WERDA PROJECT PROSPECTING RIGHT APPLICATION – SURFACE WATER STUDY

HC Van Wyk Diamonds Limited

Prepared For:

HC Van Wyk Diamonds Limited
2A Erasmus Street
Barkly-West
8375
South Africa

Prepared By:

MojaTerre (Pty) Ltd.
PO Box 1105
Montana Park
Pretoria
0159
South Africa

November 2016
PJ160013

Limitations, Reliance and Assumption

This report has been exclusively prepared for the client and the findings presented herein are limited to the scope of work approved by the client upon acceptance of MojaTerre's proposal.

The report is considered current only for a period of 180 days from the site inspection. Investigation findings presented in this report are based on MojaTerre's professional judgment using information available at the time of the assessment. It is assumed that information that MojaTerre sourced from the client during the undertaking of this assessment is accurate, current and representative of the site.

Information presented in this report is not intended as legal advice and MojaTerre makes no guarantees about the conditions of the site.

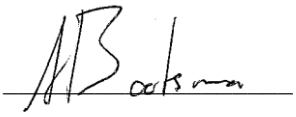
The following assumptions are made in this document:

- All wetlands within 500m of mining activities should be identified as per the DWS Water Use Licence application regulations. Wetlands within the study sites were delineated on a fine scale based on detailed soil and vegetation sampling. Wetlands that fell outside of these sites, but that fell within 500m of the proposed activities were delineated based on desktop analysis of vegetation gradients visible from aerial imagery.
- The detailed field study was conducted as a once-off field trip and thus would not depict any seasonal variation in the wetland plant species composition and richness.
- The site visit took place in a year of extreme drought and some wetness indicators may not have been present.
- Description of the depth of the regional water table and geohydrological or hydropedological processes falls outside the scope of the current assessment.
- Floodline calculation, groundwater and hydrological processes fall outside the scope of wetland and riparian delineation and functional assessments discussed in this report.
- A Red Data scan, fauna and flora, and aquatic assessments were not included in the current study.
- The recreation grade GPS used for wetland and riparian delineations is accurate to within five meters.
- The study site is located on a cattle farm and thus some vegetation components could not be identified due to grazing.
- The wetland delineation plotted digitally may be offset by at least five meters to either side. Furthermore, it is important to note that, while converting spatial data to final drawings, several steps in the process may affect the accuracy of areas delineated in the current report. It is therefore suggested that the no-go areas identified in the current report be pegged in the field in collaboration with the surveyor for precise boundaries. The scale at which maps and drawings are presented in the current report may become distorted should they be reproduced by for example photocopying and printing.

Copyright

Author: Antoinette Bootsma, Rudi Bezuidenhoudt

Designation: MojaTerre Contractor (Limosella Consulting)

Signature: 

Date: 11 November 2016

Reviewer: Renier Pretorius

Designation: Manager

Signature: 

Date: 15 November 2016

Table of Contents

List of Tables and Diagrams

List of Figures

List of Annexures

Annex A – Maps

Annex B – Specialist CVs

List of Abbreviations

Boscia	Boscia Ecological Consulting
DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
DWS	Department of Water Affairs and Sanitation
EC	Ecological Category
EIA	Environmental Impact Assessment
EIS	Environmental Importance and Sensitivity
GA	General Authorisation
GIS	Geographic Information System
GNR	Government Notice Regulation
GPS	Global Positioning System
HGM	Hydro-Geomorphic
MPRDA	Mineral and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NEM:BA	National Environmental Management: Biodiversity Act
NEM:PA	National Environment Management Protected Areas Act
NWA	National Water Act
PES	Present Ecological Status
SAWCP	South African Wetlands Conservation Programme
SR	Significance Rating
VEGRAI	Riparian Vegetation Response. Assessment Index
WIS	Wetland Importance and Sensitivity
WUL	Water Use Licence
QHI	Quick Habitat Integrity

1. Introduction

1.1 Terms of Reference

MojaTerre (Pty) Ltd (MojaTerre) was appointed by HC Van Wyk Diamonds Limited. (HVWD) to undertake a specialist surface water resource assessment of a proposed location for a new diamond prospecting project, to be located on the Farm 503 (Werda) near the mining town Lime Acres, which is situated in the Northern Cape Province of South Africa. The requested assessment is required in support of an EIA to apply for a prospecting permit.

1.2 Project Background

HVWD is in the process of applying for a prospecting right that includes bulk-sampling activities and trenching for alluvial diamond prospecting. The project is situated on the Remaining Extent of the Farm 503 (Werda) approximately 10km south of the town of Lime Cares, Northern Cape Province, as shown in ***Annex A***.

HVWD submitted a Scoping Report for approval to the DMR under the reference number NC30/5/1/1/2/11779 PR. This report forms part of the EIA phase of the application and is submitted to quantify the impact of the proposed activities on groundwater.

Fieldwork for this assessment was conducted on 22-23 September 2016.

2. Scope of Work

MojaTerre undertook the following scope of work:

- Delineate the wetland/riparian areas.
- Classify the watercourse per the system proposed in the national wetlands inventory if relevant.
- Undertake the functional assessment of wetlands and/or riparian areas within the area assessed.
- Recommend suitable buffer zones.
- Discuss potential impacts, mitigation and management procedures relevant to the conserving sensitive areas on the site.

3. Definitions and Legal Framework

This section outlines the definitions, key legislative requirements and guiding principles of the ecological study and the Water Use Authorisation process.

The NWA, 1998 (Act No. 36 of 1998) provides for constitutional water demands including pollution prevention, ecological and resource conservation and sustainable utilisation. In terms of this Act, all water resources are the property of the State and are regulated by the DWS. The NWA sets out a range of water use related principles that are to be applied by DWS when taking decisions that significantly affect a water resource. The NWA defines a water resource as including a watercourse, surface water, estuary or aquifer. A watercourse includes a river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake, pan or dam, into which or from which water flows; any collection of water that the Minister may declare to be a watercourse; and were relevant its beds and banks.

The NWA defines a wetland 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." In addition to water at or near the surface, other distinguishing indicators of wetlands include hydromorphic soils and vegetation adapted to or tolerant of saturated soils (DWS, 2005).

Riparian habitat often performs important ecological and hydrological functions, some similar to those performed by wetlands (DWS, 2005). Riparian habitat is also the accepted indicator used to delineate the extent of a river's footprint (DWS, 2005). It is defined by the NWA 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".

Water uses for which authorisation must be obtained from DWS are indicated in Section 21 of the NWA. Section 21 (c) and (i) is applicable to any activity related to a wetland:

- Section 21(c): Impeding or diverting the flow of water in a watercourse; and
- Section 21(i): Altering the bed, banks, course or characteristics of a watercourse.

Authorisations related to wetlands are regulated by GN R.1198 and GN R.1199 of 18 December 2009. GN 1198 and 1199 of 2009 grants GA for the above water uses on certain conditions:

- GN R.1198: Any activity in a wetland for the rehabilitation of a wetland for conservation purposes.
- GN R.1199: Any activity more than 500 m from the boundary of a wetland.

These regulations also stipulate that these water uses must the registered with the responsible authority. Any activity that is not related to the rehabilitation of a wetland and which takes place within 500 m of a wetland are excluded from a GA under either of these regulations, unless the impacts score as low in the requires risk assessment matrix. Wetlands situated within 500 m of proposed activities should be regarded as sensitive features potentially affected by the proposed development (GN 1199). Such an activity requires a WUL from the relevant authority.

In addition to the above, the proponent must also comply with the provisions of the following relevant national legislation, conventions and regulations applicable to wetlands and riparian zones:

- Convention on Wetlands of International Importance - the Ramsar Convention and the SAWCP.
- NEMA, 1998 (Act No. 107 of 1998).
- NEM:BA, 2004 (Act 10 of 2004).
- NEM:PA, 2003 (Act No. 57 of 2003).
- Regulations GN R.982, R.983, R. 984 and R.985 of 2014, promulgated under NEMA.
- Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983).
- Regulations and Guidelines on Water Use under the NWA.
- South African Water Quality Guidelines under the NWA.
- MPRDA, 2002 (Act No. 287 of 2002).

4. Methodology

4.1 Wetland and Riparian Delineation

The delineation method documented by the DWS in their document "An updated manual for identification and delineation of wetlands and riparian areas" (DWS, 2008), was followed throughout the field survey. This guideline describes the use of indicators to determine the outer edge of the wetland and riparian areas such as soil and vegetation forms as well as the terrain unit indicator.

A hand-held Garmin GPS60 was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and available GIS data was used as reference material for the mapping of the preliminary

wetland boundaries. These were converted to digital image backdrops and delineation lines and boundaries were imposed accordingly after the field survey.

Wetlands are delineated based on scientifically sound methods, and utilizes a tool from the DWS named 'A practical field procedure for identification and delineation of wetlands and riparian areas' (DWS, 2005). The delineation of the watercourses on the study area is based on both desktop delineation and ground truthing.

4.1.1 Desktop Delineation

A desktop assessment was conducted using a range of tools, including:

- 1: 50 000 topographical maps.
- SA Water Resources.
- Recent, relevant aerial and satellite imagery, including Google Earth.

All areas suspected of being wetland and riparian habitat based on the visual signatures on the digital base maps were mapped using google earth.

4.1.2 Ground Truthing

Wetlands are identified based on one or more of the following characteristic attributes (DWS, 2005) (***Figure 1***):

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur (***Figure 2***).
- The presence of plants adapted to or tolerant of saturated soils (hydrophytes).
- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation.
- A high-water table that results in saturation at or near the surface, leading to anaerobic conditions developing within 50cm of the soil surface.

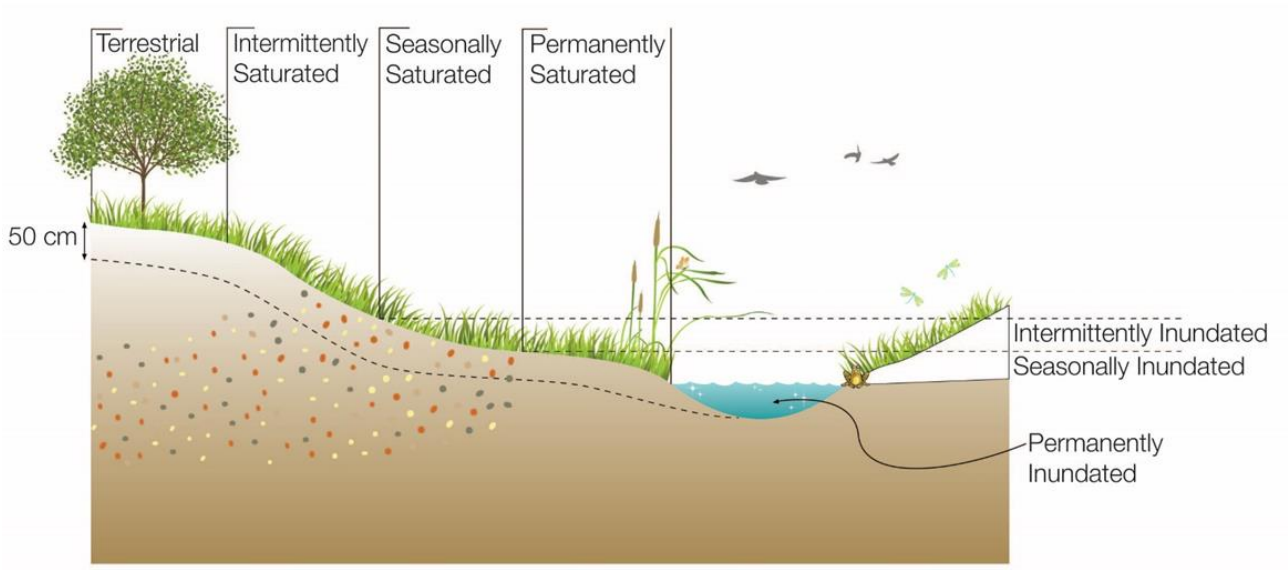


Figure 1 Typical Cross Section of a Wetland (Ollis, 2013)

4.1.3 The Terrain Unit Indicator

The terrain unit indicator (***Figure 2***) is an important guide for identifying the parts of the landscape where wetlands might possibly occur. Some wetlands occur on slopes higher up in the catchment where groundwater discharge is taking place through seeps. An area with soil wetness and/or vegetation indicators, but not displaying any of the topographical indicators should therefore not be excluded from being classified as a wetland.

