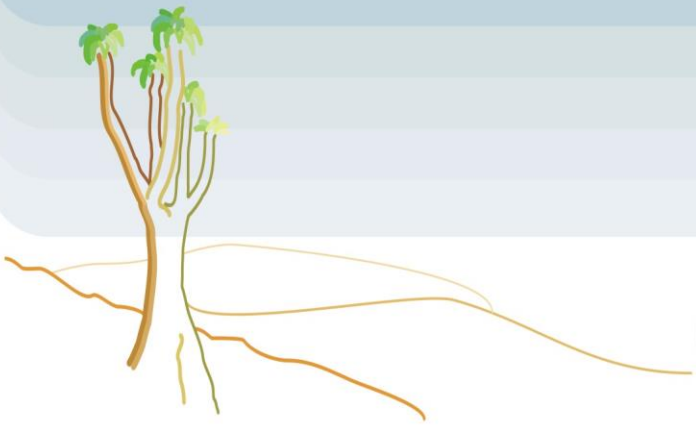


DPR
Ecologists & Environmental Services

Report on the ecological and wetland assessment for the proposed alluvial diamond mining operations on a portion of states land including a portion of the Vaal River near the town of Delportshoop, Northern Cape Province.

January 2019

Prepared by:

Darius van Rensburg
Pr.Sci.Nat. 400284/13
T 083 410 0770
darius@dprecologists.co.za
P.O. Box 12726
Brandhof
9324

61 Topsy Smith Street
Langenhovenpark
9300

Prepared for:
Kimswa Mining (Pty) Ltd

DECLARATION OF INDEPENDENCE

DPR Ecologists and Environmental Services is an independent company and has no financial, personal or other interest in the proposed project, apart from fair remuneration for work performed in the delivery of ecological services. There are no circumstances that compromise the objectivity of the study.

Report Version	**Final 1.0**		
Title	**Report on the ecological and wetland assessment for the proposed alluvial diamond mining operations on a portion of states land including a portion of the Vaal River near the town of Delportshoop, Northern Cape Province.**		
Author	**DP van Rensburg (Pr.Sci.Nat)**		**Jan'19**

Executive Summary

The study area is situated near the rural settlement of Longlands (approximately 2.5 km to the east) and also near the small town of Delportshoop (approximately 2.5 km to the west). The study area proposed for alluvial diamond mining is primarily situated along the banks and main channel of the Vaal River and has an approximate extent of 5 hectares (Map 1).

The study area has been transformed by previous mining operations (Map 1). This clearly includes all riparian zones associated with the river as well as a portion of the main channel. Rehabilitation of the post mining environment was overall poorly done and consequently the re-establishment of natural vegetation is also poor with some areas unable to establish any kind of vegetation. Portions of the study area has however been able to establish a pioneer but largely indigenous vegetation layer.

The Vaal River, its main channel, banks and floodplain form almost the entire site (Map 1). The soil samples taken along the banks of the Vaal River are clearly indicative of wetland conditions on a perennial basis (Map 1). The marginal and lower zones of the Vaal River contain distinctive wetland soil indicators (Appendix B). The Marginal Zone shows soil characters of a permanent zone of wetness. The upper zone contains a minimal grey matrix, no mottles and is not considered as being a wetland area.

The wetland conditions associated with the Vaal River can be characterised as a channel wetland system (SANBI 2009).

Habitat and species diversity is relatively low and not representative of the natural condition which should have been much higher. Nonetheless, mining of the banks of the river will still have a high level of impact, especially on the river itself and largely in the form of sedimentation. The banks of the river should therefore still be regarded as highly sensitive. A small portion of the site consists of a braided main channel and associated wetland areas which is considered relatively unique and of high conservation value. The area is capable of sustaining a large biomass and consequently contributes to species diversity. In comparison with the river section in this region this habitat type is uncommon and takes up a small percentage of the river habitats. The braided network and marginal zone is considered especially sensitive and unique. This must be seen in context that all watercourse systems must be regarded as sensitive systems although some habitats can be regarded as more unique than others. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1).

An Index of Habitat Integrity (IHI) was conducted for the Vaal River for the section forming part of the study area (Appendix C). The IHI will be taken as representative of the Present Ecological State (PES) of this system. The largest impact on the site itself is considered historical alluvial diamond mining which has had a high impact on the site. Consequently almost the entire site has been transformed from the natural vegetation type and is currently dominated by pioneer species. This will undoubtedly also have an impact on the ecological functioning of the Vaal River. Upstream impacts are also numerous and cause alteration in the functioning of the river. The most prominent impacts are alluvial diamond mining and construction of containment dams which alter the flooding regime and the functioning and habitat of the river and its floodplains. The results of the IHI indicated that the Vaal River has an Instream IHI of category C: Moderately Modified and Riparian IHI of category D: Largely Modified. This is largely due to the change in flooding regime and other significant impacts as

well as historical alluvial diamond mining within the study area which is mostly responsible for degradation of the riparian vegetation and bank modification.

The EI&S of the floodplains associated with the Vaal River has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains are not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

A Risk Assessment for the proposed mining area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix D). Mining within the main channel or banks of the Vaal River or wetland areas as described will likely cause permanent modification of this system. Although a comprehensive rehabilitation and monitoring regime may decrease this risk it is still unlikely to ensure the re-establishment of the original natural functioning. However, the banks and main channel of the river was already previously mined without any adequate rehabilitation implemented which has caused extensive modification and degradation of the river. Therefore, should the current proposed mining implement comprehensive and successful rehabilitation this may decrease the risk somewhat and may improve the condition of the river to some extent. However, a small portion of the site on the eastern border consists of a braided main channel. The braided network and marginal zone is considered especially sensitive and unique. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1). On condition that comprehensive and successful rehabilitation is undertaken and that the small portion of braided main channel is excluded from mining, the risk is considered to remain moderate.

The banks and portions of the main channel has already been transformed by previous mining operations and this thereby decreases the sensitivity of the site to some degree. Therefore, should mining take place on the site the impacts would be lower, though still significant, compared to other more natural portions of the river bank. Despite this the system still provides vital services including water transportation, flood dissipation, wetland and riparian habitat (albeit degraded) and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and mining should endeavour to keep impacts on it to a minimum. Furthermore, since previous mining did not implement adequate rehabilitation the proposed mining has the opportunity to improve rehabilitation and re-instate a more natural geomorphology and riparian community than is currently the case. As a further mitigation to the proposed mining which will offset the impacts of mining in the river, the transformed portion of the river bank adjacent to the site can also be rehabilitated which will improve the functioning of the riparian community.

A small portion of the site on the eastern border consists of a braided main channel. The area is capable of sustaining a large biomass and consequently contributes to species diversity. In comparison with the river section in this region this habitat type is uncommon and takes up a small percentage of the river habitats. The braided network and marginal zone is considered especially sensitive and unique. This must be seen in context that all watercourse systems must be regarded as sensitive systems although some habitats can be regarded as more unique than others. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1).

Table of contents

Ecological and Wetland assessment.

1. INTRODUCTION

1.1 Background

Natural vegetation is an important component of ecosystems. Some of the vegetation units in a region can be more sensitive than others, usually as a result of a variety of environmental factors and species composition. These units are often associated with water bodies, water transferring bodies or moisture sinks. These systems are always connected to each other through a complex pattern. Degradation of a link in this larger system, e.g. tributary, pan, wetland, usually leads to the degradation of the larger system. Therefore, degradation of such a water related system should be prevented.

Though vegetation may seem to be uniform and low in diversity it may still contain species that are rare and endangered. The occurrence of such a species may render the development unviable. Should such a species be encountered the development should be moved to another location or cease altogether.

South Africa has a large amount of endemic species and in terms of plant diversity ranks third in the world. This has the result that many of the species are rare, highly localised and consequently endangered. It is our duty to protect our diverse natural resources.

South Africa's water resources have become a major concern in recent times. As a water scarce country, we need to manage our water resources sustainably in order to maintain a viable resource for the community as well as to preserve the biodiversity of the system. Thus, it should be clear that we need to protect our water resources so that we may be able to utilise this renewable resource sustainably. Areas that are regarded as crucial to maintain healthy water resources include wetlands, streams as well as the overall catchment of a river system.

In order to better manage our water resources several guidelines and research sources have been developed. Amongst these are the National Freshwater Ecosystem Priority Areas for South Africa 2011 (NFEPA).

It is well known that diamond mining operations, especially pertaining to alluvial mining, has several detrimental impacts on the environment. These impacts are numerous but the most pronounced impacts are associated with the excavation of large amounts of earth materials, the storage and disposal thereof and the sedimentation associated with it. This usually causes degradation of waterways due to sedimentation as well as the transformation of the vegetation and ecosystem on the site.

The study area is situated near the rural settlement of Longlands (approximately 2.5 km to the east) and also near the small town of Delportshoop (approximately 2.5 km to the west). The study area proposed for alluvial diamond mining is primarily situated along the banks and main channel of the Vaal River and has an approximate extent of 5 hectares (Map 1). The site includes the main channel, banks and floodplain of the river. The river and its banks has clearly been transformed to a large extent by previous mining activities. The majority of the river bank has however been able to re-establish a riparian and wetland vegetation community.

A site visit was conducted on 9 January 2019. The entire footprint of the proposed mining area, including the river bank, associated wetland areas and floodplain, was surveyed over the period of one day. The site survey was conducted during summer, and plant identification along the river could be easily done.

For the above reasons it is necessary to conduct a wetland assessment of an area proposed for development.

The report together with its recommendations and mitigation measures should be used to minimise the impact of the proposed mining development.

1.2 The value of biodiversity

The diversity of life forms and their interaction with each other and the environment has made Earth a uniquely habitable place for humans. Biodiversity sustains human livelihoods and life itself. Although our dependence on biodiversity has become less tangible and apparent, it remains critically important.

The balancing of atmospheric gases through photosynthesis and carbon sequestration is reliant on biodiversity, while an estimated 40% of the global economy is based on biological products and processes.

Biodiversity is the basis of innumerable environmental services that keep us and the natural environment alive. These services range from the provision of clean water and watershed services to the recycling of nutrients and pollution. These ecosystem services include:

- Soil formation and maintenance of soil fertility.
- Primary production through photosynthesis as the supportive foundation for all life.
- Provision of food, fuel and fibre.
- Provision of shelter and building materials.
- Regulation of water flows and the maintenance of water quality.
- Regulation and purification of atmospheric gases.
- Moderation of climate and weather.
- Detoxification and decomposition of wastes.
- Pollination of plants, including many crops.
- Control of pests and diseases.
- Maintenance of genetic resources.

