Proposed prospecting application on the farm Middelwater 18,

Prieska District

Northern Cape Province

Ecological & Wetland Assessment Report

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EXECUTIVE SUMMARY

The proposed project site triggers a number of listed activities as included in the Environmental Impact Assessment Regulations (08 December 2014), GN R 982 – 985, in accordance with the National Environmental Management Act, No. 107 of 1998 (NEMA), as amended. The Environmental Assessment Practitioner, EnviroNiche Consulting, was appointed to conduct an ecological and wetland delineation, Present Ecological State (PES) and function assessment for the project site to determine the impacts which may be triggered by the proposed development.

The requirements of this assessment were to undertake a specialist study to assess the biodiversity and ecology of the project site as well as to determine the significance of the impacts that the proposed project will have on the identified project site. Outcomes required from this report in terms of the riparian and wetland assessment include the following:

- To identify Management Units within the study area according to Hydro-geomorphic (HGM) units following the guidelines in the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013) and according to location in relation to project site;
- To delineate all wetland and riparian zones within the study area according to the guidelines for delineation as defined by (DWA, 2005);
- Determine function and service provision of wetland and riparian features according to the method supplied by Kotze *et al.* (2005);
- To define the health of the systems within the study area according to the Wetland Index of Habitat Integrity according to the method described by the DWA (2007) and thereby define the Present Ecological State (PES) of the aquatic resources to be affected by the proposed prospecting activities;
- To define the Ecological Importance and Sensitivity (EIS) and Recommended Ecological Category (REC) for the features (DWA, 1999);
- To consider potential impacts on the wetland and riparian habitat and the ecological communities likely as a result of the proposed development;
- To present management and mitigation measures in order to minimise the impact on the receiving environment should the proposed project proceed.

The project site is on the farm Middelwater 18, Prieska District, Northern Cape Province.

The following general conclusions were drawn upon completion of the literature review:

- The study area falls within the Nama-Karoo Aquatic Ecoregion,
- According to the NFEPA database the study area falls within the Lower Orange Water Management Area (WMA), and
- the subWMA indicated for the study area is the Orange;
- WetVeg group: Dry Nama-Karoo Group 4;
- The subWMA is regarded as important in terms of fish sanctuaries, rehabilitation or corridors;
- The subWMA is considered important in terms of translocation and relocation zones for fish;
- The subWMA is listed a fish-FEPA;

- The NFEPA database indicates that there are no pans present on the project site;
- The NFEPA database indicates that there are no RAMSAR wetlands within the study area or within 500m of the study area;
- According to the National List of Threatened Terrestrial Ecosystems (2011) the study area does not fall in a threatened terrestrial ecosystem
- The study area is not part of a formal or an informal protected area.
- According to Northern Cape Biodiversity Plan (2016) the Orange River floodplain is classified as an aquatic Critical Biodiversity Area. The rest of the project site is classified as Critical Biodiversity Area except for the transformed areas;
- The Orange River and Katrivier are NFEPA – listed aquatic systems

Upon completion of the riparian and wetland assessment the following general conclusions were drawn: The Orange River drains the project site. The following points summarise the results obtained:

VEGRAI

Summary of results of the VEGRAI assessments conducted for the Orange River and its floodplain wetland as well as the Katrivier and its tributaries.

Features	Present State Score (%)	Present State Category
Orange River	63	C
Orange River floodplain wetland	65	C
Katrivier seasonal stream and tributaries	52	D

- These features were classified according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al.*, 2013), as Inland Systems falling within the Nama-Karoo Aquatic Ecoregion;
- At Level 4 of the Classification System, the features within the study area were classified as: Rivers & floodplain wetlands
- The riparian features found on the project site have a VEGRAI Ecological Category of:
    - The Orange River received a score of 63%, (Category C) which means that the system is moderately modified where the loss of natural habitat, biota, have occurred but the basic ecosystem functions are predominantly unchanged.
    - The floodplain wetland is 65% (Category C) which means that the system is moderately modified where the loss of natural habitat, biota, have occurred but the basic ecosystem functions are predominantly unchanged.
    - The Katrivier and its tributaries is 52% (Category D) which means that it is a largely modified system where a large loss of natural habitat, biota, and basic ecosystem functions has occurred.

WET-IHI

Summary of results of the WET-IHI assessments conducted for the Orange River and its floodplain wetland as well as the Katrivier and its tributaries.

Features	Present State Score (%)	Present State Category
Orange River	70	C
Orange River floodplain wetland	73	C
Katrivier seasonal stream and tributaries	56	D

- The riparian features found on the project site have a VEGRAI Ecological Category of:
    - The Orange River received a score of 70%, (Category C) which means that the system is moderately modified where the loss of natural habitat, biota, have occurred but the basic ecosystem functions are predominantly unchanged.
    - The floodplain wetland is 73% (Category C) which means that the system is moderately modified where the loss of natural habitat, biota, have occurred but the basic ecosystem functions are predominantly unchanged.
    - The Katrivier and its tributaries is 56% (Category D) which means that it is a largely modified system where a large loss of natural habitat, biota, and basic ecosystem functions has occurred.

WET-HEALTH (Overall PES)

Summary of results of the WET-Health assessments conducted for the Orange River its floodplain wetland as well as the Katrivier and its tributaries

Feature	Hydrology		Geomorphology		Vegetation		Overall PES Category
	Impact score	Change score	Impact score	Change score	Impact score	Change score	
Orange River	C	⬇	C	⬇	C	⬇	C
Orange River floodplain wetland	C	⬇	C	⬇	C	⬇	C
Katrivier seasonal stream and tributaries	C	⬇	C	⬇	D	⬇	C

The overall PES Category for the **Orange River its floodplain wetland as well as the Katrivier and its tributaries** is a **C** which means the system is moderately modified where a moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.

ECOLOGICAL FUNCTIONALITY AND ECOLOGICAL SERVICE PROVISION

Wetland and riparian ecological functionality and ecological service provision was assessed utilising the method described by Kotze *et al.* (2008). The results of the Eco-Services assessment are summarised in the table below.

Summary of the wetland and riparian ecological function and service provision assessments for the Orange River its floodplain wetland as well as the Katrivier and its tributaries.

Ecosystem	Score	Category
Orange River	1.5	Intermediate
Orange River floodplain wetland	1.3	Intermediate
Katrivier seasonal stream and tributaries	1.2	Moderately - low

These results indicate that **Orange River its floodplain wetland's** riparian wetlands ecological functionality and ecological service provision are calculated to be Intermediate while the Katrivier and its tributaries scored a Moderately-low ecological function and service provision**. Orange River its floodplain wetland as well as the Katrivier and its tributaries** scored low values in terms of tourism, recreation, education and research and they also do not play any form of cultural importance to the surrounding communities.

ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)

Summary of the wetland and riparian vegetation's Ecological Importance and Sensitivity (EIS) assessments for the Orange River its floodplain wetland as well as the Katrivier and its tributaries.

Ecosystem	Score	Category
Orange River	1.5	D
Orange River floodplain wetland	1.3	D
Katrivier seasonal stream and tributaries	1.2	D

These results indicate that the Orange River, its floodplain wetland as well as the Katrivier and its tributaries' riparian vegetation are calculated to fall within and EIS Category **D**, indicating that this system is **largely modified**. The floodplain scored a **D** which means that the system is also **largely modified** in terms of ecological importance and sensitivity (EIS). It is also an indication that these system is considered to be ecologically un-important and not sensitive on a provincial and local scale.

RECOMMENDED ECOLOGICAL CATEGORY (REC)

The Recommended Ecological Category (REC) for the Orange River, its floodplain wetland as well as the Katrivier and its tributaries.'s wetland features were determined taking into account the results of the IHI, wetland and riparian function, EIS and the WET-Health assessments. The REC deemed appropriate for the wetland and riparian features are presented in the table below.

Summary of the REC categories assigned to the various features for all riparian and wetland features within the project site.

Features	REC Category
Orange River	Upper D
Orange River floodplain wetland	Upper D
Katrivier seasonal stream and tributaries	Upper D

RISK ASSESSMENT

Several impacts have been highlighted and have been rated based on the project actions / impacts, as well as any potential cumulative impacts during the prospecting phase of the project. These were also assessed with and without mitigation. The proposed prospecting will take place near the river as well as outside in its catchment, including the 32m buffer.

See Table below for a summary of the Risk Assessment Matrix as required by DWS. The Risk Assessment Matrix outcomes will determine if a General Authorisation of Water Use License is required for any Section 21 c and i activities.

Table A: A summary of the impact assessment results of the prospecting phase on the Orange River, its floodplain and its riparian vegetation as well as the Katrivier's riparian vegetation.

IMPACT	CONSEQUENCE	PROBABILITY	SIGNIFICANCE	RISK RATING	CONFIDENCE
IMPACT 1: Changes to the hydrological regime of the stream					
PROSPECTING PHASE					
Without mitigation	Medium (5)	Definite (10)	50	Low	4
With mitigation	Medium (4)	Definite (8)	32	Low	4
IMPACT 2: Impact of changes to water quality					
PROSPECTING PHASE					
Without mitigation	Medium (7)	Definite (12)	85	High	4
With mitigation	Low (4)	Definite (8)	33	Medium-Low	4
IMPACT 3: Loss of riparian vegetation, aquatic habitat and stream continuity (migration corridors)					
PROSPECTING PHASE					
Without mitigation	Low (5)	Definite (12)	60	Medium	4
With mitigation	Low (4)	Definite (8)	32	Low	4
IMPACT 4: Spread of alien invasive species					
PROSPECTING PHASE					
Without mitigation	Medium (10)	Definite (12)	120	High	4

With mitigation	Low (4)	Definite (8)	32	Medium-Low	4

<u>Impact 1:</u> Changes to the hydrological regime of the stream/river

Nature of the impact

The drilling and excavation of soil layers would chance the hydrological regime of the watercourses. Excavated voids could create impacts such as the upstream impedance of flows and the retention of water if they remain open for long periods of time. The impedance of flows would cause natural pools and existing man-made dams situated downstream to dry up during drought periods.

Significance of impacts without mitigation

The soils within the study area are susceptible to erosion, especially when disturbed. During high flows (high volumes and velocities after thunderstorms) erosion gullies may readily form within the watercourse and on streambanks. This creates bed and bank instability and consequent sedimentation of downstream pools and man-made dams.

Proposed mitigation

- Any activities that take place within 32 meters of a wetland or watercourse or the 1:100 year flood lines will require authorisation in terms of the relevant regulations of NEMA, however as far as possible infrastructure should be placed outside of wetlands and / or buffer lines.
- No stockpiling should take place within a watercourse or the 32m buffer.
- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds
- Erosion and sedimentation into channels must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed stream banks;
- Ensure that erosion management and sediment controls are strictly implemented from the beginning of site clearing activities, particularly as the soils in the study area are prone to erosion;
- All areas should be re-sloped and top-soiled where necessary and reseeded with indigenous grasses to stabilise the loose material;
- A sensitivity map has been developed for the study area, indicating the drainage lines and riparian systems, and their relevant buffer zones. It is recommended that this sensitivity map be considered during all phases of the development and with special mentioning of the planning of infrastructure, in order to aid in the conservation of and minimise impact on the riparian and aquatic habitat and resources within the study area;
- Rehabilitation must ensure that the wetland structure and function are reinstated in such a way as to ensure the ongoing functionality of the larger wetland systems at pre-prospecting levels.
- Any areas where bank failure is observed, due to the prospecting impacts, should be immediately repaired;
- As far as possible the existing road network should be utilised, minimising the need to develop new access routes resulting in an increased impact on the local environment. Should temporary roads or access routes be necessary and unavoidable, proper planning must take place and the site sensitivity plan must be taken into consideration.

If additional roads are required, then wherever feasible such roads should be constructed a distance from the more sensitive riparian areas and not directly adjacent thereto. If crossings are required they should cross the systems at right angles, as far as possible to minimise impacts in the receiving environment;

- The duration of impacts on the drainage lines should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised;
- Stabilisation of banks by employing one of the individual techniques below or a combination thereof, is essential, given the inherent susceptibility of the soils to erosion. Such measures include:
    - Re-sloping of banks to a maximum of a 1:3 slope;
    - Revegetation of re-profiled slopes;
    - Temporary stabilisation of slopes using geotextiles; and
    - Installation of gabions and reno-mattresses.
    - To prevent the further erosion of soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas particularly susceptible to erosion;
- Install erosion berms during construction to prevent gully formation:
    - Berms every 50m should be installed where any disturbed soils have a slope of less than 2%,
    - Berms every 25m where the track slopes between 2% and 10%,
    - Berms every 20m where the track slopes between 10% and 15% and
    - Berms every 10m where the track slope is greater than 15%;
- Sheet runoff from access roads should be slowed down by the strategic placement of berms and/or sandbags;
- All soils compacted as a result of prospecting activities falling outside of project areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all construction and rehabilitation phases to prevent loss of floral habitat;
- As far as possible, all rehabilitation activities should occur during the drier winter months.
- Trenches and deep excavations should not be left open for extended periods of time as fauna may fall in and become trapped in them. Trenches which are exposed should contain soil ramps allowing fauna to escape the trench.

Significance of impact with mitigation

Although permanent changes to the local hydrological regime of the watercourse is highly likely, the intensity of impact in the operational and closure phases would be **moderately-high** for the prospecting activities in or near the watercourse if the recommended mitigation measures are implemented (Table 1).

Cumulative impacts

The increase in surface run-off velocities is likely to occur considering that the vegetation cover in the watercourse's catchments would be **moderately-high** due to vegetation clearance, however with appropriate mitigation the cumulative impacts are moderately-low.

Residual impacts

Possible impact on the remaining catchment due to changes in run-off characteristics in the development site.

Impact 2: Impact of changes to water quality

Nature of the impact

Presently little is known about the water quality of the seasonal watercourses directly in the study area, but it is assumed due to the proposed prospecting activities in the study area, that the aquatic systems have been moderately impacted by loose sediment.

During prospecting, various materials, such as sediments, diesel, and oils could pose a threat to the continued functioning downstream areas, if by chance it is dispersed via surface run-off, or could permeate into the groundwater. The possible negative changes to water quality during the prospecting phase would be limited to sedimentation and erosion related issues. These negative impacts would persist into the medium term.

Significance of impacts without mitigation

Changes to water quality impact on the functioning of riparian plants. This impact without mitigation would have a **Moderate** intensity as excessive pollution will also impact on instream conditions due the introduction of additional sediment and toxins. Potential toxins include the following:

- Hydrocarbons (oil, other lubricants, grease and fuels) – The persistent impact of these pollutants is varied, but can enact negatively on metabolic pathways, cellular structures (plant and animal), respiration and gene stability (heavy metals).

Proposed mitigation

- All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent entry of hydrocarbons into topsoil and groundwater;
- All spills, should they occur, should be immediately cleaned up and treated accordingly.
- Chemicals used for prospecting/mining, vehicle maintenance and construction must be stored safely on site but outside the 32m buffer and surrounded by bunds. Chemical storage containers must be regularly inspected so that any leaks are detected early.
- Littering and contamination of water sources during prospecting must be prevented by effective site management.
- Emergency plans must be in place in case of spillages especially in the watercourse.
- No stockpiling should take place within a watercourse.
- All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds.
- Stockpiles must be located away from river channels.

- Erosion and sedimentation into channels must be minimised through the effective stabilisation (gabions and Reno mattresses) and the re-vegetation of any disturbed riverbanks.
- The construction camp and necessary ablution facilities meant for construction workers must be beyond the 32m buffer described previously.

Significance of impact with mitigation

Should the prospecting sites and the works be managed properly, the negative impacts would remain localised and in the short-term. This would result in an overall low intensity as the introduction of any pollutants would be probably be limited with mitigation if properly implemented.

Cumulative impacts

The potential cumulative impact is unlikely with appropriate mitigation.

Residual impacts

Possible impact on the remaining catchment due to changes in run-off characteristics in the project site.

<u>Impact 3:</u> Loss of riparian vegetation, aquatic habitat and stream continuity (migration corridors)

Nature of the impact

Riparian and aquatic corridors create longitudinal links between a variety of habitats and refugia. The refugia are particularly important in times when surface flows are low, i.e. aquatic organisms can survive in deeper pools and man-made dams during droughts. These populations are then able to recolonise the remaining stream reaches, when reconnected by increased stream flows. This function of a catchment and its ability to act as refugia is important for the conservation of the biodiversity in and around the seasonal stream.

Prospecting in the seasonal watercourses and the riverbanks could disrupts both the instream and riparian continuity, both in terms of flows and physical habitat availability. It is thus important to retain instream and riparian continuity as far as possible.

Significance of impacts without mitigation

This impact without mitigation i.e. deep excavations, steep embankments etc. would have a **Moderate** significance.

