessment index is applied to a pre-determined segment or portion of the associated watercourse and is typically delineated by major riverine homogeneities (e.g. adjoining tributaries) and/or potential instream barriers (e.g. dams, weirs, etc.). Consequently, for the purposes of the present study, each river reach was delineated by adjoining tributaries upstream and downstream of the reach, thus encompassing habitat assessment units.

**Table 6-2: IHI Findings for the Watercourses Associated with the Proposed Project**

Site	Habitat Component	IHI Score	Ecological Category	Major Impacts
<b>Rietspruit</b>	Instream	48.36	<b>D</b>	Highly sedimented due to upstream bank disturbances including removal of indigenous vegetation.
	Riparian	63.72	<b>C</b>	Isolated infestations of alien-invasive Eucalyptus trees observed in the surrounding area.
<b>Steenkoolspruit</b>	Instream	56.3	<b>D</b>	High sedimentation and water quality deterioration due to activities associated with mines, agriculture and residential areas.
	Riparian	53.49	<b>D</b>	Removal of indigenous vegetation indicated by the dominance of Bankrupt Bush plants.
N/A = Not suitable for assessment				

The findings from the IHI assessments conducted during the current 2021 survey indicate that the habitat integrity along the assessed Rietspruit reach was *Largely Modified* (Ecological Category D) for the instream component and *Moderately Modified* (Ecological Category C) for the riparian component. Major impacts of the instream habitat were bed modification and the dominance of exotic fauna. Site NC1 was observed to contain high sediment loads and only the alien Mosquito Fish was collected (see Section 6.4.1). At the assessed Steenkoolspruit reach, both instream and riparian components were determined to be in *Largely Modified* (Ecological Category D) conditions. Similarly, to the assessed Rietspruit reach, bed modification due to high sediment loads and the dominance of alien-invasive fauna were the major impacts of the instream habitat, whilst the removal of indigenous vegetation and the dominance of Bankrupt Bush (*Seriphium plumosum*; Figure 6-3) was the major impact of the riparian habitat.

The survey conducted in 2016 (SAS, 2016) indicated that both the instream and riparian habitats were in *Moderately Modified* (Ecological Category C) conditions for the Steenkoolspruit. Similarly to the current 2021 survey, major impacts included bed modifications and water quality modifications for the instream component whilst the riparian zone impacts included flow modification, bank erosion, water quality modification and inundation.



**Figure 6-3: Photo of Bankrupt Bush (*Seriphium plumosum*) observed to dominate the surroundings at Site NC2**

### 6.3. Aquatic Macroinvertebrate Assessment

The following sections provide insights into the available habitat that was sampled at each respective monitoring sites at the time of the current 2021 survey, as well as the SASS5 metrics obtained and the subsequent determination of the ecological condition of the observed assemblages in relation to reference conditions.

#### 6.3.1. Invertebrate Habitat Assessment System

The IHAS, Version 2.2, developed by McMillan (1998), has routinely been used in conjunction with the SASS approach as a measure of variability in the quantity and quality of representative aquatic macroinvertebrate biotopes available during sampling. However, according to a study conducted within the Mpumalanga and Western Cape regions, the IHAS method does not produce reliable scores at assessed sampling sites, as its performance appears to vary between geomorphologic zones and biotope groups (Ollis *et al.*, 2006). While no conclusion can be made regarding the accuracy of the index until further testing has been conducted, these potential limitations and/or shortfalls should be noted. Nevertheless, due to the value of basic instream habitat assessment data and its suitability for comparison of available macroinvertebrate habitats between various sampling sites, an adapted IHAS approach was maintained during the interim period, excluding assessment of the '*surrounding physical stream condition*.'

Table 6-3 shows the adapted IHAS scores at the sites assessed during the current 2021 survey.

**Table 6-3: IHAS Values and Interpretation for the Sampled Sites**

Site/Point	IHAS Score (%)	Interpretation
<b>Rietspruit</b>		
NC1	60.0	Good
<b>Steenkoolspruit</b>		
NC2	47.3	Poor
NC3	49.1	Poor
NC4	40.0	Poor

During the current late wet season survey, the sampled systems were dominated by deep, slow to moderately flowing water and generally lacked the stones biotope. Marginal vegetation and sand were the common features throughout the sites. Consequently, most of the assessed sites exhibited largely *Poor* habitat availability with varying degrees of aquatic and marginal vegetation with sand and mud being the dominant biotopes. An exception was observed at Site NC1 where the invertebrate habitat availability was scored as *Good*. Aquatic/marginal vegetation, and the gravel/sand/mud (GSM) biotopes were in high abundance and occurred in varying water depth and flow classes at this site.

#### 6.3.2. Benthic Communities and Composition

Due to the differential sensitivities of aquatic macroinvertebrates, the composition of the aquatic macroinvertebrate community can provide an indication of changes in water quality



and other ecological conditions within a watercourse. The use of the SASS has undergone numerous advances, culminating in Version 5 (SASS5) presently being utilised in river health studies along with the application of the MIRAI.

Table 6-4 presents the SASS5 results for the assessed monitoring sites within the proposed Project area.

**Table 6-4: SASS5 Data Obtained for the Assessed Sites**

Monitoring Site	Rietspruit	Steenkoolspruit		
	NC1	NC2	NC3	NC4
<b>SASS5 Score</b>	67	95	44	72
<b>Taxa</b>	16	22	12	17
<b>ASPT</b>	4.2	4.3	3.7	4.2
ASPT = Average Score Per Taxon				

The aquatic macroinvertebrate community assemblages were predominantly composed of taxa that have “Low” water quality requirements. Of the collected invert families, only 4 families with a *Moderate* water quality requirement (i.e. SASS sensitivity score of >8) were collected. All four families with “*Moderate*” water quality requirements (Atyidae, Hydracarina, Aeshnidae and Dixidae) were collected along the Steenkoolspruit sites, whilst only Atyidae was collected at the Rietspruit Site NC1.

Only 16 invertebrate families were collected at the Rietspruit Site NC1, and a total of 29 were collected throughout the Steenkoolspruit sites. With the highest score for macroinvertebrate habitat availability obtained at Site NC1 for the present survey, it was expected that the highest number of invert families would be collected at this site. The highest number of invert families were however collected at the Steenkoolspruit Site NC2 (22) followed by Site NC4 (17). This finding suggests that there were factors other than habitat availability driving the composition of invert families at the assessed sites.

Similarly to the 2016 study (SAS, 2016), a higher SASS score and ASPT was obtained at the Steenkoolspruit upstream Site NC2 (named NCC1 in 2016) compared to the downstream Site NC3 (named NCC2 in 2016). This is attributed to the lack of habitat diversity at Site NC3 where bedrock dominates the habitat. However only 8 and 7 invert families were collected at sites NCC1 and NCC2 during the 2016 survey, 14 more families were collected at Site NC2 and 5 more at Site NC3 during the present 2021 survey. This notable difference in the number of collected invertebrates could be attributed the difference in timing for the surveys (i.e. the current 2021 survey was undertaken early March while the 2016 survey in April).

### **6.3.1. Ecological Condition of the Aquatic Macroinvertebrate Assemblages**

Although Chutter (1998) originally developed the SASS protocol as an indicator of water quality, it has since become clear that the SASS approach gives an indication of more than mere water quality, but also a general indication of the current state of the macroinvertebrate community. While SASS does not have a particularly strong cause-effect basis for interpretation, as it was developed for application in the broad synoptic assessment required

for the old River Health Programme (RHP), the aim of the MIRAI is to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic macroinvertebrate community (assemblage) from the reference condition (Thirion, 2008). This does not preclude the calculation of SASS scores, but encourages the application of MIRAI assessment, even for RHP purposes, as the preferred approach. Accordingly, the SASS5 data obtained was used in the MIRAI (Thirion, 2008) to determine the PES, or Ecological Category of the associated macroinvertebrate assemblage.

Results for the MIRAI at the assessed sites are shown in Table 6-5 and discussed below.

**Table 6-5: MIRAI data for the Assessed Sites**

Site	MIRAI Value	Ecological Category	Description
<b>Rietspruit</b>			
NC1	40.22	D/E	Largely to Seriously Modified
<b>Steenkoolspruit</b>			
NC2	51.8	D	Largely Modified
NC3	32.1	E	Seriously Modified
NC4	42.5	D	Largely Modified

The macroinvertebrate assemblage at the Rietspruit Site NC1 exhibited *Seriously to Largely Modified* conditions (Ecological Category D/E) and ranged between *Largely Modified* and *Seriously Modified* conditions at the Steenkoolspruit sites.

During the 2016 survey (SAS, 2016), the ecological category at sites NCC1 and NCC2 (NC2 and NC3 in the present survey) were determined to be *Largely Modified*. Thus, the biotic integrity at Site NC2 had remained the same whilst that of Site NC3 had deteriorated since the previous 2016 study.