2. SCOPE AND LIMITATIONS

- To evaluate the present state of the wetlands and riparian vegetation included within the study area. The importance of the ecological function and condition will also be assessed.
- Identify and delineate wetland and riparian areas associated with the Vaal River.
- Determine the Present Ecological State (PES) and Ecological Importance & Sensitivity (EIS) for the Vaal River in the study area.
- Conduct a risk assessment and determine the likelihood that watercourses and wetlands will be adversely affected by the mining operations.

2.1 Riparian Vegetation

Aspects of the riparian vegetation that will be assessed include:

- The vegetation types of the region with their relevance to the study area.
- The overall status of the riparian vegetation along the wetlands in the study area.
- Species composition with the emphasis on dominant-, rare- and endangered species.
- Boundary of wetlands using obligate wetland riparian species.

The amount of disturbance present on the study area assessed according to:

- The amount of grazing impacts.
- Disturbance caused by human impacts.
- Other disturbances.

2.2 Wetlands and watercourses

Aspects of the wetlands that will be assessed include:

- Identification and delineation of watercourses including rivers, streams, pans and wetlands.
- Describe condition and status of watercourses and importance relative to the larger system.
- Conduct habitat integrity assessment of perennial systems to inform the condition and status of watercourses.

2.4 Limitations

Due to the season of the survey several bulbs, seasonal herbs and subterranean succulents may have been overlooked as leaves and flowers may be absent due to their seasonal or deciduous nature.
Although a comprehensive survey of the site was done it is still likely that several species were overlooked.
Smaller drainage lines may have been overlooked where a distinct channel or riparian vegetation is absent.
Due to previous mining activities this may have altered soil layers and the morphology of the river banks which would complicate the delineation of wetland and riparian areas.
Due to a rocky substrate soil sampling was not possible along all areas of the river bank.

3. METHODOLOGY

3.1 Several literature works were used for additional information.

Vegetation:
Red Data List (Raymondo *et al.* 2009).
Vegetation types (Mucina & Rutherford 2006).
Field guides used for riparian species identification (Bromilow 1995, 2010, Coates-Palgrave 2002, Fish *et al* 2015, Gerber *et al* 2004, Gibbs Russel *et al* 1990, Griffiths & Picker 2015, Manning 2009, Roberts & Fourie 1975, Shearing & Van Heerden 2008, Van Ginkel *et al* 2011, Van Oudtshoorn 2004, Van Rooyen 2001, Van Wyk & Malan 1998).

Wetland methodology, delineation and identification:
Department of Water Affairs and Forestry 2004, 2005, 2008, Collins 2006, Duthie 1999, Kleynhans *et al* 2008, Marnewecke & Kotze 1999, Nel *et al* 2011, SANBI 2009.

3.2 Survey

The site was assessed by means of transects and sample plots.

Noted species include rare and dominant species.
The broad vegetation types present at the site were determined.
The state of the environment was assessed in terms of condition, grazing impacts, disturbance by humans, erosion and presence of invader and exotic species.
The state of the habitat was also assessed.

All rivers, streams, pans and wetlands were identified and surveyed where it occurred in the study area.

These systems were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix B).
The following guidelines and frameworks were used to determine and delineate the rivers, streams, pans and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

The following guidelines and frameworks were used to determine the sensitivity or importance of these identified watercourses in the study area:

- Nel *et al.* (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

- Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

- Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

These guidelines provide the characteristics which can be utilised to determine if a wetland or watercourse is present and also aids in determining the boundary of these systems.

A Risk Assessment will be conducted for the alluvial diamond mining operations in the study area in accordance with the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use.

3.3 Criteria used to assess sites

Several criteria were used to assess the study area and determine the overall status of the environment.

3.3.1 Vegetation characteristics

Characteristics of the vegetation in its current state. The diversity of species, sensitivity of habitats and importance of the ecology as a whole.

Habitat diversity and species richness: normally a function of locality, habitat diversity and climatic conditions.
Scoring: Wide variety of species occupying a variety of niches – 1, Variety of species occupying a single nich – 2, Single species dominance over a large area containing a low diversity of species – 3.

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely – 3.

Ecological function: All plant communities play a role in the ecosystem. The ecological importance of all areas though, can vary significantly e.g. wetlands, drainage lines, ecotones, etc.
Scoring: Ecological function critical for greater system – 1, Ecological function of medium importance – 2, No special ecological function (system will not fail if absent) – 3.

Degree of rarity/conservation value:
Scoring: Very rare and/or in pristine condition – 1, Fair to good condition and/or relatively rare – 2, Not rare, degraded and/or poorly conserved – 3.

3.3.2 Vegetation condition

The sites are compared to a benchmark site in a good to excellent condition. Vegetation management practises (e.g. grazing regime, fire, management, etc.) can have a marked impact on the condition of the vegetation.

Percentage ground cover: Ground cover is under normal and natural conditions a function of climate and biophysical characteristics. Under poor grazing management, ground cover is one of the first signs of vegetation degradation.
Scoring: Good to excellent – 1, Fair – 2, Poor – 3.

Vegetation structure: This is the ratio between tree, shrub, sub-shrubs and grass layers. The ratio could be affected by grazing and browsing by animals.
Scoring: All layers still intact and showing specimens of all age classes – 1, Sub-shrubs and/or grass layers highly grazed while tree layer still fairly intact (bush partly opened up) – 2, Mono-layered structure often dominated by a few unpalatable species (presence of barren patches notable) – 3.

Infestation with exotic weeds and invader plants or encroachers:
Scoring: No or very slight infestation levels by weeds and invaders – 1, Medium infestation by one or more species – 2, Several weed and invader species present and high occurrence of one or more species – 3.

Degree of grazing/browsing impact:
Scoring: No or very slight notable signs of browsing and/or grazing – 1, Some browse lines evident, shrubs shows signs of browsing, grass layer grazed though still intact – 2, Clear browse line on trees, shrubs heavily pruned and grass layer almost absent – 3.

Signs of erosion: The formation of erosion scars can often give an indication of the severity and/or duration of vegetation degradation.
Scoring: No or very little signs of soil erosion – 1, Small erosion gullies present and/or evidence of slight sheet erosion – 2, Gully erosion well developed (medium to large dongas) and/or sheet erosion removed the topsoil over large areas – 3.

3.3.3 Faunal characteristics

Presence of rare and endangered species: The actual occurrence or potential occurrence of rare or endangered species on a proposed site plays a large role on the feasibility of a development. Depending on the status and provincial conservation policy, presence of a Red Data species or very unique and sensitive habitats can potentially be a fatal flaw.
Scoring: Occurrence actual or highly likely – 1, Occurrence possible – 2, Occurrence highly unlikely.

3.4 Biodiversity sensitivity rating (BSR)

The total scores for the criteria discussed in section 3.3 were used to determine the biodiversity sensitivity ranking for the sites. On a scale of 0 – 30, five different classes are described to assess the biodiversity of the study area. The different classes are described in the Table 1:

Table 1: Biodiversity sensitivity ranking

BSR	BSR general floral description	Floral score equating to BSR class
Totally transformed (5)	Vegetation is totally transformed or in a highly degraded state, generally has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area has lost its inherent ecological function. The area has no conservation value and potential for successful rehabilitation is very low.	29 – 30
Advanced Degraded (4)	Vegetation is in an advanced state of degradation, has a low level of species diversity, no species of concern and/or has a high level of invasive plants. The area's ecological function is seriously hampered, has a very low conservation value and the potential for successful rehabilitation is low.	26 – 28
Degraded (3)	Vegetation is notably degraded, has a medium level of species diversity although no species of concern are present. Invasive plants are present but are still controllable. The area's ecological function is still intact but may be hampered by the current levels of degradation. Successful rehabilitation of the area is possible. The conservation value is regarded as low.	21 – 25
Good Condition (2)	The area is in a good condition although signs of disturbance are present. Species diversity is high and species of concern may be present. The ecological function is intact and very little rehabilitation is needed. The area is of medium conservation importance.	11 – 20
Sensitive/Pristine (1)	The vegetation is in a pristine or near pristine condition. Very little signs of disturbance other than those needed for successful management are present. The species diversity is very high with several species of concern known to be present. Ecological functioning is intact and the conservation importance is high.	0 - 10

4. ECOLOGICAL AND WETLAND ASSESSMENT

4.1 Overview of ecology and vegetation types (Mucina & Ruterford 2006)

According to Mucina & Rutherford (2006) the area consists of Kimberley Thornveld (SVk 4). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Map 2). The vegetation type is not currently subjected to any pronounced transformation pressures.

The study area is situated near the rural settlement of Longlands (approximately 2.5 km to the east) and also near the small town of Delportshoop (approximately 2.5 km to the west). The study area proposed for alluvial diamond mining is primarily situated along the banks and main channel of the Vaal River and has an approximate extent of 5 hectares (Map 1). The site includes the main channel, banks and floodplain of the river. The river and its banks has clearly been transformed to a large extent by previous mining activities. The majority of the river bank has however been able to re-establish a riparian and wetland vegetation community. The site itself is confined to the riparian zone and does not include a portion of the surrounding terrestrial environment. However, it is relevant that the adjacent area has been severely affected by alluvial mining operations which has also had a high impact on the site. The site itself including river banks, has also been affected to a large degree.

The study area has been transformed by previous mining operations (Map 1). This clearly includes all riparian zones associated with the river as well as a portion of the main channel. Rehabilitation of the post mining environment was overall poorly done and consequently the re-establishment of natural vegetation is also poor with some areas unable to establish any kind of vegetation. Portions of the study area has however been able to establish a pioneer but largely indigenous vegetation layer.

The previous mining operations must be regarded as the most significant impact on the study area. Impacts associated with this include the initial removal of the natural vegetation layer. Associated with this was also the removal of the topsoil layer, which was evidently not adequately replaced and consequently prevented the establishment of natural vegetation in many areas. The topography has been altered to a large degree through the excavation of a large amount of material which was not replaced adequately in the post mining environment. Large areas consist of tailings of rounded gravel rocks and boulders and in these areas vegetation is unable to establish due to the absence of soil. The inadequate rehabilitation resulting from previous mining clearly indicate the high impact this has and the need for post mining rehabilitation and adequate management of topsoil.