Proposed mitigation

- As far as possible, all rehabilitation activities should occur in the low flow season, during the drier winter months.
- Trenches and deep excavations should not be left open for extended periods of time as fauna may fall in and become trapped in them. Trenches which are exposed should contain soil ramps allowing fauna to escape the trench.
- The duration of impacts on the riverine and drainage line systems should be minimised as far as possible by ensuring that the duration of time in which flow alteration and sedimentation will take place is minimised;
- Rehabilitation must ensure that riparian structure and function are reinstated in such a way as to ensure the ongoing functionality of the larger riparian systems at pre-prospecting levels.
- Stabilisation of banks by employing one of the individual techniques below or a combination thereof, is essential, given the inherent susceptibility of the soils to erosion. Such measures include:
    - Re-sloping of banks to a maximum of a 1:3 slope;
    - Revegetation of re-profiled slopes;
    - Temporary stabilisation of slopes using geotextiles; and
    - Installation of gabions and reno-mattresses.
    - To prevent the further erosion of soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from areas particularly susceptible to erosion;
- Install erosion berms during construction to prevent gully formation:
    - Berms every 50m should be installed where any disturbed soils have a slope of less than 2%,
    - Berms every 25m where the track slopes between 2% and 10%,
    - Berms every 20m where the track slopes between 10% and 15% and
    - Berms every 10m where the track slope is greater than 15%;

Significance of impact with mitigation

With the mitigations, the negative impacts would remain localised and be permanent. This would result in an overall significance of be low (negative) as the overall continuity of the instream areas, could remain.

Cumulative impacts

The potential cumulative impact is unlikely with appropriate mitigation.

Residual impacts

Possible impact on the remaining catchment due to changes in run-off characteristics in the project site.

<u>Impact 4:</u> Spread of alien invasive species

Nature of the impact

The disturbance of the soil, loss of riparian and instream habitat and or water quality changes could possibly result in the colonisation of the degraded habitats by alien species.

Significance of impacts without mitigation

This impact without mitigation i.e. encroachment of alien invasive species would have a Moderate significance if limited not controlled properly.

Proposed mitigation

- Proliferation of alien and invasive species is expected within any disturbed areas particularly as there are some alien and invasive species within the study area at present. These species should be eradicated and controlled to prevent further spread beyond the study area;
- It is suggested that an alien plant removal program be initialised within the study area in order to help reinstate more natural hydrological and ecological functions to within the project site;
- Alien plant seed dispersal within the top layers of the soil within footprint areas, that will have an impact on future rehabilitation, has to be controlled;
- Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used;
- Footprint areas should be kept as small as possible when removing alien plant species;
- No vehicles should be allowed to drive through designated sensitive drainage lines and riparian areas during the eradication of alien and weed species.
- All alien vegetation in the riparian zone should be removed upon completion of prospecting activities and reseeded with indigenous grasses as specified by a suitably qualified specialist (ecologist);

Significance of impact with mitigation

This impact with mitigation would reduce the significance of the alien invasive impact to **Low**

Cumulative impacts

The potential cumulative impact is unlikely with appropriate mitigation

Residual impacts

Possible impact on the remaining catchment due to changes in run-off characteristics and vegetation clearing in the project site.

Upon completion of the Impact Assessment, the following general conclusions were drawn:

The results of the impact assessment indicate that although the impacts prior to mitigation may potentially be **Low to Medium,** strict and effective implementation of mitigation measures will reduce the impact significance to **medium-low,** levels. In view of the fact that large portions of the study area and the catchment of the watercourse have already been impacted due to human activities such as construction of roads, dams, farm steads, grazing pressures,

etc. It is the opinion of the specialist that should the mitigation measures, be adhered to, the proposed prospecting activities may have a lower risk to the wetland or riparian resources or natural vegetation within the project site than without the mitigation measures.

General mitigation measures which must also be implemented include the following:

- Any fauna threatened by the construction and operation activities should be removed to safety by the ECO or appropriately qualified environmental officer.
- All construction vehicles should adhere to a low speed limit (<30km/h) to avoid collisions with susceptible species such as snakes and tortoises.
- All prospecting footprint areas should remain as small as possible and should as far as possible not encroach into surrounding areas. It must be ensured that where possible the riparian and drainage line systems, and their associated buffer zones are off-limits to construction vehicles and personnel;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Appropriate sanitary facilities must be provided during the prospecting phase and all waste removed to an appropriate waste facility (landfill);
- No wood collection may take place
- No informal fires should be permitted in within the project site;
- Ensure that an adequate number of rubbish bins are provided so as to prevent litter and ensure the proper disposal of waste generated during construction activities;
- Ensure that as far as possible all infrastructure is placed outside of drainage lines and riparian areas and their respective buffer zones. Where this is not possible, construction footprints must be kept as small as possible and impacts must be minimized as far as possible.

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GLOSSARY OF TERMS

Alien vegetation: Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally. Vegetation species that originate from outside of the borders of the biome -usually international in origin.

Alluvial soil: A deposit of sand, mud, etc. formed by flowing water, or the sedimentary matter deposited thus within recent times, especially in the valleys of large rivers.

Base flow: Long-term flow in a river that continues after storm flow has passed. Biodiversity The number and variety of living organisms on earth, the millions of plants, animals and micro-organisms, the genes they contain, the evolutionary history and potential they encompass and the ecosystems, ecological processes and landscape of which they are integral parts.

Buffer: A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.

Catchment: The area contributing to runoff at a particular point in a river system.

Chroma: The relative purity of the spectral colour which decreases with increasing greyness.

Delineation (of a wetland): To determine the boundary of a wetland based on soil, vegetation and/or hydrological indicators.

Ecoregion: An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region".

Ephemeral stream: A stream that has transitory or short-lived flow.

Facultative wetland species: Species usually found in wetlands (76%-99% of occurrences) but occasionally found in non-wetland areas.

Fluvial: Resulting from water movement.

Gleying: A soil process resulting from prolonged soil saturation which is manifested by the presence of neutral grey, bluish or greenish colours in the soil matrix.

Groundwater: Subsurface water in the saturated zone below the water table.

Hydromorphic soil: A soil that in its undrained condition is saturated or flooded long enough to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).

Hydrology: The study of the occurrence, distribution and movement of water over, on and under the land surface.

Hydromorphy: A process of gleying and mottling resulting from the intermittent or permanent presence of excess water in the soil profile.

Hydrophyte: Any plant that grows in water or on a substratum that is at least periodically deficient of oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.

Intermittent flow: Flows only for short periods.

Indigenous vegetation: Vegetation occurring naturally within a defined area.

Mottles: Soils with variegated colour patterns are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.

Obligate wetland species: Species almost always found in wetlands (>99% of occurrences).

Perched water table: The upper limit of a zone of saturation that is perched on an unsaturated zone by an impermeable layer, hence separating it from the main body of groundwater.

Perennial: Flows all year round.

RAMSAR: The Ramsar Convention (The Convention on Wetlands of International Importance, especially as Waterfowl Habitat) is an international treaty for the conservation and sustainable utilisation of wetlands, i.e., to stem the progressive encroachment on and loss of wetlands now and in the future, recognising the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.

RDL (Red Data listed) species: Organisms that fall into the Extinct in the Wild (EW), critically endangered (CR), Endangered (EN), Vulnerable (VU) categories of ecological status.

Refugia: "Areas of safety" where organisms can escape impacts and from where they can recolonise habitats.

Seasonal zone of wetness: The zone of a wetland that lies between the Temporary and Permanent zones and is characterised by saturation from three to ten months of the year, within 50cm of the surface.

Temporary zone of wetness: the outer zone of a wetland characterised by saturation within 50cm of the surface for less than three months of the year.

Indigenous vegetation: Vegetation occurring naturally within a defined area

Riparian system: Riparian wetlands are recognised as boundaries between the terrestrial and riverine systems

Ecoregion: An ecoregion is a "recurring pattern of ecosystems associated with characteristic combinations of soil and landform that characterise that region

LIST OF ACRONYMS

DMEC: Desired Ecological Management Class

DWS: Department of Water Affairs and Sanitation

EIA: Environmental Impact Assessment

EIS: Ecological Importance and Sensitivity

EMC: Ecological Management Class

EAP Environmental Assessment Practitioner

FEPA: Fresh Water Priority Areas

GIS: Geographic Information System

GPS: Global Positioning System

Ha: Hectares

HGM: Hydro-geomorphic

m Metres

mm Millimetres

NEMA: National Environmental Management Act

PEMC: Present Ecological Management Class

PES: Present Ecological State

REC: Recommended Ecological Category

RHP: River Health Program

SANBI: South African National Biodiversity Institute

SASS: South African Scoring System

1. INTRODUCTION

EnviroNiche Consulting has been appointed by **Greenmined Environmental (Pty) Ltd** to conduct an ecological and wetland assessment of the project site as part of an impact assessment process to obtain environmental authorisation for the proposed right to prospect on the relevant property. The project site is on the farm Middelwater 18, Prieska District, Northern Cape Province.

1.1. Scope

The following was to be provided / undertaken:

Terrestrial assessment:

- A brief discussion, using available literature, on the vegetation type in which the broader study area and project site is situated in order to place the study in context.
- A broad-scale map of the vegetation and land cover of the project site using available aerial photography. A description of the dominant and characteristic species within the broad-scale plant communities comprising each of these units was to be provided. This was to cover the entire project site.
- List of all plant species recorded during the survey.
- A list of Red List plant species previously recorded within the quarter degree grids in which the study area and project site is situated, obtained from the relevant authorities.
- List of naturalised plant species recorded on the project site, indicating which are declared weeds or alien invasive species, according to the *National Environmental Management: Biodiversity Act (10/2004): Alien and Invasive Species Regulations, 2014*.
- Identification of sensitive habitats and plant communities. A map of sensitive areas within the project site was to be provided.

A detailed investigation into the status of the vegetation located within the project site was undertaken, including:

- Assessment of the natural vegetation;
- General floristic diversity;
- Habitat suitability for Red Data flora species;
- Potential presence of Red Data flora species;
- Potential presence of sensitive ecosystems

Wetland and riparian resource assessment:

- To identify Management Units within the study area according to Hydrogeomorphic (HGM) units following the guidelines in the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al*., 2013);
- To delineate all wetland and riparian zones within the project site, as well as within a 500m buffer zone of the proposed activity, according to the guidelines as defined by (DWA, 2005);

- Determine function and service provision of wetland and riparian features according to the method supplied by Kotze *et al*. (2005);
- To define the health of the systems within the study area according to the Wetland Index of Habitat Integrity according to the method described by the DWA (2007) and thereby define the Present Ecological State (PES) of the aquatic resources to be affected by the proposed development;
- To define the Ecological Importance and Sensitivity (EIS) and Recommended Ecological Category (REC) for the features (DWA, 1999);
- To consider potential impacts on the wetland and riparian habitat and the ecological communities likely as a result of the proposed development;
- To present management and mitigation measures in order to minimise the impact on the receiving environment should the proposed project proceed.

1.2 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The riparian zone and wetland delineations as presented in this report are regarded as a best estimate of the riparian / wetland boundaries based on the site conditions present at the time of assessment. Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies, due to the use of handheld GPS instrumentation, may occur. If more accurate assessments are required the riparian zones and ephemeral drainage line features will need to be surveyed and pegged according to surveying principles. The delineations are however deemed sufficiently accurate to ensure that the wetland and riparian resources are adequately protected if the management and mitigation measures of this report are adhered to and adequate buffers are implemented;
- Due to the extent of the study area, use was made of aerial photographs, digital satellite imagery as well as provincial and national wetland databases to identify areas of interest prior to the field survey. Any additional wetland areas, watercourses and drainage lines noted during the field survey were also assessed and added to the number of survey points. Although all possible measures were undertaken to ensure all wetland features, riparian zones and drainage lines (watercourses) were assessed and delineated, some smaller marginal features may have been overlooked that are not to be directly impacted by the proposed mine activity.
- Wetlands and terrestrial areas form transitional areas where an ecotone is formed as vegetation species change from terrestrial species to facultative wetland species. Within this transition zone some variation of opinion on the wetland boundary may occur, however, if the DWA (2005) and DWAF (2008) method is followed, all assessors should get largely similar results; and
- Aquatic, wetland and riparian ecosystems are dynamic and complex. Some aspects of the ecology of these systems, some of which may be important, may have been overlooked. The wetland data presented in this report are based on a single site visit. The effects of natural seasonal and long-term variation in the ecological conditions are therefore unknown.

1.3. Legislative framework

Acts such as those listed below (Table 1.3.1), ensure the protection of ecological processes, natural systems and natural beauty as well as the preservation of biotic diversity in the natural environment. It also ensures the protection of the environment against disturbance, deterioration, defacement or destruction as a result of man-made structures, installations, processes or products or human activities.

Table 1.3.1: List of relevant legislation

Title of legislation, policy or guideline	Applicability to the project	Administering authority	Date
National Environmental Management Act, No. 107 of 1998 (NEMA), as amended & NEMA EIA Regulations, 2014: GN544, published in Government Gazette 33306 in 2014 (as amended is 2017)	An EIA report (EIAr) is required for this project	Department of Minerals Resources (DMR)	2017
National Environmental Management: Biodiversity Act (10/2004): Amendments, 2014	Protected species may occur on site	Department of Environment and Nature Conservation (DENC)	2014
National Environmental Management: Biodiversity Act, 2004 (Act no. 10 of 2004), Alien and Invasive Species Lists	Control and management of alien invasive species	Department of Environment and Nature Conservation (DENC)	2016
National Water Act, No. 36 of 1998	The proposed development may trigger a section 21(C and/or i) water use.	Department of Water and Sanitation (DWS)	1998
Northern Cape Nature Conservation Act (Act 9 of 2009)	Protected species could occur on the proposed site	Department of Environment and Nature Conservation (DENC)	2009
National Forests Act (Act 84 of 1998)	Protected trees could occur on the proposed sites	Department of Agriculture, Forestry and Fisheries (DAFF)	1998
Mineral And Petroleum Resources Development Act (MPRDA) (Act 28 of 2002)	Regulates the mining of minerals	Department of Mineral Resources (DMR)	2002

2. STUDY APPROACH AND METHODOLOGY

Date of fieldwork: December 2018.

2.1 Terrestrial vegetation survey

2.1.1 Literature Review

- Satellite imagery (Google Earth photos) and
- 1:50 000 topographic maps were used to find features within the project site.
- VEGMAP data was consulted to determine vegetation types in the vicinity of the project site

Quantitative data was collected in each quadrat by undertaking vegetation sampling according to the Braun-Blanquet approach (Mueller-Dombois & Ellenberg 1974; Westhoff & van der Maarel 1978). In each sample site the following data was collected:

Habitat data:

- amount of bare soil;
- rock cover;
- slope;
- aspect in degrees;
- latitude and longitude position (from GPS) in decimal degrees;
- presence of biotic disturbances, e.g. grazing, animal burrows, etc.

Vegetation data

- species present;
- cover estimation of each species according to the Braun-Blanquet scale;
- vegetation height.

Data analysis

- The plant communities that were identified were described using the vegetation sample data.
- Additional checklists of plant species were compiled by traversing the project site on foot and recording species as they were encountered. Plant names follow those of POSA (2015).
- All exotic species categorised as alien invaders or weeds as listed in the *National Environmental Management: Biodiversity Act (10/2004): Alien and Invasive Species Regulations, 2014* were also recorded.

Due to the brief duration of the survey, the species list provided for the project site cannot be regarded as comprehensive, but is nevertheless likely to include the majority of the dominant and common species present.

2.1.1.1 Red Data plant species

Tables 4.1. 4.2, 4.3 & 4.4 reflect the species noted during the site visit. For all threatened plants that occur in the general geographical area of the project site, a rating of the likelihood of it occurring within the project site is given as follows:

- LOW: no suitable habitats occur on site / habitats on site do not match habitat description for species;

- MEDIUM: habitats on site match the general habitat description for species (e.g. grassland), but detailed microhabitat requirements (e.g. rocky grassland on shallow soils overlying dolomite or dolerite) are absent on the site or are unknown from the descriptions given in the literature or from the authorities;
- HIGH: habitats found on site match very strongly the general and microhabitat description for the species (e.g. rocky grassland on shallow soils overlying granite);
- DEFINITE: species found on site.

2.1.1.2 Impact rating methodology

Direct, indirect and cumulative impacts of the issues identified in the EIA phase must be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high):
- The **duration**, wherein it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5;
- The **consequences (magnitude)**, quantified on a scale from 0-10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1–5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
- The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high; and
- The **status**, which will be described as either positive, negative or neutral.
- The *degree* to which the impact can be **reversed**.
- The *degree* to which the impact may cause **irreplaceable loss of resources**.
- The *degree* to which the impact can be **mitigated**.

The significance is calculated by combining the criteria in the following formula:

$S=(E+D+M)P$
S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The significance weightings for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).

2.2 Method of wetland and riparian resource assessment:

2.2.1 Literature Review

A desktop study was compiled with all relevant information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org). Wetland specific information resources taken into consideration during the desktop assessment of the study area included:

- National Freshwater Ecosystem Priority Areas (NFEPAs, 2011)
- NFEPA water management area (WMA)
- FEPA (sub)WMA % area
- Sub water catchment area FEPAs
- Water management area FEPAs
- Fish sanctuaries
- Wetland ecosystem types
- Threatened Terrestrial Ecosystems for South Africa (2009)
- National Protected Area Expansion Strategy (2011)
- Northern Cape Biodiversity Sector Plan (2016)

2.2.1.1 National Freshwater Ecosystem Priority Areas (NFEPA; 2011)

Freshwater ecosystems provide a valuable, natural resource with economic, aesthetic, spiritual, cultural and recreational value. However, the integrity of freshwater ecosystems in South Africa is declining at an alarming rate, largely as a consequence of a variety of challenges.