## 6.4. Fish Communities

Using fish as a means to determine ecological disturbance has many advantages (Zhou *et al.*, 2008). Fish are long living, respond to environmental modification, continuously exposed to aquatic conditions, often migratory and fulfil higher niches in the aquatic food web. Therefore, fish can effectively give an indication into the degree of modification of the aquatic environment.

The catch record and subsequent ecological condition of the collected fish communities is discussed in the below sub-sections.

### 6.4.1. Catch Record

Six indigenous fish species were expected to occur within the study area, with none of the species deemed a potential conservation concern (see Section 5.2; Table 5-3).

A total of five fish species were collected (or observed), two of which were regarded as alien invasive species (*Gambusia affinis* or Mosquitofish and *Micropterus salmoides* or Largemouth Bass). The number of fish collected per site sampled is shown in Table 6-6.



**Table 6-6: Fish collected (or observed) within the sampled reaches**

Scientific Name	Rietspruit	Steenkoolspruit			Total Catch
	NC1	NC2	NC3	NC4	
<i>Clarias gariepinus</i>	-	-	-	-	0
<i>Enteromius anoplus</i>	-	-	-	-	0
<i>Enteromius paludinosus</i>	-	3	-	-	3
<i>Labeobarbus polylepis</i>	-	-	-	-	0
<i>Pseudocrenilabrus philander</i>	-	7	3	-	10
<i>Tilapia sparrmanii</i>	-	3	-	-	3
<i>Micropterus salmoides</i> *	-	1	-	-	1
<i>Gambusia affinis</i> *	8	16	4	-	28
<b>Number of Species</b>	<b>1</b>	<b>5</b>	<b>2</b>	<b>0</b>	<b>8</b>
<b>Total Catch</b>	<b>1</b>	<b>30</b>	<b>7</b>	<b>0</b>	<b>38</b>

\* Alien species; Values in parenthesis indicated observed specimens

Of the three collected indigenous fish species, two are known to be tolerant to water quality modifications, whilst one (*E. paludinosus* or Straightfin Barb) is regarded as moderately sensitive. A single species (*Gambusia affinis*) was sampled at the Rietspruit reach, whilst five species were collected along the Steenkoolspruit reaches. Along the Steenkoolspruit, most of the fish were collected/observed at the upstream site NC2, with the highest catch (30 specimens) whilst only seven specimens were collected at the downstream Site NC3. No fish were collected at the Steenkoolspruit adjoining tributary Site NC4.

The alien species *G. affinis* (Mosquitofish) dominated the assessed watercourses and was collected at three of the four sites. The Mosquitofish (Figure 6-4) was introduced in South Africa as a mosquito control agent and forage for bass, but has proved to be an aggressive invader species capable of restricting other fish populations by preying on fish larvae (Skelton, 2001). Its occurrence and dominance at Site NC2 can be attributed to its habitat requirements, which were suited at the time of the survey (i.e. slow-flowing water with plant cover).

**Figure 6-4: *Gambusia affinis* (Mosquitofish) collected within the assessed watercourses**

### 6.4.2. Ecological Condition of the Fish Assemblages

The REMP uses the FRAI which is based on the preferences of various fish species as well as the frequency of occurrence. The electro-narcosis technique was applied to sample the available fish species within the Project Area.

FRAI results for the sampled river reaches are shown in Table 6-7 and discussed below.

**Table 6-7: FRAI Results for the current aquatic assessment**

Site	FRAI Score (%)	Ecological Category	Description
<b>Rietspruit</b>			
NC1	20.0	E/F	Seriously to Critically Modified
<b>Steenkoolspruit</b>			
NC2	47.8	D	Largely Modified
NC3	26.1	E	Seriously Modified
NC4	20.0	E/F	Seriously to Critically Modified

Of the expected fish species, three are known to be tolerant to water quality modifications and three are intolerant, only one of the intolerant species (*Enteromius paludinosus*) was collected/observed during the current study. Thus, the absence of the two species *Enteromius anoplus* and *Labeobarbus polylepis*, which are intolerant to water quality modifications (and require suitable habitat) suggests the impacted state of the water quality associated with the sampled reaches within the Project Area.

FRAI results indicate *Seriously to Critically Modified* conditions (Ecological Category E/F) at the Rietspruit Site NC1. At the Steenkoolspruit reaches, the ecological conditions appeared to deteriorate along the longitudinal profile i.e. *Largely Modified* (Ecological Category D) at the upstream Site NC2, *Seriously Modified* (Ecological Category E) at the downstream Site NC3 and *Seriously to Critically Modified* (Ecological Category E/F) at the adjoining tributary of the Steenkoolspruit. However, this may have been a result of the limited depth of sampling due to unsafe conditions at Site NC3.

The biotic integrity for the previous assessment (SAS, 2016) was determined to be *Seriously Modified* (Ecological Category E) at both sites NCC1 and NCC2 (NC2 and NC3 in the present survey). Thus, in the current study, the biotic integrity at Site NC2 had improved since the 2016 study whilst that of Site NC3 remained the same. Only two species were sampled during the 2016 study, namely *G. affinis* and *T. sparrmanii*, compared to three sampled during the current study.

### 6.5. Integrated EcoStatus Determination

The EcoStatus is defined as: “*The totality of the features and characteristics of the river and its riparian areas that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services*” (Iversen et al., 2000). In essence, the EcoStatus represents an integrated ecological state representing the drivers (hydrology, geomorphology, physico-chemical) and responses (fish, aquatic invertebrates and riparian

vegetation; Kleynhans & Louw, 2008). The instream biological integrity, as well as the integrated EcoStatus, for the sampled river reaches within the Project Area were determined below (Table 6-8).

**Table 6-8: The PES of the reaches under study through the use of the ECOSTATUS4 (Version 1.02; Kleynhans & Louw, 2008)**

Site	Response Indices				EcoStatus	
	MIRAI EC	FRAI EC	Instream EC	Riparian Vegetation EC (IHI)	Score	Category
<b>Rietspruit</b>						
<b>NC1</b>	40.2	20.0	32.5	63.7	50.4	<b>D</b>
<b>Steenkoolspruit</b>						
<b>NC2</b>	51.8	47.8	50.3	53.5	52.1	<b>D</b>
<b>NC3</b>	32.1	26.1	29.8	53.5	43.4	<b>D</b>
<b>NC4</b>	42.5	20.0	33.9	53.5	45.1	<b>D</b>

Following integration of the defined ecological conditions obtained for the instream biological integrity (i.e. MIRAI from aquatic ecological invertebrates) and the riparian component (i.e. IHI from riparian vegetation assessment), it was determined that the sampled river reaches along the Rietspruit and Steenkoolspruit systems represented an integrated EcoStatus of *Largely Modified* (Ecological Category D).

In relation to the Recommended Ecological Category (REC), the assessed sections of the Rietspruit and the Steenkoolspruit systems were observed to attain the stipulated Ecological Category of D, as gazetted in April 2016 (*Proposed Classes and Resource Quality Objectives of Water Resources of the Olifants Catchment in Terms of Section 13(1)(a) and (b) of the National Water Act, 1998 (Act No.36 of 1998)*, 2016). It should be noted that the Integrated Unit of Analysis (IUA) referred to for the RECs was that of the Upper Olifants River catchment, i.e. Steenkoolspruit (confluence with the Olifants).

## 7. Impact Assessment

Any development in a natural (or modified) system will impact on the surrounding environment, potentially in a negative way. The purpose of this section of the report is to identify and assess the significance of the impacts likely to arise during the proposed activity and provide a short description of the mitigation required to limit the magnitude of the potential impact of the proposed activity on the natural environment.

Focus of the impact assessment has been solely on the proposed open cast mine including a road diversion and construction of a bridge over the Steenkoolspruit. The identified potential impacts that will negatively affect aquatic ecosystems are discussed below for the various phases of the Project (i.e. Construction Phase, Operational Phase, as well as Closure and Decommissioning Phase).

For a detailed description of the Impact Assessment Criteria and Calculations used during the assessment below, the reader is referred to Appendix A.

## 7.1. Proposed Activities

The construction, operation and decommissioning phases of the proposed Project shall comprise of the activities in Table 7-1.

**Table 7-1: Project Activities**

Phase	Activity
Construction	Removal of vegetation / topsoil for establishment of mining and linear infrastructure
	Diesel storage and explosives magazine
	Construction of additional infrastructure, and ventilation fans (Noise generation / increased noise level)
	Construction of access road and haul roads (including the bridge construction)
	Stockpiling of soils, rock dump and discard dump establishment.
Operational	Maintenance of haul roads, pipelines, machinery, water, effluent and stormwater management infrastructure and stockpile areas.
	Removal of rock (blasting)
	Concurrent rehabilitation as mining progresses
	Demolition and removal of infrastructure
Decommissioning	Post-closure monitoring and rehabilitation
	Closure of the mine

## 7.2. Construction Phase

Activities during the Construction Phase that may have potential impacts on the aquatic ecosystems are described in Table 7-2 below.