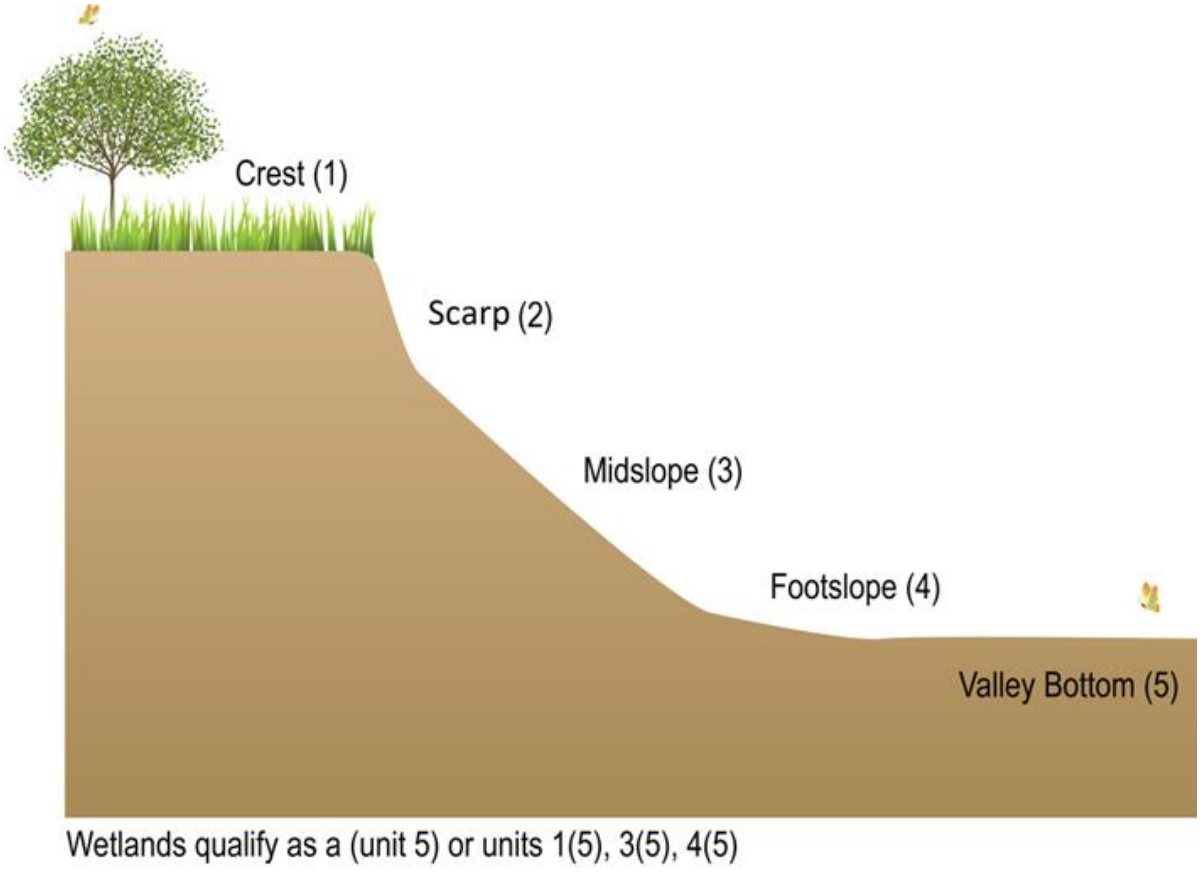


Figure 2 Terrain Units (DWS, 2005)

The type of wetland which occurs on a specific topographical area in the landscape is described using the hydrogeomorphic classification which separates wetlands into 'HGM' units. The classification of Ollis, *et al*. (2013) is used, where wetlands are classified on Level 4 as either rivers, floodplain wetlands, valley-bottom wetlands, depressions, seeps, or Flats (***Figure 3***).

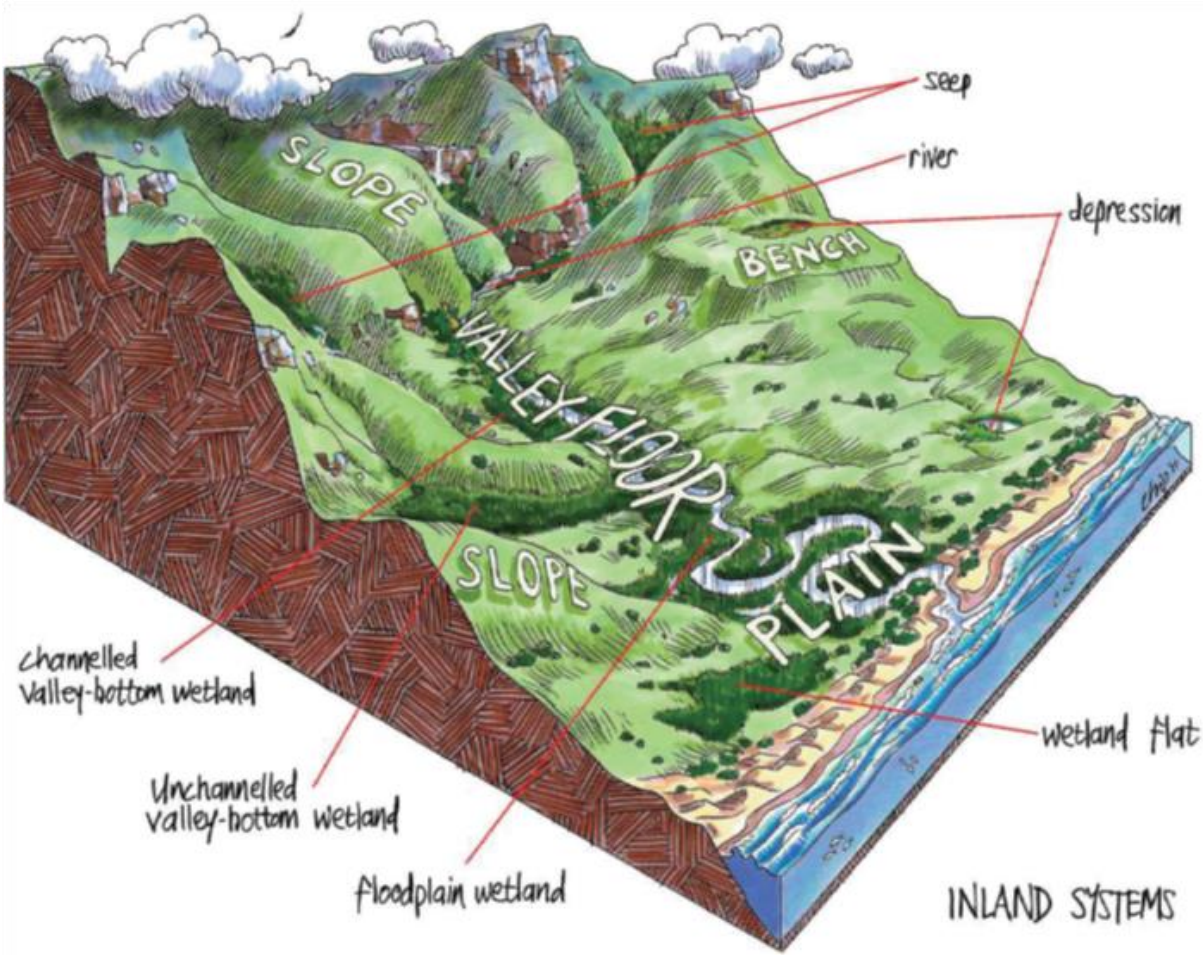


Figure 3 Wetland Units Based on Hydrogeomorphic Types (Ollis *et al*. 2013)

4.1.4 Riparian Indicators

Riparian habitat is classified primarily by identifying riparian vegetation along the edge of the macro stream channel. The macro stream channel is defined as the outer bank of a compound channel and should not be confused with the active river bank. The macro channel bank often represents a dramatic change in the energy with which water passes through the system. Rich alluvial soils deposit nutrients making the riparian area a highly productive zone. This causes a very distinct change in vegetation structure and composition along the edges of the riparian area (DWS, 2008).

The marginal zone has also been referred to as active features or wet bank (Van Niekerk and Heritage, 1993, cited in DWS, 2008). It includes the area from the water level at low flow, to those features that are hydrologically activated for the greater part of the Year (Kleyhans, 2008). The non-marginal zone is the combination of the upper and lower zones (***Figure 4***).

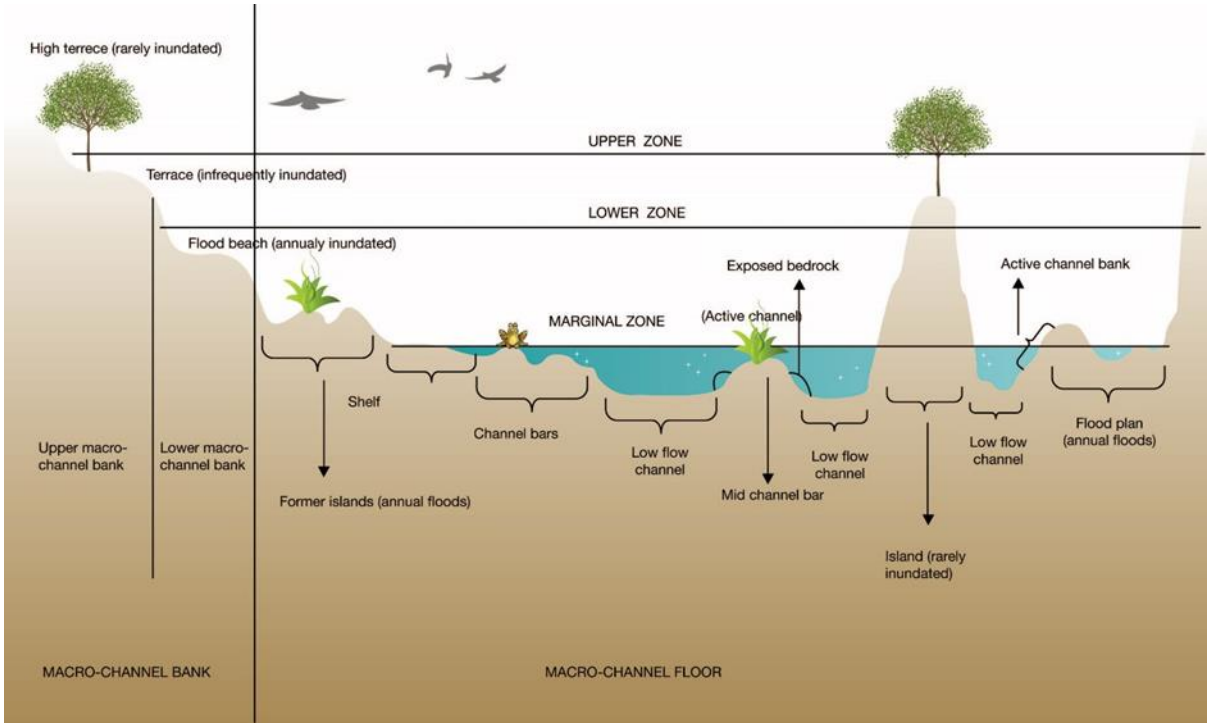


Figure 4: Schematic Diagram Illustrating an Example of where the 3 Zones would be Placed Relative to Geomorphic Diversity (Kleynhans *et al*, 2007)

The vegetation of riparian areas is divided into three zones, namely; the marginal zone, lower non-marginal zone and the upper non-marginal zone (***Table 1***). The different zones have different vegetation growth.

Table 1 Description of riparian vegetation zones (Kleynhans *et al*, 2007).

	Marginal	(Non-marginal) Lower	(Non-marginal) Upper
Alternative descriptions	Active features Wet bank	Seasonal features Wet bank	Ephemeral features Dry bank
Extends from	Water level at low flow	Marginal zone	Lower zone
Extends to	Geomorphic features / substrates that are hydrologically activated (inundated or moistened) for the Greater part of the year.	Usually a marked increase in lateral Elevation.	Usually a marked decrease in lateral elevation
Characterized by	See above ; Moist substrates next to water's edge; water loving- species usually vigorous due to near permanent access to soil moisture	Geomorphic features that are hydrologically activated (inundated or moistened) on a Seasonal basis. May have different species than marginal zone	Geomorphic features that are hydrological activated (inundated or moistened) on an Ephemeral basis. Presence of riparian and terrestrial species Terrestrial species with increased stature

Riparian Area:

A riparian area can be defined as a linear fluvial, eroded landform which carries channelized flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The "river" includes both the active channel (the portion which carries the water) as well as the riparian zone (***Figure 5***) (Kotze, 1999).