The NFEPA project aims to identify a national network of freshwater conservation areas and to explore institutional mechanisms for their implementation. The NFEPA database was searched for information in terms of conservation status of rivers, wetland habitat and wetland features present within the study area.

2.2.1.2 Classification System for Wetlands and other Aquatic Ecosystems in South Africa

All wetland or riparian features encountered within the study area were assessed using the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems, hereafter referred to as the "classification system" (Ollis *et al.*, 2013). A summary of Levels 1 to 4 of the classification system are presented in Table 2.1 and 2.2, below:

Table 2.1: Proposed classification structure for inland systems (Level - 3).

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	LEVEL 2: REGIONAL SETTING	LEVEL 3: LANDSCAPE UNIT
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table 2.2: Proposed classification structure for inland systems (Level - 4).

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	B	C
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

a) Level 1: Inland systems

From the classification system, Inland Systems are defined as aquatic ecosystems that have no existing connection to the ocean (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically.

b) Level 2: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the classification system is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.*, 2005)(Fig 2.1).

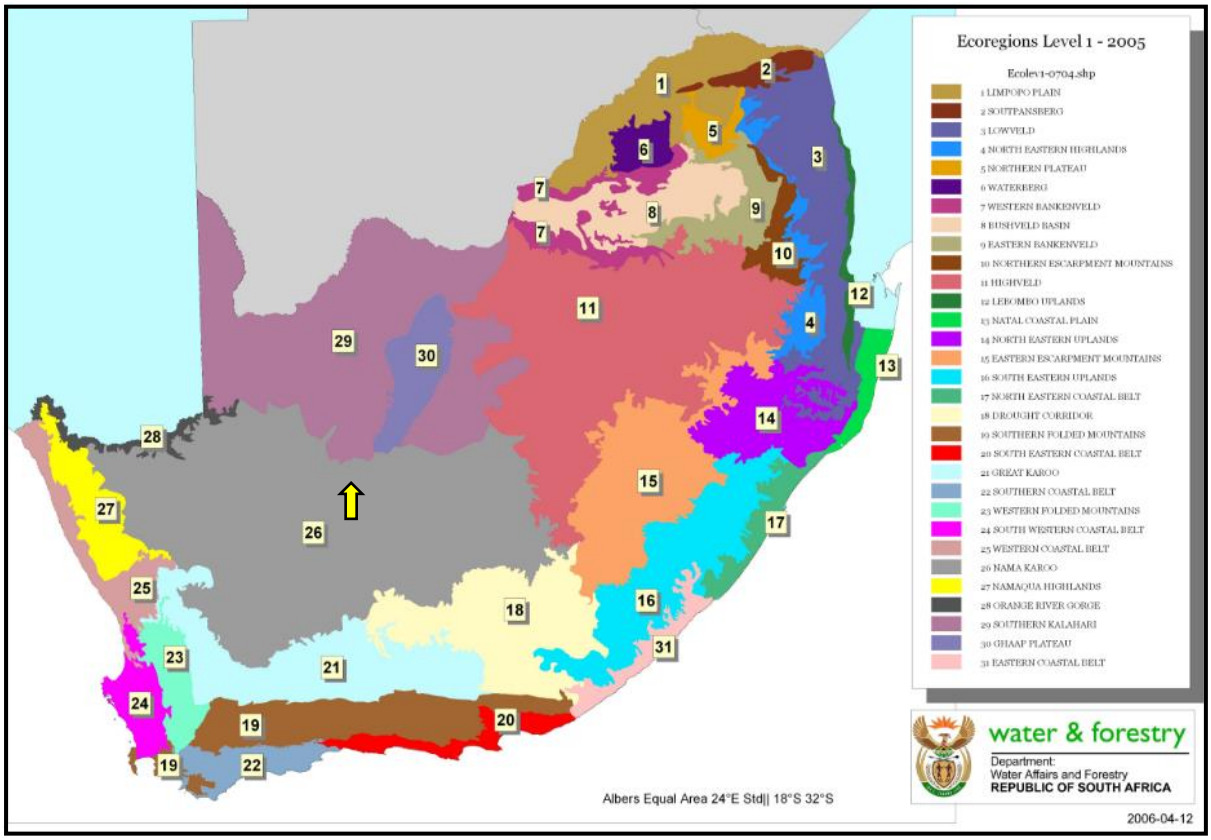

Figure 2.1: There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland. Yellow arrow indicates project site's location.

c) Level 2: NFEPA Wet Veg Groups

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) group's vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel *et al.,* 2011). There are currently 133 NFEPA WetVeg Groups.

d) Level 3: Landscape Setting

At Level 3 of the proposed classification System, for Inland Systems, a distinction is made between four Landscape Units (Table 2.3) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

- **Slope**: a stretch of ground on an incline that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.
- **Valley floor**: The base of a valley, situated between two distinct valley side-slopes.
- **Plain**: an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.
- **Bench (hilltop/saddle/shelf)**: an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

e) Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the classification system (Table 2.2), on the basis of hydrology and geomorphology (Ollis et al., 2013), namely:

- **River**: a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
- **Channelled valley-bottom wetland**: a valley-bottom wetland with a river channel running through it.
- **Unchannelled valley-bottom wetland**: a valley-bottom wetland without a river channel running through it.
- **Floodplain wetland**: the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
- **Depression**: a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- **Wetland Flat**: a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat
- **Seep**: a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

2.2.1.3 Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation is described in the NWA (Act No 36 of 1998) as follows: 'riparian habitat' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

The Riparian Vegetation Response Assessment Index (VEGRAI) is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results. Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Table 2.3: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately 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 modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

2.2.1.4 Index of Habitat Integrity (IHI)

To assess the PES of the wetland and riparian features, the IHI for South African floodplain and channelled valley bottom wetland types (Department of Water Affairs and Forestry Resource Quality Services, 2007) was used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (Table 2.3), and provide a score of the PES of the habitat integrity of the riparian system being examined.

Table 2.4: Descriptions of the A-F ecological categories.

HABITAT INTEGRITY CATEGORY	DESCRIPTION	RATING (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, 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

2.2.1.5 WET-Health Assessment

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever changing landscape. The primary purpose of this assessment is to evaluate the eco-physical health of wetlands, and in so doing promote their conservation and sensible management. Within the project site, the WET-Health of the floodplain wetland features was assessed.

a) Level of assessment

Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; or
- Level 2: On-site assessment. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

b) Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments:

- hydrology (water inputs, distribution and retention, and outputs),
- geomorphology (sediment inputs, retention and outputs) and
- vegetation (transformation and presence of introduced alien species).

c) Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on:

- geomorphic setting (e.g. hillslope or valley-bottom and whether drainage is open or closed),
- water source (surface water dominated or sub-surface water dominated) and
- pattern of water flow through the wetland unit (diffusely or channelled) as described in Section 2.2.1.3.

d) Quantification of Present State of a Wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact. The impact scores and Present State categories are provided in the table below.

Table 2.5: Impact scores and categories of Present State used by WET-Health for describing the integrity of the wetland.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

e) Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (Table 2.6).

Table 2.6: Trajectory of change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

f) Overall Health of the Wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provides a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

2.2.1.6 Riparian and Wetland Function Assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class". The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al*. (2009). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 2.7: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

2.2.1.7 Ecological Importance and Sensitivity (EIS)

The method used for the EIS determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed. A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The mean of the determinants is used to assign the EIS category as listed in Table 2.8 below.

Table 2.8: Descriptions of the EIS categories.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

2.2.1.8 Recommended Ecological Category

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure."

The Recommended Ecological Category **(**REC) (Table 2.9) was determined based on the results obtained from the PES, reference conditions and EIS of the resource (sections above). Followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland may receive the same class for the PES as the REC if the wetland is deemed in good condition, and therefore must stay in good condition.

Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as enhance the PES of the wetland feature.

Table 2.9: Descriptions of the REC categories.

EIS Category	Range of Mean	Recommended Ecological Management Class[5]
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

2.2.1.9 Wetland and Riparian Resource Delineation

For the purposes of this investigation, a wetland is defined in the National Water Act (1998) as land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

The wetland zone delineation took place according to the method presented in the DWAF (2005) document "A practical field procedure for identification and delineation of wetlands and riparian areas. An updated draft version of this report is also available and was therefore also considered during the wetland delineation (DWAF, 2008). The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The position in the landscape, which will help identify those parts of the landscape where wetlands are more likely to occur;
- The type of soil form (i.e. the type of soil according to a standard soil classification system), since wetlands are associated with certain soil types;
- The presence of wetland vegetation species; and
- The presence of redoxymorphic soil feature, which are morphological signatures that appear in soils with prolonged periods of saturation.

By observing the evidence of these features in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF, 2005 and 2008). Riparian and wetland zones can be divided into three zones (DWAF, 2005):

- The permanent zone of wetness is nearly always saturated.
- The seasonal zone is saturated for a significant periods of wetness (at least three months of saturation per annum) and
- the temporary zone surrounds the seasonal zone and is only saturated for a short period of saturation (typically less than three months of saturation per annum), but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation.

The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland / riparian area.

2.2.1.10 Risk assessment

The anticipated impacts associated with the proposed project have been assessed according to the method used for assessing risks/ impacts is outlined in the table below. This methodology has been utilised for the assessment of environmental impacts where the consequence (severity of impact, spatial scope of impact and duration of impact) and likelihood (frequency of activity and frequency of impact) have been considered in parallel to provide an impact rating and hence an interpretation in terms of the level of environmental management required for each impact.

The first stage of any impact assessment is the identification of potential environmental activities[1], aspects[2] and impacts which may occur during the commencement and implementation of a project. This is supported by the identification of receptors[3] and

resources[4], which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. Environmental impacts[5] (social and biophysical) are then identified based on the potential interaction between the aspects and the receptors/resources.

The significance (degree to which the impact may cause irreplaceable loss of resources) of the impact is then assessed by rating each variable numerically according to defined criteria as outlined in table below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity[6], spatial scope[7] and duration[8] of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity[9] and the frequency of the impact[10] together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix table as shown in Table 2.11.

This matrix thus provides a rating on a scale of 1 to 150 (low, medium low, medium high or high) based on the consequence and likelihood of an environmental impact occurring. Natural and existing mitigation measures, including built-in engineering designs, are included in the pre-mitigation assessment of significance. Measures such as demolishing of infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

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1. An activity is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or pieces of infrastructure that are possessed by an organisation.

2. An environmental aspect is an 'element of an organisations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an impact.

3. Receptors comprise, but are not limited to people or man-made structures.

4. Resources include components of the biophysical environment.

5. Environmental impacts are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. Receptors can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as aquifers, flora and palaeontology. In the case where the impact is on human health or well-being, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.

6. Severity refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.

7. Spatial scope refers to the geographical scale of the impact.

8. Duration refers to the length of time over which the stressor will cause a change in the resource or receptor.

9. Frequency of activity refers to how often the proposed activity will take place.

10. Frequency of impact refers to the frequency with which a stressor (aspect) will impact on the receptor.

Table 2.10: Risk assessment key.

SEVERITY OF IMPACT	RATING
Insignificant / Non-harmful	1
Small / Potentially harmful	2
Significant / Slightly harmful	3
Great / Harmful	4
Disastrous / Extremely harmful	5

SPATIAL SCOPE (EXTENT) OF IMPACT	RATING
Activity specific	1
Project site specific (within project site boundary)	2
Local area (within 500m of project site boundary)	3
Regional (greater region)	4
National	5

DURATION OF IMPACT	RATING
One day to one month	1
One month to one year	2
One year to ten years	3
Life of operation	4
Post closure / Permanent	5

CONSEQUENCE

FREQUENCY OF ACTIVITY / DURATION OF ASPECT	RATING
Annually or less / low	1
Six months / temporary	2
Monthly / Infrequent	3
Weekly / Life of operation / Regularly / Likely	4
Daily / Permanent / High	5

FREQUENCY OF IMPACT / INCEDENT	RATING
Almost never / Almost impossible	1
Very seldom / Highly unlikely	2
Infrequent / Unlikely / Seldom	3
Often / Regularly / Likely / Possible	4
Daily / Highly Likely / Definitely	5

PROBABILITY

LEGAL ISSUES	RATING
No legislation	1
Fully covered by legislation (Wetlands are legally governed)	5

DETECTION	RATING
Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to detect	4
Covered	5

Table 2.11: Interpretation of Impact Rating.

Consequence

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

	High	76 to 150	Improve current management
	Medium High	40 to 75	Maintain current management
	Medium Low	26 to 39	
	Low	1 to 25	No management required

SIGNIFICANCE = CONSEQUENCE x LIKELIHOOD

a) Mitigation measure development

The following points present the key concepts considered in the development of mitigation measures for the proposed development.

- Mitigation and performance improvement measures and actions that address the risks and impacts are identified and described in as much detail as possible;
- Measures and actions to address negative impacts will favour avoidance and prevention over minimization, mitigation or compensation;
- Desired outcomes are defined, and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, with estimates of the resources (including human resource and training requirements) and responsibilities for implementation.

b) Sensitivity Mapping

All the ecological features of the study area were considered and sensitive areas were delineated with the use of a Global Positioning System (GPS). The sensitivity map should guide the design and layout of the proposed development.

c) Recommendations

Recommendations were developed to address and mitigate impacts associated with the proposed development. These recommendations also include general management measures which apply to the proposed development as a whole. Mitigation measures have been developed to address issues in all phases throughout the life of the operation from planning, through construction, operation and closure through to after care and maintenance.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1 Description of the broader study area and project site

3.1.1 Location

The project site is on the farm Middelwater 18, Prieska District, Northern Cape Province. (Figures 3.1, 3.2, 3.3 & 3.4). The project site falls over four quarter degree squares namely: **2922 AD, 2922 CB, 2922 BC & 2922 DA**

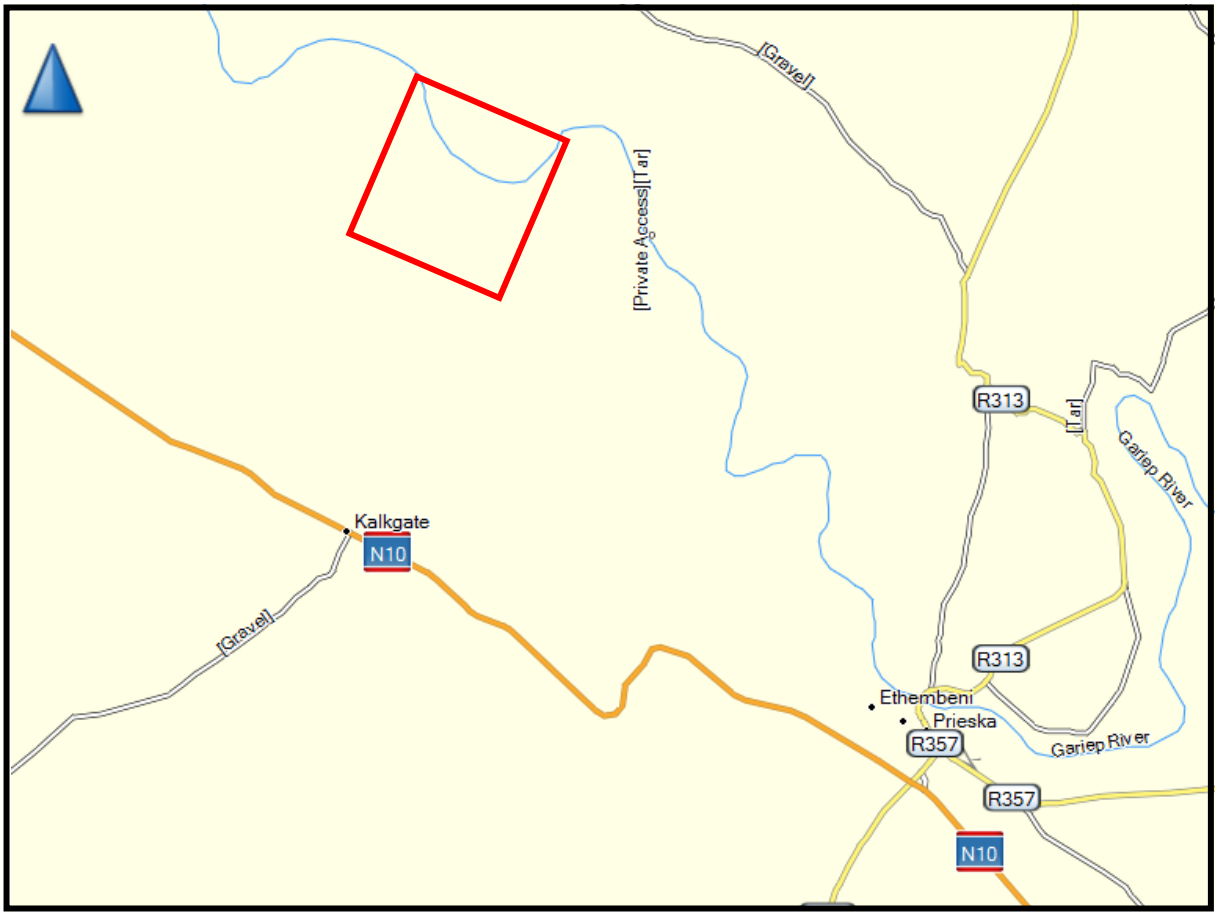

Figure 3.1: Locality map of the project site area (red polygon).