**Table 7-2: Interactions and Impacts of Activity**

Interaction	Impact
Soil disturbance and vegetation clearance for establishment of mining and linear infrastructure	<ul style="list-style-type: none"> <li>• Increase in surface runoff, erosion and subsequently sedimentation;</li> <li>• Channel and bank modifications; and</li> <li>• Alteration of the aquatic habitats.</li> </ul>
Diesel storage and explosives magazine.	<ul style="list-style-type: none"> <li>• Potential mobilisation of pollutants entering the associated watercourses; and</li> <li>• Alteration of the physio-chemistry of water, deterring water quality sensitive biota.</li> </ul>
Construction of access roads and haul roads.	
Stockpiling of soils, rock dump and discard dump establishment.	

**7.2.1.1. Management Objectives**

The main objective for mitigation would be to limit the areas proposed for disturbance/vegetation clearance.

**7.2.1.2. Management Actions**

General mitigation actions provided in the wetlands and surface water studies conducted by Digby Wells should be used to guide the effective management of aquatic resources potentially affected by the proposed Project. However, more specific management actions for the Construction Phase are listed below:

- Limit vegetation removal to the infrastructure and mining footprint area only. Where removed or damaged, vegetation areas (riparian or aquatic related) should be revegetated as soon as possible;
- Bare land surfaces downstream of construction activities must be vegetated to limit erosion from the expected increase in surface runoff from infrastructure;
- Environmentally friendly barrier systems, such as silt nets or, in severe cases, use trenches downstream from construction sites to limit erosion and possibly trap contaminated runoff from construction;
- Storm water must be diverted from construction activities and managed in such a manner to disperse runoff and prevent the concentration of storm water flow;
- Water used at construction sites should be utilised in such a manner that it is kept on site and not allowed to run freely into nearby watercourses;
- Construction chemicals, such as hydrocarbons, should be used in an environmentally safe manner with correct storage as per each chemical's specific storage descriptions;



- All vehicles must be frequently inspected for leaks. Any vehicle maintenance or repairs must be done off-site in a designated and bunded area;
- No material may be dumped or stockpiled within any rivers or drainage lines in the vicinity of the proposed Project; and
- All waste must be separated according to type, removed and transported to appropriate waste facilities.

### 7.2.1.3. Impact Ratings

Table 7-3 presents the impact ratings associated with land and vegetation clearing impacts predicted for the opencast pit, construction of a road and bridge crossing. Table 7-4 Presents the impact ratings associated with the construction of the bridge crossing. It must be noted that the ratings have been determined based on the observations during the survey.

**Table 7-3: Impact assessment ratings for the road construction**

Dimension	Rating	Motivation	Significance
<b>Activity and Interaction:</b> Site clearance and construction of proposed infrastructure in proximity to the watercourses.			
<b>Impact Description:</b> Sedimentation and water quality deterioration			
<b>Prior to Mitigation/Management</b>			
<b>Duration</b>	Project life (5)	Once vegetation is cleared for infrastructure, no revegetation will occur until project closure.	Minor (negative) – 36
<b>Extent</b>	Local (3)	Based on the distance between the proposed road and the Steenkoolspruit, the extent of the impact is expected to extend to the immediate surroundings.	
<b>Intensity x type of impact</b>	Moderately high - Negative (-4)	During periods of high rainfall, runoff from the road construction will impact on the biophysical characteristics within the Steenkoolspruit.	
<b>Probability</b>	Unlikely (3)	Based on the distance between the proposed road and the Steenkoolspruit, Biological and physical resources within the Steenkoolspruit are only expected to be impacted during periods of high rainfall.	
<b>Nature</b>	Negative		
<b>Post-Mitigation</b>			

Dimension	Rating	Motivation	Significance
<b>Duration</b>	Project Life (5)	Once vegetation is cleared for infrastructure, no revegetation will occur until the closure phase of the Project or removal of the infrastructure.	Negligible (negative) – 27
<b>Extent</b>	Limited (2)	Following mitigation actions and if high rainfall periods are avoided for construction, impacts will be limited to immediate surroundings.	
<b>Intensity x type of impact</b>	Minor - Negative (-2)	If mitigation measures are all incorporated for the road construction, the intensity of the impact should be low.	
<b>Probability</b>	Unlikely (3)	The likelihood of the impact occurring at the Steenkoolspruit and surrounding watercourses is reduced by the mitigation actions and should only result in extreme cases or unexpected rainfall events.	
<b>Nature</b>	Negative		

**Table 7-4: Impact assessment ratings for the bridge construction**

Dimension	Rating	Motivation	Significance
<b>Activity and Interaction:</b> Construction of the proposed bridge over the Steenkoolspruit.			
<b>Impact Description:</b> Sedimentation and water quality deterioration			
<b>Prior to Mitigation/Management</b>			
<b>Duration</b>	Project life (5)	Once vegetation is cleared for infrastructure, no revegetation will occur until project closure.	Major (negative) – 112
<b>Extent</b>	Catchment (4)	The bridge construction will have a direct impact on the biophysical characteristics of the Steenkoolspruit and downstream reaches, potentially extending to the larger catchment area.	

Dimension	Rating	Motivation	Significance
Intensity x type of impact	Extremely high - Negative (-7)	The construction of the bridge is expected to impact on the immediate riparian and instream areas, affecting biological and physical resources within the Steenkoolspruit and downstream reaches.	
Probability	Definite (7)	Due to the proximity of the proposed bridge construction to the Steenkoolspruit, the impact is definite.	
Nature	Negative		
Post-Mitigation			
Duration	Project Life (5)	Once vegetation is cleared for infrastructure, no revegetation will occur until the closure phase of the Project or removal of the infrastructure.	Moderate (negative) – 105
Extent	Catchment (4)	Construction of the bridge will Impact on the Steenkoolspruit and further downstream reaches.	
Intensity x type of impact	Very high - Negative (-6)	If periods of high rainfall are prevented, the extent to which the impacts stretch further downstream will be slightly reduced.	
Probability	Definite (7)	Due to the proximity of the proposed bridge construction to the Steenkoolspruit, the impact is definite.	
Nature	Negative		

### 7.3. Operational Phase

Activities during the Operational Phase that may have potential impacts on the aquatic ecosystems are described in Table 7-5 below.

**Table 7-5: Interactions and Impacts of Activity**

Interaction	Impact
Increased runoff due to bare surfaces	<ul style="list-style-type: none"> <li>• Increase in flow rates, sediment input, erosion and contaminants in the associated watercourses</li> </ul>



Interaction	Impact
Uncontrolled runoff of process water from operational areas	<ul style="list-style-type: none"> <li>Alteration of the physio-chemistry of water, deterring water quality sensitive biota.</li> </ul>

### 7.3.1. Impact Description

#### Water Quality and Habitat Deterioration Associated with Runoff, Seepage and Leaks from the Operational Areas of the Project

Like the impacts described for the Construction Phase, runoff from the mining areas and seepage/leaks has the potential to increase flow rates, sediment input, erosion and contaminants in the associated watercourses. These influences will directly impact on water quality and aquatic habitat which in turn will negatively affect the aquatic biota.

Stormwater and water used on site (e.g. dirty water and process water) has the potential to directly alter habitat and the morphology of the receiving aquatic ecosystems if allowed to flow freely from the MRA (e.g. through sedimentation). Uncontrolled runoff also has the potential to alter water chemistry and degrade water quality of the affected systems by collecting contaminants as it drains across the associated landscapes. This will consequently affect the aquatic ecology and water quality.

#### 7.3.1.1. Management Objectives

Water should not be allowed to flow freely from the operational areas. As proposed, dirty water or water runoff from mine related infrastructure should be controlled and utilised as intended.

#### 7.3.1.2. Management Actions

The following management actions are recommended to guide the effective management of stormwater and water generated on site:

- Runoff should not be allowed to flow into the nearby watercourses, unless the Department of Water and Sanitation (DWS) authorises discharge and compliance with relevant discharge standards, as stipulated in the NWA, is maintained;
- Channelled water should not be dispersed in a concentrated manner. Baffles should be incorporated into artificial drainage lines/channels around the surface infrastructure to decrease the kinetic energy of water, as it flows into the natural environment;
- Bare surfaces downstream from the Project Area where silt traps are not an option should be vegetated to limit erosion and runoff that might be carrying contaminants;
- Careful monitoring of the areas where dust suppression is proposed should be undertaken regularly. Areas concentrating water runoff should be addressed and not allowed to flow freely into associated watercourses; and

- Monitoring of the associated water courses should be done by an aquatic specialist to determine potential impacts, where after new mitigation actions should be implemented, as per the specialist's recommendations.