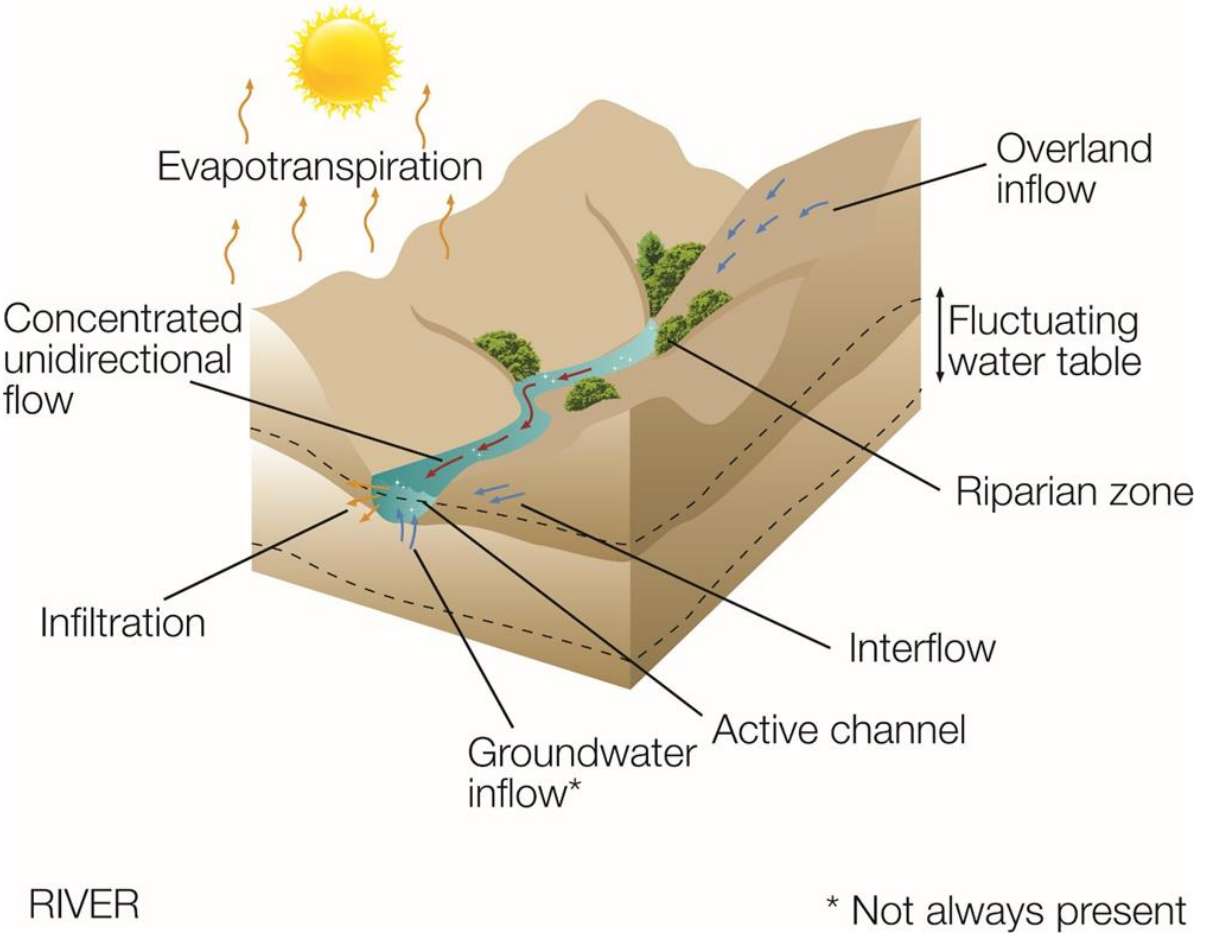


Figure 5: A Schematic Representation of the Processes Characteristic of a River Area (Ollis et al, 2013)

Riparian areas can be grouped into different categories based on their inundation period per year. Perennial rivers are rivers with continuous surface water flow, intermittent rivers are rivers where surface flow disappears but some surface flow remains, temporary rivers are rivers where surface flow disappears for most of the channel (***Figure 6***). Two types of temporary rivers are recognized, namely "ephemeral" rivers that flow for less time than they are dry and support a series of pools in parts of the channel, and "episodic" rivers that only flow in response to extreme rainfall events, usually high in their catchments (Seaman *et al*, 2010). The rivers recorded on-site are classified as ephemeral rivers/streams due to the presence of pools as well as being dry for most of the year.

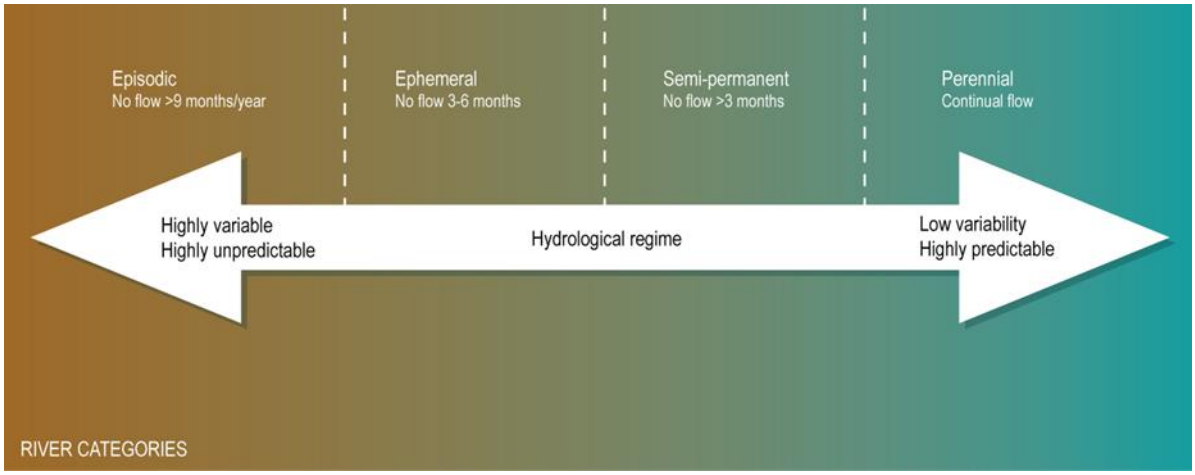


Figure 6: Four Categories Associated with Rivers and the Hydrological Continuum. Dashed Lines Indicate that Boundaries are not Fixed (Seaman *et al*, 2010).

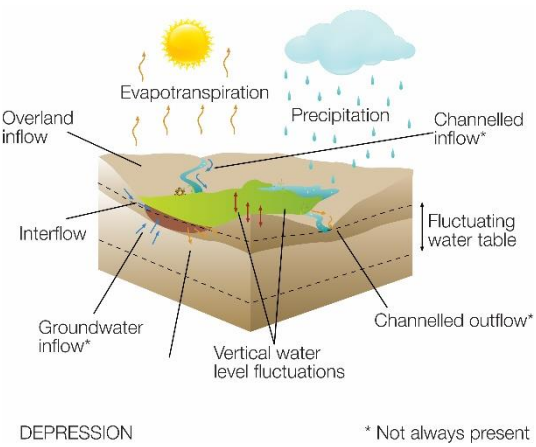
4.2 Wetland Classification

The classification system developed for the National Wetlands Inventory is based on the principles of the HGM approach to wetland classification (SANBI, 2009). The current wetland study follows the same approach by classifying wetlands in terms of a functional unit in line with a level three category recognised in the classification system proposed by SANBI (2009). HGM units take into consideration factors that determine the nature of water movement into, through and out of the wetland system. In general, HGM units encompass three key elements (Kotze *et al*, 2005):

- Geomorphic setting - This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
- Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.
- Hydrodynamics - This refers to how water moves through the wetland.

The classification of wetland areas found during the study (adapted from Brinson, 1993; Kotze, 1999, Marneweck and Batchelor, 2002 and DWS, 2005) is summarised in ***Table 2.***

Table 2 On-Site Wetland HGM Types and Descriptions

Hydro-geomorphic types	Description
Depressional pans  	Small (deflationary) depressions which are circular or oval in shape; usually found on the crest positions in the landscape. The topographic catchment area can usually be well-defined (i.e. a small catchment area following the surrounding watershed). Although often apparently endorheic (inward draining), many pans are "leaky" in the sense that they are hydrologically connected to adjacent valley bottoms through subsurface diffuse flow paths.

Potentially difficult wetland areas exist on-site due to some, or all, wetland indicators being absent during site visit. A summary of wetland sites that are generally considered "difficult sits" is provided in ***Table 3***.

Table 3 List of Types of Sites that are Difficult to Delineate (Jobs, 2009)

Type of "Difficult Site"	Approach
Some or all, wetland indicators are present but is a non-natural wetland (e.g some dams, road islands)	Decide on the relative permanence of the change and whether the area can now be said to be functioning as a wetland. Time field observations during the wet season, when natural hydrology is at its peak, to help to differentiate between naturally-occurring versus human-induced wetland. Decide appropriate policy/management i.e. can certain land uses be allowed due to "low" wetland functional value, or does the wetland perform key functions despite being artificial.
Indicators of soil wetness are present but no longer a functioning wetland (e.g. wetland has been drained)	Look for evidence of ditches, canals, dikes, berms, or subsurface drainage tiles. Decide whether or not the area is currently functioning as a wetland.
Indicators of soil wetness are present but no longer a functioning wetland (e.g. relic / historical wetland)	Decide whether indicators were formed in the distant past when conditions were wetter than the area today. Obtain the assistance of an experienced soil scientist.
Some, or all, wetland indicators are absent at certain times of year (e.g. annual vegetation or seasonal saturation)	Thoroughly document soil and landscape conditions, develop rationale for considering the area to be a wetland. Recommend that the site be revisited in the wet season.
Some, or all, wetland indicators are absent due to human disturbance (e.g. vegetation has been cleared, wetland has been ploughed or filled)	Thoroughly document landscape conditions and any remnant vegetation, soil, hydrology indicators, develop rationale for considering the area to be wetland. Certain cases (illegal fill) may justify that the fill be removed and the wetland rehabilitated.

4.3 Buffer Zones

A buffer zone is defined as a strip of land surrounding a wetland or riparian area in which activities are controlled or restricted (DWS, 2005). A development has several impacts on the surrounding environment and on a wetland. The development changes habitats, the ecological environment, infiltration rate, amount of runoff and runoff intensity of the site, and therefore the water regime of the entire site. An increased volume of storm water runoff, peak discharges, and frequency and severity of flooding is therefore often characteristic of transformed catchments.

Local government policies require that protective buffer zones be calculated from the outer edge of the temporary zone of a wetland, or edge of the riparian habitat (CoCT, 2008; GDACE, 2009). The buffer zone identified in this report serves to highlight an ecologically sensitive area in which activities should be conducted with this sensitivity in mind.

New buffer tools have been developed and been published as "Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries. Consolidated Report" by the WRC (Macfarlane *et al* 2015). This new buffer tools aims to calculate the best suited buffer for each wetland or section of a wetland based on numerous on-site observations. The resulting buffer area can thus have large differences depending on the current state of the wetland as well as the nature of the proposed development. Developments with a high-risk factor such as mining are likely to have a larger buffer area compared to a residential development with a lower risk factor. The minimum accepted buffer for low risk developments are however 15 m from the edge of the wetland (Macfarlane, *et al* 2015) as opposed to the generic recommendation of 30 m for wetlands inside the urban edge and 50 m outside the urban edge (GDARD, 2012).

A buffer of 100 m is suggested for this watercourses on the study site.

4.4 Impact Assessments

4.4.1 NEMA (2014) Impact Ratings

As required by the 2014 NEMA regulations, impact assessment should provide quantified scores indicating the expected impact, including the cumulative impact of a proposed activity. This assessment follows the format presented in ***Table 4*** and ***Table 5***.

Table 4: Criteria for Assessment of Impacts

Severity (Magnitude)	
The severity of the impact is considered by examining whether the impact is destructive or benign, whether it destroys the impacted environment, alters its functioning, or slightly alters the environment itself. The intensity is rated as	
(I)nsignificant	The impact alters the affected environment in such a way that the natural processes or functions are not affected.
(M)oderate	The affected environment is altered, but functions and processes continue, albeit in a modified way.
(V)ery High	Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.
Duration	
The lifetime of the impact that is measured in relation to the lifetime of the proposed development.	
(T)emporary	The impact will either disappear with mitigation or will be mitigated through a natural process in a period shorter than that of the construction phase.
(S)hort term	The impact will be relevant through to the end of a construction phase (1.5–2 years).
(M)edium term	The impact will last up to the end of the development phases, where after it will be entirely negated.
(L)ong term	The impact will continue or last for the entire operational lifetime i.e. exceed 30 years of the development, but will be mitigated by direct human action or by natural processes thereafter.
(P)ermanent	This is the only class of impact that will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact is transient.
Spatial scale	
Classification of the physical and spatial scale of the impact	
(F)ootprint	The impacted area extends only as far as the activity, such as the footprint occurring within the total site area.
(S)ite	The impact could affect the whole, or a significant portion of, the site.
(R)egional	The impact could affect the area including the neighbouring farms, the transport routes and the adjoining towns.
(N)ational	The impact could have an effect that expands throughout the country (South Africa).
(I)nternational	Where the impact has international ramifications that extend beyond the boundaries of South Africa.
Probability	
This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:	
(I)mprobable	The possibility of the impact occurring is none, due either to the circumstances, design or experience. The chance of this impact occurring is zero (0 %).
(P)ossible	The possibility of the impact occurring is very low, due either to the circumstances, design or experience. The chance of this impact occurring is defined as 25%.
(L)ikely	There is a possibility that the impact will occur to the extent that provisions must therefore be made. The chance of this impact occurring is defined as 50%.
(H)ighly Likely	It is most likely that the impacts will occur at some stage of the development. Plans must be drawn up before carrying out the activity. The chance of this impact occurring is defined as 75%.
(D)efinite	The impact will take place regardless of any prevention plans, and only mitigation actions or contingency plans to contain the effect can be relied on. The chance of this impact occurring is defined as 100%.

Table 5 Assessment Criteria: Ranking Scales

PROBABILITY		MAGNITUDE	
Description / Meaning	Score	Description / Meaning	Score
Definite/don't know	5	Very high/don't know	10
Highly probable	4	High	8
Probable	3	Moderate	6
Possible	2	Low	4
Improbable	1	Insignificant	2
DURATION		**SPATIAL SCALE**	
Description / Meaning	Score	Description / Meaning	Score
Permanent	5	International	5
Long Term	4	National	4
Medium Term	3	Regional	3
Short term	2	Local	2
Temporary	1	Footprint	1/0

4.4.2 Determination of Significance – With Mitigation

Determination of significance refers to the foreseeable significance of the impact after the successful implementation of the necessary mitigation measures. The Significance Rating (SR) is determined as follows equation:

Significance Rating (SR) = (Extent + Intensity + Duration) x Probability

4.4.3 Identifying the Potential Impacts without Mitigation Measures

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a value for each impact (prior to the implementation of mitigation measures). Significance without mitigation is rated using the scale summarised in ***Table 6***.

