AQUATIC IMPACT ASSESSMENT FOR THE PROPOSED PLATREEF UNDERGROUND MINE

Platreef Resources Pty (Ltd)

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DIGBY WELLS ENVIRONMENTAL

This document has been prepared by **Digby Wells Environmental**.

Report Title: **An Aquatic Impact Assessment for the proposed Platreef Underground Mine**

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EXECUTIVE SUMMARY

Platreef Resources (Pty) Ltd (Platreef) have contracted Digby Wells Environmental (Digby Wells) to assess the Environmental Impact Assessment (EIA) for the proposed Platreef platinum mine located northeast of Mokopane in the Limpopo Province. This report highlights the findings of the low-flow assessment conducted during September 2013 as well as findings of surveys undertaken in 2011. A second assessment was conducted at the proposed site of the tailings storage facility on Bultongfontein during December 2013.

The systems surveyed occur in arid regions and are prone to long dry spells and as such they are classified as ephemeral streams. Seven sites were selected based on desktop research, of which three were dry and four were able to be assessed for *in situ* water quality, Invertebrate Habitat Assessment System (IHAS), South African Scoring System version 5 (SASS 5), Macroinvertebrate Response Assessment Index (MIRAI), Fish Response Assessment Index (FRAI) and all in accordance with the River Health Programme (RHP). From the above mentioned studies it was concluded that current river systems within the catchment were in a degraded state.

The aquatic ecosystems associated with the proposed Platreef Underground Mine are considered to be seriously modified as a result of impaired water quality as a consequence of excessive sewage effluent and urban runoff into the system. The baseline aquatic ecosystem status and composition has been established for the associated river courses. The Red Data species *Oreochromis mossambicus* was found to be present within the associated river system.

The impacts of the “no-go option” were considered to be minor, however minor, the current land use is impacting on the aquatic systems of the area. The proposed project’s impacts were assessed to be moderate before mitigation and minor after mitigation. The quality and quantity of water within the associated river courses is seen to be of concern due to the high levels of eutrophication and the areas low water availability. The cumulative impacts of the proposed project were seen to be moderate.

It is advised that the flood plains and river channels be avoided when construction begins that where possible a 100 m buffer be subscribed to around the 1 in 100 year flood line of the river system to ensure that the mining operations do not further impact on the aquatic ecosystems. This shouldn’t be a large concern as the supplied infrastructure plans indicate that the workings will be approximately 300m from the nearest drainage channel. Surface and groundwater impact modelling, as well as prediction and the use thereof to implement pollution control facilities, will be critical to reduce and mitigate impacts.

Furthermore, a biomonitoring programme is suggested to be implemented in order to evaluate whether the mining operation is impacting upon the aquatic ecosystems during its construction, operations, and closure phase.

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ABBREIVIATIONS

Abbreviation	Explanation
AEMC	Attainable Ecological Management Class
ASPT	Average Score Per Taxon
CV	Curriculum Vitae
DEMC	Default Ecological Management Class
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
Digby Wells	Digby Wells Environmental
DO	Dissolved Oxygen
EC	Ecological Classification
EISC	Ecological Importance and Sensitivity Category
FRAI	Fish Response Assessment Index
FROC	Frequency of Occurence
GIS	Geographic Information Systems
GPS	Geographical Positioning System
GSM	Gravel, Sand and Mud
IHAS	Invertebrate Habitat Assessment System
IHI	Index of Habitat Integrity
MIRAI	Macroinvertebrate Response Assessment Index
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NWA	National Water Act
PCD	Pollution Control Dam
PESC	Present ecological status category
Platreef	Platreef Resources (Pty) Ltd
RHP	River Health Programme

Abbreviation	Explanation
SANS	South African National Standards
SASS5	South African Scoring System (version 5)
TDS	Total Dissolved Solids
TSF	Tailings Storage Facility
WMA	Water Management Area

1 INTRODUCTION

An integrated specialist assessment of the project area was conducted in order to identify any aquatic ecosystems associated with the project area and to then assess the ecological relevance of these ecosystems. This study consisted of an assessment of the lotic systems where possible.

According to the National Water Act, 1998 (Act No. 36 of 1998) (NWA), a water resource is not only considered to be the water that can be extracted from a system and utilized but also includes the entire water cycle. This includes evaporation, precipitation and entire aquatic ecosystem including the physical or structural aquatic habitats, the water, the aquatic biota, and the physical, chemical and ecological processes that link water, habitats and biota. The entire ecosystem is acknowledged as a life support system by the NWA. According to van Wyk *et al*. (2006) the “resource” is defined to include a water course, surface water, estuary and aquifer, on the understanding that a water course includes rivers and springs, the channels in which the water flows regularly or intermittently, wetlands, lakes and dams into or from which water flows, and where relevant, the banks and bed or the system. The aquatic ecosystem which was assessed for this study was the river systems.

The system that was assessed for the study was the floodplain system and tributaries associated with the Mogalakwena River. The importance of this floodplain system may be attributed to the location of the Nylsvlei Ramsar site in the upper catchment of the Nyl River. The Nyl River is situated in the Limpopo Province of South Africa and represents the southernmost tributary of the Mogalakwena River (Birkhead *et al*., 2007). The Nyl River passes through the Nyl River floodplain, known as ‘Nylsvlei’. According to Higgins *et al*. (1996) the floodplain is a unique and a highly biologically productive ecological system. The system is recognised internationally as an important wetland due to the large size and the variety of wildlife supported by the system, including several Red Data bird species (Birkhead *et al*., 2007). An increase in water resource developments in the upper catchment areas is threatening the ecological status of the floodplain. Although the proposed project area may not directly impact on the ecological state and functioning of the Nyl River floodplain, impacts may be incurred onto the Mogalakwena River floodplain, a beneficiary of the Nyl River floodplain. Due to this, the ecological functioning and integrity (health) of the Mogalakwena River floodplain was and is important to consider.

2 TERMS OF REFERENCE

Digby Wells Environmental (Digby Wells) was commissioned by Platreef Resources (Pty) Ltd (Platreef) to conduct an EIA of the aquatic ecosystems associated with the proposed underground mining area in the Mokopane area, Limpopo Province, which has been proposed for the Platreef Underground Mine.

An Environmental Impact Assessment (EIA) of the aquatic ecosystems that could potentially be affected by the proposed mine was completed in December of 2013. The aim of this assessment was to determine the current ecological state (health) of the aquatic ecosystems and report on any potential impacts that may occur due to mining.

3 STUDY AREA

The aquatic ecosystems associated with the study areas are located northwest of Mokopane in the Limpopo Province. The proposed project is located within the Limpopo Water Management Area (WMA1). Based on the layout of the project area, the effected aquatic ecosystems are located in quaternary catchments A61F and A61G. The rivers systems under investigation form part of the upper reaches of the Limpopo River catchment. As seen in Figure 3-1: Location of sampling sites in relation to the proposed mining area., this is a water stressed tributary.

Activities associated with the project area consist of large-scale farming practices. Also in the vicinity is the town of Mokopane with associated settlements. Large-scale residential activities occur within the affected water catchments.

In order to establish the ecological integrity of the associated aquatic ecosystems, several sites were selected on the Mogalekwena, Groot-Sandsloot, Ngwaditse, Dithokeng, Nyl, Rooisloot and Dorp rivers associated with the project area.

A total of ten sampling points were selected for the study. The Global Positioning System (GPS) co-ordinates for each of the sampled sites are given in Table 3-1: GPS co-ordinates and short descriptions of the various study sites. An illustration of the locations of the sampling sites in relation to the mine area is presented in Figure 3-1: Location of sampling sites in relation to the proposed mining area..