### 7.3.1.3. Impact Ratings

Table 7-6 presents the impact ratings determined for the potential runoff, seepage and leaks from the proposed infrastructure and associated activities.

**Table 7-6: Impact Assessment Ratings for the Operational Phase**

Dimension	Rating	Motivation	Significance
<b>Activity and Interaction:</b> Uncontrolled runoff of stormwater or process water from or through the surface infrastructure			
<b>Impact Description:</b> Water quality and habitat deterioration of watercourses receiving unnatural/contaminated runoff			
<b>Prior to Mitigation/Management</b>			
<b>Duration</b>	Project Life (5)	It is predicted that contaminant input will continue throughout the life of the Project whenever rainfall events occur.	Minor (negative) – 65
<b>Extent</b>	Local (3)	Due to the impacts that the surrounding mining activities have on the catchment, impacts associated with the proposed Project are expected to significantly impact on the local surroundings only	
<b>Intensity x type of impact</b>	High - Negative (-5)	Runoff, seepage and or leakage into watercourses is expected to impact functioning of the aquatic ecosystems.	
<b>Probability</b>	Likely (5)	The impact is likely to occur throughout the life of the Project but limited due to periodic rainfall events.	
<b>Nature</b>	Negative		
<b>Post-Mitigation</b>			
<b>Duration</b>	Project Life (5)	Runoff will continue throughout the Project life.	Negligible (negative) – 21
<b>Extent</b>	Very limited (1)	Runoff will most likely be largely restricted and captured after mitigation.	

Dimension	Rating	Motivation	Significance
<b>Intensity x type of impact</b>	Minimal to no loss - Negative (-1)	If mitigation measures are all incorporated for the Project, the intensity of the impact should decrease. However, contaminants are more difficult to manage compared to solid particles and may enter associated aquatic systems resulting in water quality deterioration.	
<b>Probability</b>	Unlikely (3)	The likelihood of the impact occurring is reduced by the mitigation actions and should only result in extreme rainfall events or if mitigation structures aren't maintained.	
<b>Nature</b>	Negative		

#### 7.4. Closure, Decommissioning and Rehabilitation Phase

This phase entails removal of mine related infrastructure, as well as rehabilitation of potentially affected areas and aquatic ecosystems, including some level of landscaping to avoid pooling and changes to catchment drainage patterns.

Activities during the Closure, Decommissioning and Rehabilitation Phase that may have potential impacts on the aquatic ecosystems are described in Table 7-7 below.

**Table 7-7: Interactions and Impacts of Activity**

Interaction	Impact
Backfilling of the pit.	<ul style="list-style-type: none"> <li>Potential mobilisation of pollutants entering the associated watercourses during hauling of backfilling material; and</li> <li>Alteration of the physio-chemistry of water, deterring water quality sensitive biota.</li> </ul>
Decant of Acid Mine Drainage.	<ul style="list-style-type: none"> <li>Deterioration in water chemistry and ecological condition.</li> </ul>

##### 7.4.1.1. Management Objectives

The main management objective should be to restore any affected areas to natural/reference conditions as far as possible without resulting in additional downstream impacts throughout the process.



#### 7.4.1.2. Management Actions

The goal of mitigation should be to treat AMD and limit erosion and runoff from the footprint of the areas/infrastructure during decommissioning as well as during rehabilitation. The following measures may be utilised in attempt to reduce the decommissioning impacts:

- Treat AMD before discharging into watercourses (refer to the Surface Water Impact Assessment Report for detailed information);
- High rainfall periods should be avoided during decommissioning;
- Removed or damaged vegetation areas should be revegetated;
- Storm water must be diverted from decommissioning activities;
- Water used during decommissioning should be kept onsite and not be allowed to freely flow into nearby watercourses; and
- Ensure the revegetation activities use appropriate indigenous plant species.

#### 7.4.1.3. Impact Ratings

The impact rating associated with activities related to the backfilling of the pit and rehabilitation of potentially affected areas have been predicted in Table 7-8 below.

**Table 7-8: Impact assessment ratings for the Decommissioning/Rehabilitation Phase**

Dimension	Rating	Motivation	Significance
<b>Activity and Interaction:</b> Backfilling of the pit and associated activities near and within drainage lines			
<b>Impact Description:</b> Water quality and habitat deterioration of watercourses in contact with heavy machinery and receiving runoff and decant from surface workings			
<b>Prior to Mitigation/Management</b>			
<b>Duration</b>	Beyond project life (6)	Impacts associated with decanting and AMD will occur beyond the project life.	Moderate (negative) – 90
<b>Extent</b>	Catchment (4)	Based on the proximity of the proposed Project to the Steenkoolspruit, the extent of runoff and decant is expected to extend to the respective catchment.	
<b>Intensity x type of impact</b>	High - Negative (-5)	Runoff into watercourses is expected to result in erosion, increased sedimentation and contamination impacting functioning of the aquatic ecosystems.	

Dimension	Rating	Motivation	Significance
Probability	Highly likely (6)	The impact is highly likely to occur throughout the Decommissioning Phase and beyond.	
Nature	Negative		
Post-Mitigation			
Duration	Medium Term (3)	Impacts will persist throughout the Decommissioning Phase until rehabilitation activities are complete.	Negligible (negative) – 15
Extent	Very limited (1)	If mitigation measures are adhered to and decant is treated for AMD, runoff is expected to be restricted to the mitigation structures.	
Intensity x type of impact	Minimal to no loss - Negative (-1)	If mitigation measures are all incorporated for the Project, the intensity of the impact should decrease notably especially after rehabilitation.	
Probability	Unlikely (3)	The likelihood of the impact occurring is reduced by the mitigation actions and should only result in extreme rainfall events or if mitigation structures aren't maintained.	
Nature	Negative		

## 7.5. Cumulative Impacts

The Project Area lies downstream of the Rietspruit Dam within a watershed draining the Steenkoolspruit catchment flanked by agriculture fields, mining and the upstream Reedstream Park residential area. Consequently, current activities (including water abstraction, vegetation removal, exotic vegetation encroachment and mine runoff, effluent amongst others) already appear to potentially impact on the identified aquatic ecosystems.

It is suspected that additional impacts associated with the proposed Project will not significantly contribute towards any notable changes to the ecological integrity of the Steenkoolspruit and associated watercourses, especially following the implementation of proposed mitigation measures.

## 7.6. Unplanned and Low Risk Events

There is a risk that watercourses associated with the proposed Project operations and infrastructure throughout the Project life might be affected by the entry of hazardous substances, such as hydrocarbons. Spillage and/or accidents, or deterioration of structures

along the roadways might affect the habitat and water quality of associated aquatic ecosystems.

Therefore, Table 7-9 outlines mitigation measures that must be adopted in the event of unplanned impacts throughout the life of the Project.

**Table 7-9: Unplanned events and Associated Mitigation Measures**

Unplanned Risk	Mitigation Measures
Chemical and (or) contaminant spills from machinery and associated activities.	<p>Ensure correct storage of all chemicals at operations as per each chemical's specific storage requirements (e.g. Material Safety Data Sheets);</p> <p>Ensure staff involved at the proposed developments have been trained to correctly work with chemicals at the sites; and</p> <p>Ensure spill kits (e.g. Drizit) are readily available at areas where chemicals are known to be used. Staff must also receive appropriate training in the event of a spill, especially near watercourses/drainage lines.</p>

## 8. Environmental Management Plan

This section provides a summary of the proposed project activities, environmental aspects and impacts on the receiving surface waterbodies. The frequency of mitigation, timing of implementation, the roles and responsibilities of persons implementing the EMP are summarized (Table 8-1).