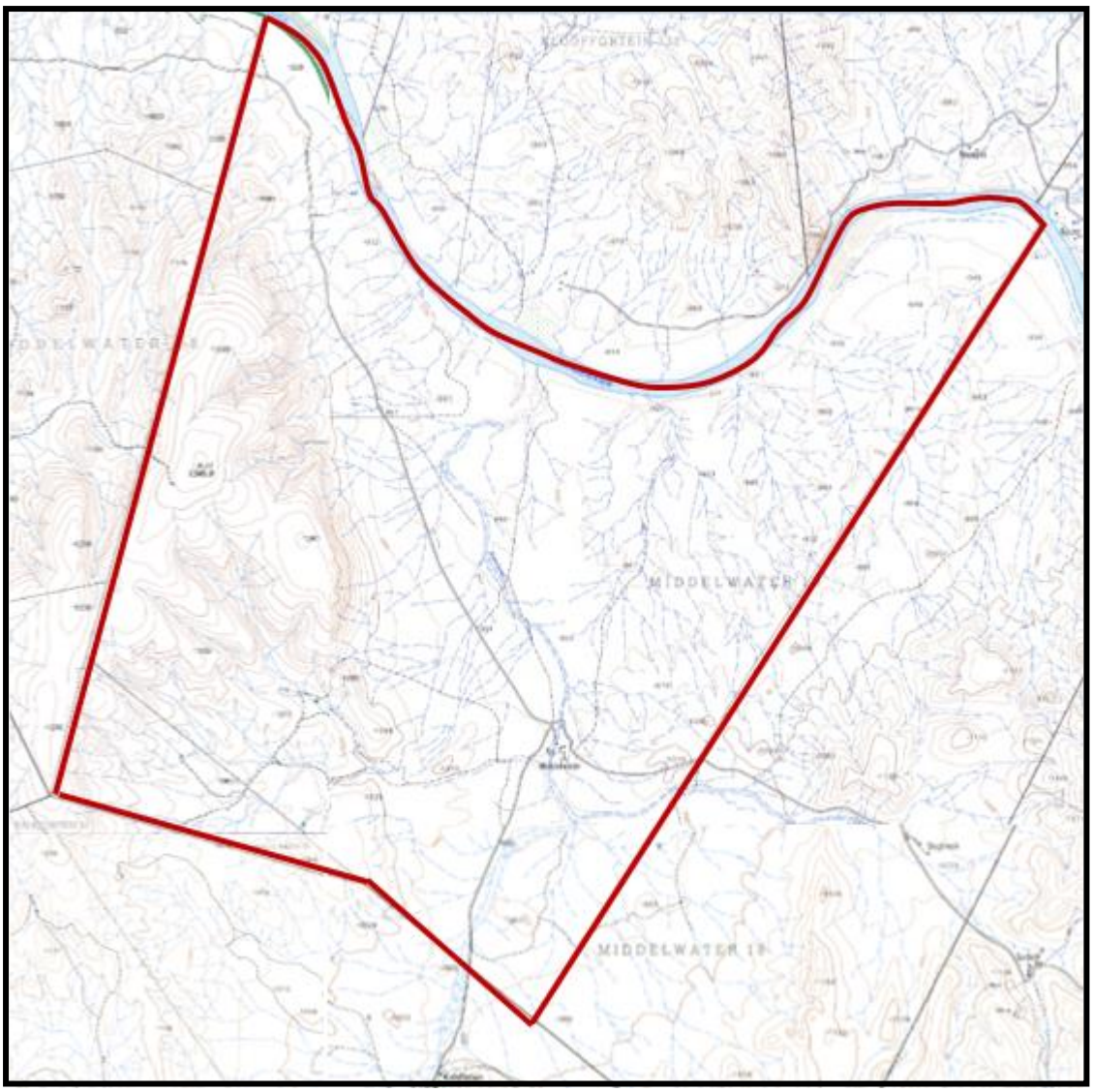

Figure 3.2: A topographic map of project site (red polygon).

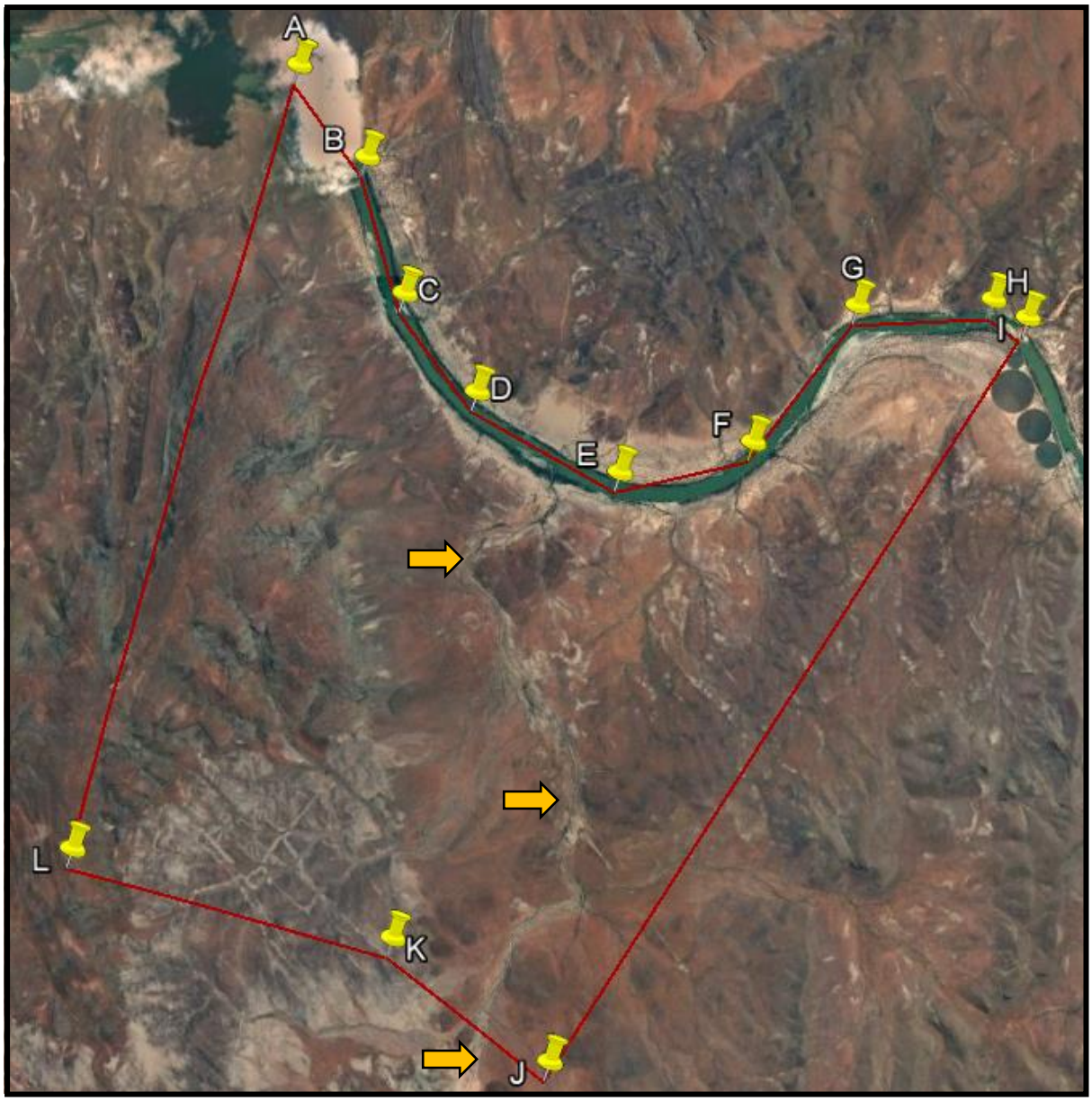

Figure 3.3: A satellite image of the project site (red polygon). Arrows indicate the Katrivier (Google Earth).

3.1.2 Topography

The topography of the landscape is relatively mountainous with low mountains scatteres through the landscape. These low mountains are incised with numerous valleys. Deep sand deposits occur on the brad valley floors. No depressions are present in the region. The landscape is drained by the Orange River and its tributaries.

3.1.3 Geology & soils

The region has a complicate geology: banded iron formation and amphibolites of the Asbestos Hills Subgroup are Vaalian and the carbonates and cherts of the Campbell Group are of the same Era. Metamorphic rocks of the Mokolian Erathem include quartzites and gneisses of the Korannaland Supergroup as well as the Riemvasmaak gneiss. Metamorphosed clastic sediments of the Uitdraai Formation are also Mokolian (Mucina & Rutherford, 2006). The soils

are shallow and skeletal (dominant soil forms are Mispah and Glenrosa), typical mainly of 1b and lc land types, and to a lesser extent also of Fb land type (MacVicar *et al.* 1974).

3.1.4 Climate (Rainfall & temperatures)

The area receives summer rainfall and is approximately 155mm per annum. The mean annual temperature is 18.0°C (Mucina & Rutherford, 2006).

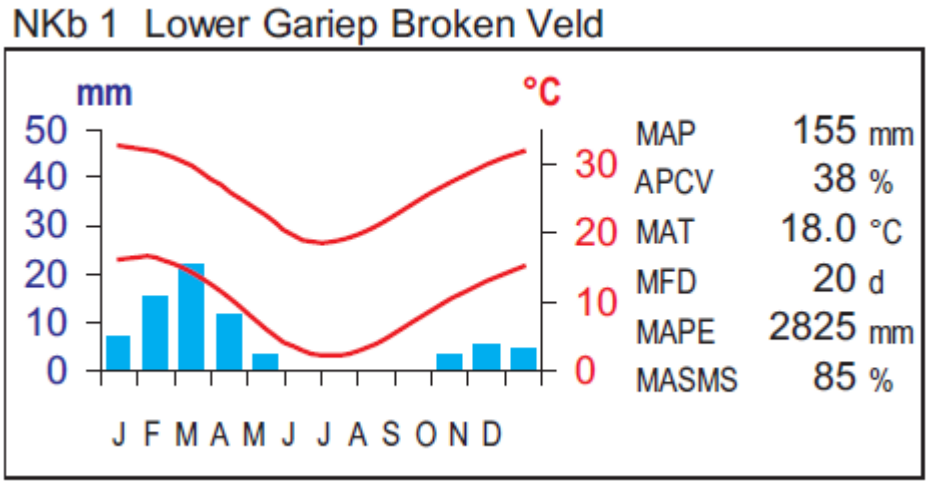

Figure 3.4: A climate-diagram of the Lower Gariep Broken Veld vegetation type (Mucina & Rutherford, 2006).

3.1.5 Land use & land cover

The project site is situated in an agricultural area. Most of the arable land along the river is used for crop production mainly pivot irrigation. The natural veld is used for sheep and cattle grazing and to a lesser extent game farming.

3.1.6 Broad vegetation types

The most recent description of the broader study area's vegetation is the general description by Mucina & Rutherford (2006) relating to the vegetation which is considered to be the "Vegetation of South Africa, Lesotho and Swaziland" as well as its accompanying map of the country by (Mucina *et al.*, 2005). This memoir contains species information and a comprehensive conservation assessment of all vegetation types.

According to Mucina & Rutherford (2006)(Fig 3.6), the vegetation type present at the project site is the Lower Gariep Broken Veld (NKb 1) as well as Bushmanland Arid Grassland (Nkb 3).

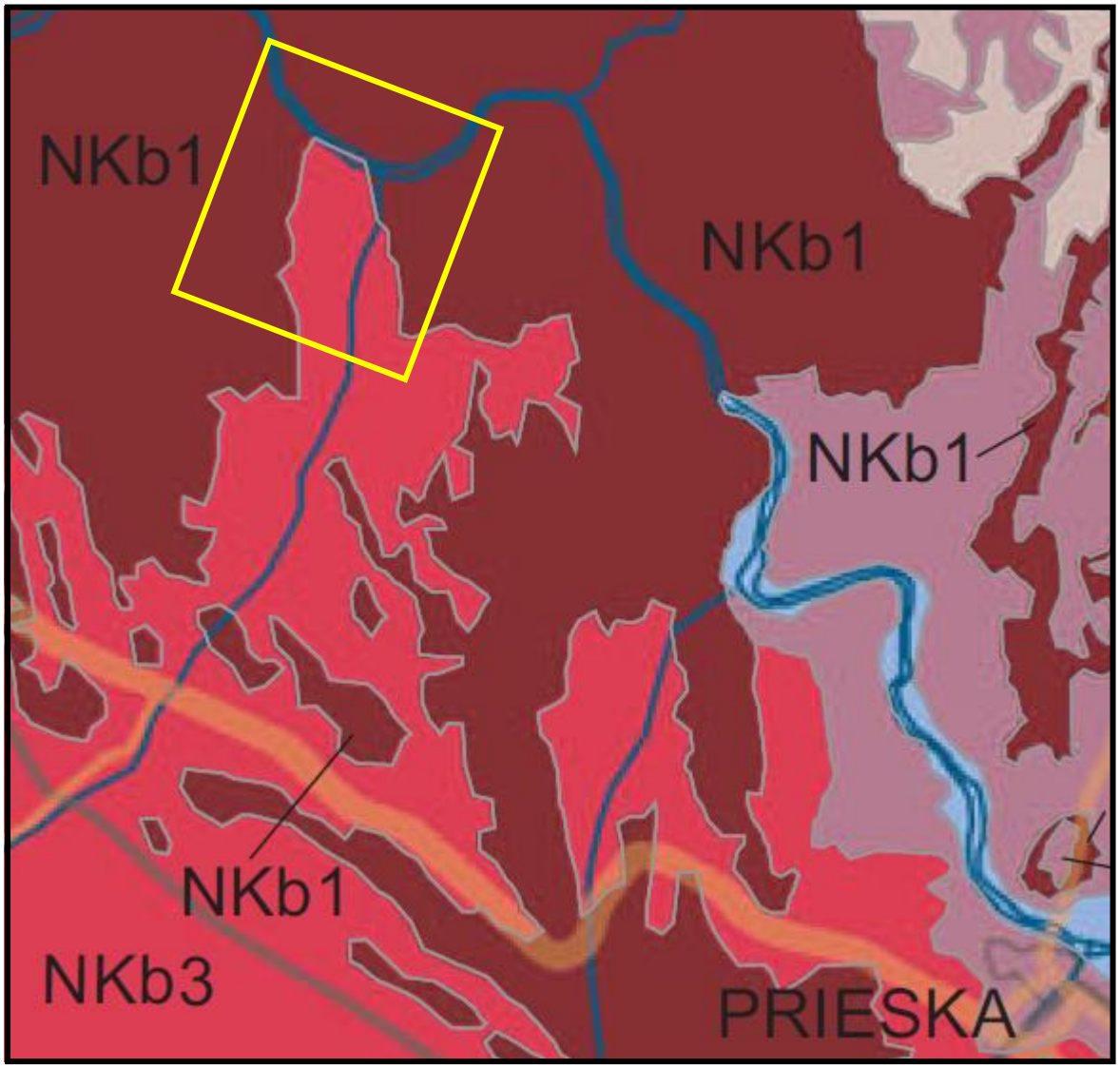

Figure 3.5: The vegetation map of the project site (yellow polygon) and the surrounding area.

- Lower Gariep Broken veld (NKb 1)
- Bushmanland Arid Grassland (NKb 3)(Mucina & Rutherford, 2006).

3.1.7 National List of Threatened Terrestrial Ecosystems for South Africa (2011)

The National threatened ecosystem classification is based on Mucina & Rutherford's map of 2006. The vegetation types of South Africa have been classified according to their conservation status which is, in turn, assessed according to the degree of transformation and rates of conservation. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. On a national scale these thresholds are as depicted in the table below, as determined by best available scientific approaches (Driver *et al.* 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver *et al.* 2005).

Table 3.1: Determining ecosystem status (from Driver *et al.* 2005). *BT = biodiversity target (the minimum conservation requirement.

Habitat remaining (%)			
	80–100	least threatened	LT
	60–80	vulnerable	VU
	*BT–60	endangered	EN
	0–*BT	critically endangered	CR

Threatened ecosystems which are in need of protection (GN1002 of 2011), was published under the National Environment Management: Biodiversity Act (Act No. 10 of 2004). It lists national vegetation types that are afforded protection on the basis of rates of transformation. The threshold for listing in this legislation is higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature.

The National Environmental Management: Biodiversity Act (Act 10 of 2004)(NEMBA) provides for listing of threatened or protected ecosystems, in one of four categories: critically endangered, endangered, vulnerable or protected. Threatened ecosystems are listed in order to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to conserve sites of exceptionally high conservation value (SANBI, BGIS).