Table 3-1: GPS co-ordinates and short descriptions of the various study sites

Site name	Coordinates	Description
PLA 1	23°59'35.92"S 28°57'34.24"E	The site is the intended downstream sampling point for the Groot-Sandsloot River. It was characterised by soft mud with steep eroded flood banks. The channel itself looked to have been recently mechanically dug.
PLA 2	24°3'44.22"S 28°58'48.49"E	This site is a flood plain of water trapped behind a sand berm. It appears to be fed by the drainage channels of the Dithokeng River located to the East of the water body. Approximately 250 metres above the system sand mining is taking place.
PLA 3	24°6'25.21"S 29°1'40.67"E	This is the upstream site of the Rooisloot River, It had a moderately wide channel and located 100m above the road crossing was large dam wall that had fallen into disrepair. The site was dry during the site visit.
PLA 4	24°8'11.46"S 28°57'49.96"E	This was the mid-stream sight for the Rooisloot River, it runs through a high density settlement. The stream was flowing and bedrock sand and gravel were present.
PLA 5	24°5'39.94"S 28°54'5.62"E	This was the downstream site of the Mogalakwena River. The site was characterised my alien riparian vegetation (Eucalyptus sp.). Dry grassy sandy channel.
PLA 6	24°10'21.01"S	The site was at the N11 road crossing of the Dorp River, The

Site name	Coordinates	Description
	28°59'11.67"E	water was coloured white, large amounts of litter were scattered on the eroded banks.
PLA 7	24°16'32.56"S 28°58'31.55"E	The upstream site of the Mogalakwena River was dry with wide banks. A large amount of grasses had grown within the channel
PLA 8	23°59'40.34"S 28°59'25.88"E	This is the site of a dam built along a minor drainage channel at the time of survey it was dry but a single frog was found
PLA 9	24° 0'9.74"S 28°58'59.63"E	This site falls within the proposed TSF site. The river bed was dry although water still persisted in the dam below.
PLA 10	23°56'57.17"S 29° 0'23.97"E	The stream flow here originated from a seepage point at the base of the dam wall. Fish and invertebrates were found in the pools that formed at the head the stream.

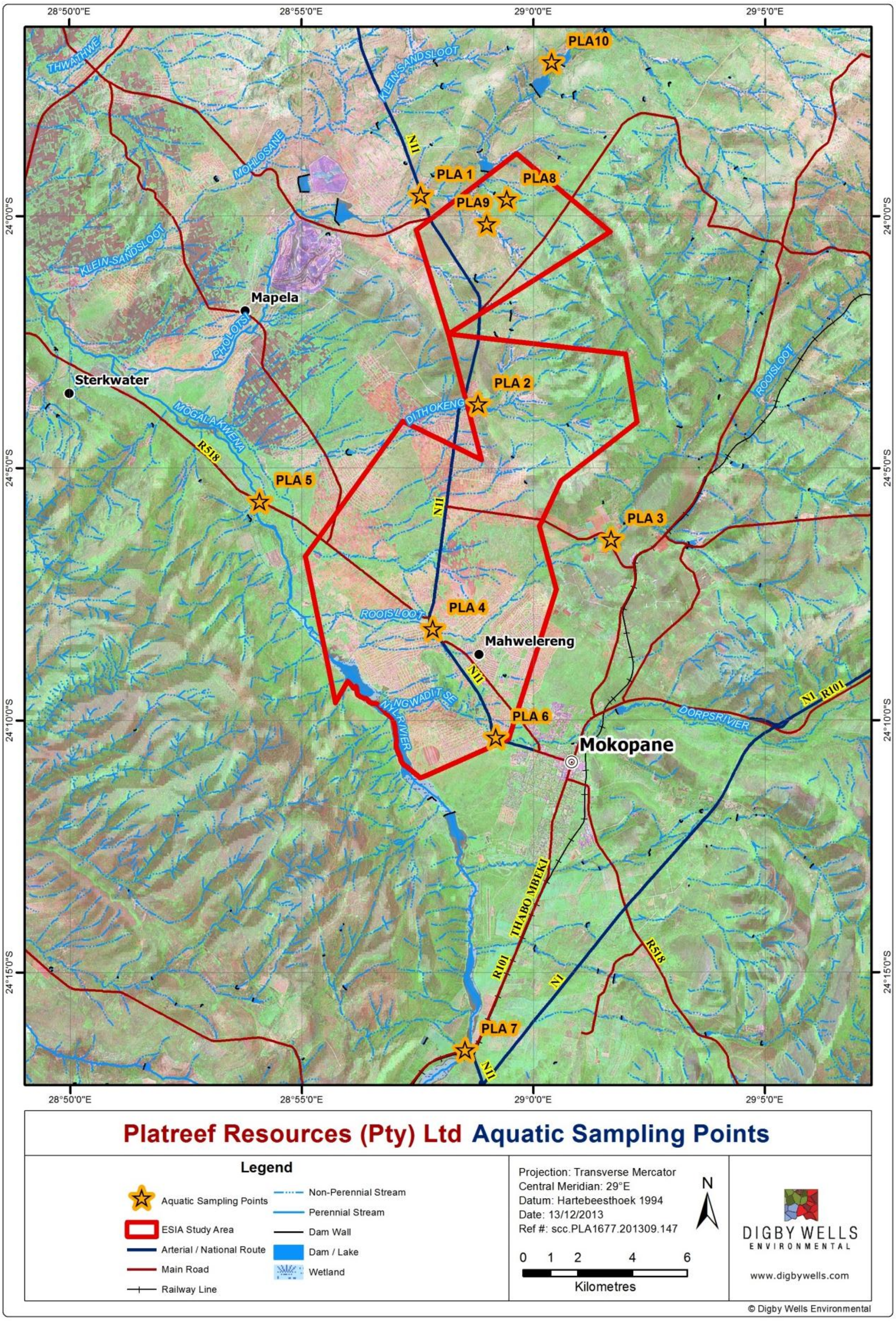

Figure 3-1: Location of sampling sites in relation to the proposed mining area.

A summary of the ecological integrity (health) and management categories for the affected river systems within the respective quaternary catchment is presented in Table 3-2: The ecological and management categories for the quaternary catchment A41E (Kleynhans, 2000).

Table 3-2: The ecological and management categories for the quaternary catchment A41E (Kleynhans, 2000)

Category	Description	State
EISC	Ecological importance and sensitivity category	Moderate
DEMC	Default ecological management class	Moderately sensitive systems
PESC	Present ecological status category	Class B: Largely natural
AEMC	Attainable ecological management class	Class B: Largely natural

According to the ecological importance classification for the quaternary catchments A61F and A61G, the Mogalakwena River floodplain system is classified as a moderate system which in its present state can be considered to be a Class B (Largely natural) system. The default ecological management class for the relevant quaternary catchments is considered to be moderately sensitive system. The attainable ecological management class for the system is a Class B (Largely natural).

The Mogalakwena River system is a floodplain system and has been assessed accordingly. According to Marneweck and Batchelor (2002), floodplains can be defined as low-gradient land onto which a river regularly overflows its banks, usually seasonally or during periods of high rainfall in the catchment with a relatively level alluvial (sand or gravel) area lying adjacent to the river channel, which has been constructed by the present river in its existing regime. The description of the floodplain according to Kotze et al. (2004) based on the setting in the landscape and hydrologic components are presented in Table 3-3.

Table 3-3: The definition of the wetland unit occurring in the study area further developed by Kotze et al. (2004).

System	Topographic Setting	Description
Floodplain	In depressions and basins, often at drainage divides on top of the hills	Valley bottom areas without a stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial transport and deposition of sediment, usually leading to a net accumulation of sediment.

The Rooisloot, Ngwaditse and Dithokeng rivers are ephemeral systems whereby the riparian areas were delineated in order to determine the extent of these systems. According to Department of Water Affairs and Forestry (DWAF) (2005) riparian areas include plant communities adjacent to and affected by surface and subsurface hydrologic features and these include rivers, streams, lakes, or drainage ways. In addition to this, both perennial and non-perennial streams support riparian vegetation. These river systems have been referred to as channelled valley bottom systems as result of the defined channel for each system.