As already mentioned the topography of the study area has been altered to a large degree. This is a result of previous mining operations and inadequate rehabilitation being undertaken. Deep excavations and a variety of small and large tailing dumps litter the study area. This is also evident in deep excavations adjacent to the river forming artificial impoundments (Map 1). The general topography, anticipated to have been present prior to mining, is considered to largely consist of a uniform plain which has a gradual slope toward the Vaal River, i.e from north to south, but which may increase significantly in the slope gradient in the portion adjacent to the river. The topography of the banks of the Vaal River is also considered modified by previous mining.

The immediate region has an approximate mean annual rainfall of 400 mm (Bezuidenhout 1994). This is considered a relatively low rainfall and causes the area to form part of the more arid parts of South Africa. The occurrence of wetlands are therefore not common, however, due to the proximity to the Vaal River the area does contain several wetlands associated with the floodplain of the Vaal River. Temperature is less erratic than rainfall with cold winters as low as -4˚C while the summer temperatures may be as high as 44˚C.

Geology of the study area is underlain by the following: Outcrops of andesitic lavas of the Ventersdorp Supergroup overlain by calcrete occur as low hills. Outcrops of tillite of the Dwyka Formation and shale of the Prince Albert Formation occur in the north west of the area. The majority of the study area is underlain by aeolian sands and alluvial gravels of Tertiary to Recent age covering Dwyka tillite. Surface limestone also occurs sporadically. Three land types, the AH, Ae and Dc land types occur in the area (Bezuidenhout 1994).

A detailed ecological study of the major plant communities of the area was conducted by Bezuidenhout (1994) which identified 11 plant communities on the site. These communities are:

- *Schmidtia pappophoroides - Themeda triandra* Grassland within the southern portions of the study area
- *Grewia flava - Acacia erioloba* Woodland of deep red sandy soil within the western portions of the study area.
- *Lycium hirsutum - Acacia erioloba* Woodland of deep yellow sandy soil of the north-northeastern portion of the study area.
- *Rhus ciliata - Tarchonanthus camphoratus* Shrubland distributed within large areas of the study area.
- *Acacia erioloba - Acacia tortilis* Woodland of ancient gravel filled water courses.
- *Boscia albitrunca - Acacia mellifera* Shrubland of the rocky isolated rocky hills.
- *Acacia tortillis - Acacia mellifera* Shrubland near the Vaal River.
- *Enneapogon cenchroides - Acacia tortillis* Woodland of recently deposited Vaal River gravel within the northern portions of the study area.
- *Pentzia incana - Acacia melifera* Shrubland in the north-northwestern portion of the study area.
- *Eragrostis sp. - Chloris virgata* Grassland restricted to the floodplain within the north-northwestern portion of the study area along the Vaal River.

Take note that the following changes to taxonomy has been made since this study:

A. erioloba - Vachellia erioloba
R. ciliata - Searsia ciliata
A. torilis - Vachellia tortilis
A. mellifera - Senegalia mellifera

4.2 Wetland Assessment

The Vaal River, its main channel, banks and floodplain form almost the entire site (Map 1).

The term watercourse refers to a river, stream, wetland or pan. The National Water Act (NWA, 1998) includes rivers, streams, pans and wetlands in the definition of the term watercourse. This definition follows:

Watercourse means:

- A river or spring.
- A natural channel in which water flows regularly or intermittently.
- A wetland, lake or dam into which water flows.
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The classification of stream orders from 1 to 3 can be illustrated by means of the Strahler 1952 classification:

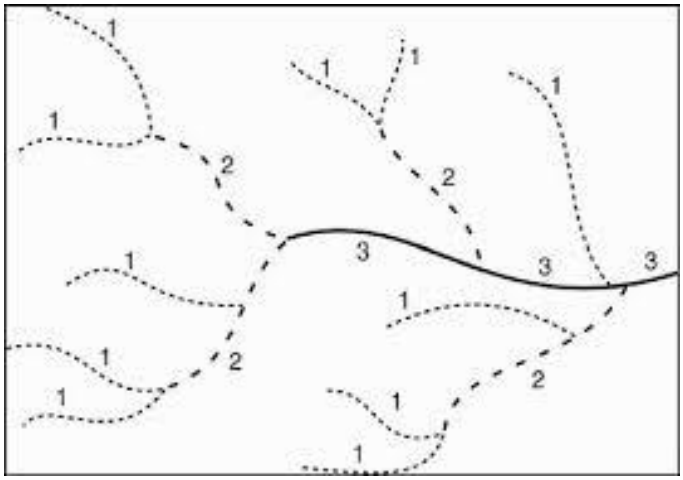


Figure 8: The classification of stream orders from 1 to 3 (Strahler 1952)

Riparian habitat is an accepted indicator of watercourses used to delineate the extent of wetlands, rivers, streams and pans (Department of Water Affairs and Forestry 2005).

The Vaal River and its associated wetland conditions were delineated by use of topography (land form and drainage pattern) and riparian vegetation with limited soil sampling (Appendix B). The following guidelines and frameworks were used to determine and delineate the watercourses and wetlands in the study area:

- Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.
- Marnewecke & Kotze 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to determine the border and also to confirm the presence of wetland soils along the banks of the Vaal River (Appendix B). Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils. The soil samples taken along the banks of the Vaal River are clearly indicative of wetland conditions on a perennial basis (Map 1). The marginal and lower zones of the Vaal River contain distinctive wetland soil indicators. The Marginal Zone shows soil characters of a permanent zone of wetness.

The upper zone contains a minimal grey matrix, no mottles and is not considered as being a wetland area (Appendix B). However, the marginal and lower zone of the Vaal River contains distinctive wetland soil indicators. The banks (Lower Zone) shows indications of a seasonal zone of wetness whilst the Marginal Zone shows soil characters of a permanent zone of wetness.

It should be noted that due to previous extensive mining this has altered the natural geomorphology of the river, the riparian zones and consequently has complicated the determination of the wetland areas associated with the river. For example, several backwater artificial impoundments has been formed which although resembling backwater areas are clearly formed by mining excavations (Map 1).

4.2.1 Classification of wetland systems

The wetland conditions identified along the Vaal River can be classified into a specific wetland type.

The wetland conditions associated with the Vaal River can be characterised as a channel wetland system (SANBI 2009):

"An open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. Note that, for purposes of the classification system, channels generally refer to rivers or streams (including those that have been canalised) that are subject to concentrated flow on a continuous basis or periodically during flooding, as opposed to being characterised by diffuse flow (see unchannelled valley-bottom wetland). As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks. An active channel is a channel that is inundated at sufficiently regular intervals to maintain channel form and keep the channel free of established terrestrial vegetation. These channels are typically filled to capacity during bankfull discharge (i.e. during the annual flood, except for intermittent rivers that do not flood annually)."

This accurately describes the wetland conditions along the Vaal River (Map 1). Here the wetland conditions are most prominent along the main channel and decrease in distance from the channel.

4.2.2 Description of the Vaal River

The Vaal River was surveyed by three separate locations along the banks of the river situated on the site (Map 1). The length of river included in the study area is approximately 2 km. The Vaal River, though well known to be degraded and modified, still performs several vital ecosystem services as well as services rendered to downstream users. The section of river in the study area has clearly been heavily affected by previous mining but nonetheless forms part of a linear system which will also affect downstream areas.

Obligate wetland vegetation was also used to determine the presence of wetland conditions. Obligate wetland species are confined to wetlands and are only able to occur in wetlands. They are therefore reliable indicators of wetland conditions. Field observations over time as well as the following sources were used to determine FW and OW species:

- Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

- DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M.Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

River systems can be divided into different riparian zones within the lateral section of the system. These zones are as follows:

The marginal zone is the lowest zone and is always present in river systems while the other two zones may not always be present. The zone is situated from the water level at low flow, if present, up to the features that are hydrologically activated for the most of the year (Figure 21 & 22). From the survey it is clear that the marginal zone was also heavily affected by previous mining operations and the geomorphology has been altered in many areas. The marginal zone has however managed to become stable and a representative wetland community has again established, resembling to a significant degree the natural condition. It is however clear that the transformation of the geomorphology is a large impact which has also altered the flow regime to a significant extent. The majority of the marginal zone is relatively narrow, except at the eastern end of the site where a braided portion occurs and forms a rather unique habitat which will also have a more important functioning in terms of water purification and wetland habitat. It is evident that previous mining has also impacted this area although it remains of a higher sensitivity and should be excluded from mining as far as possible. Vegetation in the marginal zone is dominated by a variety of obligate wetland plants including aquatic and semi-aquatic species. These include sedges *Cyperus marginatus, C. longus, C. sexangularis,* rushes, *Juncus exertus,* reeds, *Phragmites australis*, hygrophilous grasses, *Agrostis lachnantha, Hemarthria altissima, Setaria incrassata, Paspalum distichum* and a variety of aquatic and semi-aquatic herbs *Ranunculus multifidus, Gomphostigma virgatum, Beula erecta, Persicaria lapathifolia, Conyza podocephala, Nidorella ivifolia* and *Pseudognaphalium luteo-album*. The riparian tree, *Salix mucronata*, is also scattered along the marginal zone. Exotic weeds are common but do not dominate and do indicate a disturbed marginal zone. These include *Verbena bonariensis, Oenothera rosea, Ambrosia artemisiifolia, Sesbania bispinosa* var. *bispinosa* and *Myriophyllum spicatum*. The diversity of species is significant despite the zone having been affected by previous mining and indicates that the marginal zone is able to rehabilitate itself to a comparatively natural condition. The braided portion at the eastern border of the site does contribute to habitat diversity and is considered a unique habitat with high conservation value.

Figure 9: View of the marginal zone (red) at the western border of the site. Note that the zone is relatively narrow. Aldo the low water bridge immediately downstream of the site.

Figure 10: View of the marginal zone (red) at the western border of the site. Note mine tailings are evident in the upper zone.