Table 3.2: Conservation status of the vegetation type occurring in and around the study area.

Vegetation Type	**Target (%)**	**Conserved (%)**	**Transformed (%)**	**Conservation Status**	
				Driver *et al*., 2005; Mucina & Rutherford, 2006	National Ecosystem List (NEM:BA)
NONE					

The National threatened ecosystem classification is based on Mucina & Rutherford's map. According to the National List of Threatened Terrestrial Ecosystems (2011) the project site **does not** fall in a threatened ecosystem.

3.1.8 Ecoregions

Ecoregion: Nama-Karoo Ecoregion (Fig 2.1). Main attributes: Table 3.3.

Table 3.3: Summary of the main attributes of the Nama-Karoo Ecoregion

Main Attributes	Nama Karoo
Terrain Morphology: Broad division (dominant types in bold) (Primary)	Plains; Low Relief; **Plains Moderate Relief;** **Lowlands; Hills and Mountains; Moderate and High Relief;** Open Hills, Lowlands; Mountains; Moderate to High Relief; Closed Hills; Mountains; Moderate and High Relief
Vegetation types (dominant types in bold) (Primary)	Eastern Mixed Nama Karoo; Upper Nama Karoo; **Bushmanland Nama Karoo;** Orange River Nama Karoo; Great Nama Karoo (very limited) Lowland Succulent Karoo (limited); Upland Succulent Karoo Escarpment Mountain Renosterveld
Altitude (m a.m.s.l) (secondary)	300-1700, 1700-1900 (limited)
MAP (mm) (modifying)	0 to 500
Coefficient of Variation (% of annual precipitation)	30 to >40
Rainfall concentration index	15 to >65
Rainfall seasonality	Late to very late summer to Winter
Mean annual temp. (°C)	12 to 20
Mean daily max. temp. (°C): February	26 to >32
Mean daily max. temp. (°C): July	10 to 22
Mean daily min. temp. (°C): February	12 to 18
Mean daily min temp. (°C): July	0 to 6
Median annual simulated runoff (mm) for quaternary catchment	<5 to 60

3.1.9 National Freshwater Priority Areas (NFEPA)

The FEPA database was consulted with regards to areas in close proximity to or traversed by the project site that may be of ecological importance. Aspects applicable to the study area are discussed below:

- The study area falls within the Nama-Karoo Aquatic Ecoregion,
- According to the NFEPA database the study area falls within the Lower Orange Water Management Area (WMA), and
- the subWMA indicated for the study area is the Orange;
- WetVeg group: Dry Nama-Karoo Group 4;
- The subWMA is regarded as important in terms of fish sanctuaries, rehabilitation or corridors;
- The subWMA is considered important in terms of translocation and relocation zones for fish;
- The subWMA is listed a fish-FEPA;
- The NFEPA database indicates that there are no pans present on the project site;
- The NFEPA database indicates that there are no RAMSAR wetlands within the study area or within 500m of the study area;
- According to the National List of Threatened Terrestrial Ecosystems (2011) the study area does not fall in a threatened terrestrial ecosystem
- The study area is not part of a formal or an informal protected area.
- According to Northern Cape Biodiversity Plan (2016) the Orange River floodplain is classified as an aquatic Critical Biodiversity Area. The rest of the project site is classified as Critical Biodiversity Area except for the transformed areas;
- The Orange River and Katrivier are NFEPA – listed aquatic systems

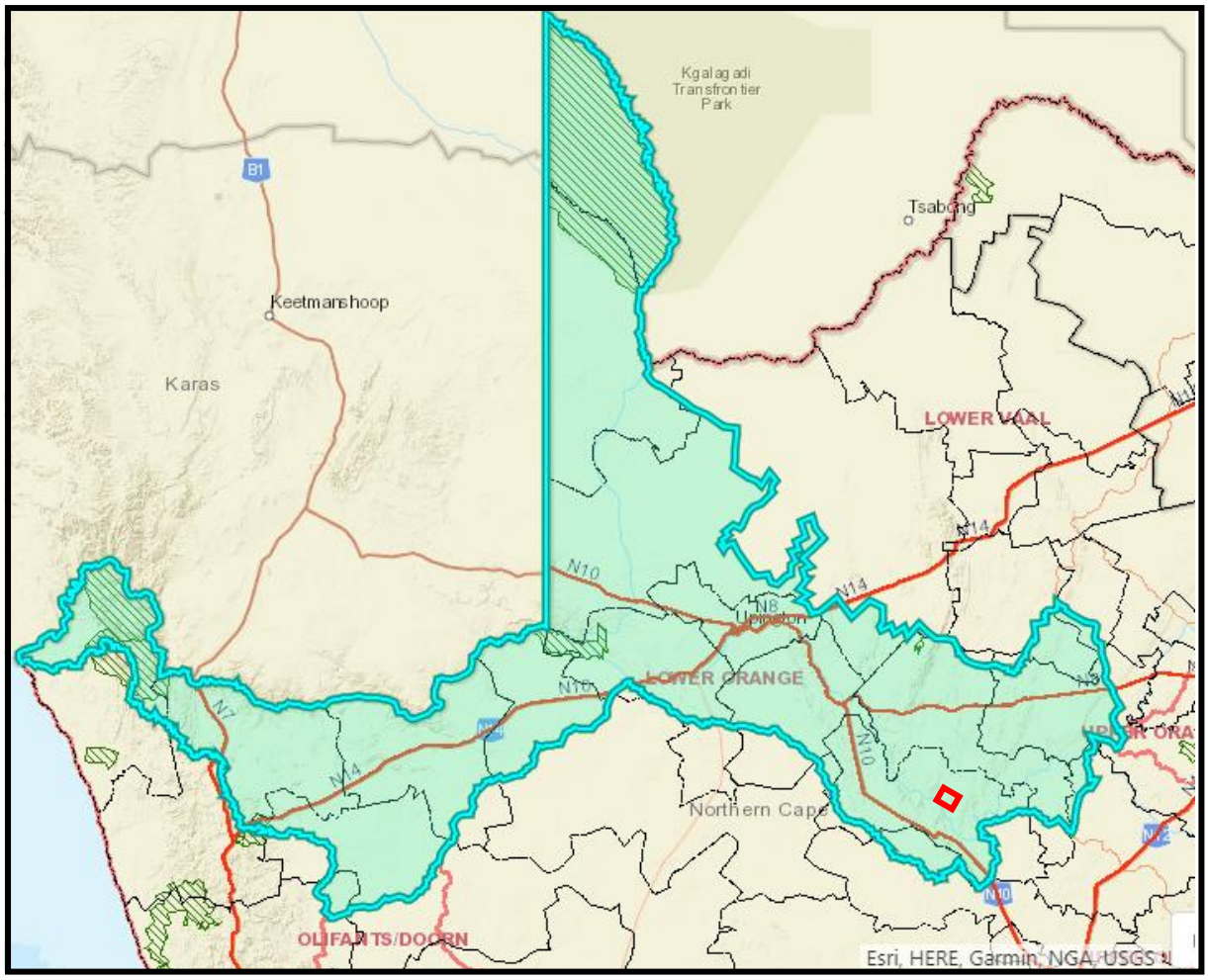

Figure 3.6: The project area (red polygon) in relation to the Orange River and its tributaries near the project site (turquoise polygon).

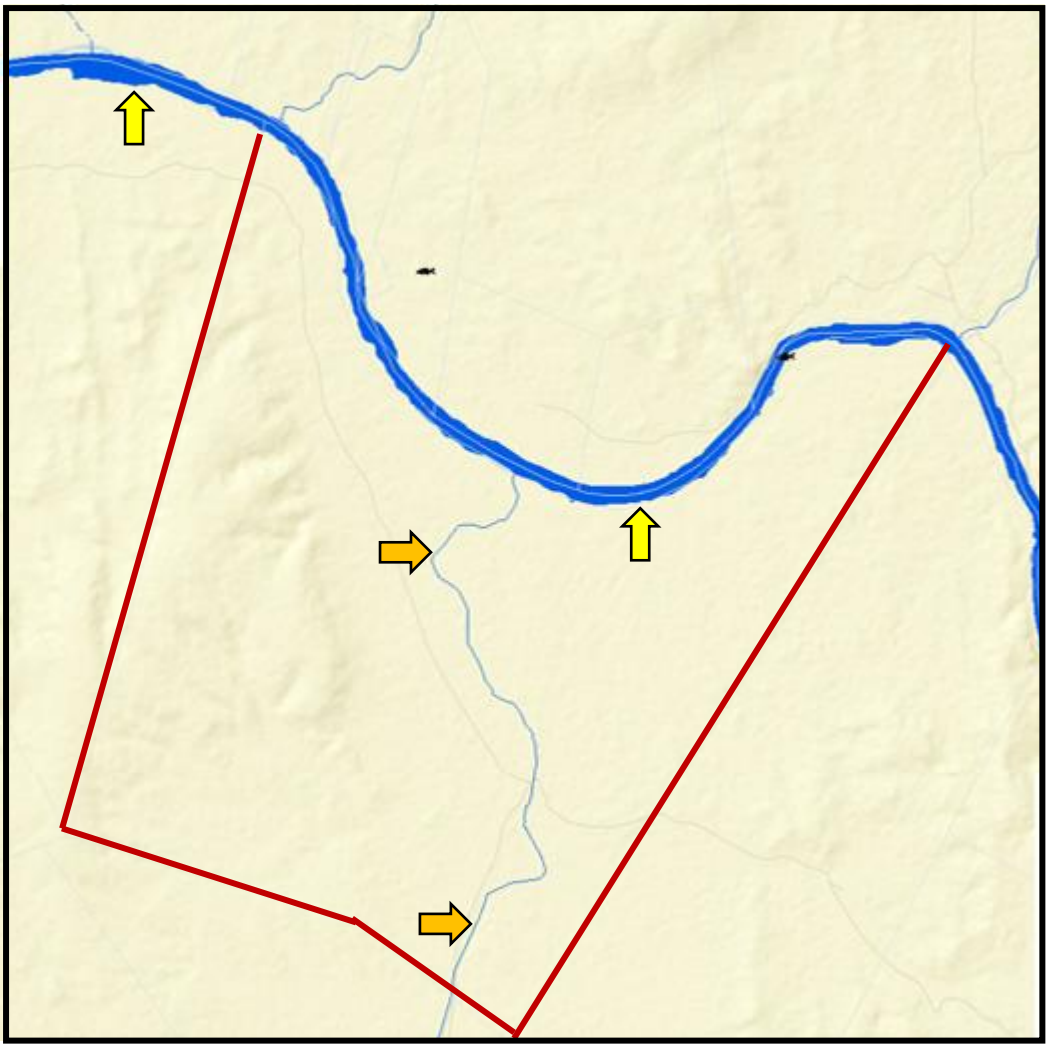

Figure 3.7: The blue line indicates the NFEPA-listed Orange River (Yellow arrow) and the Katrivier (Orange arrows) in relation to the project area (red polygon).

3.1.10 National Biodiversity Assessment (NBA, 2011)

The National Biodiversity Assessment (NBA) (2011) provides an assessment of South Africa's biodiversity and ecosystems, including headline indicators such as ecosystem threat status and ecosystem protection level, and national maps for the terrestrial, freshwater, estuarine and marine environments.

- According to maps and the Northern Cape Biodiversity Sector Plan (2016), the study areas are not located within or near any provincial or national protected area.

3.1.11 Northern Cape Biodiversity Plan (2016)

a) Definitions and descriptions of Critical Biodiversity Areas of the Province

Critical Biodiversity Areas (CBAs) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services. These form the key output of a systematic conservation assessment and are the biodiversity sectors inputs into multi-sectoral planning and decision making tools. The use of CBAs within

the province follows the definition laid out in the guideline for publishing bioregional plans (Anon, 2008).

The identification and mapping of CBAs forms part of the biodiversity assessment of the province which will be used to inform the development of the Provincial Biodiversity Sector plans, bioregional plans, and also be used to inform Spatial Development Frameworks (SDFs), Environmental Management Frameworks (EMFs), Strategic Environmental Assessments (SEAs) and in the Environmental Impact Assessment (EIA) process in the province.

Simply put, the purpose of the CBA is to indicate spatially the location of critical or important areas for biodiversity in the landscape. The CBA, through the underlying land management objectives that define the CBA, prescribes the desired ecological state in which the province would like to keep this biodiversity. Therefore, the desired ecological state or land management objective determines which land-use activities are compatible with each CBA category based on the perceived impact of each activity on biodiversity pattern and process. According to the guidelines for bioregional plans, three basic CBA categories can be identified based on three high-level and management objectives (Table 3.4).

Table 3.4: Definitions and framework for linking CBAs to land-use planning and decision-making guidelines based on a set of high-level land biodiversity management objectives (Adapted from the guidelines for bioregional plans (Anon 2008)).

CBA category	**Land Management Objective**
Critical Biodiversity Areas (CBAs) Definition: CBAs are areas of the landscape that need to be maintained in a natural or near-natural state in order to ensure the continued existence and functioning of species and ecosystems and the delivery of ecosystem services. In other words, if these areas are not maintained in a natural or near-natural state then biodiversity conservation targets cannot be met. Maintaining an area in a natural state can include a variety of biodiversity-compatible land uses and resource uses.	
Protected Areas (PA) & CBA 1	**Natural landscapes:** Ecosystems and species are fully intact and undisturbed. These are areas with high irreplaceability or low flexibility in terms of meeting biodiversity pattern targets. If the biodiversity features targeted in these areas are lost then targets will not be met. These are landscapes that are at or past their limits of acceptable change.
CBA 2	**Near-natural landscapes:** Ecosystems and species are largely intact and undisturbed. Areas with intermediate irreplaceability or some flexibility in terms of the area required to meet biodiversity targets. There are options for loss of some components of biodiversity in these landscapes without compromising the ability to achieve targets. These are landscapes that are approaching but have not passed their limits of acceptable change.
Ecological Support Areas (ESAs) Definition: ESAs are areas that are not essential for meeting biodiversity representation targets/thresholds but which nevertheless play an important role in supporting the ecological functioning of critical biodiversity areas and / or in delivering ecosystem	

services that support socio-economic development, such as water provision, food mitigation or carbon sequestration. The degree of restriction on land use and resource use in these areas may be lower than that recommended for critical biodiversity areas.	
ESA	**Functional landscapes:** Ecosystem is moderately to significantly disturb but still able to maintain basic functionality. Individual species or other biodiversity indicators may be severely disturbed or reduced. These are areas with a low irreplaceability with respect to biodiversity pattern targets only.
ONA (Other Natural Areas) and Transformed	Production landscapes: Manage land to optimise sustainable utilisation of natural resources.

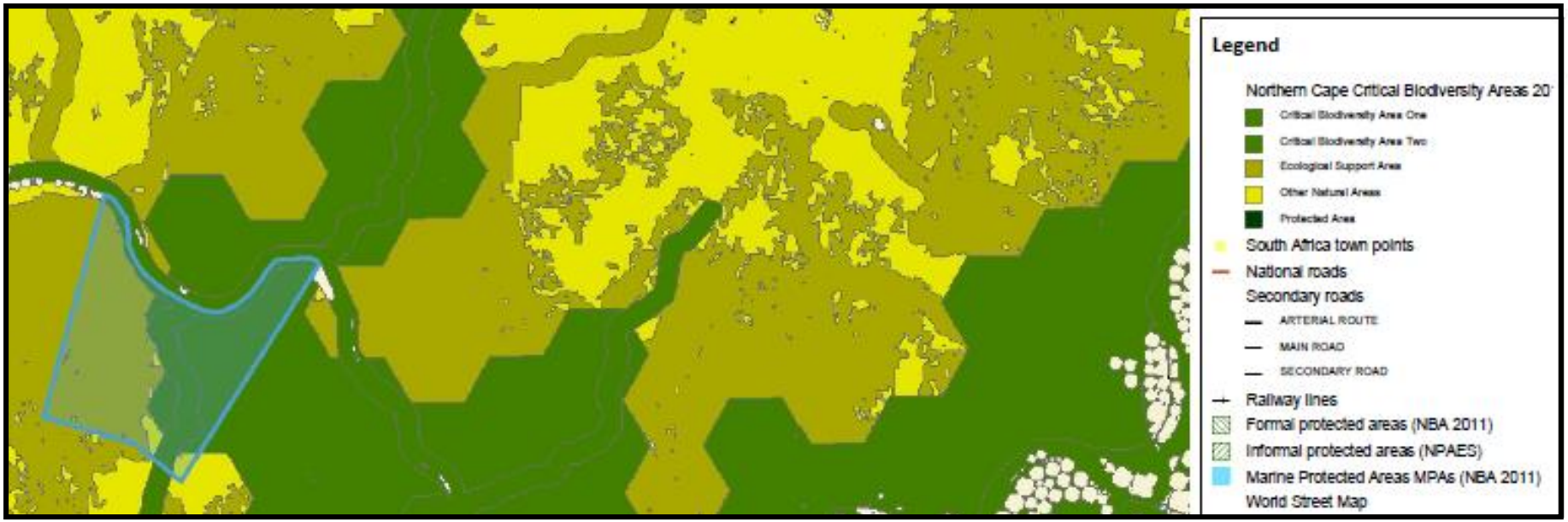

Figure 3.8: A map showing the project site (blue polygon) in relation to the Critical Biodiversity and Ecological Support areas. White-coloured areas are transformed areas (mines & center pivots)

According to the Northern Cape Province's Biodiversity Sector plan (2016), parts of the project sites are classified having Aquatic Critical Biodiversity Areas (CBA 1 & 2) along the Orange River, and Critical Biodiversity Areas (CBA 1 & 2) the terrestrial areas. The perennial Orange River and seasonal Katrivier are NFEPA-listed systems (Fig 3.8). No pans are present on the project site.