Table 6 Significance Rating Scales Without Mitigation

Significance Rating	Significance	Description
SR < 30	Low (L)	Impacts with little real effect and which should not have an influence on or require modification of the project design or alternative mitigation. No mitigation is required.
30 < SR < 60	Medium (M)	Where it could have an influence on the decision unless it is mitigated. An impact or benefit which is sufficiently important to require management. Of moderate significance - could influence the decisions about the project if left unmanaged.
SR > 60	High (H)	Impact is significant, mitigation is critical to reduce impact or risk. Resulting impact could influence the decision depending on the possible mitigation. An impact which could influence the decision about whether or not to proceed with the project.

4.4.4 Identifying the Potential Impacts with Mitigation Measures

To gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated using the scale summarised in ***Table 7***.

Table 7 Significance Rating Scales with Mitigation

Significance Rating	Significance	Description
SR < 30	Low (L)	The impact is mitigated to the point where it is of limited importance.
30 < SR < 60	Medium (M)	Notwithstanding the successful implementation of the mitigation measures to reduce the negative impacts to acceptable levels, the negative impact will remain of significance. However, taken within the overall context of the project, the persistent impact does not constitute a fatal flaw.
SR > 60	High (H)	The impact is of major importance. Mitigation of the impact is not possible on a cost-effective basis. The impact is regarded as high importance and taken within the overall context of the project, is regarded as a fatal flaw. An impact regarded as high significance after mitigation could render the entire development option or entire project proposal unacceptable.

4.5 Wetland Functionality, Status and Sensitivity

Wetland functionality is defined as a measure of the deviation of wetland structure and function from its natural reference condition. The natural reference condition is based on a theoretical undisturbed state extrapolated from an understanding of undisturbed regional vegetation and hydrological conditions. In the current assessment, the hydrological, geomorphological and vegetation integrity was assessed for the wetland unit associated with the study site, to provide a PES score (Macfarlane *et al*, 2007) and an EIS category (DWS, 1999). These impacts are based on evidence observed during the field survey and land-use changes visible on aerial imagery.

The allocations of scores in the functional and integrity assessment are subjective and are thus vulnerable to the interpretation of the specialist.

The functional assessment methodologies presented below take into consideration subjective recorded impacts to determine the scores attributed to each functional HGM wetland unit. The aspect of wetland functionality and integrity that are predominantly addressed include hydrological and geomorphological function (subjective observations) and the integrity of the biodiversity component (mainly based on the theoretical intactness of natural vegetation) as directed by the assessment methodology.

In the current study the wetland was assessed using the WET-Health (Macfarlane *et al*, 2007) and EIS (DWS, 1999) programmes.

4.5.1 Present Ecological Status (PES) – WET-Health

The PES is based on the ability of the wetland to preform indirect benefits such as those summarised in ***Table 8***.

Table 8 Indirect Benefits Provided by Wetland Habitats (Macfarlane *et al*, 2007)

Regulating & supporting benefits	**Flood attenuation**		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream.
	Streamflow regulation		Sustaining streamflow during low flow periods.
	Water Quality Enhancement	**Sediment trapping**	The trapping and retention in the wetland of sediment carried by runoff waters.
		Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters, thereby enhancing water quality.
		Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters, thereby enhancing water quality.
		Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters, thereby enhancing water quality.
		Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
	Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter.

A summary of the three components of the WET-Health assessment, namely hydrological, geomorphological and vegetation health, for the water features found on-site is described in ***Table 9***.

Table 9 Health Categories Used during a WET-Health Assessment for Describing the Integrity of Wetlands (Macfarlane *et al*, 2007)

Description	Impact Score Range	PES Score	Summary
Unmodified, natural.	0.0.9	A	Very High
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	High
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	Moderate
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D	Moderate
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	Low
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	Very Low

A summary of the class, description and symbols used to evaluate the change in wetland systems health are summarised in ***Table 10***.

Table 10 Trajectory Class, Change Scores and Symbols Used to Evaluate Trajectory of Change to Wetland Health (Macfarlane *et al*, 2007)

Change Class	Description	Symbol
Improve	Condition is likely to improve over the over the next 5 years	(↑)
Remain stable	Condition is likely to remain stable over the next 5 years	(→)
Slowly deteriorate	Condition is likely to deteriorate slightly over the next 5 years	(↓)
Rapidly deteriorate	Substantial deterioration of condition is expected over the next 5 years	(↓↓)

4.5.2 Ecological Importance and Sensitivity (EIS)

The EIS score forms part of a larger assessment called the WIS scoring system which also addresses hydrological importance and direct human benefits relevant to a HGM unit. Both PES and EIS form part of a larger reserve determination process documented by the DWS.

Ecological importance is an expression of a wetland's importance to the maintenance of ecological diversity and functioning on local and wider spatial scales.

Ecological sensitivity refers to the system's ability to tolerate disturbance and its capacity to recover from disturbance once it has occurred (DWS, 1999).

This classification of water resources allows for an appropriate management class to be allocated to the water resource which includes the following:

- Ecological importance in terms of ecosystems and biodiversity such as species diversity and abundance.
- Ecological functions including groundwater recharge, provision of specialised habitat and dispersal corridors.
- Basic human needs including subsistence farming and water use (***Table 11***).

Table 11 Direct Human Benefits Associated with Wetland Habitats (Macfarlane *et al*, 2007)

Subsistence benefits	**Water for human use**	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes.
	Harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
	Cultivated foods	Areas in the wetland used for the cultivation of foods.
Cultural benefits	**Cultural heritage**	Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants.
	Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife.
	Education and research	Sites of value in the wetland for education or research.

The Ecological Importance and Sensitivity of on-site water features are described in the results section, whilst descriptions of the associated scores are given in ***Table 12***.

Table 12 Environmental Importance and Sensitivity Rating Scale Used for the Estimation of EIS Scores (DWS, 1999)

Ecological Importance and Sensitivity Categories	Rating	Recommended Ecological Management Class
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. They play a major role in moderating the quantity and quality of water in major rivers	>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. They play a role in moderating the quantity and quality of water of major rivers	>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. They play a small role in moderating the quantity and quality of water in major rivers	>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. They play an insignificant role in moderating the quantity and quality of water in major rivers	>0 and <=1	D

4.5.3 Quick Habitat Integrity (QHI) Model for the Riparian Zone

To accommodate a less-detailed process, a desktop habitat integrity assessment (using the Quick Habitat Integrity model) that allows for a coarse assessment was developed. This assessment rates the habitat according to a scale of 0 (close to natural) to 5 (critically modified) using the following metrics (Seaman *et al*, 2010):

- Bed modification.
- Flow modification.
- Introduced In-stream biota.
- Inundation.
- Riparian / bank condition.
- Water quality modification.

4.5.4 Present Ecological Category (EC): Riparian

In the current study, the Ecological Category of the riparian areas was assessed using a level 3 VEGRAI (Riparian Vegetation Response Assessment Index) (Kleynhans *et al*, 2007) and QHI (Quick Habitat Integrity) to calculate the ecological category of the river system (Table 13)

Table 13: Generic ecological categories for EcoStatus components (modified from Kleynhans, 1996 & Kleynhans, 1999)

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

5. Results

5.1 Land Use and Land Cover

The study site is located on farm 503 (Werda) south of Lime Acres. The study site is bordered in the west by the Rooiberge mountain range and is mainly used as a cattle farm with numerous camps.

The study site is located on two catchment areas and most of the site drains in a southerly direction with only a small area draining in a northern direction. It is likely that these large drainage areas contribute to the inflow of water into some of the pans during flooding.

A combination of extremely dry conditions and overgrazing contributed to the establishment of a short grass and herb vegetative layer as well as large areas of open barren soil, especially within on-site pans.

Several dirt roads and overhead cables cross the site. The veld consists of dry open woodlands on the slopes and grasslands associated with the pans within the vicinity of the site. This grassland hosts a range of dwarf shrubs and succulent herbs, which include *Eriocephalus ericiodes*, *Chrysocoma ciliate* and *Ruschia calcarea*.

5.2 Wetland Indicators

Due to the very low annual rainfall and the long intervals between major rainfall events within the area, the wetlands on-site showed very few wetland indicators. Obligate wetland plants were not found in any of the surface water features. The features were instead dominated by grass, dwarf shrubs and succulent herbs including species adapted to growing on calcrete pans (*Ruschia calcarea*). Signs of wetness in the soil were also limited. Wetland areas downstream of the study site were inundated during the site visit with dominant obligate wetland species such as *Juncus rigidus* and *Schoenoplectus muricinux* recorded in the wetland. It is likely that these species will occur in the pans in the study site when the pans are inundated. Pan 8 had large scattered boulders within the pan and pan 4 was characterised by numerous small rocks and pebbles (Figure 7).

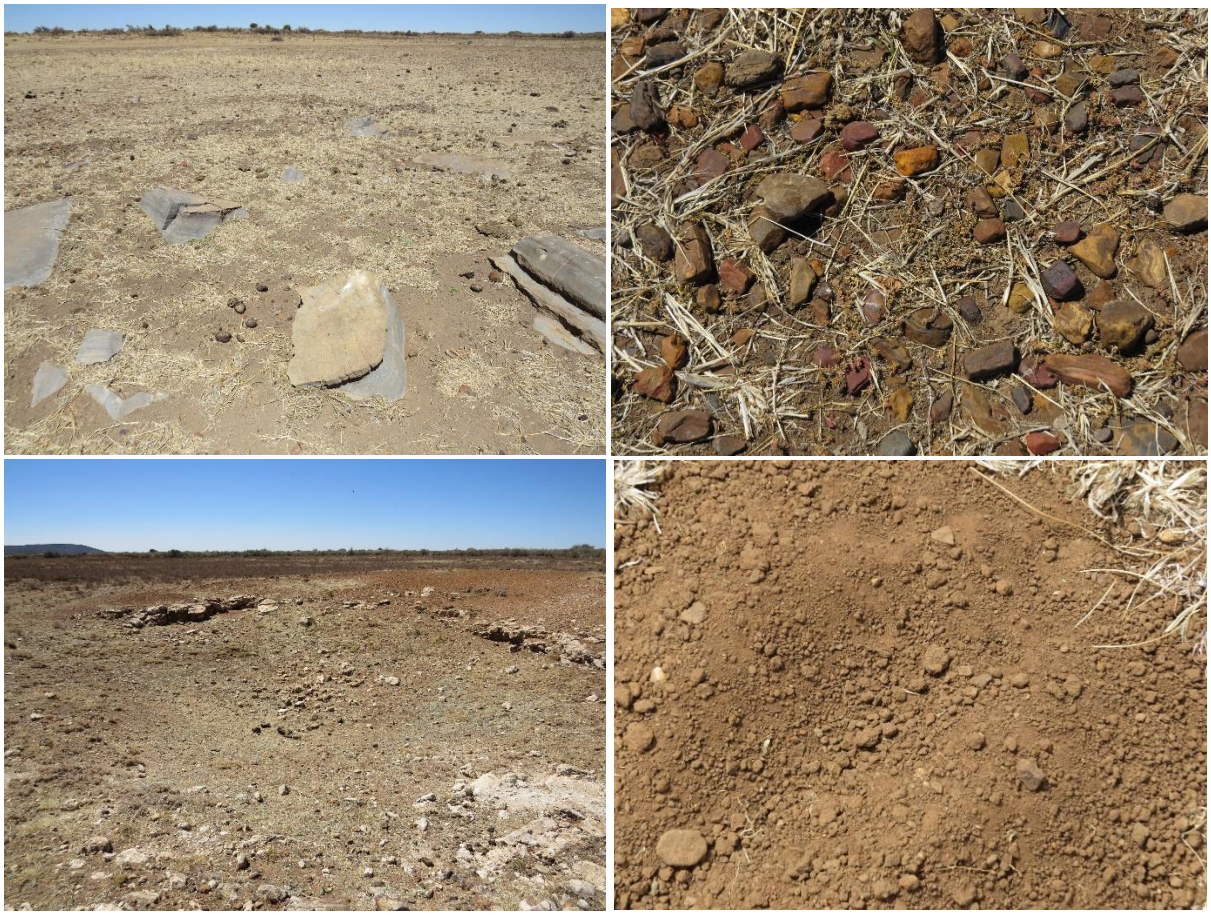


Figure 7: Soil, rocks and bedrock recorded in the pans in the study site.

The pans found throughout the studied area can stand dry for years between temporary flooding (Davies & Day 1986 in Cowan, 1995). This is due to a high evaporation rate and a low precipitation rate associated with the area.

The highest concentration of pans in South Africa are found in the Northern Cape, Western and North-Central Free State as well as Southern Transvaal (Gauteng) (Cowan, 1995) Most are thus distributed throughout various vegetation biomes and found especially in the grassland, Nama Karoo and Kalahari biomes. Most pans occur on shale or unconsolidated surficial sands (Cowan, 1995) such as the areas common throughout the study area. Most pans found are characterised by a lack of integrated drainage and have a slope of less than one degree (Le Roux, 1978 in Cowan, 1995). The vast number of dry pans found throughout the study site suggests that the water table is not close to the surface but that the pans rather fill up with water in seasons of heavy rain and subsequently dry out over time. Because of the dry nature of these pans, it could be expected that impacts associated with infrastructure should be less extensive compared to permanently inundated pans.