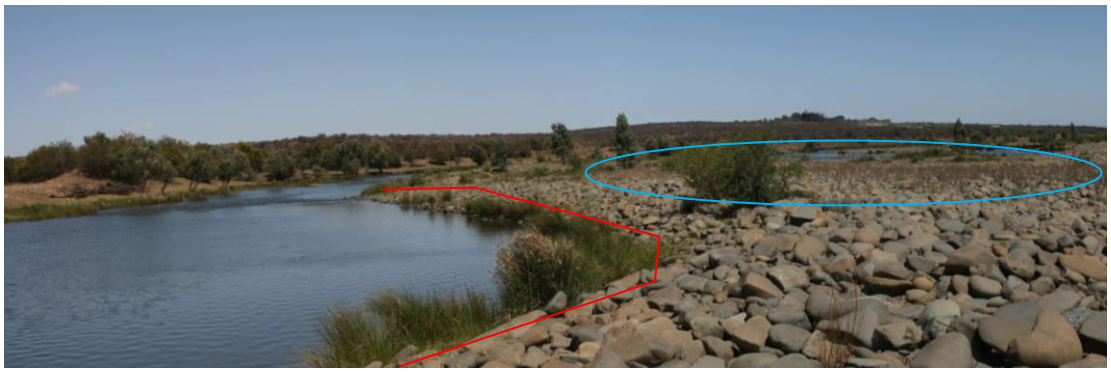


Figure 11: View of the marginal zone (red) in the middle section of the site. Note how mining has caused extensive transformation here. The lower zone is also dominated by exotic weeds (blue).

Figure 12: View of the marginal zone (red) at the eastern border of the site at the braided portion of the river. Note that the marginal zone is more extensive here and although mining impacts are visible this are is still considered a unique habitat.

The lower zone is characterised by seasonal features and extends from the marginal zone up to an area of marked elevation. This area may be accompanied by a change in species distribution patterns. The lower zone consists of geomorphic features that are activated on a seasonal basis (Figure 21 & 22). The lower zone is significantly wider than the marginal zone and has a distinct gradient. Its border with the marginal zone is quite distinct and easily identified but the border with the upper zone is vague, mostly due to previous mining. The lower zone is clearly heavily degraded and transformed by previous mining without adequate rehabilitation and consequently the vegetation layer also clearly reflects this. The lower zone is inundated infrequently and only during larger flooding events. It is dominated by riparian grasses. Vegetation include riparian grasses *Cynodon dactylon, Panicum coloratum,* sedges, *Cyperus marginatus*, which is a clear indicator of wetland conditions persisting in the lower zone and low, herbaceous species, *Phyla nodiflora, Arctotis arctotoides, Heliotropium ovalifolium, Cullen tomentosum*. The herbaceous shrub, *Gomphocarpus fruticosus*, is also common and a pioneer species indicating disturbed areas. Due to the degraded and transformed nature of the lower zone exotic weeds are abundant and may dominate where disturbance is high. These include *Plantago major, Ambrosia artemisiifolia, Argemone ochroleuca, Gomphrena celosioides, Nicotiana longituba, Verbena bonariensis* and *Ciclospermum leptophyllum*.

Figure 13: The lower zone (red) at the western border of the site is clearly wider than the marginal zone and dominated a short grass/herb layer.

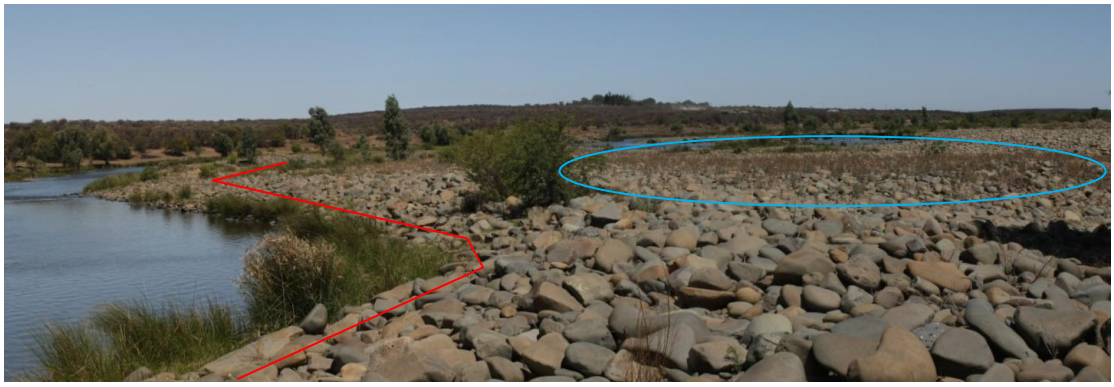


Figure 14: The lower zone (red) at the central section of the site. Note that mining has caused serious degradation here and large areas has been unable to establish natural vegetation. A patch of exotic weeds are indicated (blue).

Figure 15: Another view of the same area as depicted in Fig. 14 illustrating extensive disturbance caused by mining.

Figure 16: Another view of the lower zone in the central section of the site. Note that here vegetation is present and clearly indicative of wetland condition, albeit on a seasonal basis.

Figure 17: The lower zone (red) at the eastern portion of the site. Note again large-scale degradation caused by previous mining. A poorly rehabilitated excavation formed by mining (red) has also formed an artificial impoundment.

The upper zone is characterised by ephemeral features as well as the presence of both riparian and terrestrial species. The zone extends from the lower zone to the riparian corridor. The upper zone contains geomorphic features that are hydrologically activated on an ephemeral basis (Figure 21 & 22). The geomorphology of the upper zone has been extensively transformed by previous mining and consequently the borders between the upper zone and terrestrial environment is no longer identifiable. The vegetation does indicate the relative location of the zone and is dominated by riparian trees though does not form a thicket as is natural to this area and is clearly transformed. The geomorphology which would naturally be an easy indicator of the zone has been altered by previous mining although some areas do indicate a drastic decrease over a short distance which is similar to the natural shape. The upper zone is severely degraded due to previous mining although adequate rehabilitation would considerably have alleviated this impact. The upper zone is only flooded during exceptionally large floods and this occurs on an ephemeral basis. The vegetation is very low in species diversity and dominated by a short grass layer with scattered riparian trees and exotic weeds dominant in some areas. The riparian tree species within the upper zone is dominated by *Searsia lancea, Vachellia karroo, V. tortilis* and *Diospyros lycioides*, which is much lower than the natural species diversity. The grass layer is dominated by *Cynodon dactylon* and *Aristida congesta* with scattered clumps of *Themeda triandra, Eragrostis lehmanniana, Panicum coloratum* and *Heteropogon contortus*. Pioneer shrubs and herbs are scattered and include *Laggera decurrens* and *Gomphocarpus fruticosus*. As mentioned exotic weeds and invaders are abundant and include *Argemone ochroleuca, Bidens bipinnata, Schkuhria pinata, Datura ferox, D. stramonium, Eucalyptus camaldulensis, Prosopis glandulosa, Sonchus oleraceus* and *Boerhavia cordobensis*.

Figure 18: The upper zone (red) is clearly transformed but somewhat discernible where it levels off from the lower zone.

Figure 19: Mining in the upper zone has formed deep excavations which have become filled with groundwater and form artificial impoundments.

Figure 20: The upper zone in many areas is severely degraded and transformed from the natural condition.

Habitat and species diversity is relatively low and not representative of the natural condition which should have been much higher. Nonetheless, mining of the banks of the river will still have a high level of impact, especially on the river itself and largely in the form of sedimentation. The banks of the river should therefore still be regarded as highly sensitive. A small portion of the site consists of a braided main channel and associated wetland areas which is considered relatively unique and of high conservation value. The area is capable of sustaining a large biomass and consequently contributes to species diversity. In comparison with the river section in this region this habitat type is uncommon and takes up a small percentage of the river habitats. The braided network and marginal zone is considered especially sensitive and unique. This must be seen in context that all watercourse systems must be regarded as sensitive systems although some habitats can be regarded as more

unique than others. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1).

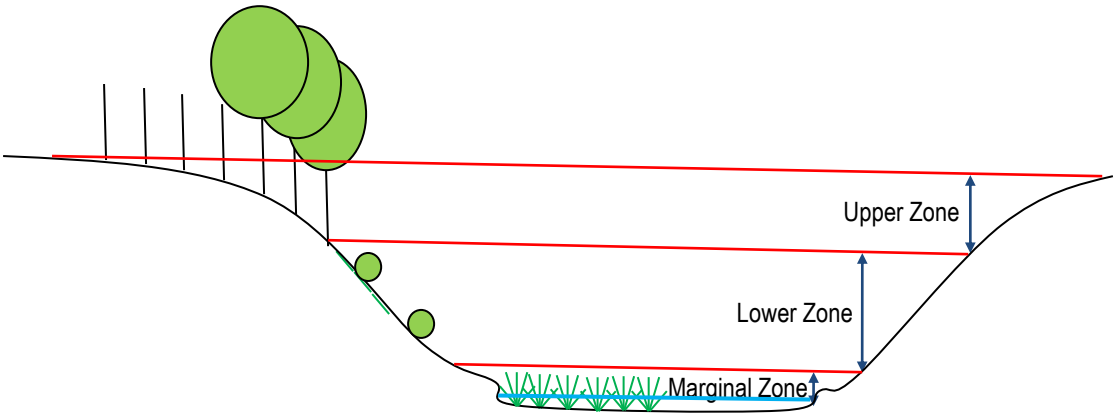


Figure 21: Illustration showing the different riparian zones of the of Vaal River in the study area. This is the general situation in the region but due to previous mining has been transformed and is not readily discernible.

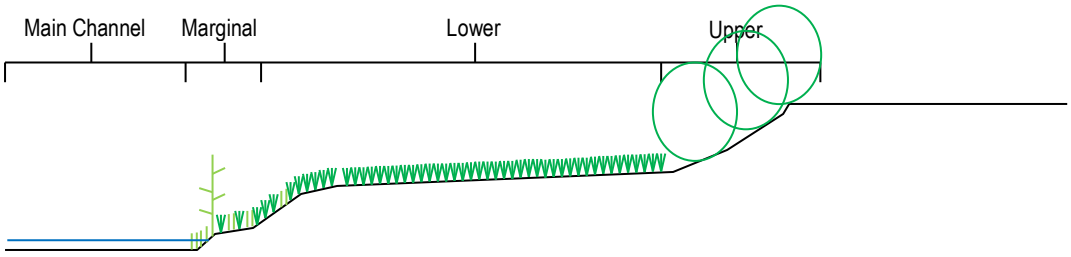


Figure 22: Illustration showing the different riparian zones of the of Vaal River in the study area. This is the general situation in the region but due to previous mining has been transformed and is not readily discernible.

4.2.3 Condition and importance of the affected watercourses

An Index of Habitat Integrity (IHI) was conducted for the Vaal River for the section forming part of the study area (Appendix C). The IHI will be taken as representative of the Present Ecological State (PES) of this system.