**Table 8-1: Environmental Management Plan**

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
<ul style="list-style-type: none"> <li>Site clearing;</li> <li>Access and haul road construction;</li> <li>Construction of a bridge;</li> <li>Topsoil stockpiling; and</li> <li>Loading, transport, tipping and spreading of materials.</li> </ul>	<ul style="list-style-type: none"> <li>Siltation of water resources due to increased turbidity from dust and soil erosion; and</li> <li>Water contamination due to leaks or spills of hazardous and hydrocarbon containing material</li> </ul>	Aquatic Biodiversity	Construction	<ul style="list-style-type: none"> <li>Clearing of vegetation must be limited to the development footprint, and the use of any existing access roads must be prioritised to minimise creation of new ones;</li> <li>If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments, dust generation and hazardous substances from construction vehicles used during site clearing;</li> <li>Hydrocarbon and hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;</li> <li>Vehicles should regularly be maintained as per the developed maintenance program. This should also be inspected daily before use to ensure there are no leakages underneath;</li> <li>Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited contractors; and</li> <li>Implementation of the proposed stormwater management plan including installation of drains, berms and storage structures.</li> </ul>	<p><i>Modify</i> through construction site planning</p> <p><i>Control</i> through stormwater management and sediment containment infrastructure.</p>	During the construction and operational phase

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
<ul style="list-style-type: none"> <li>Stockpiling;</li> <li>Movement of vehicles and mine machinery; and</li> <li>Storage, handling and treatment of hazardous products (including fuel and oil) and waste</li> </ul>	<ul style="list-style-type: none"> <li>Siltation of water resources due to increased turbidity from dust and soil erosion; and</li> <li>Water contamination due to leaks or spills of hazardous and hydrocarbon containing material.</li> </ul>	Aquatic Biodiversity	Operational	<ul style="list-style-type: none"> <li>The aquatic biomonitoring programme provided in this report should be adhered to for monitoring water resources within and in close proximity to the Project Area to allow detection of any contamination arising from operational activities;</li> <li>The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to appropriate disposal sites;</li> <li>The overall housekeeping and storm water management system (including the maintenance of berms and clean-up of leaks) must be maintained throughout the LOM; and</li> <li>The hydrocarbon and chemical storage areas and facilities must be located on hard-standing area (paved or concrete surface that is impermeable). This will prevent mobilisation of leaked hazardous substances;</li> <li>Training of mine personnel and contractors in proper hydrocarbon and chemical waste handling procedures is recommended;</li> <li>Vehicles must only be serviced within designated service bays;</li> </ul>	Control through Implementation of the proposed stormwater management plan	During the construction and operational phase

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
<ul style="list-style-type: none"> <li>Backfilling of the pit;</li> <li>Rehabilitation and closure.</li> </ul>	<ul style="list-style-type: none"> <li>Siltation of water resources due to increased turbidity from soil erosion;</li> <li>Restoration of the pre-mining streamflow regime</li> </ul>	Aquatic Biodiversity	Decommissioning	<ul style="list-style-type: none"> <li>Restore the topography to pre-mining conditions as much as is practically possible by backfilling, removing stockpiles and restore the slope gradient and angle of the site;</li> <li>Clearing of vegetation should be limited to the decommissioning footprint area and immediate revegetation of cleared areas;</li> <li>Decommissioning activities should be prioritized during dry months of the year where practical;</li> <li>Disturbance of soils during infrastructure demolition should be restricted to relevant footprint areas;</li> <li>Movement of machinery and vehicles should be restricted to designated access roads to minimise the extent of soil disturbance;</li> <li>Use of accredited contractors for removal of infrastructure during decommissioning is recommended; this will reduce the risk of waste generation and accidental spillages; and</li> <li>The groundwater levels should be taken into account during excavations to minimize potential impact of groundwater quality.</li> </ul>	Storm water management: prevent contamination of receiving waterbodies by controlling storm water/surface runoff and strategic decommissioning to minimize on potential environmental impacts	During the decommissioning phase And post-decommissioning phase



## 9. Monitoring Programme

An aquatic biomonitoring programme has been developed for the monitoring and preservation of the aquatic ecosystems assessed for the Project. This programme is aimed at better determining the ecological health of the ecosystems, as well as to act as an early detection tool for impacts that might severely affect the expected aquatic biota in the associated riverine systems.

Table 9-1 outlines the aquatic monitoring methods to be undertaken at the monitoring points set out above (see section 4.7) – with the exception of sites NC1 and NC4 – on an annual basis by a suitably-qualified aquatic ecologist. It is recommended that Site NC1 is removed from the monitoring programme due to its distance from the proposed project location (~7 km) and Site NC4 is positioned downstream of a mined area. The annual programme comprises of a single survey during the dry season (or low flow season) for the Project Area and a single survey during the wet season (or high flow) at the monitoring points indicated. This will determine the PES for the assessed aquatic ecosystems which will further determine whether the proposed Project is impacting the associated aquatic ecology and to what extent.

**Table 9-1: Biomonitoring Programme**

Monitoring Element	Comment	Frequency	Responsibility
<b>Water Quality:</b> <i>In situ</i> water testing focusing on temperature, pH, conductivity and oxygen content.	No noticeable change from determined baseline water quality for each respective season. Nutrient concentrations must be improved to prevent deterioration of the ecological conditions. Salt Concentrations must be maintained at levels where they do not render the ecosystem unsustainable.	Water quality should be tested on a biannual basis at each monitoring site to determine the extent of change from baseline results.	Aquatic Ecologist (SASS-accredited)
<b>Habitat Quality:</b> Instream and riparian habitat integrity; and Availability/suitability of macroinvertebrate habitat at each monitoring site.	The application of the IHI should be done for the Steenkoolspruit system. The IHAS must be applied at each monitoring site prior to sampling.	Habitat quality should be assessed on a biannual basis	

Monitoring Element	Comment	Frequency	Responsibility
	The Ecological Category determined for each assessed site must be in a largely modified or better conditions to support the ecosystem.		
<b>Aquatic Macroinvertebrates:</b>  Aquatic Macroinvertebrate assemblages must be assessed biannually.	This must be done through the application of the latest SASS, incorporated with the application of the MIRAI as outlined in this Aquatic Study.  The baseline SASS5 scores should not noticeably deteriorate.  Baseline Ecological Categories should not be allowed to drop in category for each assessed site.	The latest version of the SASS should be conducted on a biannual basis.	
<b>Fish:</b>  Fish assemblages must be assessed biannually	Sampling of fish must be undertaken by utilising various methods such as cast nets or by means of a boat in addition to the standard electro-narcosis techniques for the inaccessible deeper sites.  Baseline Ecological Categories should not be allowed to drop in category for each assessed site.	Sampling of fish communities should be undertaken on a biannual basis	
<b>Integrated EcoStatus Determination</b>	The EcoStatus is defined as: <i>"The totality of the features and characteristics of the river and its riparian areas that bear upon its</i>	The Integrated EcoStatus should be determined upon completion of the biannual aquatic surveys.	

Monitoring Element	Comment	Frequency	Responsibility
	<p><i>ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services" (Iversen et al., 2000).</i></p> <p>The Ecological Category for each assessed river reach should not deteriorate from the Resource Quality Objectives of the Olifants Catchment</p>		
*REC = Recommended Ecological Category			

The Project should not commence without inclusion of the above Aquatic Biomonitoring Programme.

## 10. Conclusion

The current Aquatic Ecology Impact Assessment report forms part of the required specialist studies to support the Environmental Application for the proposed NCC opencast mine in the Nkangala Magisterial District of the Mpumalanga Province. The main aquatic ecosystems of focus in the Aquatic Study were the Rietspruit, which flows in the north west direction along the south west boundary of the proposed Project and the Steenkoolspruit which flows northwards along the east and north of the proposed Project.

Conclusions from the findings of the aquatic survey undertaken in May 2021 (high-flow season) are as follows: amongst the water quality results, temperature values were recorded within typical summer season temperatures in South Africa. The pH values recorded exhibited close to neutral to slightly alkaline conditions with two of the four assessed sites exceeding the recommended guideline, i.e. the site located upstream of the proposed Project and the site located downstream along the Steenkoolspruit. The recorded alkaline pH was likely attributed to the surrounding agriculture land uses. Conductivity values were recorded above the recommended guideline at all the sites except at a downstream site along the Steenkoolspruit. A site lying below a wetland recorded the highest conductivity suspected to be attributed to a cumulation of impacts stemming from the surrounding land use activities. The dissolved oxygen concentration levels exceeded the recommended guideline at all sites, however the dissolved oxygen saturation levels were recorded below the recommended guideline at three of the four sites. Most of the sampled sites were largely sedimented, smothering the substrates of the sites. The least clear (or most turbid) water was that of the upstream Rietspruit site which is located downstream of intensive mining areas and agriculture fields, thus the turbidity at this site was likely attributed to associated land uses such as the

clearing of vegetation leading to soil erosion. The water at Site NC4 was the most clear (or least turbid) however, a thick layer of sediments had settled at the bottom and only re-suspended when disturbed. The recorded *in situ* water quality was determined to be modified however was not expected to significantly impact on inhabiting indigenous aquatic biota. Only biota that are sensitive to high sediment loads (such as those that utilize gills for respiration) and those with high requirements for unmodified water quality may be deterred from colonising the sites. The extreme conductivity level recorded at a channel lying below a wetland was however of potential concern and likely deterred aquatic biota from colonising the site, inhabiting biota at this site were probably adapted to escalated conductivity levels.

The findings from the Index for Habitat Integrity assessments indicated that the habitat integrity along the assessed Rietspruit reach was *Largely Modified* (Ecological Category D) for the instream component and *Moderately Modified* (Ecological Category C) for the riparian component. Major impacts of the instream habitat were bed modification and the dominance of exotic fauna. At the assessed Steenkoolspruit reach, both instream and riparian components were determined to be in *Largely Modified* (Ecological Category D) conditions. Similarly to the assessed Rietspruit reach, bed modification due to high sediment loads and the dominance of alien-invasive fauna were the major impacts of the instream habitat, whilst the removal of indigenous vegetation leading to the dominance of Bankrupt Bush (*Seriphium plumosum*) were the major impact of the riparian habitat.