The floodplain surface usually slopes away from the channel margins due to sediment deposition along the channel edges and areas closest to the channel which can then result in the formation of backwater swamps at the edges of the floodplain margins (DWAF, 2007). According to Kotze *et al*. (2007) floodplains usually receive most of their water during high flow events when waters overtop the stream banks.

According to McCartney (2000), flood attenuation is likely to be high early in the season until the floodplain soils are saturated and the oxbows and other depressions are filled. Additionally, the flood attenuation capacity is drastically reduced in the late season. It is unlikely that floodplains contribute significantly to stream flow regulation (Kotze *et al*., 2007). The contribution of water from floodplains to stream flow and groundwater recharge is limited as a result of the clayey floodplain soils which retain water (Kotze *et al.,* 2007). Generally the inundation period of floodplains is short but in the oxbow depression portions of the floodplain inundation is more prolonged. Floodplains also assist with the enhancement of water quality but this is limited due to short residence times during flood events and due to the limited sub-surface water movement within the wetland.

4 AIMS AND OBJECTIVES

- The aim of the assessment is to establish the current ecological integrity of the reach of the Mogalakwena-Nyl River system associated with the proposed mining operation and to identify potential impacts in order to propose means to preferably avoid, reduce or to mitigate against them. The aim of this project will be met through the following objectives:
- The delineation and description of the identified aquatic ecosystems;
- Characterise the current ecological state of the aquatic ecosystems by making use of selected driver indices which address in situ water quality states and habitat;
- Characterise the current ecological state of the aquatic ecosystem by making use of selected responder indices which address macroinvertebrate and ichthyofauna population attributes;
- Make recommendations on the management and conservation of the systems in order to increase the ecological integrity of potentially impacted aquatic ecosystems and to conserve the ecological integrity of healthy ecosystems; and
- Make recommendations on a medium term monitoring programme that should be implemented.

5 KNOWLEDGE GAPS

A Level III EcoStatus assessment was conducted for this study and results of the study should therefore be considered in light of this. The methodologies described by the River Healt Program (RHP) have been updated for this study.

During the various surveys (high and low flow) conducted for the current impact assessment, low flow volumes were identified at various sites. This has skewed results in that species adapted to higher flow velocities will be absent from the current biotic indices.

6 METHODOLOGY

6.1 Survey Timing

A combined aquatic and wetland delineation high flow assessment was conducted during the 2011 period. A subsequent low flow survey was completed during August 2013. Due to access requirements at some sites, an additional survey was completed during the December 2013 high flow period.

6.2 Desktop Study

A desktop study involving the use of Geographic Information Systems (GIS) maps and a previous high flow (Digby Wells 2011, Kleynhans 2000) assessment of the area was carried out prior to visiting the site.

6.3 Ecological Integrity

In order to determine the ecological integrity of the aquatic environment, individual biophysical components of the streams in the study area were assessed. These biophysical attributes were considered by implementing selected tools or indices that refer to selected drivers and biological responses of an aquatic ecosystem. Methodologies formulated by the RHP (RHP, 2001) were implemented. The selected drivers and biological responses include:

The abiotic driver assessment:

- *In situ* water quality (DWAF, 1996);
- The Index of Habitat Integrity (IHI) (Kleynhans *et al*, 2008); and
- The Invertebrate Habitat Assessment System (IHAS) (McMillan, 2002).

The biotic response indicator assessment:

- South African Scoring System 5 (SASS 5);
- Macroinvertebrate Assessment Index (MIRAI);and
- The Fish Response Assessment Index (FRAI).

According to Kleynhans and Louw (2007), the directional change in the attributes of the drivers and biota is referred to as a trend. Generally, an assessment may be approached from a driver perspective (Kleynhans & Louw, 2007). The driver components will be considered in order to determine the degree of contribution towards the current state of the biological communities. The ultimate objective is to determine if the biota have adapted to the current habitat template or are still in a state of flux (Kleynhans & Louw, 2007).

6.3.1 Water Quality

Water quality is determined by a variety of factors including: physical, chemical, biological and aesthetic properties. These factors determine waters fitness for a variety of uses as well as for the protection of the health and integrity of aquatic ecosystems refers to the quality of water (DWAF, 1996). Various water quality parameters were all taken *in situ*, these include pH, temperature (°C), conductivity (µS/cm), oxygen content (mg/l) and oxygen saturation (DO %) using calibrated water quality meters.

The South African Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996) were applied to this study as the primary source of reference information. The South African Water Quality Guidelines contains information similar to that which is available in the international literature; however, the information provided is specifically formulated for Southern African aquatic ecosystems and water users (DWAF, 1996).

6.3.2 Habitat Quality

An important factor which determines the survival of a species in an ecosystem is the state of the available habitat. The assessment of the composition of the surrounding physical habitat which influences the quality of the water resource and the condition of the resident aquatic community is referred to as a habitat assessment (Barbour *et al*. 1996).

As a result of habitat loss, alteration or degradation will cause the number of species to decline (Karr 1981). The diversity of biota dependant on the habitat will decrease if the habitat integrity decreases (Karr 1981).

6.3.2.1 Index of Habitat Integrity

The quality and diversity of the available habitat was assessed by means of the IHI (Kleynhans *et* al., 2008). The IHI was applied on a systems basis. The IHI integrity classes and a description of each class are presented in Table 6-1. This index assesses the number and severity of anthropogenic perturbations and the damage they potentially inflict on the habitat integrity.

Table 6-1: The IHI integrity classes and short descriptions of each class (Kleynhans *et al*., 2009)

Integrity Class	Description	IHI Score (%)
A	Natural	>90
B	Largely Natural	80 – 90

Integrity Class	Description	IHI Score (%)
C	Moderately Modified	60 – 79
D	Largely Modified	40 – 59
E	Seriously Modified	20 – 39
F	Critically Modified	0 – 19

6.3.3 Fish Assessment

The information gained using FRAI gives an indication of the present ecological state of the river based on the fish assemblage structures observed. Fish species are then compared to those expected to be present for the Limpopo catchment. The expected fish species list was developed from a literature survey and included sources such as (Kleynhans *et al*., 2007) and Skelton (2001).

6.3.3.1 Invertebrate Habitat Assessment System

The IHAS was specifically designed to be used in conjunction with the SASS 5, benthic macroinvertebrate assessments. The IHAS assesses the availability of the biotopes at each site and expresses the availability and suitability of habitat for macroinvertebrates, this is determined as a percentage, where 100% represents "ideal" habitat availability. A description based on the IHAS percentage scores is presented in Table 6-2.

Table 6-2: Description of IHAS scores with the respective percentage category (McMillan, 2002)

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

6.3.4 Aquatic Invertebrate Assessment

The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem. Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or sessile lifestyles. The analysis of macroinvertebrate communities is well-suited for assessing site-specific impacts.This is done by comparing upstream and downstream studies (USEPA, 2006). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing good supportive evidence for interpreting cumulative effects (USEPA, 2006).

6.3.4.1 South African Scoring System Version 5

The SASS 5 is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution. These sensitivities range from highly tolerant families such as Oligochaeta and Cnidaria, to highly sensitive families like Oligoneuridae. SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).

All SASS 5 and ASPT scores are compared with the SASS 5 Data Interpretation Guidelines (Dallas, 2007) for the relevant ecoregion. This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database.

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

6.3.4.2 Macroinvertebrate Response Assessment Index

The aim of the MIRAI is to provide a habitat-based cause-and-effect base to interpret the deviation of the aquatic invertebrate community from the reference condition. This assessment does not exclude the calculation of SASS scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic organisms are as follows:

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

6.3.5 Ecological Description

Ecological classification is a means by which current biophysical attributes of ecosystems are compared to the natural or close to natural reference conditions in order to determination and categorise of the systems integrity (Kleynhans and Louw, 2007). According to Iversen *et al*. (2000) EcoStatus may be defined as the totality of the features and characteristics of the system that bear upon its ability to support an appropriate natural flora and fauna. For the purpose of this study ecological classifications have been determined for biophysical attributes of the associated water courses.