Table 2 refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers relative to the natural or close to the natural reference condition. The purpose of the EcoClassification process is to gain insights and understanding into the causes and sources of the deviation of the PES of biophysical attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river (Kleynhans & Louw 2007).

Table 3 refers to the Ecological Importance and Sensitivity (EIS) of wetlands. "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to

the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The Ecological Importance and Sensitivity (EIS) provides a guideline for determination of the Ecological Management Class (EMC).

Table 2: Ecological categories for Present Ecological Status (PES).

Ecolocial Category	Description
A	Unmodified, natural
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.
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominately unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem function has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	Critically/Extremely modified. Modifications have reached a critical level and the system has been modified completely with 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.

Table 3: Ecological importance and sensitivity categories.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very High Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of	>0 and <=1	D

water of major rivers.		

According to Kleynhans (2000) a desktop assessment of the Vaal River in the study area and which will be affected by mining operations is considered to have a PES of Category D: Largely Modified. On-site observation indicate that this is relatively accurate as this study has also calculated the river as having a PES of Category C/D: Moderately Modified. A large loss of natural habitat, biota and basic ecosystem function has occurred. Despite this the system still provides vital services including water transportation, flood dissipation, wetland and riparian habitat (albeit degraded) and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and mining should endeavour to keep impacts on it to a minimum. In addition, a small portion of the site on the eastern border consists of a braided main channel. The area is capable of sustaining a large biomass and consequently contributes to species diversity. In comparison with the river section in this region this habitat type is uncommon and takes up a small percentage of the river habitats. The braided network and marginal zone is considered especially sensitive and unique. This must be seen in context that all watercourse systems must be regarded as sensitive systems although some habitats can be regarded as more unique than others. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible.

The section of the Vaal River within the study area is considered to be moderately to largely modified by several impacts. The flood dynamics of the river has been altered to a large degree by the construction of large dams upstream. The construction of large containment dams such as the Bloemhof- and Vaal Dams has influenced the frequency and magnitude of flooding which is part of the natural system. As a result thereof the flooding of the floodplain within the upper zone does no longer take place at the same regular intervals and magnitude. The floodplain within the upper zone of the river is now more dependent on surface runoff. Extensive alluvial diamond mining takes place in several areas upstream and downstream of the site as well as previous mining which had taken place in the study area (Map 1). This occurs within the catchment as well as the riparian zone and it is clear that large portions of the main channel was also affected. This is considered a high impact which has mostly affected the river bank morphology and the habitat, vegetation and fauna sustained by it. This will undoubtedly also have a high impact in terms of the sediment load. These transformed areas are extensive and has permanently altered the geomorphology of the river and will undoubtedly also have had an effect on sediment and flow dynamics. The impact of historical mining has diminished to some extent as the environment rehabilitates itself although the change in topography and morphology is not rehabilitatable through succession of the environment itself. Historical mining within the catchment has also occurred and the impact considered high since no rehabilitation was undertaken in those days. This is quite apparent at the study area. Deep excavations and large tailing dumps dominate the surrounding terrestrial environment. Centre-pivot irrigation takes place along the river in upstream and downstream areas and may be extensive in some areas. This will impact on the river as a result of fertiliser runoff and enrichment, pesticides and other impacts associated with commercial irrigation. The study area itself has been heavily affected by previous mining operations as has already been discussed. This will still contribute to some ongoing impacts on the river, mostly in terms of sediment load. Currently the site is being utilised as communal grazing. Although the impact on the interior of the site will not be high the impact on the riparian zone is significant. In times of drought domestic stock is concentrated in the floodplain and banks of the river which provide a more constant grazing area. Consequently, overgrazing and trampling along the river can be high. This reduces vegetation cover, disturbs and mobilises soils and in so doing increases erosion and consequent sediment load in the river.

The Vaal River and its associated floodplains are considered a fifth order watercourse (Appendix C). This is also due to the river being a large lowland river. The quaternary catchment of this area is C91E. The largest impact on the site itself is considered historical alluvial diamond mining which has had a high impact on the site. Consequently almost the entire site has been transformed from the natural vegetation type and is currently dominated by pioneer species. This will undoubtedly also have an impact on the ecological functioning of the Vaal River. Upstream impacts are also numerous and cause alteration in the functioning of the river. The most prominent impacts are alluvial diamond mining and construction of containment dams which alter the flooding regime and the functioning and habitat of the river and its floodplains. An Index of Habitat Integrity (IHI) was conducted along the Vaal River within the study area (Appendix C). The results of the IHI indicated that the Vaal River has an Instream IHI of category C: Moderately Modified and Riparian IHI of category D: Largely Modified. This is largely due to the change in flooding regime and other significant impacts as well as historical alluvial diamond mining within the study area which is mostly responsible for degradation of the riparian vegetation and bank modification.

The EI&S of the floodplains associated with the Vaal River has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains are not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

4.2.4 Anticipated Impacts

According to recent research concerning small scale mining along the Vaal River and specifically in the Kimberley/Windsorton area several impacts of alluvial diamond mining occur and is likely to take place during these operations (Heath *et al* 2004):

- Accelerated erosion of areas adjacent to workings that have been de-vegetated leads to increased suspended sediment loads in nearby streams and rivers.
- Excavation of flood terraces and riverbanks increases the instability of these riverbanks and enhances the likelihood of increased flood scouring.
- Alteration of river channels and flows due to mining of alluvial deposits in the river bed.
- Excavation of river sediments exposes these sediments to oxidising conditions and enhances the solubility and release of any metal ions that may previously have been previously trapped as insoluble sulphides.
- Wind-blown dusts from unprotected tailings and waste rock dumps enter aquatic environment.

The impacts of alluvial diamond mining primarily affect the instream and riparian habitat due to riverbed degradation, increased suspended sediment and changes in the river morphology and hydraulics. Furthermore, many areas along the Vaal and Orange Rivers were mined a century ago and the environmental footprints are still visible. It is important that rehabilitation is comprehensive and successful and that the prevalent impacts as listed be managed and mitigated adequately.

The banks and portions of the main channel has already been transformed by previous mining operations and this thereby decreases the sensitivity of the site to some degree. Therefore, should mining take place on the site the impacts would be lower, though still significant,

compared to other more natural portions of the river bank. Despite this the system still provides vital services including water transportation, flood dissipation, wetland and riparian habitat (albeit degraded) and support of ecological processes. The system should still be regarded as sensitive with a high conservation value and mining should endeavour to keep impacts on it to a minimum. Furthermore, since previous mining did not implement adequate rehabilitation the proposed mining has the opportunity to improve rehabilitation and re-instate a more natural geomorphology and riparian community than is currently the case. As a further mitigation to the proposed mining which will offset the impacts of mining in the river, the transformed portion of the river bank adjacent to the site can also be rehabilitated which will improve the functioning of the riparian community.

A small portion of the site on the eastern border consists of a braided main channel. The area is capable of sustaining a large biomass and consequently contributes to species diversity. In comparison with the river section in this region this habitat type is uncommon and takes up a small percentage of the river habitats. The braided network and marginal zone is considered especially sensitive and unique. This must be seen in context that all watercourse systems must be regarded as sensitive systems although some habitats can be regarded as more unique than others. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1).

Mining within the study area will undoubtedly lead to substantial impacts on the Vaal River in the study area. As a result strict mitigation measures will have to be implemented to ensure that impacts are kept to a minimum. Predicted impacts include increased sedimentation of watercourses, increased establishment of weeds and invaders and increased erosion due to mining in watercourse channels. Mining in close proximity to the river and within the main channel will clear vegetation, disturb the soil surface and mobilise soils. This may cause high levels of sedimentation within the river. It is therefore recommended that measures be implemented to prevent sediment from entering the river. Measures such as berms and cut-off trenches can be investigated. Due to the removal of vegetation and disturbance of the soil surface the mining area will be highly susceptible to the establishment of invasive weeds. It is therefore recommended that weed control be judiciously and continually practised. Monitoring of weed establishment should form a prominent part of management of the mining area. Mining within the river will cause disturbance of the bed and banks and will mobilise sediments. Due to the clearing of vegetation these sediments will be transported downstream and in the Vaal River. Disturbance of the bed surface and streamflow after rain events will also lead to erosion of the riverbed and banks. Further mitigation which will decrease these anticipated impacts should include that the entire site should not be mined at the same time but that the mining area should be divided into several portions and each portion mined separately. Each mined portion should be rehabilitated before the next portion is commenced. This will decrease the area of impact and will allow each portion to stabilise before the next is mined.

In the event that mining of the riverbank and -bed takes place environmental monitoring must play a crucial part in keeping the impacts as described to a minimum. Internal monitoring should be conducted on a daily basis and external monitoring on a monthly basis. Monitoring should focus on the rehabilitation of the environment to a similar topography as was initially present, monitoring of erosion and topsoil replacement and monitoring of weed establishment. Often the follow-up rehabilitation after mining has ceased is not carried out and this is when erosion and weed establishment degrades the rehabilitated environment. It is therefore recommended that monitoring and remedial action take place even after mining has ceased.

4.2.5 Risk Assessment

A Risk Assessment for the proposed mining area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix D). Activities likely to be associated with the mining operations and which will likely affect the Vaal River and associated wetlands include mining within the river.

Mining within the main channel or banks of the Vaal River or wetland areas as described will likely cause permanent modification of this system. Although a comprehensive rehabilitation and monitoring regime may decrease this risk it is still unlikely to ensure the re-establishment of the original natural functioning. However, the banks and main channel of the river was already previously mined without any adequate rehabilitation implemented which has caused extensive modification and degradation of the river. Therefore, should the current proposed mining implement comprehensive and successful rehabilitation this may decrease the risk somewhat and may improve the condition of the river to some extent. However, a small portion of the site on the eastern border consists of a braided main channel. The braided network and marginal zone is considered especially sensitive and unique. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1). On condition that comprehensive and successful rehabilitation is undertaken and that the small portion of braided main channel is excluded from mining, the risk is considered to remain moderate.

Moderate Risks: Risk and impact on watercourses are notable and require mitigation measures on a higher level.

Mitigation as recommended should be implemented as far as possible which should considerably alleviate the risks on the Vaal River in the study area.

For the complete risk assessment please refer to Appendix D.