Topography and vegetation structure were good indicators of the pan boundaries. The absence of trees within the pans, in combination with changes in slope allowed for delineating the edge of these features. ***Annex A*** presents a map which shows the locations of the delineated pans on and within the vicinity of the site.

The non-perennial river identified on-site (also illustrate in ***Annex A***) was delineated by shrubs and taller grasses on the banks compared with the sparse vegetation growth of the main channel. Alluvial deposits were also found in the river channel.

Two protected trees were located within the study site (*Vachelia erioloba*), which are also indicated in ***Annex A***. The coordinates of these trees are S28° 26.333' E23° 26.869' and S28° 26.347' E23° 26.828'.

It is also important to note that a large number of animals and birds were recorded in the study site and within some of the pans. Evidence of animals include large meerkat manors in the pans, numerous antelope observed, porcupine holes, as well as signs of larger animals.

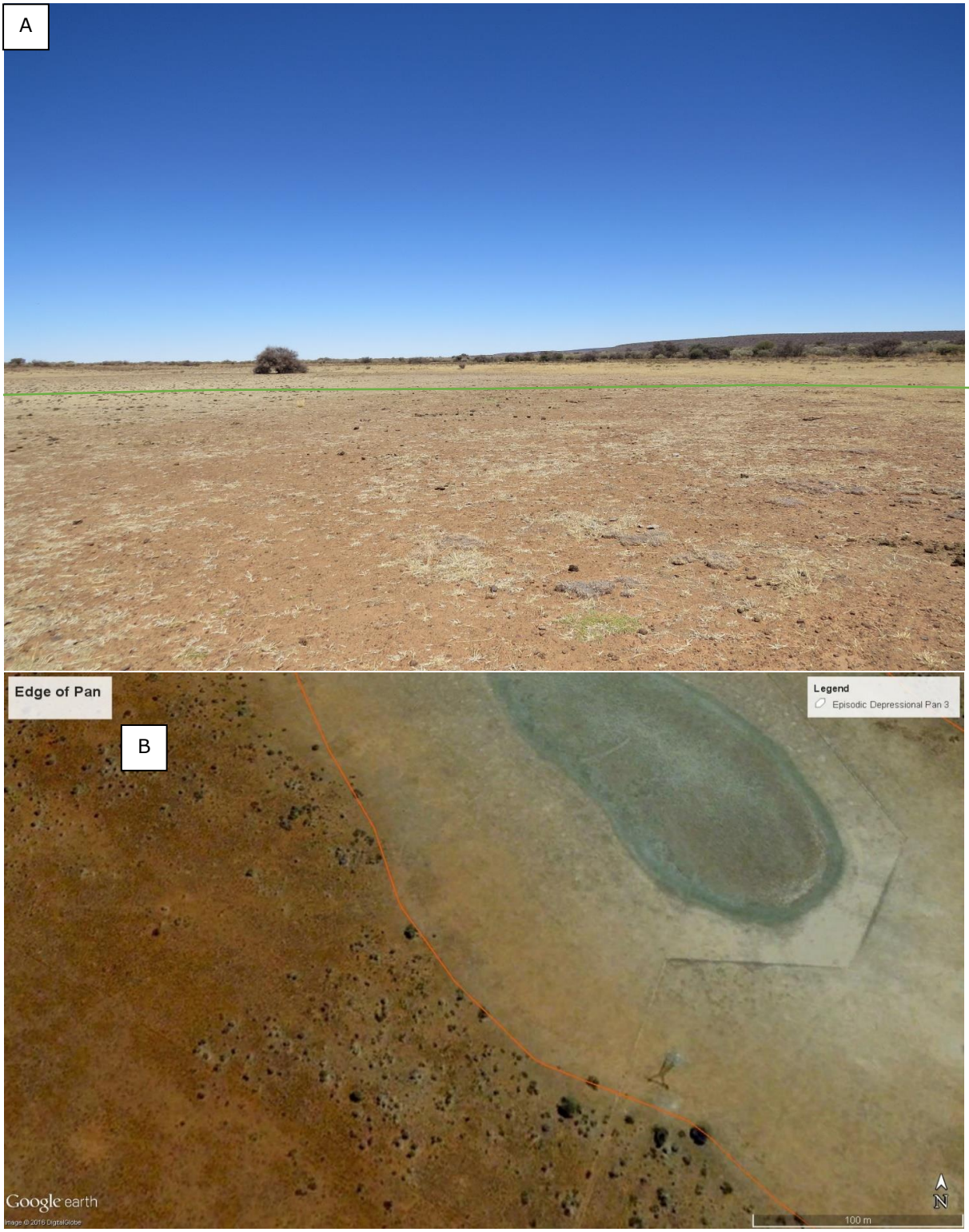


Figure 8 A) Photograph Indicating the Edge of an Identified On-Site Pan (Orange line). B) Aerial Imagery of the Same Pan Showing the Edge of the Pan (Orange Line)

Figure 9 Sparse Vegetation and Alluvial Deposits of the Episodic Non-Perennial River Identified On-Site with Shrubs and Taller Vegetation Growth on the Banks

5.3 Surface Water Feature Classification and Delineation

A total of 15 water features were identified within the study site. The features can be classified as 14 episodic pans and one episodic non-perennial river (***Annex A***). Although the study was conducted in the dry season in a year of extreme drought some wetland indicator species were recorded although the topography of the pans was used as the main characteristic feature. Pans are generally easy to identify due to their typically circular to oval shape, and their shallow slopes (Cowan 1995). Furthermore, Day *et al* (2009) suggests that the absence of an indicator does not necessarily equate to the absence of a wetland and that detailed delineation of cryptic wetlands is unlikely to be achievable with any useful degree of confidence based on a dry season assessment only and thus a follow up study is suggested during the wet season.

During high rainfall events in the D71B catchment, run-off water is anticipated to drain from the Rooiberge located north-west and west of the study site, towards pan numbers 2-12, 14, 15, via the non-perennial river (no. 1). It is anticipated that pan numbers 1 and 13 would receive water from run-off coming from the north in the catchment C92C (***Annex A***).

Some pans are considered to be newly formed as a result of grazing and trampling of animals and/or erosion which leads to the formation of depressions which, in an area with a high concentration of pans, can also in itself become a place where water collects during rainfall events and thus becomes a pan. The hydro-period of the wetlands were determined using different years of aerial imagery (historical photographs and google earth time-line function) to determine the time and period in which the pans are inundated. Furthermore, the farmers living on the land were invaluable with their knowledge in the hydro-period of the pans on their farms.

On-site surface water features are classified up to level 6 per the SANBI wetland guidelines (Ollis *et al*, 2013) as summarised in the ***Table 13*** to ***Table 15***.

Table 14 Level 1- 4 Classification of the Water Features Recorded On-Site (Adapted from Ollis *et al*, 2013)

Level 1: System Type	Level 2: Regional Setting	Level 3: Landscape Setting	Level 4: HGM Unit		
System	**DWS Ecoregion**	**Landscape Unit**	**Level 4A:Wetland Type**	**Level 4B: Longtitudinal Zonation**	**Level 4C: Inflow Drainage**
Inland.	Ghaap Platue.	Valley Floor & Slope.	Depressions (1-4, 9, 13, and 15).	Endorheic.	With channelled inflow.
			Non-Perennial River (1).	Lower-Foothills.	Active Channel.
	Southern Kalahari.	Valley Floor & Slope.	Depressions (5-8, 10, 11, 12, 14).	Endorheic.	With channelled inflow.

Table 15 Level 5 Classification of the Water Features Recorded On-Site (Adapted from Ollis *et al*, 2013)

Level 5: Hydroperiod and depth of inundation		
Level 5A	**Proportional Rating (0-6) for Water Features On-Site**	
Inundation Peroid	**Depressions**	**Non-Perennial River**
Permanently Inandated		
Seasonally Inandated	4	5
Intermittently Inandated	4	4
Never/Rarely Inandated	1	1
Unknown		
Level 5B	**Proportional Rating (0-6) for Features On-Site**	
Saturartion Periodicity (within 50 cm of the Soil Surface)		
Permanently Inandated		
Seasonally Inandated	3	3
Intermittently Inandated	5	5
Never/Rarely Inandated	1	1
Level 5C: Inundation Depth-Class		
	Littoral	Littoral

Table 16 Level 6 Classification of the Water Features Recorded On-Site (Adapted from Ollis *et al*, 2013)

Component	Dominant categories for selected descriptorss (Level 6)							
	Natural vs Artificial		Substratum Type	Vegetation Cover, Form and Status				
	6A: NAtural vs Artificial	6B: Artificial Categories	6A: Primary Categories	6A: Vegetation Cover	6B: Primary Vegetation Cover	Detailed Vagetation From		6E: Vegetation Status
						6C: Herbaceous Vegetation	6D: Forest Vegetation	
Depressions.	Natural.	n/a.	Sandy, Rocky, Carbonate.	Sparsely Vegetated.	Grasses & Herbaceous with shrubs on edge.	No obligate wetland species.	n/a.	Natural.
Non-Perennial River.	Natural.	n/a.	Alluvial Deposits.	Sparsely Vegetated.	Grasses & Herbaceous with shrubs on edge.	No obligate wetland species.	n/a.	Natural.

5.4 Water Feature Functional Assessment

5.4.1 Present Ecological State (PES)

The depressional pan wetlands delineated in this report are similar to each other in hydrology, geomorphology and vegetation growth. One of the main difference between the identified pans are that some have been more grazed, even over-grazed, while others have good robust vegetation growth. This is likely due to the farmer's rotation of cattle and as such all the pans are likely to have enough time to recover the grazed vegetation while not actively being grazed on. The pans number 1, 2, 3, 6, 9, 13, 14 and 15 were more impacted by grazing compared to the other pans. Pan 4 were impacted somewhat by Eskom pylons within the pan. The pans numbered 1 and 2 were impacted by a dirt road that crosses through the wetlands.

Although exotic vegetation was recorded on the study site, it was very sparse and usually confined to the disturbed areas such as adjacent to roads. Further impacts associated with the pans are dirt roads and powerline cables that transect some pans. The pans in the study area are generally small to medium sized with small direct catchment areas. The area available for impacts are thus small and not as susceptible to impacts compared to other wetland systems such as valley bottoms that can be affected by many upstream activities. The impacts associated with the pans are visually indicated in figure 9.

The pans on the study site scored either an ***A - Unmodified, natural*** or a ***B - 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. The trajectory of the wetlands are all likely to remain stable over the next 5 years (→)

5.4.2 Ecological Importance and Sensitivity (EIS)

All the depressional pans scored between 2 – 3, and thus falls into a category characterised by high ecological importance and sensitivity. Surface water features that fall into this category are considered to be ecologically important and sensitive. The biodiversity of these features may be sensitive to flow and habitat modifications (also see ***Table 16***). The pans scored low on key features such as sensitivity in changes in flood and sensitivity in changes in dry season as pans are generally not sensitive to such changes however, the pans scored high for direct human benefits as they provide water, grazing area potential tourism area (such as birding) as well as potential educational value. Furthermore, the pans contribute positively to the hydro-functionality of the area and helps trap sediment and aids in flooding events.

The Recommended Ecological Management Class for the identified water features is thus a ***B***.

Table 17 The PES and EIS scores of the possibly affected watercourses along the proposed line

No.	Affected Watercourse	PES	EIS
1	Depressional Pan.	B - Largely natural with few modifications. →	B – High.
2	Depressional Pan.	B - Largely natural with few modifications. →	B – High.
3	Depressional Pan.	B - Largely natural with few modifications. →	B – High.
4	Depressional Pan.	A - Unmodified, natural. →	B – High.
5	Depressional Pan.	A - Unmodified, natural. →	B – High.
6	Depressional Pan.	B - Largely natural with few modifications. →	B – High.
7	Depressional Pan.	A - Unmodified, natural. →	B – High.
8	Depressional Pan.	A - Unmodified, natural. →	B – High.
9	Depressional Pan.	B - Largely natural with few modifications. →	B – High.
10	Depressional Pan.	A - Unmodified, natural. →	B – High.
11	Depressional Pan.	A - Unmodified, natural. →	B – High.

No.	Affected Watercourse	PES	EIS
12	Depressional Pan.	A - Unmodified, natural. →	B – High.
13	Depressional Pan.	B - Largely natural with few modifications. →	B – High.
14	Depressional Pan.	B - Largely natural with few modifications. →	B – High.
15	Depressional Pan.	B - Largely natural with few modifications. →	B – High.

Figure 10: Impacts associated with the pans including overgrazing, fences within the wetland, exotic vegetation and inadequate stormwater drains.

5.4.3 Ecological Category (EC)

The episodic nature of the riparian areas provided some difficulty to the determination of the EC using VEGRAI assessment, due to the majority of the vegetation being terrestrial. The confidence for the VEGRAI component is thus low. Currently no tools are available to rapidly assess non-perennial systems other than long term monitoring.

The instream biota score was also not available during the time of the site assessment to use in the QHI calculations and was thus omitted from the calculations. Although it is unlikely that the episodic streams provide sufficient habitat for these animals to thrive while the pools in the ephemeral streams might provide some limited habitat.

The non-perennial river located on the study site has limited impacts which includes grazing and dirt road crossing. Furthermore, the vegetation composition of the non-perennial river was generally characterised by indigenous shrubs. No riparian woody vegetation was recorded in the river area.