7 RESULTS AND DISCUSSIONS

Two types of systems were identified for the project area, namely the Mogalakwena River floodplain and the Rooisloot, Ngwaditse and Dithokeng Rivers (valley bottom wetlands). The Rooisloot, Ngwaditse and Dithokeng Rivers are ephemeral systems and were predominantly dry during the field survey periods. Water was noted in the lower reaches of the Rooisloot and Ngwaditse Rivers and it was concluded that this is largely attributed to household effluent. No water was noted in the upper catchment areas of these systems, supporting this conclusion. As a result of this, an ecological state assessment of these systems could not be conducted.

7.1 Water Quality

Organisms which are present within freshwater ecosystems are directly affected by water quality. It is therefore essential to collate the water quality data in order to understand the responses of biota within the freshwater systems. The assessment of water quality of local river systems is based on selected *in situ* variables.

Table 7-1 presents the *in situ* variables measured within sampling points associated with the proposed project area during the 2011 and 2013 low flow assessment.

The *in situ* water quality analysis for the low flow period indicated that the water quality at site PLA 1 was within acceptable pH and temperature range, however, conductivity was elevated and dissolved oxygen was below guideline levels. The high conductivity of the river is most likely associated with the pollution in the stream. The levels recorded are elevated and this could be negatively effecting the in stream biota. Table 7-1 presents the results for the low flow assessment.

Table 7-1: *In situ* water quality results for the Groot-Sandsloot, Nyl, Mogalakwena, Rooisloot and Dorps Rivers

Constituent	Range	PLA 1	PLA 2	PLA 3	PLA 4	PLA 5	PLA 6	PLA 7	PLA 8	PLA 9	PLA 10
pH	6.5 – 9	7.89	7.98	DRY	8.10	DRY	7.73	DRY	DRY	DRY	6.72
Temperature (°C)	5 – 30	17.8	18.7	DRY	18.5	DRY	20.8	DRY	DRY	DRY	27.9
Conductivity (µS/cm)	< 700	1255	1086	DRY	973	DRY	1256	DRY	DRY	DRY	753
DO (mg/l)	> 5	4.4	4.36	DRY	2.28	DRY	0.9	DRY	DRY	DRY	3.32
DO (% saturation)	80 - 120	46	42	DRY	22.71	DRY	7.8	DRY	DRY	DRY	48

The *in situ* water quality analysis for the low flow period indicated that the water quality at sites PLA1, PLA2, PLA4 and PLA6 was poor with conductivity and dissolved oxygen concentrations being out of the recommended DWAF (1996) guidelines values.

PLA 10 was recorded during the high flow from the table it can be seen that of the variable is an impacted state it has water quality closer to the specified guidelines than those results recorded during the low flow.

The elevated levels of conductivity may be attributed to the associated urban pressures these rivers find themselves under, namely the discharge of chemicals and untreated effluent would increase the levels of conductivity and could negatively affect aquatic biota.

The levels of dissolved oxygen were a concern as oxygen is the most important measure of water quality for aquatic biota (Mason, 1991). Levels below 5.0mg/l (Kempster *et al*., 1980) were seen to negatively affect aquatic biota and the levels of oxygen at PLA1, PLA2, PLA4 and PLA6 may be negatively affecting the aquatic biota during the low flow period.

7.1.1 Water Quality Concluding Remarks

The *in situ* water quality associated with the project area is considered to be in a poor and degraded state. Several signs of sewage effluent and urban runoff were present within the associated river systems as seen in the below figure (Figure 7-1). Results from the surface water analysis confirm the above statement and refer to eutrophic conditions and high concentrations of chloride and nutrients.

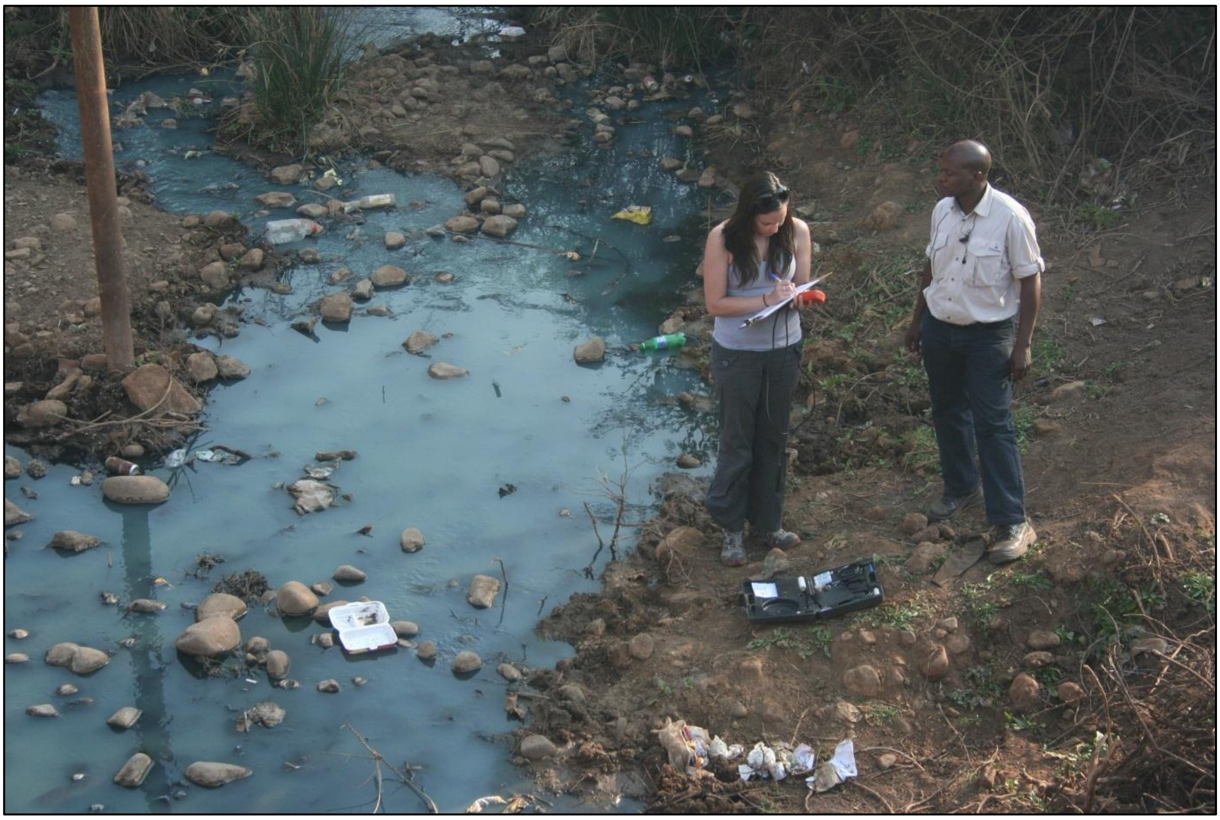

Figure 7-1: Image of urban runoff and effluent in the Dorp River

7.2 Habitat

The IHI assesses the number and severity of anthropogenic impacts and the damage they potentially inflict on the habitat integrity of aquatic ecosystems. Some of the factors considered for the IHI and the project area are given in Figure 7-2. The results of the IHI of the Limpopo River are presented in Table 7-2.

Table 7-2: IHI results for the Groot-Sandsloot, Nyl, Mogalakwena, Rooisloot and Dorps River systems during the 2013 low flow period.