4. RESULTS

4.1 Fine- scale vegetation description

Tables 4.1. - 4.4 reflect the species noted during the site visit. Red Data species status is according to the Red List of South African Plants published by SANBI in *Strelitzia* 25 (Raimondo *et al.* 2009, updated 2013).

4.1.1 Terrestrial vegetation and animals

According to Mucina & Rutherford (2006) two vegetation types are present on the project site namely the Lower Gariep Broken veld (NKb 1) and Bushmanland Arid Grassland (NKb 3)(Mucina & Rutherford, 2006).

The dominant species present in these vegetation types includes the trees and shrubs: *Dendroaloe dichotoma. Senegalia mellifera* subsp. *detinens, Commiphora gracilifron, Ficus cordata, Pappea capensis, Searsia populifolia, Ziziphus mucronata. Rhigozum trichotomum, Adenolobus garipensis Antherothamnus pearsoni, Cadaba aphylla, Caesalpinia bracteata, Ehretia alba, Nymania capensis, Rhigozum obovatum, R. trichotomum, Searsia burchellii, Tapinanthus oleifolius, Ceraria namaquensis, Cryptolepis decidua, Euphorbia avasmontana, E. gregaria, Kleinia longiflora, Lycium bosciifolium, Zygophyllum dregeanum, Sarcostemma viminale.* Low Shrubs: *Blepharis mitrata, Aizoon schellenbergii, Aptosimum albomarginatum, A. lineare, A. marlothii, Barleria rigida, Berkheya spinosissima, Dyerophytum africanum, Hermannia spinosa, H. vestita, Hibiscus elliottiae, Indigofera heterotricha, Limeum aethiopicum, Lophiocarpus polystachyus, Monechma spartioides, Phaeoptilum spinosum, Phyllanthus maderaspatensis, Polygala seminuda, Ptycholobium biflorum, Sericocoma avolans, Solanum capense.* Graminoids: *Aristida adscensionis, Enneapogon desvauxii, E. scaber, Eragrostis nindensis, Stipagrostis obtusa, S. uniplumis, Aristida congesta, A. engleri, Cenchrus ciliaris, Digitaria eriantha, Enneapogon cenchroides, Eragrostis annulata, E. lehmanniana, E. porosa, Schmidtia kalahariensis, Setaria verticillata, Sporobolus fimbriatus, Stipagrostis anomala, S. ciliata, Tragus berteronianus, Triraphis ramosissima* Herbs*: Forsskaolea candida, Acanthopsis hoffmannseggiana, Barleria lichtensteiniana, Chamaesyce glanduligera, Chascanum garipense, Cleome angustifolia diandra, Codon royenii, Dicoma capensis, Garuleum schinzii, Rogeria longiflora, Sesamum capense, Tribulus zeyheri, Trichodesma africanum.* Succulent Herbs: *Orbea lutea, Stapelia flavopurpurea* (Mucina & Rutherford, 2006).

***FINDINGS*:**

Table 4.1: Description of the assessment of the terrestrial vegetation on project site.

Site features	**Comments**
Landscape features	The mountainous landscape is dissected by numerous seasonal drainage lines. Deep narrow valleys as well as broad sandy floodplains are present. There are no pans occur on this project site. The project site is drained by numerous seasonal drainage lines which drain down to the Katrivier and Orange River
Land use of the project site	Agricultural area: Mainly grazing areas with centre pivots on floodplains near the Orange River.
Condition of the vegetation (pristine / degraded / totally transformed)	The character of this area's vegetation is an extensive karroid landscape. The vegetation cover in general is sparse. It is still in a natural condition although areas has been invaded by encroachers such as *Rhigozum trichotomum*, the exotics *Prosopis velutina* and *Prosopis glandulosa*.
Protected plant species noted	A number of protected species occur in the area namely *Dendroaloe dichotoma, Boscia albitrunca, Euphorbia avasmontana*
Visual indication of and impact on terrestrial fauna (mammals)	The potential diversity of mammals within the study area is low because it is a disturbed area and most natural habitats have been transformed. There are several factors which will reduce the actual number of species present within the project site. The presence of humans and roads, the destruction of natural vegetation, noise etc., has had a major impact on the natural animal populations in the project area. During the site visit the following faunal species were confirmed within the project site: • Single rodent burrows (most likely Four-striped Grass Mouse (*Rabdomys pumilo*). • Relative large burrows (likely to have been made and utilized by Aardwolf (*Proteles cristatus*), Porcupine (*Hystrix africae-australis*). and/or Aardvark – (*Orycteropus afer*). Smaller burrows were noted and were probably made by Ground squirrel (*Geosciurus inauris*), Yellow Mongoose (*Cunictis penicillata*) and Zorilla (*Ictonyx striatus*) None of these species noted within the project site are listed and or protected species.

Visual indication of and impact on terrestrial fauna (herpetofauna)	Of the many reptilian species that have been recorded with the region none of these species are listed as Red Data species. Fifteen amphibian species have been recorded within the region and of these 15 species eight species were recorded within close proximity of the project site. One near threatened species namely the Giant Bullfrog (*Pyxicephalus adspersus*) has been recorded for the quarter degree grid square (QDGS). Although this species was not found on site (not a suitable habitat), it is still likely for this species to occur near the project site as potential suitable habitat (pans and drainage lines) is available in the vicinity of the project site.
Visual indication of and impact on terrestrial fauna (birds)	Of the more than 320 bird species that have been recorded in the region a few species occur on the study area. Birds such as African Fish Eagle, Crowned Lapwing, Blacksmith Lapwing, Orange River Francolin, Helmeted Guineafowl, Thick-knee, Northern Black Korhaan, Cattle Egrets, Black-headed Heron, Turtle Doves, Rock Pigeons, and Hadeda and others could occur in the project site.
Signs of pollution	No obvious signs of pollution are present on the site.
Erosion potential	There are no extensive signs of disturbance and clearance of the vegetation. The area slopes towards the Orange River and some erosion gullies are present.
Ecosystem function	The remaining natural vegetation provides nesting areas for avifauna and occasional shelter for terrestrial fauna. Niche habitats for fauna – providing sheltered burrows and nesting sites. Micro-climate is created by the shrubs and trees housing species sensitive to direct sunlight or frost

The following tables present the dominant floral species identified within each HGM type, and terrestrial communities although it should be noted that these lists are not an extensive listing of the floral species found within the project site.

Table 4.2: Dominant plant species noted in the terrestrial shrubland on the project site. * indicates exotic species.

Trees / shrubs	Grasses/reeds/bulrushes	Forbs
Boscia albitrunca	*Aristida adscensionis*	*Acanthopsis hoffmannseggiana*
Cadaba aphylla	*Aristida congesta*	**Argemone ocholeucra*
Dendroaloe dichotoma	*Aristida bipartita*	*Atriplex lindleyii*
Ehretia alba	*Cenchrus ciliaris*	*Barleria rigida*
Euphorbia avasmontana	*Cynodon dactylon*	*Barleria lichtensteiniana*
Ficus cordata	*Enneapogon desvauxii*	*Chascanum garipense*
Lycium boscifolium	*Enneapogon cenchroides*	*Chrysocoma ciliata*
Lycium villosum	*Enneapogon scaber*	**Datura ferox*
Melianthus comosus	*Eragrostis annulata*	**Chenopodium album*
Nymania capensis	*Eragrostis echinochloidea*	**Chenopodium schraderianum*
Pappea capensis	*Eragrostis lehmanniana*	*Felicia muricata*
Phaeoptilum spinosum	*Eragrostis porosa*	*Kleinia longiflora*
**Prosopis glandulosa*	*Stipagrostis anomala*	*Monechma spartioides*
**Prosopis velutina*	*Stipagrostis obtusa*	**Salsola kali*
Rhigozum obovatum	*Stipagrostis ciliata*	*Sarcostemma viminale*
Rhigozum trichotomum	*Tragus berteronianus*	*Sesamum capense*
Searsia burchellii		**Tagetes minuta*
Searsia lancea		*Tribulus zeyheri*
Senegalia mellifera		
Vachellia karroo		
Vachellia tortilis		
Zygophyllum dregeanum		

The following tables present the dominant floral species identified within each HGM type, and terrestrial communities although it should be noted that these lists are not an extensive listing of the floral species found within the project site.

4.1.2 Conservation status of species

a) Red List and protected plant species of the study area

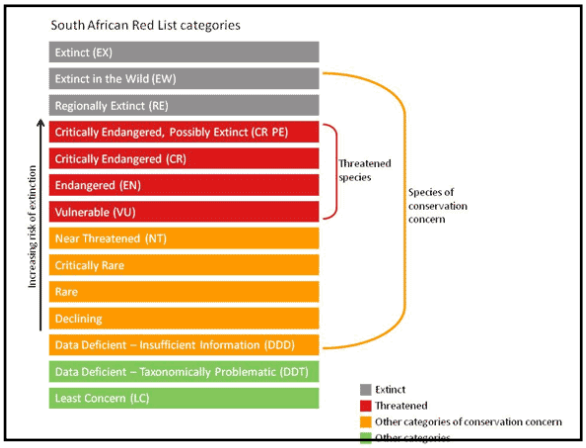

Figure 4.1: Schematic representation of the South African Red List categories. Taken from http://redlist.sanbi.org/redcat.php

Table 4.3: Protected species noted on the project site.

Trees / shrubs	Grasses/reeds/bulrushes	Forbs
Boscia albitrunca		*Aloe claviflora*
Dendroaloe dichotoma		
Euphorbia avasmontana		

4.1.3 Alien Invasive Plants (AIPs) confirmed during the survey

Due to the agricultural activities disturbance of the natural vegetation occurred around the seasonal water courses. The dominant alien species and pioneer species noted on these disturbed areas are *Prosopis velutina, P. glandulosa, Argemone ocholeuca, Salsola kali,* and *Datura ferox.* Along the Orange River exotics such as Salix babylonica, *Eucalyptus camuldulensis, Prosopis glandulosa, Tamarix ramosissima, and forbs such as Bidens bipinnata. Chenopodium album, Datura ferox, Schkuhria pinnata,* and *Tagetes minuta,* occur.

4.1.4 Riparian and wetland system characterisation

The following tables present the dominant floral species identified within each HGM type although it should be noted that these lists are not an extensive listing of the floral species found within the project site.

Table 4.4: Dominant plant species noted along the Orange River on the project site. * indicates exotic species.

Trees / shrubs	Grasses/reeds/bulrushes	Forbs
**Eucalyptus camuldulensis*	*Chloris virgata*	**Atriplex semmibaccata*
Lycium hirsutum	*Cyperus margaritaceus*	**Bidens bipinnata*
Melianthus comosus	*Cyperus longus*	**Chenopodium album*
**Prosopis glandulosa*	*Cyperus bellus*	**Conyza bonariensis*
Searsia lancea	**Cyperus sexangularis*	**Datura ferox*
Searsia pendulina	*Cynodon dactylon*	**Schkuhria pinnata*
**Salix babylonica*	**Paspalum dilatatum*	*Senecio hastatus*
Salix mucronata	*Phragmites australis*	**Tagetes minuta*
**Tamarix ramosissima*	*Setaria sphacelata*	**Xanthium strumarium*
Vachellia karroo	*Setaria verticillata*	
Ziziphus mucronata	*Schoenoplectus muricinux*	
	Scirpoides inanis	

It should be noted that although the wetland and riparian features identified may extend beyond the project site, only portions located within the study area (including the 500m buffer) were assessed and ground-truthed. Furthermore, the study focused on features located within the study area and features located outside of this area were delineated using digital satellite imagery with limited field verification. Nonetheless, the potential impacts of activities such as crop production, erosion and clearing of natural vegetation within the greater catchment were taken into consideration during the assessment.

All wetland and watercourse/riparian features identified within the study area were classified as Inland Systems falling within the Highveld Aquatic Ecoregion. The table below presents the classification on level 3 and 4 of the wetland classification system.

Table 4.5: Characterisation of the riparian and wetland systems within the study area according to the classification system (Ollis *et al.* 2013)

System	Level 3: Landscape unit	Level 4: Hydro-geomorphic Unit	
		HGM type	**Longitudinal zonation / landform / Inflow drainage**
Orange River	Plain	River	Lowland river with active channel & riparian zone
Ephemeral drainage lines	Low hill slopes	Stream	Lowland river with active channel & riparian zone
Floodplain wetland	Plain	Floodplain wetland	Floodplain of lowland river with active channel & riparian zone

Wetland habitat is land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil (NWA; Act No. 36 of 1998).

Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas. The rivers and non-perennial drainage lines with riparian characteristics are defined as watercourses, whilst the smaller ephemeral drainage lines without riparian zones are not considered wetlands or systems with an associated riparian zone but may still be defined as watercourses if the features have floodlines applicable to them.

***FINDINGS*:**

Table 4.6: Description of the assessment of the perennial Orange River and seasonal Katrivier River on the project site

Site features	Comments
Upstream and catchment features	The catchment area consists of natural shrubland covering a mountainous landscape. There are numerous areas near the river and streams where agricultural activities have disturbed the natural vegetation. The deeper sandy soils in the catchment especially along the drainage lines have been invaded by the exotic Prosopis tree. Dirt roads are present in the catchment area.
Type of wetland (Ephemeral / perennial)	The Orange River is a perennial system while the Katrivier and its tributaries have an ephemeral character. No pans are situated on the project site

Other sources of input (springs etc.)	None
Downstream significance	Weirs and dams are present in the Orange River further up- and downstream.
Vegetation characteristics	The vegetation is dominated by a mix of trees, shrubs, grasses and sedges.
Presence of algae	Some algal species were noted in the Orange River
Visual indication of and impacts on aquatic fauna	None
Depth characteristics	The Orange River has varying depths at the project site. The Katrivier is an ephemeral stream which only flows after rainfall events.
Flow conditions	No obstructions are present in the Orange River and the Katrivier and its tributaries
Water clarity	The Orange River's water was turbid during the time of the assessment.
Water odour	No odour was noted
Erosion potential	There is a high potential for erosion due to the poor vegetation cover on the project site

Much of the functionality of the Orange River and its riparian features has been altered due to anthropogenic activities such as impounding the river with dams and weirs, river bank disturbance by clearing the riparian vegetation and some agricultural activities close to the river such as ploughing the floodplains. Currently, the water does not have a real value for the local community however the water in the river is used for irrigation and as a watering points for domestic animals.

4.2 Riparian Vegetation Response Index (VEGRAI)

The VEGRAI method was applied in order to assess the impacts of modifications to the system on the riparian vegetation of the river. The riparian zones located along the river have been impacted by the growth of alien vegetation. The resultant encroachment of alien vegetation has led to an impediment of water flow and displacement of indigenous floral and faunal species within the riparian areas. Furthermore, all of these systems have been impacted upon by agriculture (crop cultivation and grazing of domestic livestock) activities.

Table 4.7: Summary of results of the VEGRAI assessments conducted for the Orange River and its floodplain wetland as well as the Katrivier and its tributaries.

Features	Present State Score (%)	Present State Category
Orange River	63	C
Orange River floodplain wetland	65	C
Katrivier seasonal stream and tributaries	52	D

- These features were classified according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems (Ollis *et al.*, 2013), as Inland Systems falling within the Nama-Karoo Aquatic Ecoregion;
- At Level 4 of the Classification System, the features within the study area were classified as: Rivers & floodplain wetlands
- The riparian features found on the project site have a VEGRAI Ecological Category of:
    - The Orange River received a score of 63%, (Category C) which means that the system is moderately modified where the loss of natural habitat, biota, have occurred but the basic ecosystem functions are predominantly unchanged.
    - The floodplain wetland is 65% (Category C) which means that the system is moderately modified where the loss of natural habitat, biota, have occurred but the basic ecosystem functions are predominantly unchanged.
    - The Katrivier and its tributaries is 52% (Category D) which means that it is a largely modified system where a large loss of natural habitat, biota, and basic ecosystem functions has occurred.

4.3 Index of Habitat Integrity (IHI)

The Index of Habitat Integrity (IHI) as described by the DWA (2007) was utilised to assess the present Habitat Integrity state of the wetlands on the properties.

Wetland health is defined as a measure of the similarity of a wetland to a natural or reference condition. “Deviations” from this natural or reference state, particularly the extent of human impacts which may have caused the wetland to differ from this natural state, are considered when ascertaining the “health” of a wetland (Macfarlane *et al.,* 2008).