No.	Phases	Aspect	Impact	Risk Rating	Confidence level	Control measures
	Mostly Operational Phase but extending long after closure	Mining within or on the banks of the Vaal River	Mining within the main channel or the banks of the Vaal River will remove riparian vegetation, transform the soils profile and in so doing the hydrology, geomorphology, flow and flooding regime. Due to the larger volume of water transportation and general higher level of ecosystems services of the Vaal River this risk is anticipated to be higher. It is however less probable to influence the larger hydrological functioning and will impact higher at a localised scale. Due to the previous mining operations the river has already been degraded to a large degree and this will likely decrease the risk somewhat. Increased establishment of exotic weeds and invaders due to disturbance caused by mining is also probable.	**M**	4	This impact will be mainly during the operational phase but due to its nature will extend into the closure phase and it is highly likely that the impact will have a permanent impact on the Vaal River. However, due to the already heavily modified and degraded nature caused by previous mining, adequate and comprehensive rehabilitation may increase the condition of the river to some degree. Consequently, should comprehensive rehabilitation and monitoring be applied the impact on the river can be contained to medium term alteration. This may also alleviate the current high level of degradation caused by previous mining and inadequate rehabilitation. However, some impacts to the geomorphology and biota will have a lasting impact.

5. BIODIVERSITY CONDITION AND SENSITIVITY RATING

5.1 Overall condition of the study area

Habitat diversity and species richness:
The natural vegetation type on the site has largely been transformed and is consequently rather uniform with a low diversity of habitats. As a result the species diversity is also low.

Presence of rare and endangered species:
No protected, rare or endangered species could be identified on the site. Such species are often adapted to specialised habitats in good conditions and it is therefore highly unlikely that such a species would occur on the site which has been transformed to a large degree.

Ecological function:
The ecological function of the site has been altered to a significant degree. The site functions as habitat for a variety of fauna, supports a specific vegetation type and Vaal River forming part of the site also provides vital functions in terms of water transportation, wetland and aquatic habitats and bio-remediation. The vegetation type on the site has been transformed to a large degree and the resultant habitat provided to fauna is also altered and unable to sustain the natural population. The functioning of the Vaal River has been altered to a significant degree, especially the riparian component and geomorphology, but is still considered a highly sensitive system providing several important ecological functions.

Degree of rarity/conservation value:
According to Mucina & Rutherford (2006) the area consists of Kimberley Thornveld (SVk 4). This vegetation type is currently listed as being of Least Concern (LC) under the National List of Threatened Ecosystems (Notice 1477 of 2009) (National Environmental Management Biodiversity Act, 2004) (Map 2). The vegetation type is not currently subjected to any pronounced transformation pressures. Furthermore, it has been mostly transformed in this area and consequently the conservation value is relatively low.

Although degraded the Vaal River still plays a vital role in water transport and is therefore considered to have a high conservation value. The small portion of braided river section at the eastern border of the site is considered unique and has an exceptionally high conservation value (Map 1).

Percentage ground cover:
The percentage vegetation cover is relatively low mostly as a result of previous mining operations and inadequate rehabilitation of the post mining environment.

Vegetation structure:
The vegetation structure along the bank of the river is dominated by a short grass layer with wetland sedges and hygrophilous grasses in the marginal zone and scattered trees in the upper zone. Previous mining has degraded the vegetation structure to a significant degree and is especially visible in the lower and upper zones.

Infestation with exotic weeds and invader plants:
Numerous exotic weeds occur on the site, and may dominate in some areas.

Degree of grazing/browsing impact:
The area is being utilised as communal grazing and consequently overgrazing and -browsing is noticeably high.

Signs of erosion:
Signs of erosion is common, especially where previous mining has not filled voids as well as tailing dumps.

Terrestrial animals:
The Vaal River is able to sustain a higher bio-load which in turn supports a larger mammal population and it is likely that the mammal population along the river will be substantial. However, the available riparian and wetland habitat is highly modified by previous mining which would influence the mammal population along the river to a large extent and would be greatly diminished from the natural situation. The exception being the braided section at the eastern border of the site which contains a higher habitat diversity in better condition and would support a higher faunal diversity. As long as this small portion is excluded from mining it would remain unaffected.

Table 4: Biodiversity Sensitivity Rating for the proposed mining development.

	Low (3)	Medium (2)	High (1)
Vegetation characteristics			
Habitat diversity & Species richness	3		
Presence of rare and endangered species	3		
Ecological function			1
Uniqueness/conservation value		2	
Vegetation condition			
Percentage ground cover	3		
Vegetation structure	3		
Infestation with exotic weeds and invader plants or encroachers	3		
Degree of grazing/browsing impact	3		
Signs of erosion	3		
Terrestrial animal characteristics			
Presence of rare and endangered species		2	
Sub total	21	4	1
Total		26	

5.2. Biodiversity sensitivity rating (BSR) interpretation

Table 5: Interpretation of Biodiversity Sensitivity Rating.

Site	Score	Site Preference Rating	Value
Mining Operations	26	Advanced Degraded	4

6. DISCUSSION AND CONCLUSION

Due to previous mining activities, which included the main channel and banks of the Vaal River, the overall ecology of the site is considered to be advanced degraded. Despite this the river itself must still be considered as highly sensitive and the small portion of braided main channel at the eastern border of the site especially so (Map 1).

The study area is situated near the rural settlement of Longlands (approximately 2.5 km to the east) and also near the small town of Delportshoop (approximately 2.5 km to the west). The study area proposed for alluvial diamond mining is primarily situated along the banks and main channel of the Vaal River and has an approximate extent of 5 hectares (Map 1). The site includes the main channel, banks and floodplain of the river. The site itself is confined to the riparian zone and does not include a portion of the surrounding terrestrial environment.

The study area has been transformed by previous mining operations (Map 1). This clearly includes all riparian zones associated with the river as well as a portion of the main channel. Rehabilitation of the post mining environment was overall poorly done and consequently the re-establishment of natural vegetation is also poor with some areas unable to establish any kind of vegetation. Portions of the study area has however been able to establish a pioneer but largely indigenous vegetation layer.

The Vaal River, its main channel, banks and floodplain form almost the entire site (Map 1). The soil samples taken along the banks of the Vaal River are clearly indicative of wetland conditions on a perennial basis (Map 1). The marginal and lower zones of the Vaal River contain distinctive wetland soil indicators (Appendix B). The Marginal Zone shows soil characters of a permanent zone of wetness. The upper zone contains a minimal grey matrix, no mottles and is not considered as being a wetland area.

It should be noted that due to previous extensive mining this has altered the natural geomorphology of the river, the riparian zones and consequently has complicated the determination of the wetland areas associated with the river. For example, several backwater artificial impoundments has been formed which although resembling backwater areas are clearly formed by mining excavations.

The wetland conditions associated with the Vaal River can be characterised as a channel wetland system (SANBI 2009).

The Vaal River was surveyed by three separate locations along the banks of the river situated on the site. The length of river included in the study area is approximately 2 km (Map 1). The section of river in the study area has clearly been heavily affected by previous mining but nonetheless forms part of a linear system which will also affect downstream areas.

Habitat and species diversity is relatively low and not representative of the natural condition which should have been much higher. Nonetheless, mining of the banks of the river will still have a high level of impact, especially on the river itself and largely in the form of sedimentation. The banks of the river should therefore still be regarded as highly sensitive. A small portion of the site consists of a braided main channel and associated wetland areas which is considered relatively unique and of high conservation value. The area is capable of sustaining a large biomass and consequently contributes to species diversity. In comparison with the river section in this region this habitat type is uncommon and takes up a small

percentage of the river habitats. The braided network and marginal zone is considered especially sensitive and unique. This must be seen in context that all watercourse systems must be regarded as sensitive systems although some habitats can be regarded as more unique than others. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1).

An Index of Habitat Integrity (IHI) was conducted for the Vaal River for the section forming part of the study area (Appendix C). The IHI will be taken as representative of the Present Ecological State (PES) of this system. The largest impact on the site itself is considered historical alluvial diamond mining which has had a high impact on the site. Consequently almost the entire site has been transformed from the natural vegetation type and is currently dominated by pioneer species. This will undoubtedly also have an impact on the ecological functioning of the Vaal River. Upstream impacts are also numerous and cause alteration in the functioning of the river. The most prominent impacts are alluvial diamond mining and construction of containment dams which alter the flooding regime and the functioning and habitat of the river and its floodplains. The results of the IHI indicated that the Vaal River has an Instream IHI of category C: Moderately Modified and Riparian IHI of category D: Largely Modified. This is largely due to the change in flooding regime and other significant impacts as well as historical alluvial diamond mining within the study area which is mostly responsible for degradation of the riparian vegetation and bank modification.

The EI&S of the floodplains associated with the Vaal River has been rated as being Moderate: Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains are not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

A Risk Assessment for the proposed mining area has been undertaken according to the Department of Water & Sanitation's requirements for risk assessment and the provisional Risk Assessment Matrix for Section 21(c) & (i) water use (Appendix D). Mining within the main channel or banks of the Vaal River or wetland areas as described will likely cause permanent modification of this system. Although a comprehensive rehabilitation and monitoring regime may decrease this risk it is still unlikely to ensure the re-establishment of the original natural functioning. However, the banks and main channel of the river was already previously mined without any adequate rehabilitation implemented which has caused extensive modification and degradation of the river. Therefore, should the current proposed mining implement comprehensive and successful rehabilitation this may decrease the risk somewhat and may improve the condition of the river to some extent. However, a small portion of the site on the eastern border consists of a braided main channel. The braided network and marginal zone is considered especially sensitive and unique. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1). On condition that comprehensive and successful rehabilitation is undertaken and that the small portion of braided main channel is excluded from mining, the risk is considered to remain moderate.

The banks and portions of the main channel has already been transformed by previous mining operations and this thereby decreases the sensitivity of the site to some degree. Therefore, should mining take place on the site the impacts would be lower, though still significant, compared to other more natural portions of the river bank. Despite this the system still provides vital services including water transportation, flood dissipation, wetland and riparian habitat (albeit degraded) and support of ecological processes. The system should still be regarded as

sensitive with a high conservation value and mining should endeavour to keep impacts on it to a minimum. Furthermore, since previous mining did not implement adequate rehabilitation the proposed mining has the opportunity to improve rehabilitation and re-instate a more natural geomorphology and riparian community than is currently the case. As a further mitigation to the proposed mining which will offset the impacts of mining in the river, the transformed portion of the river bank adjacent to the site can also be rehabilitated which will improve the functioning of the riparian community.