The availability and integrity of aquatic macroinvertebrate biotopes were predominantly *Poor* across the sampled river reaches, only the upstream Site NC1 was determined to be in a *Good* state. The sampled systems were dominated by deep, slow to moderately flowing water and generally lacked the stones biotope. Marginal vegetation and sand were the common features throughout the sites. At the upstream Rietspruit site however, aquatic/marginal vegetation and the gravel/sand/mud (GSM) biotopes were in high abundance and occurred in varying water depth and flow classes. Similarly, the results of the South African Scoring System version 5 (SASS5) and Macroinvertebrate Response Assessment Index (MIRAI) indicate that conditions at the sampled reaches ranged between *Seriously Modified* (Ecological Category E) and *Largely Modified* (Ecological Category D) with macroinvertebrate community assemblages largely composed of taxa that have “Low” water quality requirements.

Results of the fish community assessment indicated that the sampled River Reaches ranged from *Seriously to Critically Modified* (Ecological Category E) to *Largely Modified* condition (Ecological Category E). A total of five fish species were collected (or observed), two of which were regarded as alien invasive species (*Gambusia affinis* and *Micropterus salmoides*). Of the three collected indigenous fish species, two are known to be tolerant to water quality modifications (*Pseudocrenilabrus philander* and *Tilapia sparrmanii*) whilst one (*Enteromius paludinosus*) is intolerant. Only the invasive *G. affinis* was sampled at the Rietspruit reach whilst all five species were collected along the Steenkoolspruit reaches.

The ecological states represented by the response indicators (aquatic macroinvertebrates and fish) appeared to be linked to modified water quality and not habitat at the upstream Rietspruit site, whilst those of the Steenkoolspruit sites appeared to be linked to modified water quality and habitat.



Following integration of the defined ecological conditions obtained for the instream biological integrity and the riparian component, it was determined that all assessed sites represented an integrated EcoStatus of *Largely Modified* (Ecological Category D).

## 11. Impact Assessment and Mitigation Measures

During the Construction Phase, potential impacts on aquatic ecosystems include increased surface runoff, erosion and water quality deterioration due to an increase in bare surfaces. These impacts were determined to be *Minor* during construction of the road/pit establishment and *Negligible* upon adequate implementation of mitigation measures; *Major* for the construction of the bridge crossing at the Steenkoolspruit and moderate upon adequate implementation of mitigation measures that limit areas proposed for soil disturbance and vegetation clearing.

Similarly to the Construction Phase, potential impacts during the Operational phase include runoff from the mining areas, erosion, sediment input and leaks. Thus these impacts were determined to be *Minor* and *Negligible* upon adequate implementation of mitigation measures that control the flow of water from operational areas.

During the Closure, Decommissioning and Rehabilitation phase, potential impacts on the watercourses include contamination as a result of the pit backfilling and AMD. Thus the overall impact was determined to be *Moderate* and *Negligible* upon adequate implementation of mitigation measures aimed at controlling runoff from the footprint of the mine areas and to neutralise and treat AMD.

An aquatic biomonitoring programme has been provided for the monitoring and preservation of the aquatic ecosystems associated with the proposed Project. This programme is aimed at better determining the ecological health of the ecosystems as well as to act as an early detection tool for impacts that might significantly affect aquatic biota.

## 12. Reasoned Opinion Whether Project Should Proceed

In light of the Seriously Modified and Largely Modified Present Ecological States at the Rietspruit and Steenkoolspruit systems under study, highlighted foreseeable negative impacts are likely to exacerbate the ecological states. Furthermore, impacts of the proposed Project onto the associated water courses are predicted to be *Negligible* upon implementation of mitigation measures.

No notable fatal flaws were identified during the current study, thus the proposed Project may proceed with the restriction that mitigation measures and the aquatic biomonitoring programme are implemented throughout the operation and Decommissioning phases to ensure no deterioration of the associated watercourses occur.

## 13. Recommendations

Based on the results of the current study, the following recommendations are proposed:

- The depth of the Steenkoolspruit presents challenges in sampling the instream habitat, therefore, whole effluent toxicity assessments should be undertaken to provide a better indication of the PES and determine the potential drivers of change;
- Sites NC1 and NC4 should be excluded from the monitoring programme due to the distance from the proposed project location and existing associated impacts. These sites were sampled due to their ease of accessibility. Additional sites, upstream and downstream of the proposed project location should be sampled along the Steenkoolspruit to provide better representation of the biophysical integrity of the River; and
- The developed Aquatic Biomonitoring Programme must be adopted on an annual basis after commencement of the Establishment Phase of the Project. This programme should continue for the life of the Project and for at least three years post the Decommissioning Phase.

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## Appendix A: Baseline and EIA Methodology

## Baseline Methodology

Descriptions of the various approaches for the determination of the aquatic ecology baseline are detailed in the respective sections below.

## Water Quality

Selected *in-situ* water quality variables were measured at each of the sampling sites using water quality meters manufactured by Extech Instruments, namely an ExStik EC500 Combination Meter and an ExStik DO600 Dissolved Oxygen Meter. Temperature, pH, electrical conductivity and dissolved oxygen were recorded prior to sampling, while the time of day at which the measurements were assessed was also noted for interpretation purposes.

## Habitat Quality

The availability and diversity of aquatic habitat is important to consider in assessments due to the reliance and adaptations of aquatic biota to specific habitats types (Barbour *et al.*, 1996). Habitat quality and availability assessments are usually conducted alongside biological assessments that utilise fish and macroinvertebrates. Aquatic habitat will be assessed through visual observations on each river system considered.

## Index for Habitat Integrity

The IHI (Version 2, Kleynhans, C.J., pers. comm., 2015) aims to assess the number and severity of anthropogenic perturbations along a river/stream/wetland and the potential inflictions of damage toward the habitat integrity of the system (Dallas, 2005). Various abiotic (e.g. water abstraction, weirs, dams, pollution, dumping of rubble, etc.) and biotic (e.g. presence of alien plants and animals, etc.) factors are assessed, which represent some of the most important and easily quantifiable, anthropogenic impacts upon the system (Table 14-1).

As per the original IHI approach (Kleynhans, 1996), the instream and riparian components were each analysed separately to yield two separate ecological conditions (i.e. Instream and Riparian components). However, it should be noted that the data for the riparian area is primarily interpreted in terms of the potential impact upon the instream component and as a result, may be skewed by a potentially deteriorated instream condition.

While the recently upgraded index (i.e. IHI-96-2; Dr. C. J. Kleynhans, pers. comm., 2015) replaces the aforementioned comprehensive and expensive IHI assessment model developed by Kleynhans (1996), it is important to note that the IHI-96-2 does not replace the IHI model developed by Kleynhans *et al.* (2008a) which is recommended in instances where an abundance of data is available (e.g. intermediate and comprehensive Reserve Determinations). Accordingly, the IHI-96-2 model is typically applied in cases where a relatively few numbers of river reaches need to be assessed, the budget and time provisions are limited, and/or any detailed available information is lacking (i.e. rapid Reserve Determinations and for REMP/RHP purposes).

**Table 14-1: Descriptions of criteria used to assess habitat integrity (Kleynhans, 1996; cited in Dallas, 2005)**

Factors	Relevance
Water abstraction	Direct impact upon habitat type, abundance and size. Also impacted 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 the 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 sources. Measured directly, or 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.
Alien/Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Alien/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.
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. Allochthonous 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 riverbank 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.

In accordance with the magnitude of the impact created by the abovementioned criterion, the assessment of the severity of the modifications was based on six descriptive categories



ranging between a rating of 0 (no impact), 1 to 5 (small impact), 6 to 10 (moderate impact), 11 to 15 (large impact), 16 to 20 (serious impact) and 21 to 25 (critical impact; Table 14-2). Based on available knowledge of the site and/or adjacent catchment, a confidence level (high, medium, low) was assigned to each of the scored metrics.

Given the subjective nature of the scoring procedure utilised within the general approach to habitat integrity assessment (including IHI-96-2; see Appendix A), the most recent version of the IHI application (Kleynhans *et al.*, 2008) and the Model Photo Guides (Graham & Louw, 2008) were used to calibrate the severity of the scoring system. It should be noted that the assessment was limited to observed and/or suspected impacts present within the immediate vicinity of the delineated assessment units, as determined through the use of aerial photography (e.g. Google Earth) and observations made at each of the assessed sampling points during the field survey. However, in cases where major upstream impacts (e.g. construction of a dam, major water abstraction, etc.) were confirmed, potential impacts within relevant sections were considered and accounted for within the application of the method.