The Index of Habitat Integrity (IHI) was applied to the Orange River and floodplain wetland as well as the Katrivier and its tributaries to assess the Present Ecological State (PES). The table below provides a summary of the IHI results for each group of features and the river which are discussed in detail in the sub-sections that follow.

Table 4.8: Summary of results of the WET-IHI assessments conducted for the Orange River and its floodplain wetland as well as the Katrivier and its tributaries.

Features	Present State Score (%)	Present State Category
Orange River	70	C
Orange River floodplain wetland	73	C
Katrivier seasonal stream and tributaries	56	D

- The riparian features found on the project site have a VEGRAI Ecological Category of:
    - The Orange River received a score of 70%, (Category C) which means that the system is moderately modified where the loss of natural habitat, biota, have occurred but the basic ecosystem functions are predominantly unchanged.
    - The floodplain wetland is 73% (Category C) which means that the system is moderately modified where the loss of natural habitat, biota, have occurred but the basic ecosystem functions are predominantly unchanged.
    - The Katrivier and its tributaries is 56% (Category D) which means that it is a largely modified system where a large loss of natural habitat, biota, and basic ecosystem functions has occurred.

4.4 Wet-Health Assessment (Overall PES)

A Level 1 Wet-Health assessment of the floodplain HGM Units was undertaken. Three modules, namely hydrology, geomorphology and vegetation, were assessed as a single unit for the HGM Units and subsequently an area weighted score was obtained for the HGM Units. The potential impacts of activities such as agriculture, altered hydrological functions and clearing of natural vegetation within the greater catchment were taken into consideration during the assessment. These results are summarised in the table below.

Table 4.9: Summary of results of the WET-Health assessments conducted for the Orange River its floodplain wetland as well as the Katrivier and its tributaries

Feature	**Hydrology**		**Geomorphology**		**Vegetation**		**Overall PES Category**
	Impact score	Change score	Impact score	Change score	Impact score	Change score	
Orange River	C	🡻	C	🡻	C	🡻	C
Orange River floodplain wetland	C	🡻	C	🡻	C	🡻	C
Katrivier seasonal stream and tributaries	C	🡻	C	🡻	D	🡻	C

The overall PES Category for the **Orange River its floodplain wetland as well as the Katrivier and its tributaries** is a **C** which means the system is moderately modified where a moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.

What needs to be considered is that if the disturbance and spread of alien invasive plants are allowed to continue unchecked and prospecting activities are not planned for properly, and without proper rehabilitation it is highly likely that the disturbed areas in the project site will be further degraded and it will suppress the wetland function capabilities.

4.5 Riparian and Wetland Function Assessment

The ecological functions and service provision for the river's riparian zones were assessed utilising the WET-EcoServices method (Kotze *et. al.* 2009) as described in the methodology (Chapter 2) of this report. The results of the assessments are tabulated and discussed below.

Table 4.10: Results of the ecological function and services provision assessment applied to the Orange River and Orange River's floodplain as well as the Katrivier and its tributaries' riparian features within the project site.

Ecosystem service	Wetlands's riparian vegetation		
	Orange River	Orange River Floodplain	Katrivier & tributaries
1. Flood attenuation	1.2	1.6	1.8
2. Streamflow regulation	1.5	1.2	1.0
3. Sediment trapping	1.9	1.9	2.0
4. Phosphate trapping	1.7	1.9	1.5
5. Nitrate removal	1.5	1.0	0.6
6. Toxicant removal	1.7	1.8	1.4
7. Erosion control	2.2	1.9	2.2
8. Carbon storage	2.0	1.3	1.0
9. Maintenance of biodiversity	0.8	1.2	1.2
10.Water supply for human use	2.6	1.2	1.0
11. Natural resources	0.2	0.0	0.0
12. Cultivated foods	1.2	1.0	0.6
13. Cultural significance	0.0	0.0	0.0
14.Tourism and recreation	1.3	0.4	0.0
15. Education and research	0.5	0.5	0.5
16. Threats	3.0	3.0	3.0
17. Opportunities	2.0	2.0	2.0
TOTAL	**25.3**	**21.9**	**19.8**
Mean	**1.48**	**1,29**	**1.16**

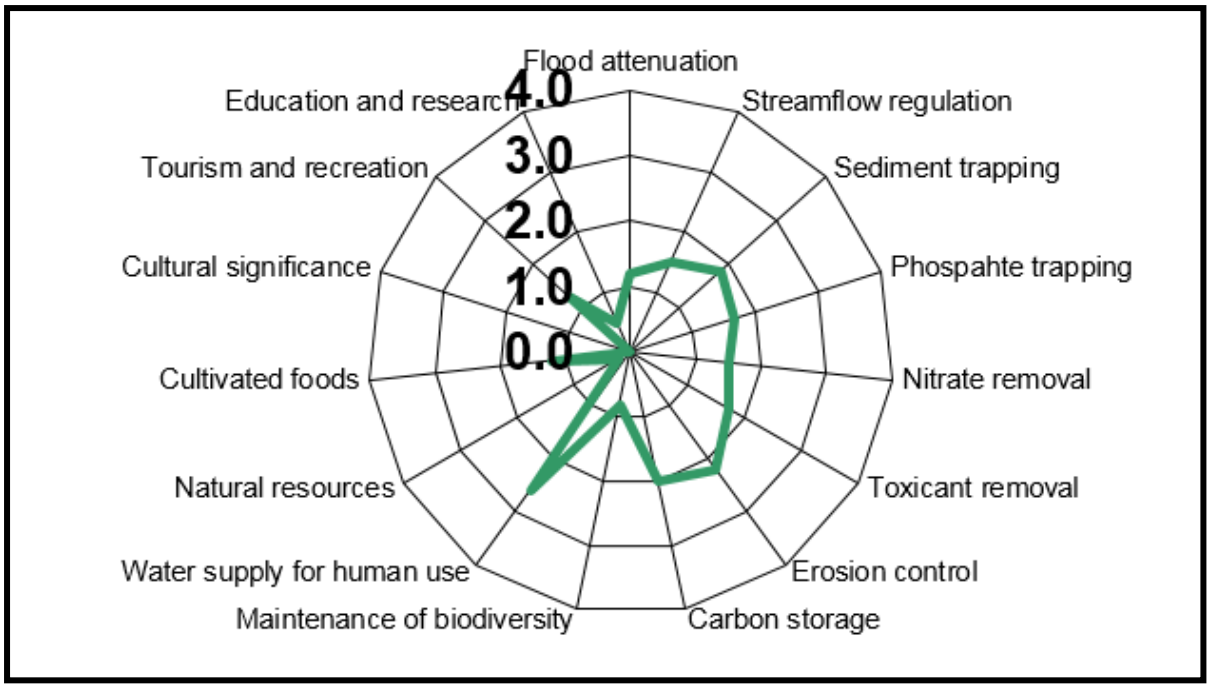

Figure 4.2: A spider diagram of the ecological function and services provision assessment applied to the Orange River's riparian vegetation on the project site.

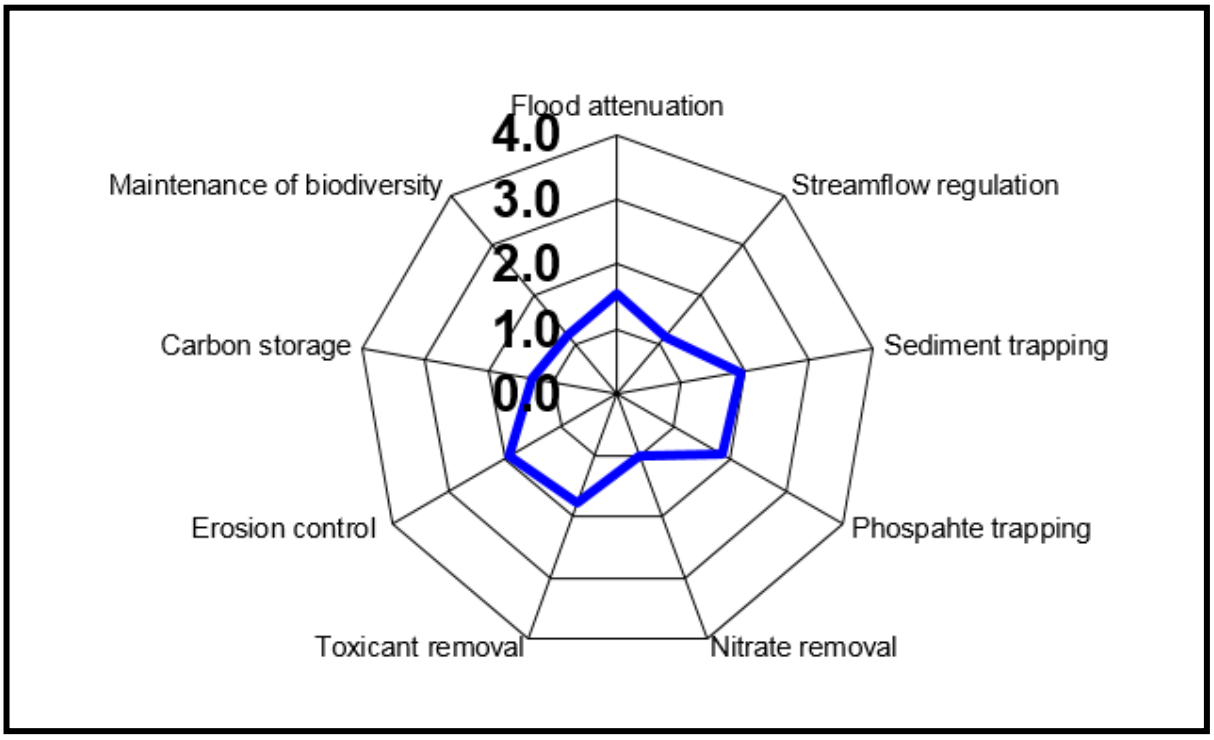

Figure 4.3: A spider diagram of the ecological function and services provision assessment applied to the Orange River's floodplain's riparian vegetation on the project site.

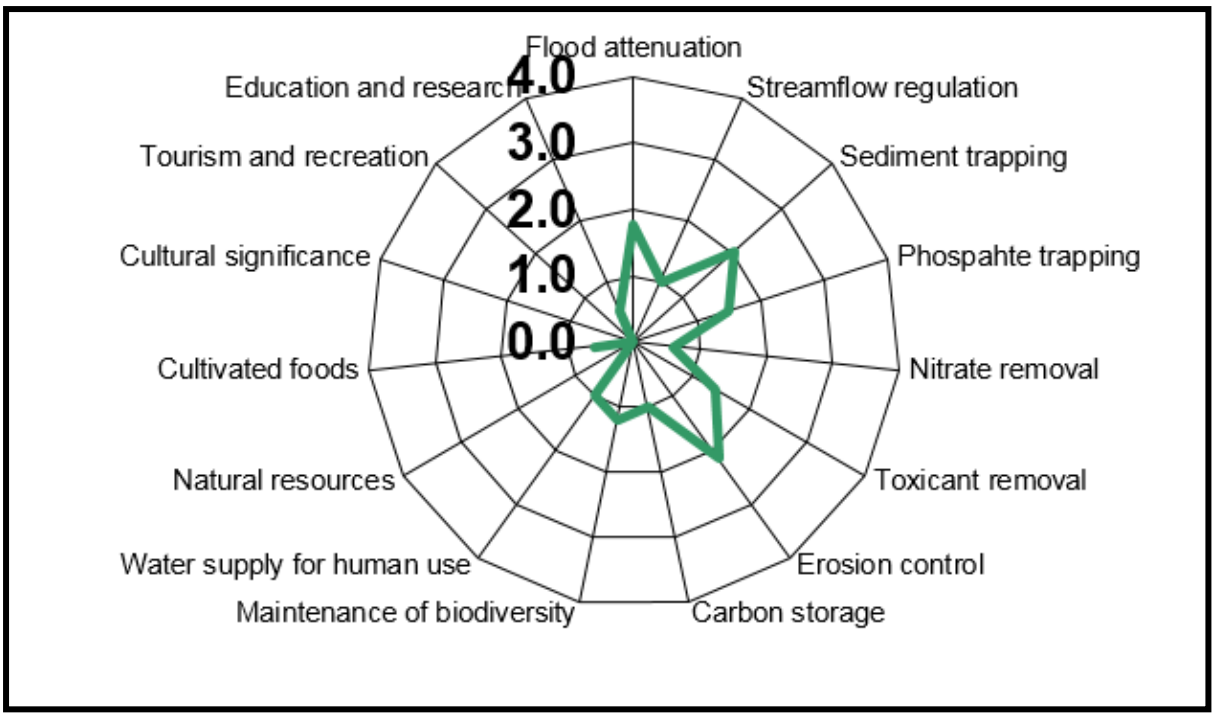

Figure 4.3: A spider diagram of the ecological function and services provision assessment applied to the Katrivier and its tributaries' riparian vegetation on the project site.

The ecological functions and service provision for these hydro-geomorphic units and the hydro-geomorphic units as a whole was calculated in Table 4.11. Biodiversity maintenance is low in the Orange River's and floodplain's as well as the Katrivier and its tributaries' riparian vegetation. The presence of exotic species has a limiting factor in this area in terms of biodiversity maintenance and support. The ecological functions and service provision score for the Orange River's and floodplain's as well as the Katrivier and its tributaries' riparian vegetation on the project site is 1.3 and 1.5 respectively which scores a **Moderately – Low** rating.

Orange River its floodplain wetland as well as the Katrivier and its tributaries scored low values in terms of tourism, recreation, education and research and they also do not play any form of cultural importance to the surrounding communities.

4.6 Ecological Importance and Sensitivity (EIS) Assessment

The EIS assessment was applied to all watercourse/riparian and wetland features within the study area in order to ascertain the levels of sensitive and ecological importance of the features, as well as to assist in informing a suitable REC for each. The results of these assessments are summarised in the table below.

Table 4.11: Results of the Ecological Importance and Sensitivity (EIS) assessments all riparian and wetland features within the project site.

Determinant		Orange River's vegetation	Orange River Floodplain's vegetation	Katrivier's vegetation	Confidence
	PRIMARY DETERMINANTS				
1	Rare & endangered species	0	0	0	4
2	Populations of unique species	0	0	0	4
3	Species/Taxon richness	0	0	0	4
4	Diversity of habitat types or features	1	1	1	4
5	Migration route/breeding & feeding site for wetland species	2	1	1	4
6	PES as determined by WET-Health assessment	1	1	1	4
7	Importance in terms of ecosystem function & service provision	1	0	0	4
	MODIFYING DETERMINANTS				
8	Protected Status according to NFEPA WetVeg	1	1	0	4
9	Ecological integrity	2	0	2	4
TOTAL		**8**	**4**	**4**	
MEAN		**0,88**	**0,44**	**0.44**	
Overall EIS		**D**	**D**	**D**	

These results indicate that both the Orange River's and Orange River's floodplain's as well as the Katrivier and its tributaries' riparian vegetation are calculated to fall within and EIS Category **D**, indicating that this system is largely modified. It is also an indication that these systems are considered to be ecologically un-important and not sensitive on a provincial and local scale.

4.7 Recommended Ecological Category (REC)

The Recommended Ecological Category for the riparian features along the Orange River's and floodplain were determined taking into account the results of the IHI, wetland function, and EIS assessments. These assessments show that all riparian and seasonal drainage line features within the project site have to an extent undergone fairly significant levels of transformation as a result of historical and current impacts disruption of the hydrological cycle and alien vegetation encroachment. Nevertheless, despite the lowered ecological integrity of these systems, they are considered to provide important ecological services. The REC estimated appropriate for the watercourse/riparian and seasonal drainage line features are presented in table below.

Table 4.12: Summary of the REC categories assigned to the various features for all riparian and wetland features within the project site.

Features	REC Category
Orange River	Upper D
Orange River floodplain wetland	Upper D
Katrivier seasonal stream and tributaries	Upper D

Where applicable mitigation measures to lower the impacts associated with prospecting activities must be implemented in order to at minimum, retain current levels of ecological integrity and functioning. It is preferable however that suitable rehabilitation measures be implemented, particularly to curb erosion, and to implement an invasive weed removal program to clear the drainage lines and riparian areas in order to improve the Present State of these and to improve the ecological service provision by these systems.

4.8 Delineation and Sensitivity Mapping

All features were delineated on a desktop level with the use of digital satellite imagery and topographical maps. Portions of the features were then verified during the field survey according to the guidelines advocated by DWA (2005, 2008) and the watercourse/riparian delineations as presented in this report are regarded as a best estimate of the temporary and riparian zone boundaries based on the site conditions present at the time of assessment. Ground-truthing of riparian boundaries focused on those areas that were accessible as well as within the proposed project site footprint.

During the assessment, the following indicators were used to ascertain the boundaries of the perennial drainage lines with riparian characteristics and the wetland features:

- Terrain units were used as the primary indicator, as the drainage lines and depressions were the most likely areas through which water will flow. In some of the riparian areas, the presence of alien plant species made it difficult discern riparian / drainage line boundaries;
- Vegetation, although transformed, was considered informative at many features;
- Soil form was considered; and the presence of mottles (soils with variegated colour patterns) was used as an indicator for wetlands and riparian boundaries in some instances. In some areas the mottling of soils did not provide an accurate delineation of boundaries, and as such the above mentioned characteristics were used in conjunction to determine boundaries.