The VEGRAI EC and QHI is summarised in the ***Table 17***. The combined EC scores for the riparian area on the study site is a ***B - largely natural with few modifications***. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged (Kleynhans, 1999).

Table 18 Ecosystem Services Provided by the Non-Perennial River (Kleynhans *et al*, 2008)

Level 3 Assessment					
Metric Group	**Calculated Rating**	**Weighted Rating**	**Confidence**	**Rank**	**% weight**
Marginal	100,0	23,1	2,5	2,0	30,0
Non -Marginal	80,5	61,9	0,0	1,0	100,0
Level 3 VEGRAI (%)				85,0	
VEGRAI EC				B	
Average confidence				1,3	

Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged (Kleynhans, 1999). The combined QHI score for the episodic non-perennial streams on the study site is a ***B - Largely natural with few modifications***. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged (Kleynhans, 1999).

The quick habitat integrity (QHI) score is summarised in ***Table 18***.

Table 19 QHI for the Non-Perennial and Drainage Areas on the Study Site (Seaman *et al*, 2010)

Quaternary Catchment	River	Bed Modification (0-5)	Flow Modification (0-5)	Introduced Instream Biota (0-5): Only Enter Value if Rating is Higher than any of the other Metrics	Inundation (0-5)	Riparian/Bank Condition (0-5)	Water Quality Modification (0-5)	Desktop Habitat Integrity	Invertebrate Rating (0-5)	Fish Rating (0-5)	Instream EC%	Instream EC	Vegetation Rating (0-5)
D71B	Non-Perennial	0	2	-	1	0	2	83,0	-	-	83,0	B	1

6. Impacts and Mitigation

Proposed project activities that are considered likely to have an impact on the identified surface water features, are indicated in ***Figure 9*** and listed in ***Table 19***.

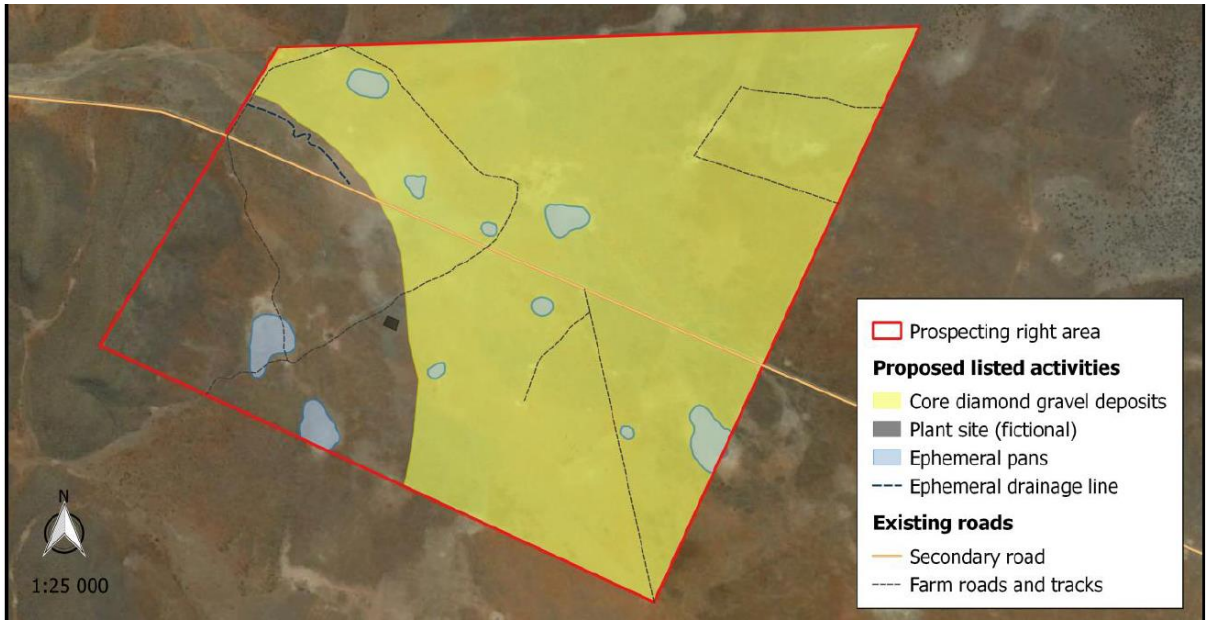


Figure 11 Proposed Potential Project Activity Impacts on the Study Site (Boscia, 2016)

Table 20 Listed Activities as Presented on Figure 9 (Boscia, 2016)

Map Legend Entry	Associated Activities
Prospecting Right Area	• The proposed operation on Werda directly relates to prospecting of a mineral resource (diamonds) and requires a prospecting right. • The operation directly relates to prospecting of a mineral resource (diamonds) and requires permission in terms of Section 20 (MPRDA), for the removal and disposal of bulk samples of any minerals.
Ephemeral Pans and Ephemeral Drainage Line	• The possible excavation of soil, sand, shells, shell grit, pebbles or rock of more than 5 m^2 from a watercourse.
Core Diamond Gravel Deposits	• The clearance of an area of more than 20 ha of indigenous vegetation. • The development of haul roads 15 m wide with no reserve. • The continuous lengthening (and rehabilitation) of haul roads 15 m wide with no reserve. • The development of access roads 6 m in width with no reserve. • The continuous establishment and reclamation of temporary stockpiles resulting from activities which require a prospecting right.
Plant Site (Fictional) The exact location of the plant site is directly related to locality of pits and trenches. This will only be determined once non-invasive prospecting activities have been completed.	• The operation on Werda directly relates to activities associated with the primary processing of a mineral resource. • The development of infrastructure for the storage and handling of dangerous goods (fuel), in containers with a combined capacity of 30 80 m^3. • The establishment of a residue deposit (slimes dam) resulting from activities which require a prospecting right.

Map Legend Entry	Associated Activities
	• General site infrastructure, including office complexes, workshop facilities, storage facilities, concrete bund walls and diesel depots, ablution facilities, water storage tanks and pipelines.

An extract from the DWS Risk Matrix spreadsheet, which is presented in ***Table 20*** to ***Table 22***, shows that the expected risk score falls within the Low, Medium and High risk category.

Medium and high risk category activities refer to risks and impacts on surface water features that are notable and require adequate mitigation measures. Consequently, medium to high risk activities will be more expensive to implement and require specialist input. Additionally, activities which fall within the medium to high risk categories should be authorised through a WUL.

Table 21 The Severity Score (After Mitigation) Derived from the DWS (2014) Risk Assessment Matrix for the Proposed Activities

Activity	Aspect	Phase	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity
The possible excavation of soil, sand, shells, shell grit, pebbles or rock of more than 5 m^3 from a watercourse.	Vehicles driving in / through the surface water features.	Operation.	Changing the quantity and fluctuation properties of the watercourse by for example storm water input, or restricting water flow.	4	3	4	3	3.5
	Excavation of soil, sand, shells, shell grit, pebbles or rock of more than 5 m^3 from a watercourse (Should not occur as part of mitigation measures).			1	1	1	1	1
	Development within surface water features, thereby diverting or impeding flow (Should not occur as part of mitigation measures).			1	1	1	1	1
	Lack of adequate rehabilitation resulting in invasion by invasive plants.			3	3	3	3	3
	Damage to vegetated areas.			3	3	3	3	3
	Movement of heavy machinery in surface water features or their associated buffer zone.			3	3	3	3	3
	Maintenance of infrastructure.	Maintenance.		2	2	2	2	2

Risk = Consequence x Likelihood
Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of the Activity + Frequency of the Impact +Legal Issues + detection

Table 22 Severity Scores without Mitigation Measures

Activity	Aspect	Spatial scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
The possible excavation of soil, sand, shells, shell grit, pebbles or rock of more than 5 m^3 from a watercourse.	Vehicles driving in / through the surface water features.	2	3	8.5	5	4	5	1	15	127.5	M
	Excavation of soil, sand, shells, shell grit, pebbles or rock of more than 5 m^3 from surface water features (should not occur).	1	1	3	1	1	1	5	8	24	L
	Development within surface water features, thereby diverting or impeding flow (Should not occur as part of mitigation measures).	1	1	3	1	1	1	5	8	24	L
	Damage to vegetated areas.	2	2	7	1	1	1	2	5	35	L
	Maintenance of infrastructure.	2	2	6	3	3	1	2	9	54	L
	Movement of heavy machinery in surface water features or	2	2	8	2	1	5	1	9	72	M

Activity	Aspect	Spatial scale	Duration	Consequence	Frequency of Activity	Frequency of Impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
	their associated buffer zone.										

Table 23 Severity Scores with Mitigation Measures

Activity	Aspect	Risk Score	Control Measure including extracts from the GDACEL approved EMP dated 2012	Watercourse Type
The possible excavation of soil, sand, shells, shell grit, pebbles or rock of more than 5 m^3 from a watercourse.	Vehicles driving in / through the surface water features.	M	• Crossings to be undertaken with only one vehicle that have the minimum footprint as decided on during planning. • Limit the removal of indigenous vegetation around the construction footprint. • Limit compaction by not working in wet conditions and limiting vehicular access. • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out (DAWF, 2005). • Contractors should refrain from impacting areas beyond the demarcated construction area. • Areas where soil has been compacted should be ripped to encourage vegetation growth. • Ripping shall be done to a depth of 250 mm in two directions at right angles. • Do not rip and / or scarify areas under wet conditions, as the soil will not break up and compaction will be worsened. • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out (DAWF, 2005). • Rip and / or scarify all disturbed (and other specified) areas of the construction site, including temporary access routes and roads, compacted during the execution of the Works. (DWS, 2005).The contractor must avoid traffic or storing of equipment and material in vegetated areas that will not be cleared. • In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water and Sanitation (DWS) must be informed immediately and corrective action taken. • All equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse. • Drip trays (minimum of 10cm deep) must be placed under all vehicles that stand for more than 24 hours. Vehicles suspected of leaking must not be left unattended, drip trays must be utilised. • Drip trays must be utilised during repairs and maintenance of all machinery. The depth of the drip tray must be determined considering the total amount / volume of oil in the vehicle. The drip tray must be able to contain the volume of oil in the vehicle. • Provision of adequate sanitation facilities located outside of the pan/riparian area or its associated buffer zone	All identified water features.

Activity	Aspect	Risk Score	Control Measure including extracts from the GDACEL approved EMP dated 2012	Watercourse Type
			• Remove all construction equipment and material on completion of construction.	
	Excavation of soil, sand, shells, shell grit, pebbles or rock of more than 5 m^2 from a watercourse (should not occur).	L	• This activity should not occur in surface water features. • Planning of construction site must include eventual rehabilitation / restoration of indigenous vegetative cover. • Rehabilitation of damage/impacts that arise as a result of construction must be implemented immediately upon completion of construction. • Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. • Runoff from the construction area must be managed to avoid erosion and pollution problems. • Implementation of best management practices. • Source-directed controls. • Buffer zones to trap sediments. • Active rehabilitation. • Plan construction camps to be placed outside of watercourses and their associated buffer zones. • Plan construction activities to have the smallest possible footprint. • Project engineers should compile a method statement, outlining the construction and earthwork methodologies. The required mitigation measures to limit the impacts on the watercourse and associated buffers should be contained within the method statement. The method statement must be approved by the ECO and be available on site for reference purposes. • Contractors should refrain from impacting areas beyond the demarcated construction area.	All identified water features.
	Development within surface water features, thereby diverting or impeding flow (Should not occur as part of mitigation measures).	L	• Planning of construction site must include eventual rehabilitation / restoration of indigenous vegetative cover. • Rehabilitation of damage/impacts that arise as a result of construction must be implemented immediately upon completion of construction. • Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. • Runoff from the construction area must be managed to avoid erosion and pollution problems. • Implementation of best management practices.	All identified water features.

Activity	Aspect	Risk Score	Control Measure including extracts from the GDACEL approved EMP dated 2012	Watercourse Type
			• Source-directed controls. • Buffer zones to trap sediments. • Active rehabilitation. • Plan construction camps to be placed outside of watercourses and their associated buffer zones. • Plan construction activities to have the smallest possible footprint. • Project engineers should compile a method statement, outlining the construction and earthwork methodologies. The required mitigation measures to limit the impacts on the watercourse and associated buffers should be contained within the method statement. The method statement must be approved by the ECO and be available on site for reference purposes. • Plan to demarcate the construction area and ensure that no disturbance to vegetation and soils outside of the planned construction site take place. • Only use access roads as designated during the planning phase. • Limit the removal of indigenous vegetation around the construction footprint. • Limit compaction by not working in wet conditions and limiting vehicular access. • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out (DAWF, 2005). • The contractor must avoid traffic or storing of equipment and material in vegetated areas that will not be cleared. • All equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse. • Drip trays (minimum of 10cm deep) must be placed under all vehicles that stand for more than 24 hours. Vehicles suspected of leaking must not be left unattended, drip trays must be utilised. • Remove all construction equipment and material on completion of construction. • No water should be abstracted from any surface water features. • Keep soil storage periods as short as possible.	
	Damage to vegetated areas	L	• Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. • Limit clearing of vegetation to the smallest area possible.	All surface water features.
	Maintenance of infrastructure	L	• Ensure that maintenance planning does not take place haphazardly, but according to a fixed plan.	All surface water features.