**Table 14-2: Descriptive of scoring guidelines for the assessment of modifications to habitat integrity**

Impact Category	Description	Score
None	No discernible impact or the factor 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 a very few localities and the impact on habitat quality, diversity, size and variability is also very small.	1 - 5
Moderate	The modification is present at a small number of localities and the impact on habitat quality, diversity, size and variability is 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 of almost the whole of the defined section are affected. Only small areas are not influenced.	16 - 20
Critical	The modification is present overall with a high intensity; the habitat quality, diversity, size and variability in almost the whole of the defined section are detrimentally influenced.	21 - 25

Each of the allocated scores was then moderated by a weighting system (Table 14-3), which is based on the relative threat of the impact to the habitat integrity of the riverine system. The total score for each impact is equal to the assigned score multiplied by the weight of that impact. The estimated impacts (assigned score / maximum score [25] X allocated weighting) of all criteria are then summed together, expressed as a percentage and then subtracted from 100 to determine the Present Ecological State score (PES; or Ecological Category) for the instream and riparian components, respectively.

**Table 14-3: Criteria and weightings used to assess habitat integrity**

<b>Instream Criteria</b>	<b>Weight</b>	<b>Riparian Zone Criteria</b>	<b>Weight</b>
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality modification	14	Water abstraction	13
Inundation	10	Inundation	11
Alien/Exotic macrophytes	9	Flow modification	12
Alien/Exotic aquatic fauna	8	Water quality	13
Solid waste disposal	6		
<b>TOTAL</b>	<b>100</b>	<b>TOTAL</b>	<b>100</b>

However, in cases where selected instream component criteria (i.e. water abstraction, flow, bed and channel modification, water quality and inundation) and/or any of the riparian component criteria exceeded ratings of large, serious or critical, an additional negative weight was applied. The aim of this is to accommodate the possible cumulative effect (and integrated) negative effects of such impacts (Kemper, 1999). The following rules were applied in this respect:

- Impact = Large, lower the integrity status by 33% of the weight for each criterion with such a rating.
- Impact = Serious, lower the integrity status by 67% of the weight for each criterion with such a rating.
- Impact = Critical, lower the integrity status by 100% of the weight for each criterion with such a rating.

Subsequently, the negative weights were added for both facets of the assessment and the total additional negative weight subtracted from the provisionally determined integrity to arrive at a final habitat integrity estimate (Kemper, 1999). The eventual total scores for the instream and riparian zone components are then used to place the habitat integrity in a specific habitat integrity ecological category (

Table 14-4).

**Table 14-4: Ecological Categories for the habitat integrity scores**

<b>Ecological Category</b>	<b>Description</b>	<b>Score (% of Total)</b>
<b>A</b>	Unmodified, natural.	90 - 100

Ecological Category	Description	Score (% of Total)
<b>B</b>	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80 - 89
<b>C</b>	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
<b>D</b>	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
<b>E</b>	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
<b>F</b>	Modifications have reached a critical level and there has been an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

## Aquatic Invertebrate Assessment

### Integrated Habitat Assessment System

Assessment of the available habitat for aquatic macroinvertebrate colonization at each of the sampling sites is vital for the correct interpretation of results obtained following biological assessments. It should be noted that the available methods for determining habitat quality are not specific to rapid biomonitoring assessments and are inherently too variable in their approach to achieve consistency amongst users.

Nevertheless, the Invertebrate Habitat Assessment System (IHAS) has routinely been used in conjunction with the South African Scoring System, Version 5 (SASS5) as a measure of the variability of aquatic macroinvertebrate biotopes available at the time of the survey (McMillan, 1998). The scoring system was traditionally split into two sections, namely the sampling habitat (comprising 55% of the total score) and the general stream characteristics (comprising 45% of the total score), which were summed together to provide a percentage and then categorized according to the values in Table 14-5.

**Table 14-5: Adapted IHAS Scores and associated description of available aquatic macroinvertebrate habitat**

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

According to a study conducted within the Mpumalanga and Western Cape regions, the IHAS method does not produce reliable scores at assessed sampling sites, as its performance appears to vary between biotopes. However, the lack of reliability and evidence of notable variability within the application of the IHAS method has prompted further field validation and testing, which implies a cautious interpretation of results obtained until these studies have been conducted (Ollis *et al.*, 2006). In the interim and for the purpose of this assessment, the IHAS method was adapted by excluding the assessment of the aforementioned '*general stream characteristics*,' which resulted in the calculation of a percentage score out of 55 that was then categorised by the aforementioned Table 14-5. Consequently, the assessment index describes the quantity, quality and diversity of available macroinvertebrate habitat relative to an "ideal" diversity of available habitat.

### South African Scoring System Version 5 (SASS5)

While there are a number of indicator organisms that are used within these assessment indices, there is a general consensus that benthic macroinvertebrates are amongst the most sensitive components of the aquatic ecosystem. This was further supported by their largely non-mobile (or limited mobility) within reaches of associated watercourses, which also allows for the spatial analysis of disturbances potentially present within the adjacent catchment area. However, it should also be noted that their heterogeneous distribution within the water resource is a major limitation, as this results in spatial and temporal variability within the collected macroinvertebrate assemblages (Dallas & Day, 2004).

SASS5 is essentially a biological assessment index which determines the health of a river based on the aquatic macroinvertebrates collected on-site, whereby each taxon is allocated a score based on its perceived sensitivity/tolerance to environmental perturbations (Dallas, 1997). However, the method relies on a standardised sampling technique using a handheld net (300 mm x 300 mm, 1000 micron mesh size) within each of the various habitats available for standardised sampling times and/or areas. Niche habitats (or biotopes) sampled during SASS5 application include:

- Stones (both in-current and out-of-current);
- Vegetation (both aquatic and marginal); and
- Gravel, sand and mud.

Once collection is complete, aquatic macroinvertebrates are identified to family level and a number of assemblage-specific parameters are calculated including the total SASS5 score, the number of taxa collected, and the Average Score per Taxa i.e. SASS5 score divided by the total number of taxa identified (Thirion *et al.*, 1995); Davies and Day, 1998; (Dickens and Graham, 2002; Gerber and Gabriel, 2002). The SASS5 bio-assessment index has been proven to be an effective and efficient means to assess water quality impairment and general river health (Chutter, 1998; Dallas, 1997).

### Macroinvertebrate Response Assessment Index (MIRAI)



In order to determine the Present Ecological State (PES; or Ecological Category) of the aquatic macroinvertebrates collected/observed, the SASS5 data was used as a basic input (i.e. prevalence and abundance) into the recently improved MIRAI (Version 2, Thirion. C., *pers. comm.*, 2015). This biological index integrates the ecological requirements of the macroinvertebrate taxa in a community (or assemblage) and their respective responses to flow modification, habitat change, water quality impairment and/or seasonality (C. Thirion, 2008). The presence and abundance of the aquatic macroinvertebrates collected are compared to a derived reference list of families/taxa that are expected to be present under natural, un-impacted conditions (i.e. prior to the effect of anthropogenic activities). Consequently, the three (or four) aforementioned metric groups utilised during the application were combined within the model to derive the ecological condition of the site in terms of aquatic macroinvertebrates (Table 14-6).

**Table 14-6: Allocation protocol for the determination of the Present Ecological State for aquatic macroinvertebrates following application of the MIRAI**

MIRAI (%)	Ecological Category	Description
90-100	<b>A</b>	Unmodified and natural. Community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.
80-89	<b>B</b>	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.
60-79	<b>C</b>	Moderately modified. Community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
40-59	<b>D</b>	Largely modified. Fewer species present than expected due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
20-39	<b>E</b>	Seriously modified. Few species present due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
0-19	<b>F</b>	Critically modified. Few species present. Only tolerant species present, if any.