A small portion of the site on the eastern border consists of a braided main channel. The area is capable of sustaining a large biomass and consequently contributes to species diversity. In comparison with the river section in this region this habitat type is uncommon and takes up a small percentage of the river habitats. The braided network and marginal zone is considered especially sensitive and unique. This must be seen in context that all watercourse systems must be regarded as sensitive systems although some habitats can be regarded as more unique than others. As a result, this small portion of the site is recommended to be excluded from mining operations as far as possible (Map 1).

7. REFERENCES

Bezuidenhout, H. 1994. An ecological study of the major vegetation communities of the Vaalbos National Park, Northern Cape. 1. The Than-Droogeveld section. *Koedoe* 37(2): 19-42. Pretoria.

Bromilow, C. 1995. Problem Plants of South Africa. Briza Publications CC, Cape Town.

Bromilow, C. 2010. Problem plants and alien weeds of South Africa. Briza Publications CC, Cape Town.

Coates-Palgrave, M. 2002. Keith Coates-Palgrave Trees of Southern Africa, edn 3, imp. 4. Random House Struik (Pty.) Ltd, Cape Town.

Collins, N.B. 2005. Wetlands: The basics and some more. Free State Department of Tourism, Environmental and Economic Affairs.

Conservation of Agricultural Resources Act, 1983 (ACT No. 43 OF 1983) Department of Agriculture.

Department of Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Edition 1. Department of Water Affairs and Forestry, Pretoria.

Duthie, A. 1999. Appendix W5: IER (floodplain and wetlands) determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

DWAF. 2008. Updated manual for the identification and delineation of wetlands and riparian areas, prepared by M.Rountree, A.L. Batchelor, J. MacKenzie and D. Hoare. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Fish, L., Mashau, A.C., Moeaha, M.J. & Nembudani, M.T. 2015. Identification guide to the southern African grasses. An identification manual with keys, descriptions and distributions. *Strelitzia* 36. South African National Biodiversity Institute, Pretoria.

Gerber, A., Cilliers, C.J., Van Ginkel, C. & Glen, R. 2004. Easy identification of aquatic plants. Department of Water Affairs, Pretoria.

Government of South Africa. 2008. National Protected Area Expansion Strategy for South Africa 2008: Priorities for expanding the protected area network for ecological sustainability and climate change adaptation. Government of South Africa, Pretoria.

Germishuizen, G. & Meyer, N.L. (eds) 2003. Plants of Southern Africa: an annotated checklist. *Strelitzia* 14. National Botanical Institute, Pretoria.

Gerber, A., Cilliers, C.J., Van Ginkel, C. & Glen, R. 2004. Easy identification of aquatic plants. Department of Water Affairs, Pretoria.

Gibbs Russell, G.E., Watson, L., Koekemoer, M., Smook, L., Barker, N.P., Anderson, H.M. & Dallwitz, M.J. 1990. Grasses of Southern Africa. Memoirs of the Botanical Survey of South Africa No. 58. Botanical Research Institute, South Africa.

Griffiths, C., Day, J. & Picker, M. 2015. Freshwater Life: A field guide to the plants and animals of southern Africa. Penguin Random House South Africa (Pty) Ltd, Cape Town.

Kleynhans, C.J. 2000. Desktop estimates of the ecological importance and sensitivity categories (EISC), default ecological management classes (DEMC), present ecological status categories (PESC), present attainable ecological management classes (present AEMC), and best attainable ecological management class (best AEMC) for quaternary catchments in South Africa. DWAF report, Institute for Water Quality Studies, Pretoria, South Africa.

Kleynhans, C.J. & Louw, M.D. 2007. Module A: EcoClassification and EcoStatus determination in River EcoClassification: Manual for EcoStatus Determination (version 2). Joint water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 329/08.

Kleynhans, C.J., Louw, M.D. & Graham, M. 2008. Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical Manual). Joint Water Research Commission and Department of Water Affaris and Forestry Report. WRC Report No. TT 377-08.

Manning, J. 2009. Field Guide to Wild Flowers. Struik Nature, Cape Town.

Marnewecke, G. & Kotze, D. 1999. Appendix W6: Guidelines for delineation of wetland boundary and wetland zones. In: MacKay (Ed.), H. Resource directed measures for protection of water resources: wetland ecosystems. Department of Water Affairs and Forestry, Pretoria.

Mucina, L. & Rutherford, M.C. (eds.) 2006. The Vegetation of South Africa, Lesotho and Swaziland. *Strelitzia* 19.South African National Biodiversity Institute, Pretoria.

National Environmental Management: Biodiversity Act (10/2004): National list of ecosystems that are threatened and in need of protection. Government Notice 1002 of 2011, Department of Environmental Affairs.

National Water Act (Act No. 36 of 1998). Republic of South Africa.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., Van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. and Nienaber, S. (2011). Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

Raymondo, D. Van Staden, L. Foden, W. Victor, J.E. Helme, N.A. Turner, R.C. Kamundi, D.A. Manyama, P.A. (eds.) 2009. Red List of South African Plants. *Strelitzia* 25. South African National Biodiversity Institute, Pretoria.

Roberts, B.R. & Fourie, J.H. 1975. Common grasses of the Northern Cape. Northern Cape Livestock Co-Operative Limited, Vryburg.

SANBI. 2009. Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

Shearing, D. & Van Heerden, K. 2008. Karoo: South African wild flower guide 6. Botanical Society of South Africa, Cape Town.

Van Ginkel, C.E., Glen, R.P., Gordon-Grey, K.D., Cilliers, C.J., Musaya, M. & Van Deventer, P.P. 2011. Easy Identification of some South African Wetland Plants. WRC Report No. TT 479/10.

Van Oudtshoorn, F. 2004. Gids tot Grasse van Suider-Afrika. Briza Publications, Pretoria.

Van Rooyen, N. 2001. Flowering plants of the Kalahari dunes. Ekotrust CC, Lynnwood.

Van Wyk, B. & Malan, S. 1998. Field guide to the wild flowers of the Highveld. Struik Publishers, Cape Town.

Van Wyk, B. & Van Wyk, P. 1997. Field guide to trees of Southern Africa. Struik Publishers, Cape Town.

Annexure A: Maps and Site photos

Wetland delineation map of the alluvial diamond mining operations on a portion of states land including a portion of the Vaal River near the town of Delportshoop, Northern Cape Province.

Preparred for:
Kimswa Mining (Pty) Ltd

Legend:

- Property boundaries
- Application area
- Road network
- Watercourses
- Delineated Wetlands
- Braided river section

Map Information

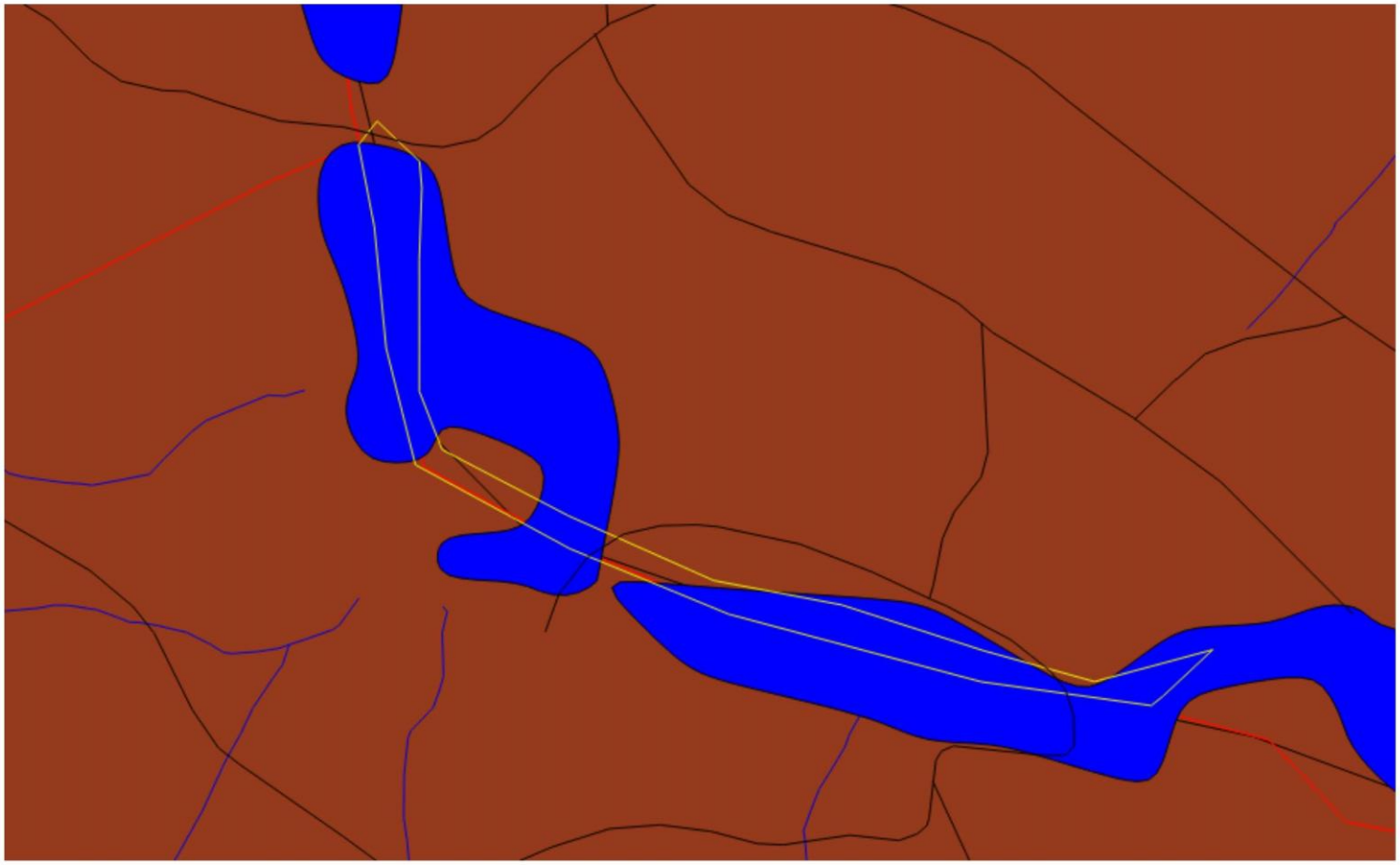
S 28.455467º
E 24.329079º

Spheroid: WGS 84
Scale: 1:5 000
Quantum GIS

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

Map 1: Wetland delineation map for the proposed alluvial diamond mining operations near the town of Delportshoop. The wetland areas occurring in the mining area and associated with the banks of the Vaal River is indicated. The small section of braided main channel recommended to be excluded from mining operations is also indicated. Note that the extensive transformation of the area, including the river bank, by mining is clearly visible

General ecology of the alluvial diamond mining operations on a portion of states land including a portion of the Vaal River near the town of Delportshoop, Northern Cape Province.