Component	Score	Description
Instream IHI %	51.2	Largely modified
Instream Category	D	
Riparian IHI %	53.9	Largely modified
Riparian Category	D	

The current land-uses have impacted on the functioning of this system. Local agricultural practices, pertaining predominantly to livestock have impacted on the ability of this system to provide important services. Agricultural activities have altered the natural hydrology of the system. The decrease in surface roughness due to overgrazing has resulted in a potentially destructive hydrological regime for the system. In addition to this, livestock also impact directly on the quality of water as a result of nutrient input and trampling of the system. Owing to the fact that agricultural practices are on-going for the project area, coupled by the absence of mitigation measures for the current land-uses, it is assumed that the ability of the units to provide important ecological services will continue to deteriorate. The severity of the current identified impacts was however determined to be minor at this stage. Photographs of threats to the ecological functioning of the floodplain are presented in Figure 7-2

Livetsock and cattle paths

Hydrological alterations

Overgrazing

Figure 7-2: Photographs of threats to the ecological functioning of the system

A Summary of the findings of the IHI is represented in Figure 7-3.

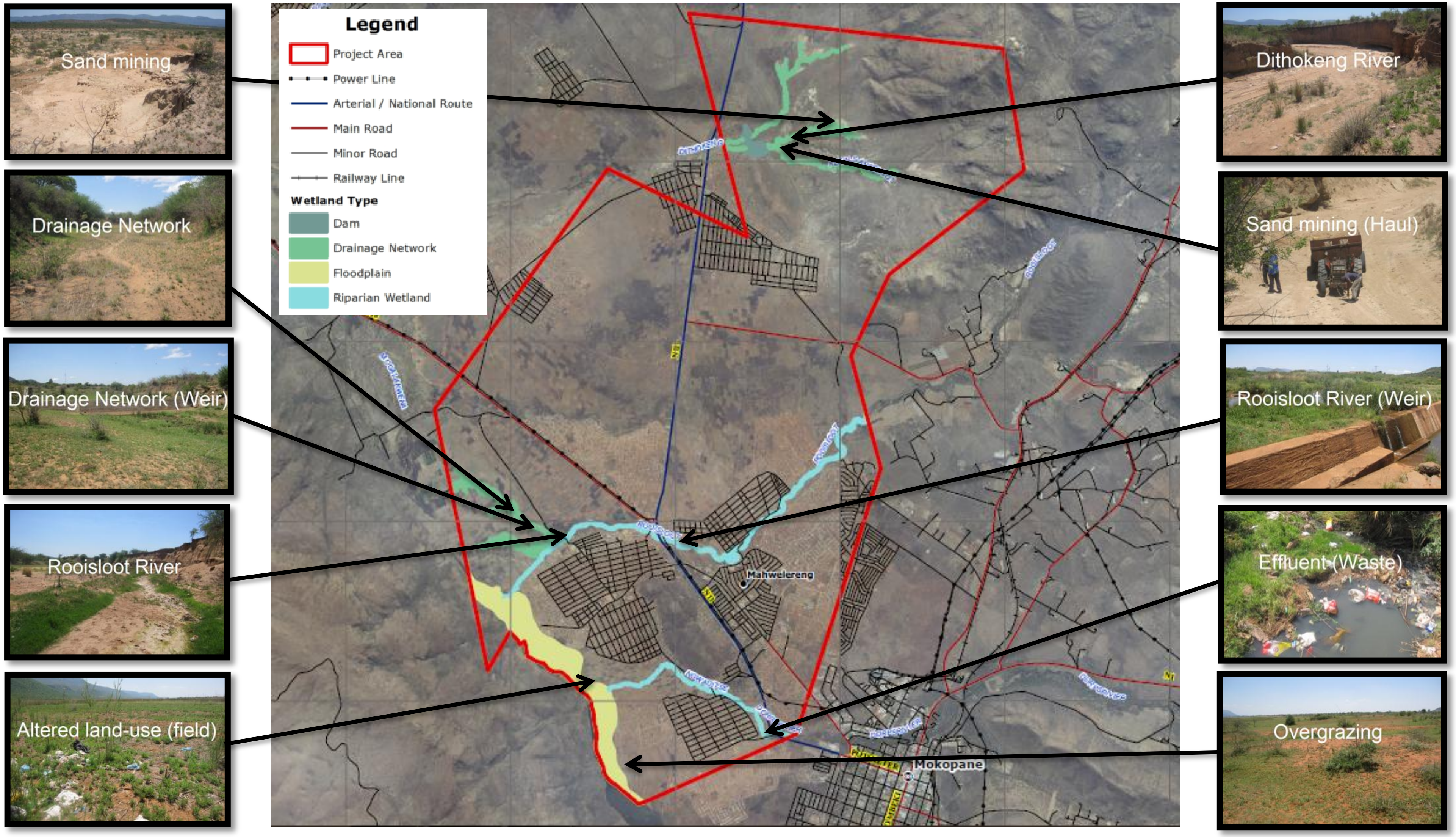

Figure 7-3: Identified impacts and the resulting affects to IHI for the study area

Current land uses illustrated above have impacted the system and as a result a preliminary buffer zone of 100 m has been allocated for all the delineated aquatic and wetland systems. This buffer was suggested with consultation of the National Freshwater Ecosystem Priority Areas (NFEPA) implementation manual. Only two provinces have legislated required buffers for development they are Gauteng which requires 50m in rural areas and 30m in urban. Mpumalanga requires a 100m buffer be placed on aquatic systems. Using the precautionary principle, due to the lack of knowledge about the system, and as it forms part of the Nylsvlei floodplain a minimum 100m buffer is recommended.

The Mogalakwena River floodplain provides both direct and indirect ecological services; some of these services include direct water use and maintaining food resources such as fish. The system also provides water enhancement services.

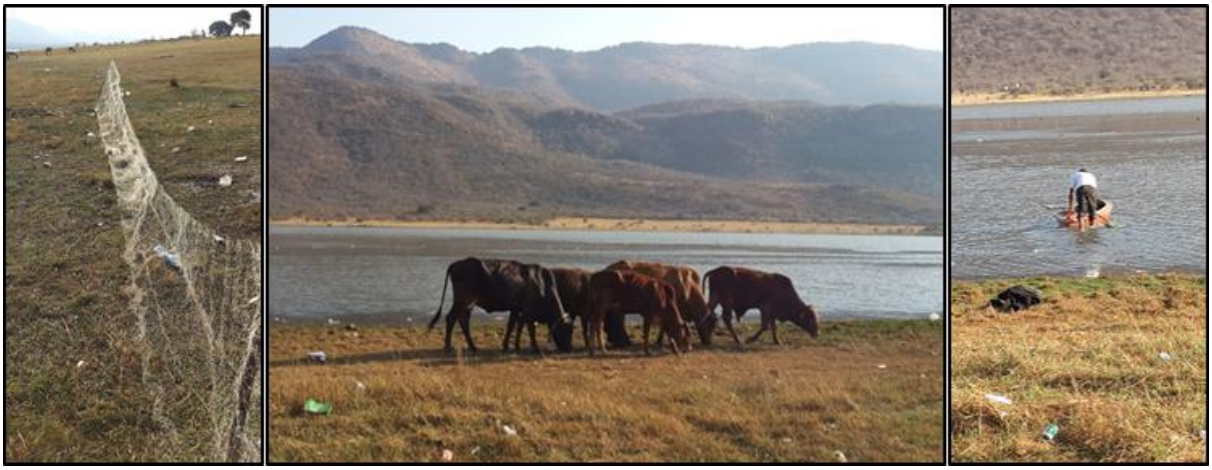

Figure 7-4: Ecological services provided by the Mogalakwena dam

7.3 Fish assessment

The use of 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 RHP uses fish in the biotic index FRAI. The FRAI is based upon the preferences of various fish species as well the frequencies of occurrence in which the species occur. Electroshocking was carried out in those rivers that contained water.

The expected species of the A61F and A61G quaternary catchments was adapted and is presented in Table 7–3.

Table 7-3: Expected fish species of the A61F and A61G quaternary catchments.