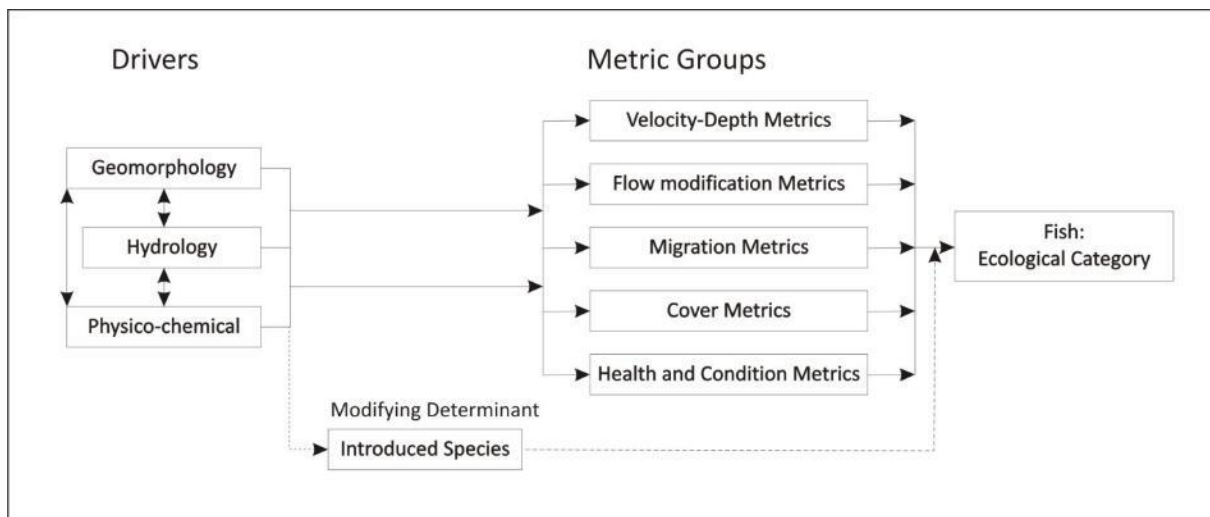
## Ichthyofaunal Assessment

Fish were collected by means of electro-narcosis (or electro-fishing), whereby an anode and a cathode are immersed in the water to temporarily stun fish in the near vicinity. Each of the collected fish specimens were identified in the field – using the “Complete Guide to the Freshwater Fishes of Southern Africa” (Skelton, 2001) – and released back into the river.

## Fish Response Assessment Index

Assessment of the Present Ecological State (PES; or Ecological Category) of the fish assemblage of the watercourses associated with the study area was conducted by means of the FRAI (Kleynhans, 2008). This procedure is an integration of ecological requirements of fish species in an assemblage and their derived (or observed) responses to modified habitat conditions. In the case of the present assessment, the observed response was determined by means of fish sampling, as well as a consideration of species requirements and driver changes (Kleynhans, 2008). The expected fish species assemblage within the study area was derived from (Kleynhans et al., 2008) and aquatic habitat sampled.

Although the FRAI uses essentially the same information as the Fish Assemblage Integrity Index (FAII), it does not follow the same procedure. The FAII was developed for application in the broad synoptic assessment required for the River Health Programme, and subsequently does not offer a particularly strong cause-and-effect basis. The purpose of the FRAI, on the other hand, is to provide a habitat-based cause-and-effect underpinning to interpret the deviation of the fish assemblage from the perceived reference condition (Kleynhans, 2008).



**Figure 14-1: Relationship between drivers and fish metric groups**

The FRAI is based on the assessment of selected metrics within metric groups, which are assessed in terms of:

- Habitat changes that are observed or derived;
- The impact of such habitat changes on species with particular preferences and tolerances; and
- The relationship between the drivers used in the FRAI and the various fish response metric groups, as are indicated in Figure 14-1. Table 14-7 provides the steps and procedures required for the calculation of the FRAI.

**Table 14-7: Main steps and procedures followed in calculating the Fish Response Assessment Index**

STEP	PROCEDURE
River section earmarked for assessment	As for study requirements and design
Determine reference fish assemblage: species and frequency of occurrence	<ul style="list-style-type: none"> <li>• Use historical data &amp; expert knowledge</li> <li>• Model: use ecoregional and other environmental information</li> <li>• Use expert fish reference frequency of occurrence database if available</li> </ul>
Determine present state for drivers	<ul style="list-style-type: none"> <li>• Hydrology</li> <li>• Physico-chemical</li> <li>• Geomorphology; or</li> <li>• Index of habitat integrity</li> </ul>
Select representative sampling sites	Field survey in combination with other survey activities
Determine fish habitat condition at site	<ul style="list-style-type: none"> <li>• Assess fish habitat potential</li> <li>• Assess fish habitat condition</li> </ul>
Representative fish sampling at site or in river section	<ul style="list-style-type: none"> <li>• Sample all velocity depth classes per site if feasible</li> <li>• Sample at least three stream sections per site</li> </ul>
Collate and analyse fish sampling data per site	Transform fish sampling data to frequency of occurrence ratings
Execute FRAI model	<ul style="list-style-type: none"> <li>• Rate the FRAI metrics in each metric group</li> <li>• Enter species reference frequency of occurrence data</li> <li>• Enter species observed frequency of occurrence data</li> <li>• Determine weights for the metric groups</li> <li>• Obtain FRAI value and category</li> <li>• Present both modelled FRAI &amp; adjusted FRAI.</li> </ul>

Interpretation of the FRAI score follows a descriptive procedure in which the FRAI score is classified into a particular PES (or Ecological Category) based on the aforementioned integrity classes (Kleynhans, 1999). Each category describes the generally expected conditions for a specific range of FRAI scores (Table 14-8).

**Table 14-8: Allocation protocol for the determination of the Present Ecological State (or Ecological Category) of the sampled/observed fish assemblage following application of the FRAI**

FRAI (%)	Ecological Category	Description
90-100	<b>A</b>	Unmodified and natural. Community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.
80-89	<b>B</b>	Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged.
60-79	<b>C</b>	Moderately modified. Community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.
40-59	<b>D</b>	Largely modified. Fewer species present than expected due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
20-39	<b>E</b>	Seriously modified. Few species present due to loss of most intolerant forms. An extensive loss of basic ecosystem function has occurred.
0-19	<b>F</b>	Critically modified. Few species present. Only tolerant species present, if any.

### EcoStatus4 1.02 Model

For the purpose of the present assessment, the latest ECOSTATUS4 1.02 model was used, which is an upgraded and refined version of the original ECOSTATUS4 model (Kleynhans & Louw, 2008). The results obtained from the fish and aquatic macroinvertebrate response indices (i.e. FRAI and MIRAI) are to be integrated within the model to determine an Instream Ecological Category, whereas the riparian elements from the IHI-96-2 model can be used as a surrogate for the Riparian Ecological Category in the following manner (Dr. C.J. Kleynhans, pers. comm., 2015):

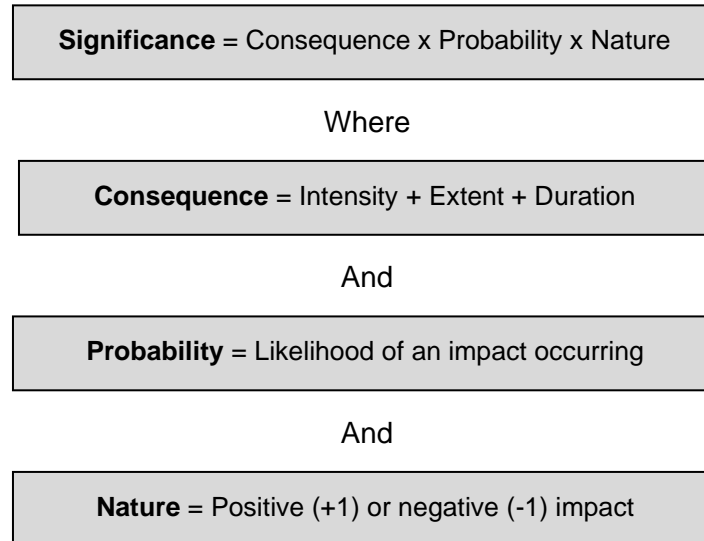
**Riparian Vegetation EC =  $100 - (((\text{IHI 'Natural vegetation removal'}) + (\text{IHI 'Exotic Vegetation Encroachment'})) / 50 * 100)$ .**



## Impact Assessment Methodology

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:



Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts.

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 14-11. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 14-10, which is extracted from Table 14-9. The description of the significance ratings is discussed in Table 14-11.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

**Table 14-9: Impact Assessment Parameter Ratings**

Rating	Intensity/Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
7	Irreplaceable loss or damage to biological or physical resources or highly sensitive environments. Irreplaceable damage to highly sensitive cultural/social resources.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	<u>International</u> The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or moderate to highly sensitive environments. Irreplaceable damage to cultural/social resources of moderate to highly sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	<u>National</u> Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.

Rating	Intensity/Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
5	Serious loss and/or damage to physical or biological resources or highly sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	<u>Province/ Region</u> Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or moderately sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense natural and / or social benefits to some elements of the baseline.	<u>Municipal Area</u> Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

Rating	Intensity/Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
3	Moderate loss and/or damage to biological or physical resources of low to moderately sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	<u>Local</u> Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	Unlikely: Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur. <25% probability.
2	Minor loss and/or effects to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	<u>Limited</u> Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.



Rating	Intensity/Replaceability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
1	Minimal to no loss and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	<u>Very limited/Isolated</u> Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

**Table 14-10: Probability/Consequence Matrix**

		Significance																																					
Probability	7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
	6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
	5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
	4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
	3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
	2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
	1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		Consequence																																					

**Table 14-11: Significance Rating Description**

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

## Appendix B: Site Photographs





Site NC1



Site NC2





Site NC3



Site NC4