Preparred for:
Kimswa Mining (Pty) Ltd

Legend:

- Property boundaries
- Application area
- Road network
- Watercourses
- NFEPA Wetlands
- Kimberley Thornveld

Map Information

S 28.455467°
E 24.329079°

Spheroid: WGS 84
Scale: 1:5 000
Quantum GIS

DPR Ecologists
Contact Darius van Rensburg at:
darius@dprecologists.co.za
P.O. Box 12726, Brandhof, 9324
Tel: 083 410 0770

Map 2: General ecology map for the proposed alluvial diamond mining operations near the town of Delportshoop. Note that only one vegetation type is present in the area. Wetland areas associated with the Vaal River as identified by the National Freshwater Ecosystems Priority Areas (NFEPA) is indicated.

Appendix B: Soil Samples

Obligate wetland vegetation was utilised to determine the presence and border of wetlands. Soil samples were used to confirm the wetland conditions along the Vaal River. Soil samples were taken at approximately 10 meter intervals. Soil samples were investigated for the presence of anaerobic evidence which characterises wetland soils.

Within wetlands the hydrological regime differs due to the topography and landscape. For instance; a valley bottom wetland would have a main channel that is below the water table and consequently permanently saturated, i.e. permanent zone of wetness. As you move away from the main channel the wetland would become dependent on flooding in order to be saturated. As a result along this hydrological regime areas of permanent saturation, seasonal and temporary saturation would occur. At some point along this gradient the saturation of the soil would be insufficient to develop reduced soil conditions and therefore will not be considered as wetland.

Within wetland soils the pores between soil particles are filled with water instead of atmosphere. As a result available oxygen is consumed by microbes and plantroots and due to the slow rate of oxygen diffusion oxygen is depleted and biological activity continues in anaerobic conditions and this causes the soil to become reduced.

Reduction of wetland soils is a result of bacteria decomposing organic material. As bacteria in saturated soils deplete the dissolved oxygen they start to produce organic chemicals that reduce metals. In oxidised soils the metals in the soil give it a red, brown, yellow or orange colour. When these soils are saturated and metals reduced the soil attains a grey matrix characteristic of wetland soils.

Within this reduction taking place in the wetland soils there may be reduced matrix, redox depletions and redox concentrations. The reduced matrix is characterised by a low chroma and therefore a grey soil matrix. Redox depletions result in the grey bodies within the soil where metals have been stripped out. Redox concentrations result in mottles within the grey matrix with variable shape and are recognised as blotches or spots, red and yellow in colour.

Soil wetness indicator is used as the primary indicator of wetlands. The colour of various soil components are often the most diagnostic indicator of hydromorphic soils. Colours of these components are strongly influenced by the frequency and duration of soil saturation. Generally, the higher the duration and frequency of saturation in a soil profile, the more prominent grey colours become in the soil matrix.

Coloured mottles, another feature of hydromorphic soils, are usually absent in permanently saturated soils and are at their most prominent in seasonally saturated soils, becoming less abundant in temporarily saturated soils until they disappear altogether in dry soils (Collins 2005).

The following soil wetness indicators can be used to determine the permanent, seasonal and temporary wetness zones. The boundary of the wetland is defined as the outer edge of the temporary zone of wetness and is characterised by a minimal grey matrix (<10%), few high chroma mottles and short periods of saturation (less than three months per year). The seasonal zone of wetness is characterised by a grey matrix (>10%), many low chroma mottles and significant periods of wetness (at least three months per year). The permanent zone of wetness

is characterised by a prominent grey matrix, few to high chroma mottles, wetness all year round and sulphuric odour (rotten egg smell).

According to convention hydromorphic soil must display signs of wetness within 50 cm of the soil surface (DWAF 2005).

Table 1: Soil samples taken along a lateral transect of the Vaal River along the western portion of the site (S 28.451381°, E 24.327183°).

	
Soil sample taken in the marginal zone of the river. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	Soil sample taken in the lower zone of the river bank. A grey matrix (<10%) is clear and mottling is present indicating a seasonal zone of wetness. Wetland conditions are therefore clearly present.
	
Soil sample taken in the upper zone of the river bank. A grey matrix and mottling is clearly absent and wetland conditions are not present. A high silt content does indicate it still forming part of the floodplain.	

Table 2: Soil samples taken along a lateral transect of the Vaal River along the central portion of the site (S 28.455938°, E 24.329991°).

	
Soil sample taken in the marginal zone of the river. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	Soil sample taken in the lower zone of the river bank. A grey matrix (<10%) is clear and prominent mottling is present indicating a seasonal zone of wetness. Wetland conditions are therefore clearly present.
	
Soil sample taken in the upper zone of the river bank. A grey matrix and mottling is clearly absent and wetland conditions are not present.	

Table 3: Soil samples taken along a lateral transect of the Vaal River along the eastern portion of the site (S 28.456620°, E 24.333812°).

	
Soil sample taken in the marginal zone of the river. A prominent grey matrix (>10%) is clear and mottling is present indicating a permanent zone of wetness. Wetland conditions are therefore clearly present.	

Appendix C: Index of Habitat Integrity (IHI) Summary

For the complete IHI please contact the author of this report.

ASSESSMENT UNIT INFORMATION	
ASSESSMENT UNIT INFORMATION	
UPPER LATITUDE	S 28.456777
UPPER LONGITUDE	E 24.336245
UPPER ALTITUDE	1024 m
LOWER LATITUDE	S 28.450648
LOWER LONGITUDE	E 24.326647
LOWER ALTITUDE	1019 m
SURVEY SITE (if applicable)	Vaal River Delportshoop
SITE LATITUDE (if applicable)	
SITE LONGITUDE (if applicable)	
SITE ALTITUDE (if applicable)	
WMA	Low er Vaal
QUATERNARY	C91E
ECOREGION 2	29_2
DATE	09/01/2019
RIVER	Vaal River
TRIBUTARY	
PERENNIAL (Y/N)	**Y**
GEOMORPH ZONE	**LOWLAND**
WIDTH (m)	**>15**

METRIC GROUP	RATING	CONFIDENCE
HYDROLOGY MODIFICATION	2.3	1.7
PHYSICO-CHEMICAL MODIFICATION	1.5	1.1
BED MODIFICATION	1.7	4.0
BANK MODIFICATION	2.0	3.0
CONNECTIVITTY MODIFICATION	2.0	4.0
INSTREAM IHI%	62.4	
CATEGORY	C	
CONFIDENCE	2.8	

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with 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

METRIC GROUP	RATING	CONFIDENCE
HYDROLOGY	2.85	3.00
BANK STRUCTURE MODIFICATION	2.50	4.00
CONNECTIVITY MODIFICATION	1.75	4.00
RIPARIAN HABITAT INTEGRITY (%)	51.03	
CATEGORY	D	
CONFIDENCE	3.67	

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with 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

	MRU
INSTREAM IHI	
Base Flows	-3.0
Zero Flows	1.0
Floods	-3.5
HYDROLOGY RATING	**2.3**
pH	1.0
Salts	1.5
Nutrients	2.0
Water Temperature	1.0
Water clarity	2.0
Oxygen	1.0
Toxics	1.5
PC RATING	**1.5**
Sediment	2.0
Benthic Growth	1.5
BED RATING	**1.7**
Marginal	2.0
Non-marginal	2.0
BANK RATING	**2.0**
Longitudinal Connectivity	2.0
Lateral Connectivity	2.0
CONNECTIVITY RATING	**2.0**
INSTREAM IHI %	**62.4**
INSTREAM IHI EC	**C**
INSTREAM CONFIDENCE	**2.8**

	MRU
RIPARIAN IHI	
Base Flows	-3.0
Zero Flows	-1.0
Moderate Floods	-3.0
Large Floods	-4.0
HYDROLOGY RATING	**2.8**
Substrate Exposure (marginal)	2.0
Substrate Exposure (non-marginal)	3.0
Invasive Alien Vegetation (marginal)	2.0
Invasive Alien Vegetation (non-marginal)	3.0
Erosion (marginal)	1.0
Erosion (non-marginal)	2.0
Physico-Chemical (marginal)	1.5
Physico-Chemical (non-marginal)	1.5
Marginal	2.0
Non-marginal	3.0
BANK STRUCTURE RATING	**2.5**
Longitudinal Connectivity	2.0
Lateral Connectivity	1.5
CONNECTIVITY RATING	**1.8**
RIPARIAN IHI %	**51.0**
RIPARIAN IHI EC	**D**
RIPARIAN CONFIDENCE	**3.7**

Appendix D: Risk Assessment Matrix

RISK MATRIX (Based on DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

Risk to be scored for construction and operational phases of the project. MUST BE COMPLETED BY SACNASP REGISTERED PROFESSIONAL MEMBER REGISTERED IN AN APPROPRIATE FIELD OF EXPERTISE

					Severity																
No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
1	Mostly Operational Phase but extending long after closure	Alluvial diamond mining	Mining within or on the banks of the Vaal River	Mining within the main channel or the banks of the Vaal River will remove riparian vegetation, transform the soils profile and in so doing the hydrology, geomorphology, flow and flooding regime. Due to the larger volume of water transportation and general higher level of ecosystems services of the Vaal River this risk is anticipated to be higher. It is however less probable to influence the larger hydrological functioning and will impact higher at a localised scale. Due to the previous mining operations the river has already been degraded to a large degree and this will likely decrease the risk somewhat. Increased establishment of exotic weeds and invaders due to disturbance caused by mining is also probable.	3	3	2	3	2.75	3	4	9.75	4	4	5	4	17	165.75	M	4	This impact will be mainly during the operational phase but due to its nature will extend into the closure phase and it is highly likely that the impact will have a permanent impact on the Vaal River. However, due to the already heavily modified and degraded nature caused by previous mining, adequate and comprehensive rehabilitation may increase the condition of the river to some degree. Consequently, should comprehensive rehabilitation and monitoring be applied the impact on the river can be contained to medium term alteration. This may also alleviate the current high level of degradation caused by previous mining and inadequate rehabilitation. However, some impacts to the geomorphology and biota will have a lasting impact.