Fish Species	Common Name	Captured
Aplocheilichtys johnstoni	Johnsons top Minnow	No
Barbus bifrenatus	Hyphen Barb	No
Barbus mattozi	Papermouth	No
Barbus paludinosus	Straightfin Barb	Yes

Fish Species	Common Name	Captured
Barbus unitaeniatus	Longbeard Barb	No
Barbus viviparus	Bowstripe Barb	No
Clarias gariepinus	Sharptooth Catfish	Yes
Chiloglanis pretoriae	Suckermouth	No
Labeo cylindricus	Red Eyed Labeo	No
Labeo molybdinus	Leaden Labeo	No
Oreochromis mossambicus*	Mozambique Tilapia	Yes
Pseudocrenilabrus philander	Southern Mouth Brooder	Yes
Synodontis zambezensis	Brown Squeaker	No
Tilapia sparrmanii	Banded Tilapia	Yes
Tilapia rendalli	Red breasted Tilapia	No
Barbus trimaculatus	Three spot barb	Yes

The FRAI assessment was adjusted to suit the site specific requirements with the frequencies of occurrence (FROC) of particular species adjusted from the expected species list (Kleynhans *et al*., 2007). The FRAI and FROC have been adjusted according to the following factors: sampling effort, habitat type, cover combination, stream lengths and altitude. Below in Table 7-4 are the results for the FRAI assessment.

Table 7-4: FRAI results for the 2013 survey

Component	Results
FRAI (%, adjusted)	47
EC: FRAI	D
Category	Largely modified

Based on the outcome of the fish assemblage assessment the fish community associated with the Platreef project area can be considered to be largely modified. This largely modified state of the fish community is a result of poor water quality compounded with low water availability. Many species of the fish are believed to be present within the refuge areas in the local impoundments. Due to the reliance of local communities on the fish as a protein source it is important to maintain these aquatic systems.

Many of the absent fish species such as *Chiloglanis pretoriae* are sensitive to pollutants and modified flow regimes. The absence of these species confirms that the water quality as well as the instream habitat of the associated river systems is currently largely modified.

Oreochromis mossambicus was sampled at the sites included in the study. This organism is a listed Red Data species with an IUCN Red Data status of “Near Threatened”.

7.4 Macroinvertebrate Assessment

As a result of aquatic macroinvertebrates integrating the effects of physical and chemical changes in the aquatic ecosystems, they are good, short-term indicators of ecological integrity. Integration of biological indicators (like aquatic invertebrates) with chemical and physical indicators will ultimately provide information on the ecological status of the river (RHP, 2001).

7.4.1 Habitat for Aquatic Macroinvertebrates

The reaches which were assessed consisted of a variety of biotopes with each of the systems comprising of different habitat structures. The dominant feature of the invertebrate habitat is the sandy-clay substrate which dominates the river systems under study. Generally, no stones in or out of current biotope were found to be available at any of the sites except for PLA 4 where bed rock and small stones were present. During both surveys aquatic and marginal vegetation was limited due to low flow volumes. Flow velocities during the surveys were also found to be low/not discernible. Four of the seven sites visited were found to have water in them the result of their habitat assessment is listed in Table 7-5.

Table 7-5: IHAS results for the Groot-Sandsloot, Nyl, Mogalakwena, Rooisloot and Dorps Rivers systems low flow 2013

IHAS Component	PLA 1	PLA 2	PLA 3	PLA 4	PLA 5	PLA 6	PLA 7	PLA 8	PLA 9	PLA 10
Flow speed (m/s)	1<	No discernible flow	DRY	1<	DRY	1<	DRY	DRY	DRY	1<
Total score (%)	15	45	DRY	50	DRY	12	DRY	DRY	DRY	64
Suitability	Poor	Inadequate	DRY	Inadequate	DRY	Poor	DRY	DRY	DRY	Fair

The IHAS results were poor to inadequate for PLA 1, PLA 2, PLA 4 and PLA 6. This was largely due to sandy benthic conditions coupled with poor riparian vegetation. Flow rates were below 1 m/s at all sites with water. PLA 2 is a standing water body with no flow. PLA 3, PLA 5 and PLA 7 were all dry sites and could therefore not be assessed. The poor habitat conditions would not be able to support a large degree of species diversity within the invertebrate taxa.

7.4.2 SASS Version 5

The findings of the macroinvertebrate assessment for the system recorded taxa with sensitivity scores ranging from highly pollution tolerant to moderately pollution tolerant. A large variety of taxa with low tolerances to pollution were found in the site associated with the project area.

According to Kleynhans (2000) the associated sites consist of aquatic biota that is moderately sensitive and of a moderate ecological importance. During the current surveys (2013) no sensitive organisms were sampled. The absence of these sensitive taxa confirms the classification of Klenyhans (2000). The SASS5 results for the low flow survey of the associated sites are given in Table 7-6.

Table 7-6: SASS 5 scores for the Groot-Sandsloot, Nyl, Mogalakwena, Rooisloot and Dorps rivers systems high flow 2013

Site	PLA 1	PLA 2	PLA 3	PLA 4	PLA 5	PLA 6	PLA 7	PLA 8	PLA 9	PLA 10
SASS Score	15	11	DRY	37	DRY	4	DRY	DRY	DRY	40
Taxa	5	5	DRY	7	DRY	3	DRY	DRY	DRY	11
ASPT	3	2.2	DRY	5.28	DRY	1.3	DRY	DRY	DRY	3.63
Category	E	E	DRY	E	DRY	E	DRY	DRY	DRY	E

The SASS5 scores for the low flow survey ranged from 4 at site PLA 6 to 37 at site PLA 4. The ASPT ranged from 1.3 at site PLA 6 to 5.28 at site PLA 4. The SASS5 scores where then placed into the biological bands based on Dallas (2007) (Table 7-7).

Table 7-7: Limpopo Plain biological banding (Dallas, 2007)

Class	SASS 5 Score	ASPT	Condition
A	>143	>5.8	Natural/unmodified
B	115 – 143	5.5 – 5.8	Minimally modified
C	94 – 115	5.1 – 5.5	Moderately modified
D	72 – 94	4.6 – 5.1	Largely modified
E	<72	<4.6	Seriously modified

According to Dallas (2007) the sites associated with the project area are considered to be within the Class E category indicating that the macroinvertebrate community is present in a seriously modified state. The SASS5 interpretation guidelines are given in the table below (Table 7-8).

Table 7-8: The suggested SASS 5 and ASPT interpretations (Chutter, 1998)

SASS 5	ASPT	Suggested Interpretation
>100	>6	Water quality natural, habitat diversity high
<100	>6	Water Quality natural, habitat diversity reduced
>100	<6	Borderline case between water quality natural and some deterioration in water quality

SASS 5	ASPT	Suggested Interpretation
50 - 100	<6	Some deterioration in water quality
<50	Variable	Major deterioration in water quality

According to the SASS 5 interpretation guidelines there is a major deterioration in water quality at all of the sites. The results of the *in situ* and FRAI corroborate this finding. Additionally, only pollution tolerant species were found to be present at the selected sites. The IHAS assessment revealed that the invertebrate habitat at the sites was inadequate to support a diverse community of invertebrate. Although the habitat was determined to be inadequate sensitive species should still be present. The complete absence of sensitive species is indicative of water quality impairment.

The seriously modified SASS 5 category confirms the observation of the negative effects and presence of sewage effluent and urban runoff.

7.5 MIRAI

In order to compressively understand the structure and status of the invertebrate population the MIRAI was implemented. The results of the MIRAI are given in Table 7-9. The MIRAI was implemented based on the collective score of the sites associated with the project area and is considered as per the reach of the river assessed.

Table 7-9: MIRAI results for the 2013 survey

Component	Results
MIRAI (%)	19
EC: MIRAI	E/F
Category	Seriously modified

The results of the MIRAI indicate that the invertebrate community that is currently present is in a seriously modified state. The invertebrate communities present at all the sites of the current study are indicative of modified water quality. This is confirmed by the absence of pollution sensitive species from the selected sites.