Activity	Aspect	Risk Score	Control Measure including extracts from the GDACEL approved EMP dated 2012	Watercourse Type
			• Management of on-site water use and prevent storm water or contaminated water directly entering the watercourse. • Management of point discharges. • Pollution control.	
	Movement of heavy machinery in surface water features or their associated buffer zone	M	• Crossings to be undertaken with only one vehicle that have the minimum footprint as decided on during planning. • Limit the removal of indigenous vegetation around the construction footprint. • Limit compaction by not working in wet conditions and limiting vehicular access. • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out (DAWF, 2005). • Contractors should refrain from impacting areas beyond the demarcated construction area. • Areas where soil has been compacted should be ripped to encourage vegetation growth. • Ripping shall be done to a depth of 250 mm in two directions at right angles. • Do not rip and / or scarify areas under wet conditions, as the soil will not break up and compaction will be worsened. • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out (DAWF, 2005). • Rip and / or scarify all disturbed (and other specified) areas of the construction site, including temporary access routes and roads, compacted during the execution of the Works. (DWS, 2005). The contractor must avoid traffic or storing of equipment and material in vegetated areas that will not be cleared. • In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water and Sanitation (DWS) must be informed immediately and corrective action taken. • All equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse. • Drip trays (minimum of 10cm deep) must be placed under all vehicles that stand for more than 24 hours. Vehicles suspected of leaking must not be left unattended, drip trays must be utilised. • Drip trays must be utilised during repairs and maintenance of all machinery. The depth of the drip tray must be determined considering the total amount / volume of oil in the vehicle. The drip tray must be able to contain the volume of oil in the vehicle.	All surface water features.

Activity	Aspect	Risk Score	Control Measure including extracts from the GDACEL approved EMP dated 2012	Watercourse Type
			• Provision of adequate sanitation facilities located outside of the pan/riparian area or its associated buffer zone. • Remove all construction equipment and material on completion of construction.	

7. Conclusion

A total of 15 surface water features were recorded within the study site. The features were classified as 14 episodic pans and one episodic non-perennial river (refer to ***Annex A*** for their position and extent).

During high rainfall events in the D71B catchment, run-off water is anticipated to drain from the Rooiberge located north-west and west of the study site, towards pan numbers 2-12, 14, 15, via the non-perennial river (no. 1). It is anticipated that pan numbers 1 and 13 would receive water from run-off coming from the north in the catchment C92C.

Potential impacts of the proposed prospecting included:

- Loss and disturbance of aquatic habitat and fringe vegetation.
- Introduction and spread of alien invasive vegetation.
- Changes in the amount of sediment entering the system.
- Changes in water quality due to toxic contaminants entering the system.
- Changes in water flow regime due to the alteration of surface characteristics.

Two potential activities achieved risk scores that fell in the Medium risk category. These activities could require authorization through a WUL application from the DWS. These activities are:

- Vehicles driving in / through the wetland.
- Movement of heavy machinery in wetlands or within their buffer zones.

Appropriate mitigation measures should be put into place and careful monitoring is required to ensure potential impacts are mitigated. Some of the measures recommended include:

- Prospecting should not occur within water feature or associated buffer zones.
- Where possible, the natural drainage should be preserved to allow water to enter the system from the Rooiberge.
- Formalise access roads and make use of existing roads and tracks where feasible.
- Retain vegetation and soil in position where feasible, revegetate if disturbed.
- Protect all areas susceptible to erosion
- All potentially polluting and hazardous substances used and stored on-site should be stored in clearly demarcated areas away from storm water.
- Maintain vehicles and machinery to prevent excessive polluting.
- Monitor and control alien invasive species.

It is MojaTerre's opinion that authorisation for prospecting is granted for the proposed project, given that the mitigations and recommendations made in this report are implemented and maintained.

8. References

Boscia Ecological Consulting (2016). Scoping Report – HC Van Wyk Diamonds – NC 30/5/1/1/2/11779 PR.

Chief Directorate: Surveys & Mapping. 1996: Hydrology. Cape Town: CDSM.

Cowan G.L (ed) 1995. Wetlands of South Africa. Department of Environmental Affairs and Tourism, Pretoria.

Day J., Day E., Ross-Gillespie V. and Ketley A. (2009). The assessment of Temporary wetlands During Dry Conditions. Wetland Health and Importance research programme. Water Research Commision (WRC), Pretoria. Report no: TT434/09

Department of Water Affairs (2008): Updated Manual for the Identification and Delineation of Wetlands and Riparian areas.

Department of Water Affairs (2010). National Water Act, 1998 (Act No 36 of 1998) S21(c) & (i) Water Uses. Version: February 2010. Training Manual.

Department of Water Affairs and Forestry (1999). Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0. Pretoria

Department of Water Affairs and Forestry (2008). Updated Manual for the identification and delineation of wetlands and riparian areas. Department of Water affairs and Forestry. Pretoria. South Africa Second Edition. September 2008.

Department of Water Affairs and Forestry, (2005): Environmental Best Practice Specifications: Construction for Construction Sites, Infrastructure Upgrades and Maintenance Works. Version 3

Department of Water Affairs and Sanitation (2015a) Risk-based Water Use Authorisation Approach and Delegation Protocol for Section 21(c) and (i), Edition 02

Department of Water Affairs and Sanitation (2015b) Appendix A: Risk Matrix (Based on the DWS 2015 publication: Section 21 c and I water use Risk Assessment Protocol)

http://www.agis.agric.za

Kleynhans C.J., MacKenzie J. and Louw M.D. (2007). Module F: Riparian Vegetation Response Assessment Index in River Classification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 333/08

Kleynhans C.J., MacKenzie J. and Louw M.D. (2007). Module F: Riparian Vegetation Response Assessment Index in River Classification: Manual for EcoStatus Determination (version 2). Joint Water Research Commission and Department of Water Affairs and Forrestry report. WRC Report No. TT 333/08

Kleynhans, C.J. (1999): A procedure for the determination of the for the determination of the ecological reserve for the purpose of the national water balance model for South African Rivers. Institute for Water Quality Studies Department of Water Affairs and Forestry, Pretoria.

Kotze D C, (1999): A system for supporting wetland management decisions. Ph.D. thesis. School of Applied Environmental Sciences, University of Natal, Pietermaritzburg.

Macfarlane D.M., Kotze D.C., Ellery W.N., Walters D, Koopman V, Goodman P and Goge C. (2008). WET-Health: A technique for rapidly assessing wetland health. Water Research Commission, Pretoria. WRC Rport TT340/08 February 2008

Macfarlane D.M., Teixeira-Leite A., Goodman P., Bate G and Colvin C. (2010) Draft Report on the Development of a Method and Model for Buffer Zone Determination. Water Research Commission project K5/1789. The Institute of Natural Resources and its Associates

Macfarlane D.M., Teixeira-Leite A., Goodman P., Bate G and Colvin C. (2010) Draft Report on the Development of a Method and Model for Buffer Zone Determination. Water Research Commission project K5/1789. The Institute of Natural Resources and its Associates

Mucina L., & Rutherford M. C. (2006). Vegetation Map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. South African National Biodiversity Institute., Pretoria.

Mucina L., and Rutherford M. C. (2006). Vegetation Map of South Africa, Lesotho and Swaziland, 1:1 000 000 scale sheet maps. South African National Biodiversity Institute, Pretoria

SANBI 2010. National Freshwater Ecosystem Priority Areas. South African National Biodiversity Institute

Schultze R.E. (1997). South African Atlas of Agrohydrology and Climatology. Water Research Commission, Pretoria, Report TT82/96

Annex A – Maps

Map 1 – Location Map

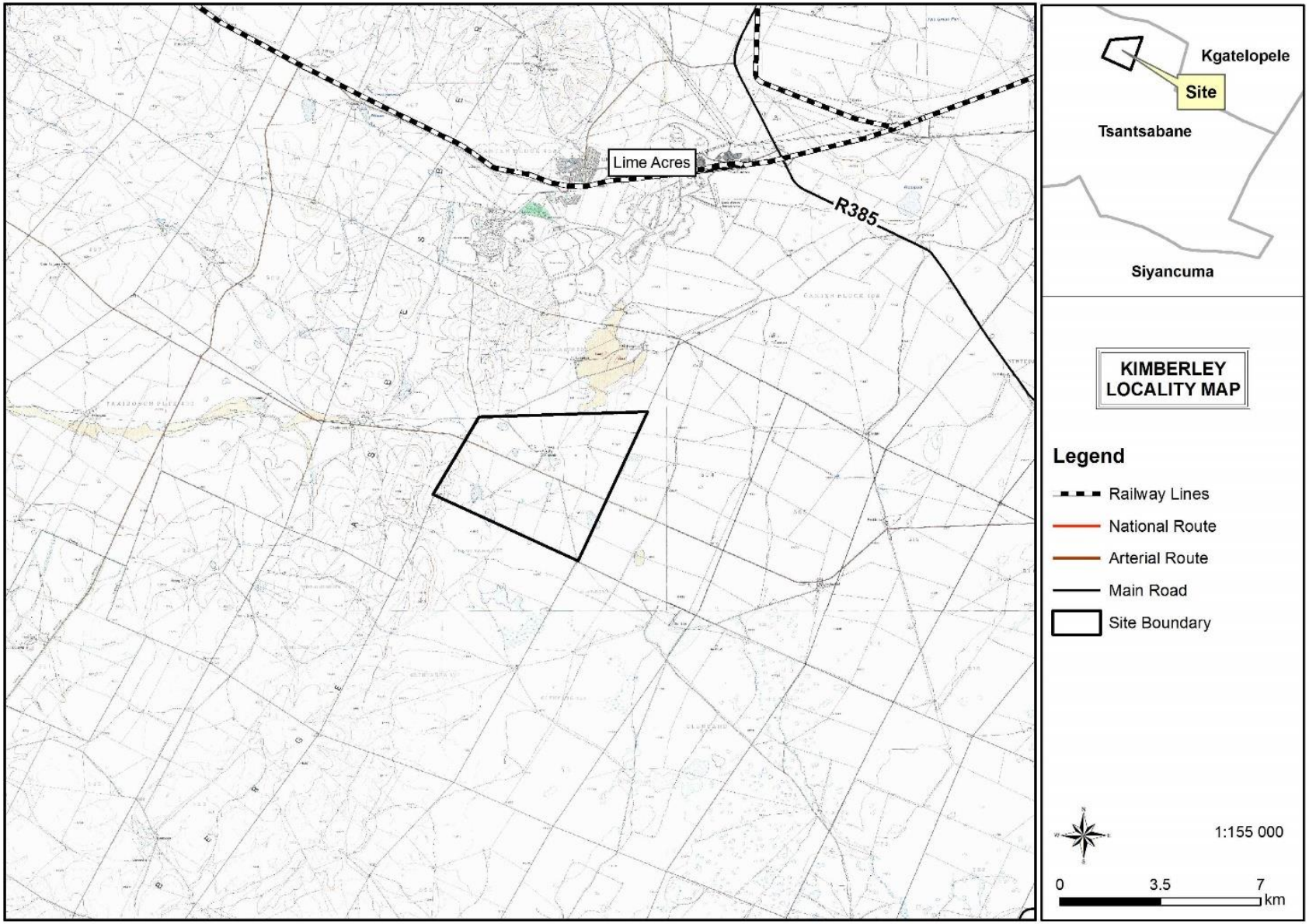
Map 2 – Surface Hydrology

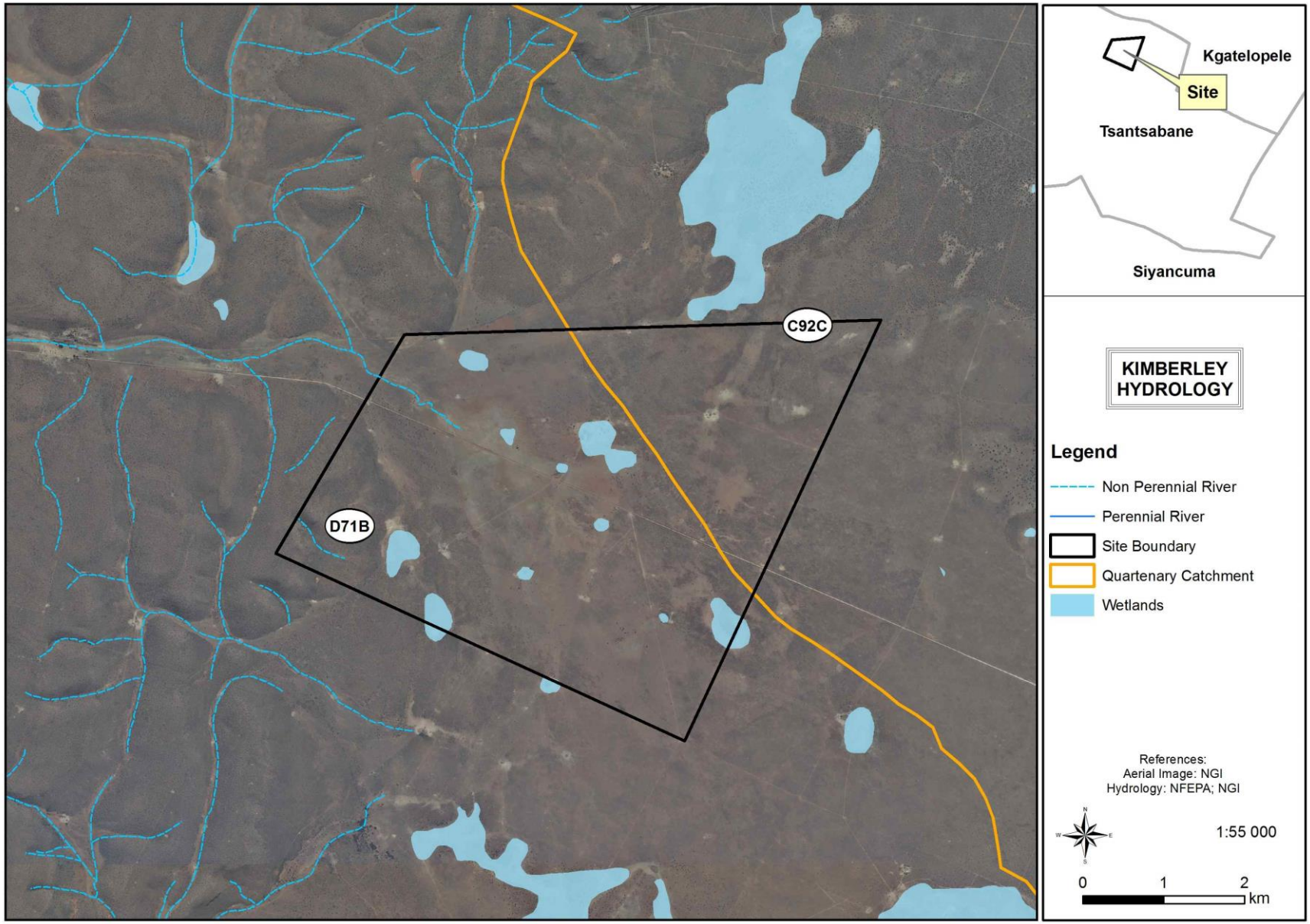
Map 3 – Geology of the Study Site and Surroundings