Legislative requirements were used to determine the extent of buffer zone required for each group depending on whether a group is considered wetland/riparian habitat or not. As such, if any activities are to take place within 32 meters of a wetland or watercourse or the 1:100 year flood lines authorisation in terms of the relevant regulations of NEMA will be required. In addition the Section 21 of the National Water Act and Regulation 1199 of 2009 as it relates to the NWA will also apply and therefore a Water Use License will be required for the proposed development.

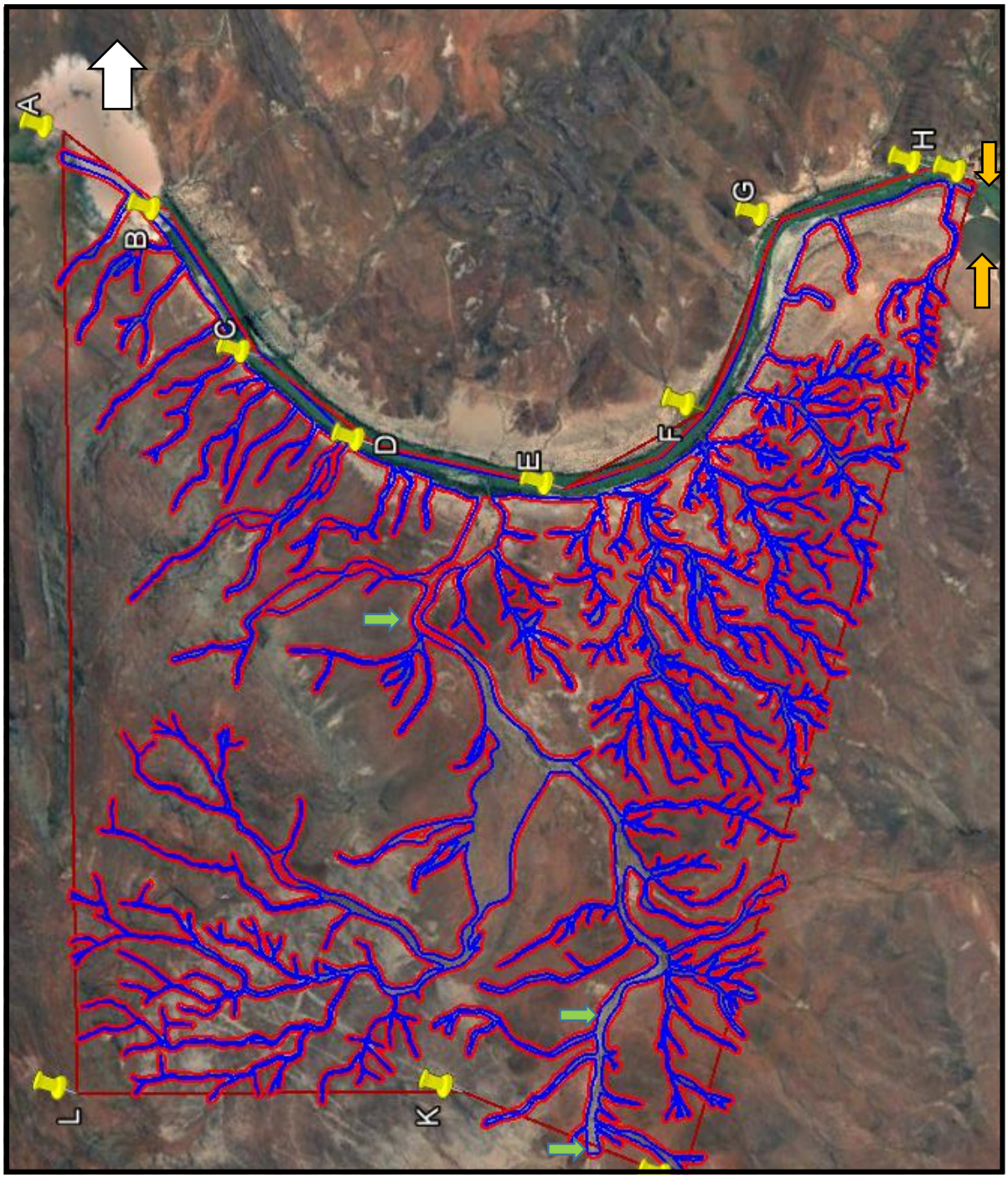

Figure 4.5: The Middelwater project site (red polygon) in relation to the nearby Orange River and the Kat River's seasonal drainage lines (blue lines). The red lines indicate the buffer lines. The orange arrows indicate centre pivots on neighbouring properties. Green arrows indicate the seasonal Katrivier.

5 SITE ASSESSMENT OF IMPACTS, MITIGATION AND MANAGEMENT MEASURES

5.1 Impacts of the proposed prospecting activities, access roads and associated infrastructure

Table 5.1 serves to summarise the significance of potential impacts on the wetland and aquatic integrity of the existing and proposed prospecting activities based on a risk matrix. The

sections below present the impact assessment according to the methods described in Chapter 2. In addition, it also indicates the required mitigatory measures needed to minimise the impact and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures and assuming that they are fully implemented.

Table 5.1: A summary of the impact assessment results of the prospecting phase on the Orange River, its floodplain and its riparian vegetation as well as the Katrivier's riparian vegetation.

IMPACT	CONSEQUENCE	PROBABILITY	SIGNIFICANCE	RISK RATING	CONFIDENCE
IMPACT 1: Changes to the hydrological regime of the stream					
PROSPECTING PHASE					
Without mitigation	Medium (5)	Definite (10)	50	Low	4
With mitigation	Medium (4)	Definite (8)	32	Low	4
IMPACT 2: Impact of changes to water quality					
PROSPECTING PHASE					
Without mitigation	Medium (7)	Definite (12)	85	High	4
With mitigation	Low (4)	Definite (8)	33	Medium-Low	4
IMPACT 3: Loss of riparian vegetation, aquatic habitat and stream continuity (migration corridors)					
PROSPECTING PHASE					
Without mitigation	Low (5)	Definite (12)	60	Medium	4
With mitigation	Low (4)	Definite (8)	32	Low	4
IMPACT 4: Spread of alien invasive species					
PROSPECTING PHASE					
Without mitigation	Medium (10)	Definite (12)	120	High	4
With mitigation	Low (4)	Definite (8)	32	Medium-Low	4

The proposed prospecting development will have a "Negative-moderate" impact on the above-ground ecology of the site as some areas are already partly degraded. On undisturbed areas the impact will be high. The impacts such as erosion potential, dust generation and spread of alien weeds can be lowered if mitigated properly. The project site has a low ecological sensitivity because of the presence of several man-made impacts on the site.

With the diligent implementation of mitigating measures by the developer, contractors, and operational staff, the severity of these impacts can be minimised and reduced to acceptable levels. The impact on fauna is expected to be small to low due to the existing disturbance and human activities.

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ANNEXURE A:

PHOTOS OF THE PROJECT SITE: Photos of the project site:

Figure A1: View of the vegetation along the Katrivier. The green shrubs are exotic Prosopis (*Prosopis velutina*).

Figure A2: Degraded vegetation invaded by *Rhigozum trichotomum*.

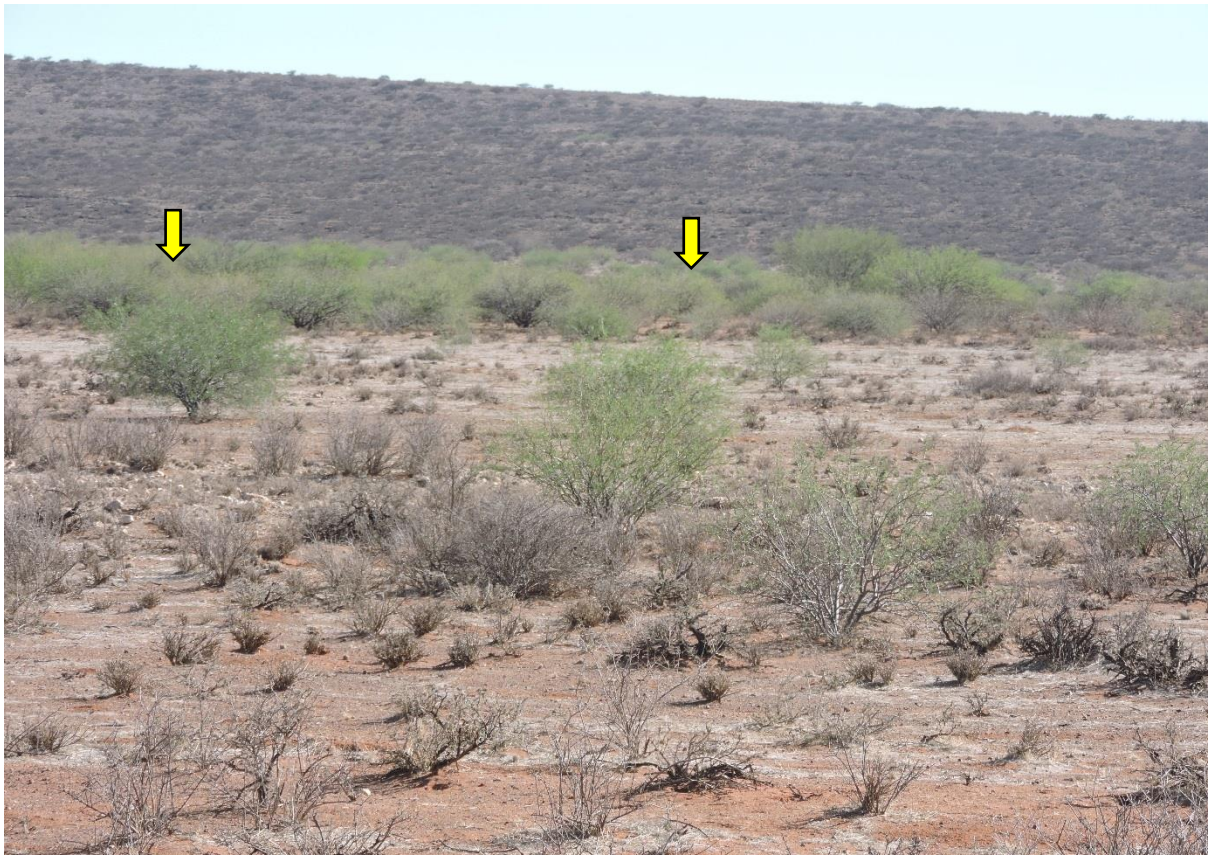

Figure A3: The green Prosopis line in the background indicates the Katrivier (arrows) Note the sparsely covers soil surface in the foreground.

Figure A4: A stand of Black Thorn (*Senegalia mellifera*).

Figure A5: View the Black Thorn (*Senegalia mellifera*) dominated plains in the foreground. The vegetation on the mountain range in the background belongs to the Lower Orange River Broken Veld.

Figure A6: The protected Shepherd's Tree (*Boscia albitrunca*).

Figure A7: The protected Quiver Tree (*Dendroaloe dichotoma*).

Figure A8: The protected Slender Candelabra-euphorbia (*Euphorbia avasmontana*).

Figure A9: Namaqua Fig (*Ficus cordata*) on rocky slopes.

Figure A10: *Aloe claviflora* a protected Aloe.

ANNEXURE B

SITE SPECIFIC REHABILITATION PLAN

The objective of the rehabilitation plan is to ensure that:

a) the areas disturbed by the prospecting and mining activities are rehabilitated and/or landscaped;

b) that the site and areas disturbed by prospecting and mining activities are visually appealing and are left in a neat and tidy condition;

c) contaminants/pollution sources are removed from the site or that appropriate measures are in place to control long-term contamination sources;

d) the site and surrounding disturbed areas are in a stable condition.

Listed below are the provisional requirements for rehabilitation of the site. These are intended as a guideline.

Actions to clear the site:

1. Remove all containers and temporary office structures from the site.
2. Drain all pollution sumps and dispose of all solid and liquid waste at a permitted landfill site.
3. Break up all concrete structures, cart concrete from the site and dispose of at a permitted landfill site.
4. Collect all litter and packaging from within the site as well as the peripheral areas and dispose at a permitted landfill site.
5. Remove all waste building components/parts from the site (whether scrap or not) including metal, wood, drums, plastic, cabling, tubing, etc.
6. Ensure that no waste is buried on site.
7. Disconnect all temporary power, water and sewerage connections.
8. Disassemble and remove all ablution facilities.
9. Ensure that all infrastructure routes are rehabilitated and stable.
10. Clear weeds from the construction site and peripheral disturbed areas.
11. Clear all litter and rubble from drainage lines and disposes of appropriately.
12. Ensure that all public roads are satisfactorily cleared of rubble
13. Repair damaged road curbs or other structures

Landscape the mine site:

1. Backfill all remaining voids or if not possible blast steps of 2m high x 3m wide to make the steep cliffs safer.
2. Flatten the heaps of over burden that remains after all voids have been filled
3. Remove all stockpiled rubble from the site and dispose of at a permitted disposal site
4. Ensure that no bare, unvegetated areas remain.
5. Rehabilitate (rip and hydroseed) all disused compacted surfaces, tracks and roads

6. Make provision for the rehabilitation of peripheral areas not directly included within the site that were disturbed during the construction process. Rehabilitation may entail grading, leveling, fertilizing and re-grassing.
7. Identify actual and potential erosion sites and implement measures for control/prevention of erosion. Ensure that appropriate erosion control measures are installed around storm water outlets and stabilise and re-grass areas around storm water outlets with indigenous species.
8. Stabilise the stream banks and re-grassing to prevent erosion
9. Where possible indigenous plants must be used as part of the landscaping process.
10. The Landscape Contractor is to ensure that adequate planting of indigenous plants is catered for. The ECO is to review and approve the landscaping plans.
11. It is recommended that efforts on invasive species management, erosion control and rehabilitation is coordinated to avoid negative effects of one development on the environmental state on and around the other.

ANNEXURE C:

ALIEN INVASIVE MANAGEMENT PLAN

1: Prospecting Phase					
Nr	**Task**	**Responsible Party**	**Frequency**		
			Footprint	**Area of Influence**	**Project Site**
1.1	Clearing of alien species must be organized and approved	Contractor	Daily	Daily	Daily
1.2	All manually cleared alien plants must be disposed of carefully and must not be dumped in any areas of indigenous vegetation, even temporarily.	Contractor	Daily	Daily	Daily
1.3	No mass clearing of vegetation should be done, but rather vegetation should be cleared as work progresses. No large areas should be cleared unless surfacing occurs immediately after.	Contractor	Weekly	N/A	N/A
1.4	Cleared areas that will not be surfaced for an extended period of time (over 2 weeks) should be stabilized with packed brush (from indigenous plants cleared from the site), or with jute pegged over the area.	Contractor	Weekly	N/A	N/A
1.5	Any exposed construction areas that have become invaded can be sprayed with herbicides (only those that break down on contact with the soil e.g. “Round-up”)	Contractor	Weekly	N/A	N/A
1.6	Any soil stockpiles that have become invaded should be cleared through manual control methods (weeding).	Contractor	Weekly	N/A	N/A
1.7	Areas that will be vegetated though rehabilitation must be done so through the rehabilitation plan. No organic matter from outside the site should be used to encourage regrowth of vegetation.	Contractor	Monthly	N/A	N/A

1.8	Introduction of alien plant species to the site should be prevented as far as practicable. Vehicles entering should be inspected, outside sources of soil and sand should be clear of invasive species.	Contractor	Daily		
1.9	Alien invasive species must be controlled throughout the entire site during the construction process.	Contractor	Monthly	Every 2 months	Every 6 months
1.10	Species-specific control measures should be used. These are provided in this plan for species recorded from the site. If any new species are recorded, best practice means of control must be researched and used.	Contractor	Monthly	Every 2 months	Every 6 months
1.11	Clearing must be restricted to the footprint of the site as defined in the Ecological Impact Assessment.	Contractor	Weekly	Weekly	Monthly
1.12	Any no-go areas (such as wetlands) should be demarcated and workers should be informed that no activities are to occur in these areas.	Contractor	Daily	N/A	N/A
2: Mining Phase					
Nr	**Task**	**Responsible Party**	**Frequency**		
			Footprint	**Area of Influence**	**Project Site**
2.1	Surveys of the site for alien invasive species must be conducted throughout the life of the project. These include new invasions by recorded species as well as new invader species on site.	Contractor	Monthly for 2 years (the defects notification period), then every 3 months.	Once a year for two years, then every second year.	Once in the first two years, then every 5 years.

2.2	To prevent increased invasion in areas cleared for construction but not needed for operation, rehabilitation of the natural vegetation should be done. This should follow the prescribed Rehabilitation Plan.	Contractor	Refer to Rehabilitation Plan		
2.3	Areas where vegetation is required to be kept low, should be managed using weedeaters above the soil line to maintain the indigenous vegetation and reduce invasion potential.	Contractor	When necessary	N/A	N/A