7.6 Macroinvertebrate conclusion

The majority of the sites are located within non-perennial river systems and therefore confidence in the invertebrate assessment is low. Based on the results of the SASS 5 and MIRAI the invertebrate communities present at the sites are in a seriously modified state. Based on the findings of the *in situ* water quality analysis as well as previous baseline information eutrophication and the concentration of salts as a result of evaporation and sewage effluent have negatively influenced the water quality of the associated river systems resulting in a seriously modified state of invertebrates.

8 INTEGRATED ECOLOGICAL STATE

The ecological class of the study components are presented in Table 8-1.

Table 8-1: The ecological classification of study components and the resulting Ecostatus for the low flow 2013 survey

River/area	Groot-Sandsloot	Dithokeng	Rooisloot		Mogalakwena	Dorps	Nyl	Bultongfontein TSF option		
Component	**PLA1**	**PLA1**	**PLA3**	**PLA4**	**PLA5**	**PLA6**	**PLA7**	**PLA8**	**PLA9**	**PLA10**
Water quality (*in situ*)	D	D	DRY	D	DRY	D	DRY	DRY	DRY	C/D
Habitat	D									
Fish	D									
Invertebrates	E	E	DRY	E	DRY	E	DRY	DRY	DRY	E
Ecostatus	E	E	DRY	E	DRY	E	DRY	DRY	DRY	E

Although the RHP does not take the water and habitat quality into consideration when determining the ecostatus of a system, it is noted for the purposes of transparency that the sites associated with the project had impaired water quality and modified habitat states. The final ecostatus for the associated sites was determined to be a Category E meaning the conditions at the biological communities present at the sites are in a seriously modified state.

The reason for the seriously modified ecostatus is a result of impaired water quality. Water quality modification is occurring in the form of treated and untreated sewage effluent resulting in eutrophication at most sites as well as the influx if urban runoff. These above factors are compounded by low rainfall and high evaporation leading to water that has a high level of dissolved salts with a low concentration of dissolved oxygen.

When the current study is compared to the ecological and management categories for the quaternary catchments set out in Kleynhans (2000) the following findings can be noted: The PESC of river reaches included in this study is not largely natural (Class B), but the current PESC is a Class E. The ecological importance and sensitivity as described in Kleynhans (2000) was moderate, the current study sampled aquatic species which were of importance (*Oreochromis mossambicus*), and therefore, the ecological importance is seen as moderate.

9 IMPACT ASSESSMENT

The impact table considered for the study is presented in Table 9-1. The significance rating for the identified potential impacts and associated description for the significance for each impact are presented in Table 9-2 and Table 9-3 respectively.

Table 9-1: The impact table for the proposed Platreef Underground Mine

Rating	Severity	Spatial scale	Duration	Probability
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or eco system. Persistent severe damage.	International The effect will occur across international borders	Permanent: No Mitigation No mitigation measures of natural process will reduce the impact after implementation.	Certain/ Definite. The impact will occur regardless of the implementation of any preventative or corrective actions.
6	Significant impact on highly valued species, habitat or ecosystem.	National Will affect the entire country	Permanent: Mitigation Mitigation measures of natural process will reduce the impact.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate	Province/ Region Will affect the entire province or region	Project Life The impact will cease after the operational life span of the project.	Likely The impact may occur.
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year	Municipal Area Will affect the whole municipal area	Long term 6-15 years	Probable Has occurred here or elsewhere and could therefore occur.
3	Moderate, short-term effects but not affecting ecosystem function. Rehabilitation requires intervention of external specialists and can be done in less than a month.	Local Local extending only as far as the development site area	Medium term 1-5 years	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.
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of	Limited Limited to the site and its immediate surroundings	Short term Less than 1 year	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the project but has happened

Rating	Severity	Spatial scale	Duration	Probability
	external consultants.			elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures
1	Limited damage to minimal area of low significance, (eg ad hoc spills within plant area). Will have no impact on the environment.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month	Highly unlikely/None Expected never to happen.

Table 9-2: The significance rating for each potential impact

Significance										
		Consequence (severity + scale + duration)								
		1	3	5	7	9	11	15	18	21
Probability / Likelihood	1	1	3	5	7	9	11	15	18	21
	2	2	6	10	14	18	22	30	36	42
	3	3	9	15	21	27	33	45	54	63
	4	4	12	20	28	36	44	60	72	84
	5	5	15	25	35	45	55	75	90	105
	6	6	18	30	42	54	66	90	108	126
	7	7	21	35	49	63	77	105	126	147

Table 9-3: A description of the significance classes for each impact

Significance		
High (Major)	**108- 147**	
Medium-High (Moderate)	**73 – 107**	
Medium-Low (Minor)	**36 – 72**	
Low (Negligible)	**0 – 35**	

The table below (Table 9-4) describes the various activities associated with the respective phases of mining proposed for the Platreef platinum mine.

Table 9-4: Mining activities for the proposed Platreef Underground Mine

Activity No.	**Activity**
1	Site Clearing: removal of topsoil and vegetation.
2	Construction of any surface infrastructure e.g. access roads, pipes, storm water diversion berms, change houses, admin blocks etc. (including transportation of materials and stockpiling).
3	Transportation of materials & workers on site.

Activity No.	Activity
4	Temporary storage of hazardous chemicals and fuels.
5	Removal PGM's (underground mining process).
6	Operation of surface infrastructure such as the operation of the mining shaft, crusher, pipelines, the TSF and processing plant (includes water use and storage on site, including pollution control dams).
7	Storage, handling and treatment of hazardous products (fuel, explosives, oil) and waste activities (waste, sewage, discards, PCD).
8	Demolition & removal of all infrastructures (incl. transportation off site).
9	Rehabilitation (spreading of soil, re-vegetation & profiling/contouring) (includes sealing of adit and ventilation shaft entrances).
10	Storage, handling and treatment of hazardous products (fuel, explosives, oil) and waste activities (waste and sewage).
11	Post-closure monitoring and rehabilitation.

9.1 Issues and Impacts

9.1.1 Impacts and issues of current land use (the no-go option)

9.1.1.1 Aspect 1: Effects of water quality on aquatic ecology

Current land use of the proposed mine site is residential light industry and subsistence farming. The types of impacts are listed below:

1. Introduction of anthropogenic substances; and
2. Mechanical alteration of water course e.g. around developments and development of infrastructure.

Aspect 1	**Effects on water quality**				
Parameters	***Severity***	***Spatial scale***	***Duration***	***Probability***	***Significance***
Impact 1	**Introduction of untreated sewage**				
Pre- Mitigation	Very High (5)	Municipal (4)	Project life (5)	Certain (7)	98 (Medium-High)
Post- Mitigation	N/A				
Impact 2	**Mechanical alteration of water course**				
Pre- Mitigation	Medium (2)	Local (3)	Long term (4)	Likely (5)	45 (Minor)
Post- Mitigation	N/A				

9.1.1.2 Aspect 2: Effects on the quantity of water

Due to the need to develop the areas infrastructure as well as provide more homes water is being removed from the various sites for the construction industry. The impacts affecting water quantity are:

3. Water abstraction.

Aspect 2	**Effects on the quantity of water**				
Parameters	***Severity***	***Spatial scale***	***Duration***	***Probability***	***Significance***
Impact 3	**Water abstraction**				
Pre- Mitigation	Medium (3)	Local (3)	Medium term (3)	High (6)	54 (Minor)
Post- Mitigation	N/A				

9.1.2 Impacts of the proposed Platreef Underground Mine

9.1.2.1 Aspect 1: Effects of water quality on aquatic biota

The proposed underground platinum mine covers a large area, activities related to mining such as the temporary storage of hazardous chemicals, products and waste as well the dewatering of mine workings present potential hazards to the aquatic environment. Previous studies in South Africa have shown that underground platinum mining operations can negatively affect aquatic biota (Gumede et al., 2012).

1. Introduction of pollutants; and
2. Sedimentation from stockpiles.

Issue 1	**Effects on water quality**				
Parameters	***Severity***	***Spatial scale***	***Duration***	***Probability***	***Significance***
Impact 1	**Introduction of pollutants**				
Construction Phase					
Pre- Mitigation	Very Serious (5)	Region (5)	Project life(5)	Probable (4)	60 (Minor)
Post- Mitigation	Very Serious (5)	Region (5)	Project life(5)	Unlikely (3)	45 (Minor)
Operational Phase					
Pre- Mitigation	Very Serious (5)	Region (5)	Project life(5)	Probable (4)	60 (Minor)
Post- Mitigation	Very Serious (5)	Region (5)	Project life(5)	Unlikely (3)	45 (Minor)
Closure Phase					
Pre- Mitigation	Very Significant (7)	Region (5)	Permanent (7)	Highly probable (6)	114 (High)

Post- Mitigation	Very Significant (7)	Region (5)	Permanent (7)	Unlikely (3)	57 (Minor)
Impact 2	**Sedimentation**				
Construction Phase					
Pre- Mitigation	Very Serious (5)	Region (5)	Project life(5)	Probable (4)	60 (Minor)
Post- Mitigation	Very Serious (5)	Region (5)	Project life(5)	Unlikely (3)	45 (Minor)
Operational Phase					
Pre- Mitigation	Very Serious (5)	Region (5)	Project life(5)	Probable (4)	60 (Minor)
Post- Mitigation	Very Serious (5)	Region (5)	Project life(5)	Unlikely (3)	45 (Minor)

Mitigation and Management:

Based on the findings of the impact and aquatic assessment as well as the presence of sensitive and Red Data species it is recommended that the following mitigation actions are planned for the proposed project:

- Cut-off trenches should be constructed around any tailings facilities, stockpiles of overburden and topsoil;
- All hydrocarbons and hazardous materials should be stored within a bunded area, spill kits should be provided in areas where any handling of hydrocarbons/hazardous materials is occurring;
- Only remove vegetation that is within the project footprint area to ensure that runoff and seepage around the project area is maintained;
- Ensure effective storm water management to capture dirty water;
- Ensure quality of discharged water is within a similar state as the current state (baseline);
- TSF's runoff should be contained in a pollution control facility and seepage risks and rates reduced with pollution control facilities (e.g. under drain systems, cut off trenches, use of clay etc.).

9.1.2.2 Aspect 2: Effects on water quantity on aquatic ecology

Due to the proposed mine being underground, large areas of the surface need not be disturbed and the river systems may not need to be modified to a great extent. However the workings may require water for everyday operations (such as cooling). The impacts of such activities are listed below:

- Impact 4: Reduction of water quantity to the Mogalakwena River

Issue 2	Effects on water quantity				
Parameters	***Severity***	***Spatial scale***	***Duration***	***Probability***	***Significance***
Impact 4	**Reduced water quantity**				
Construction Phase					
Pre- Mitigation	Very serious (5)	Local (3)	Project life (5)	Likely (5)	65 (Minor)
Post- Mitigation	Very serious (5)	Local (3)	Project life (5)	Likely (5)	65 (Minor)
Operational Phase					
Pre- Mitigation	Significant (6)	Local (3)	Project life (5)	Highly probable (6)	84 (Moderate)
Post- Mitigation	Significant (6)	Local (3)	Project life (5)	Likely (5)	70 (Minor)

Mitigation and Management:

Based on the findings of the impact assessment on water quantity the following mitigation measures should be implemented in order to minimise the impact of the proposed mining operation on the associated aquatic ecosystems:

- Only dirty water should be managed in the storm water management plan;
- No un-contaminated water should be stored;
- Runoff should be managed in such a manner that channel straightening and erosion does not result in habitat loss; and
- Water abstraction and effluent should be managed so as to replicate the volumes of local aquatic ecosystems.

10 CUMULATIVE IMPACTS

The proposed project is located in a water scarce area. Current residential and industrial practises such as the release of untreated sewage into the water ways seriously compromises the ecological state of the river systems associated with this study.

Based on the current state of the biological communities associated with the project area the cumulative impact of the proposed project will be seen as moderate. This is due to the water stresses and low quality of surface water in the area as well as the potential for secondary impacts such as the increase in need for local water supplies coupled by an increase in waste production by local communities.

Downstream impacts on the "Nylsvlei" system are important to consider due to the sensitive and internationally importance of this system. In light of this the proposed project will be seen to have a moderate impact as a result of potential water quality and quantity impacts.

10.1 Current ecological state

The aquatic ecosystems associated with the proposed Platreef Underground Mine is categorised as seriously modified. This is largely due to the presence of untreated effluent and urban runoff.

10.2 Recommendations

Based on the findings of the current aquatic assessment the following recommendations can be made:

1. An additional high flow survey should be conducted in order to aid in the identification of temporal trends. This should be followed up by on-going biomonitoring;
2. Delineated floodplains and channels should have a 100m buffer zone to help prevent impacts occurring in the aquatic systems
3. Manage water quality impacts through the implementation of measures such as berms and cut off trenches as well as effective surface water management; and
4. Limit abstraction of groundwater if aquifers are connected to the local river systems as substantiated in the groundwater report.

10.3 Monitoring Programme

10.3.1 Location

The monitoring programme should include sites/locations where biological monitoring has occurred previously. The sites included in this study will be sufficient to include in future monitoring applications during the high flow season.

10.3.2 Parameters

The following parameters should be monitored by qualified specialists:

- *In situ* and *ex* situ water quality constituents;
- Sediment and water column metal analysis;
- Toxicity testing;
- Habitat integrity;
- Aquatic macroinvertebrates;
- Fish assemblages; and
- Riparian vegetation.

10.3.3 Objectives

The objectives of the programme would be to monitor the state of the aquatic ecosystem through the measurement of physical and biological properties. As of this study the baseline data is established and can be used to compare with in future studies as a means to determine if ecological degradation or improvement has occurred.

10.3.4 Key performance indicators

Key performance indicators would include the improvement of fish communities associated with the project area.

10.3.5 Responsibility

Environmental manager.

10.3.6 Frequency

Biomonitoring activities should occur bi-annually during the months in which the high flow assessment should preferably be conducted in middle to late February with the low flow assessment in May.

10.3.7 Resources

Aquatic specialist.

10.3.8 Reporting structure

A biomonitoring report should be provided annually on completion of the two surveys or where required monthly.

10.3.9 Threshold or limits

If modifications to the system occur, a reduced biological diversity will be observed. Proliferation of pollution tolerant species may also be an indication of a deterioration of ecological integrity. If there is further reduction in species diversity further studies should be undertaken which should include water quality analysis as well as the accumulation of pollutants in the sediments.

10.3.10 Corrective action

Bi-annual biomonitoring should be undertaken to ascertain any effects caused by the mine. Should there be any deterioration discovered corrective action should be followed, however, if mitigation measures are followed this may be avoided or reduced.

11 CONCLUSION

The aquatic ecosystems associated with the proposed Platreef Underground Mine are considered to be seriously modified as a result of impaired water quality as a consequence of excessive sewage effluent and urban runoff. The baseline aquatic ecosystem status and composition has been established for the associated river courses.

The Red Data species *Oreochromis mossambicus* was found to be present within the associated river system.

The systems under survey occur in arid regions and are prone to long dry spells as such they are classified as ephemeral streams.

The impacts of the “no-go option” were considered to be moderate. The proposed projects impacts were assessed to be moderate before mitigation and minor after mitigation. The baseline quality of water within the associated river courses is seen to be of concern due to the high levels of eutrophication and low water availability. The cumulative impacts of the proposed project were seen to be moderate as a result of the potential for pollutants to further degrade water quality in the area.

Given the current state of the aquatic environment, the proposed mine could potentially have a positive impact through offsetting and rehabilitation of current degraded wetland and riparian ecosystems.

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