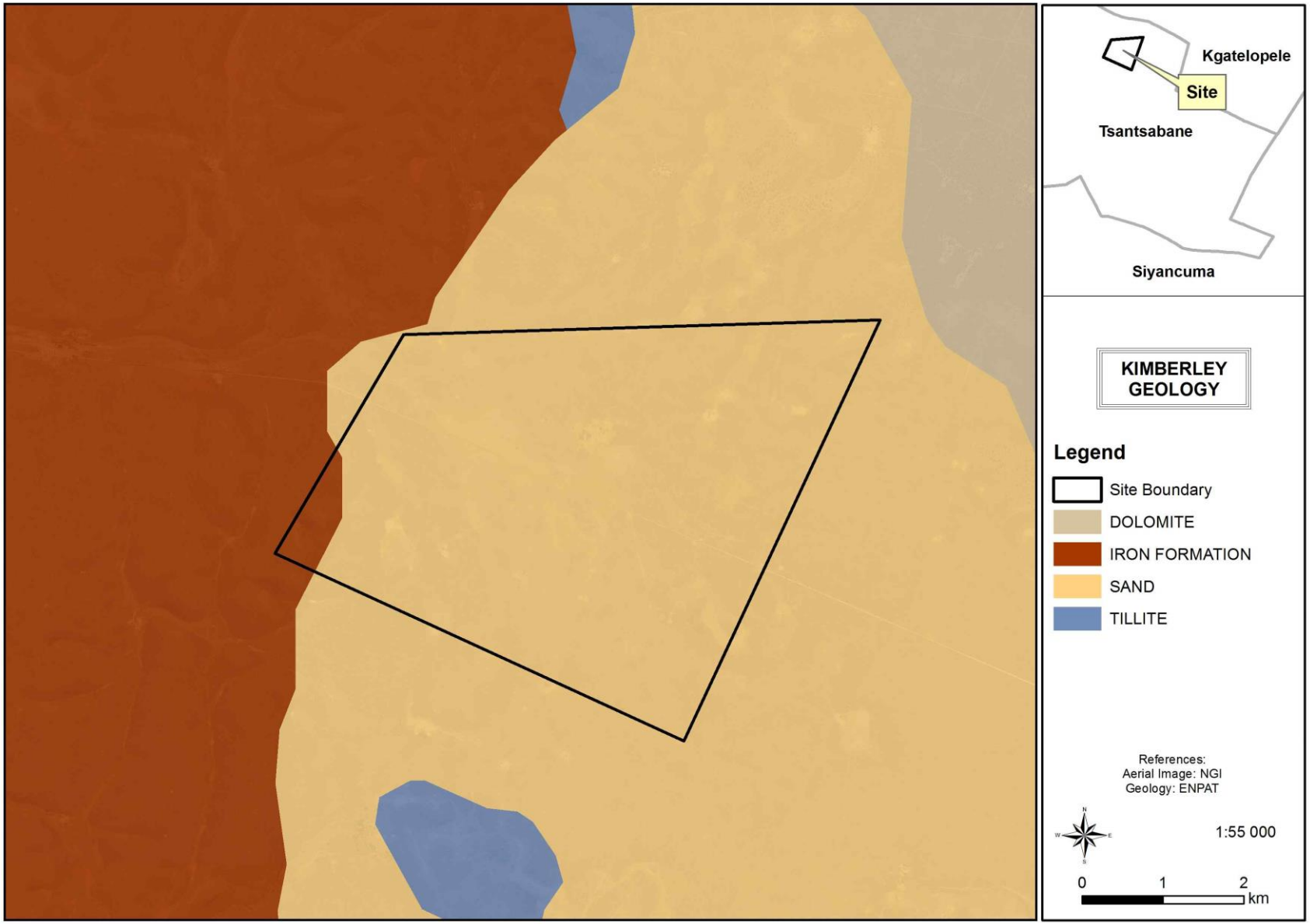
Map 4 – Soil of the Study Site and Surroundings

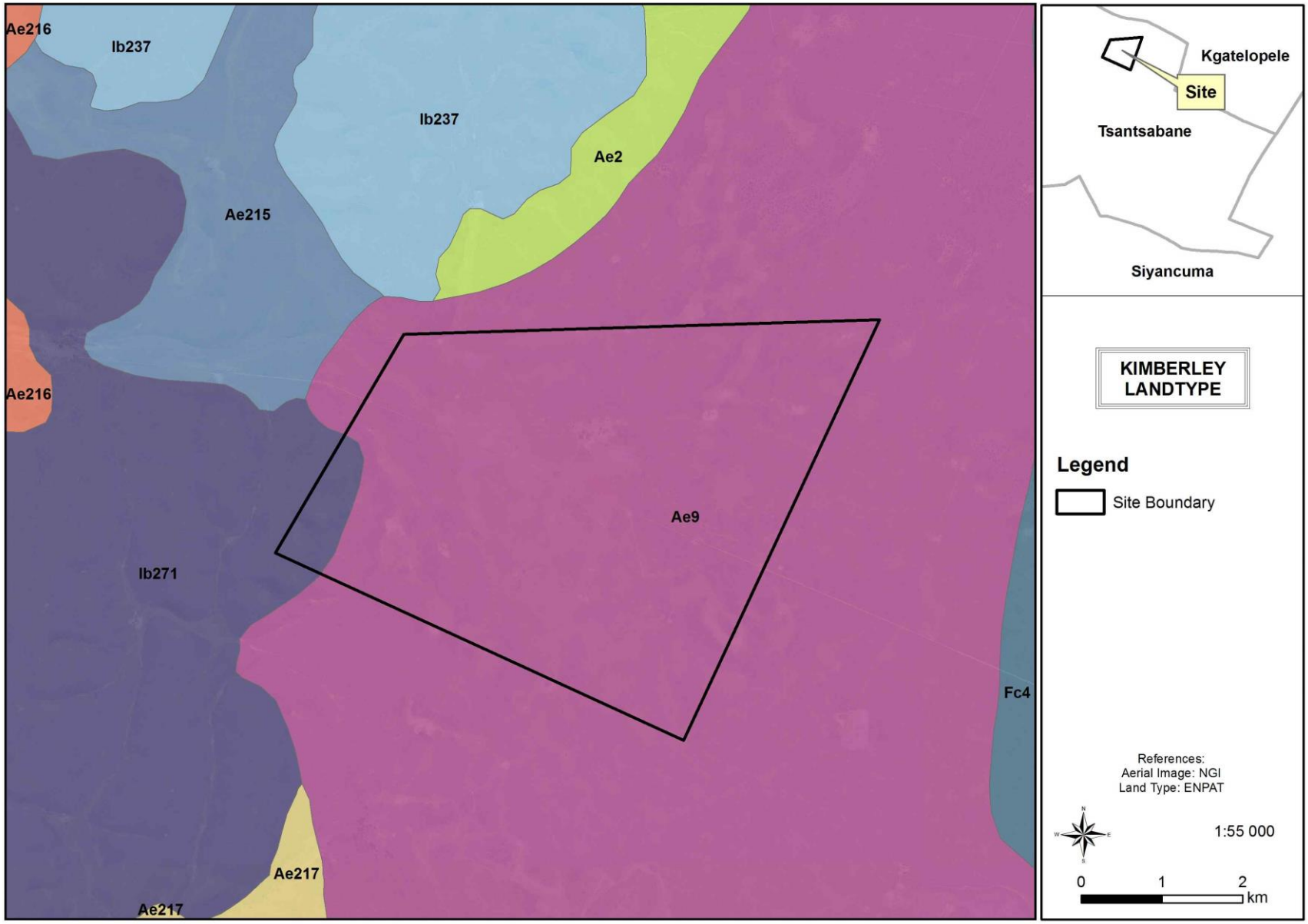
Map 5 – Vegetation types of the study site and surrounds

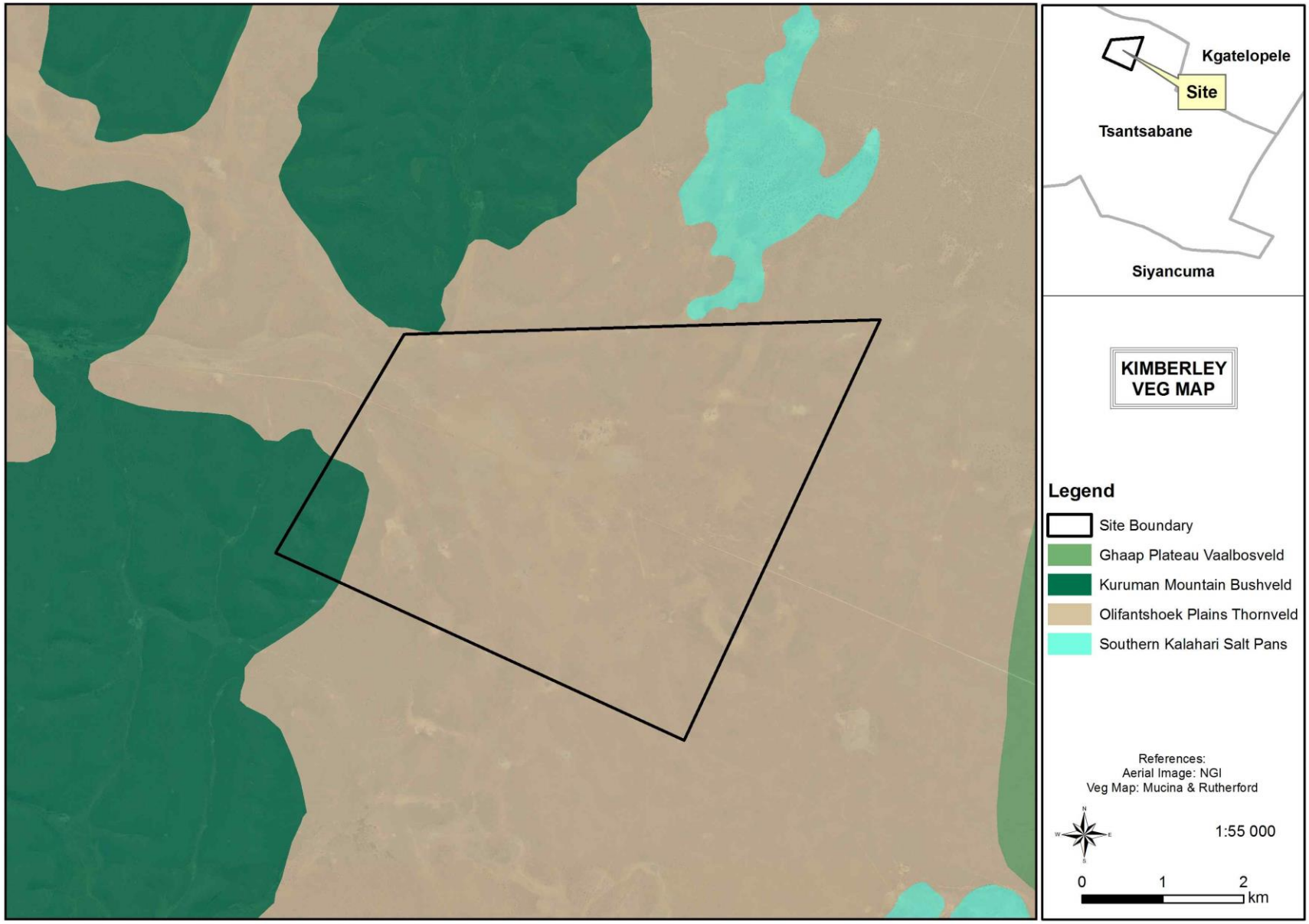
Map 6 – Wetlands and associated buffer zones and protected trees

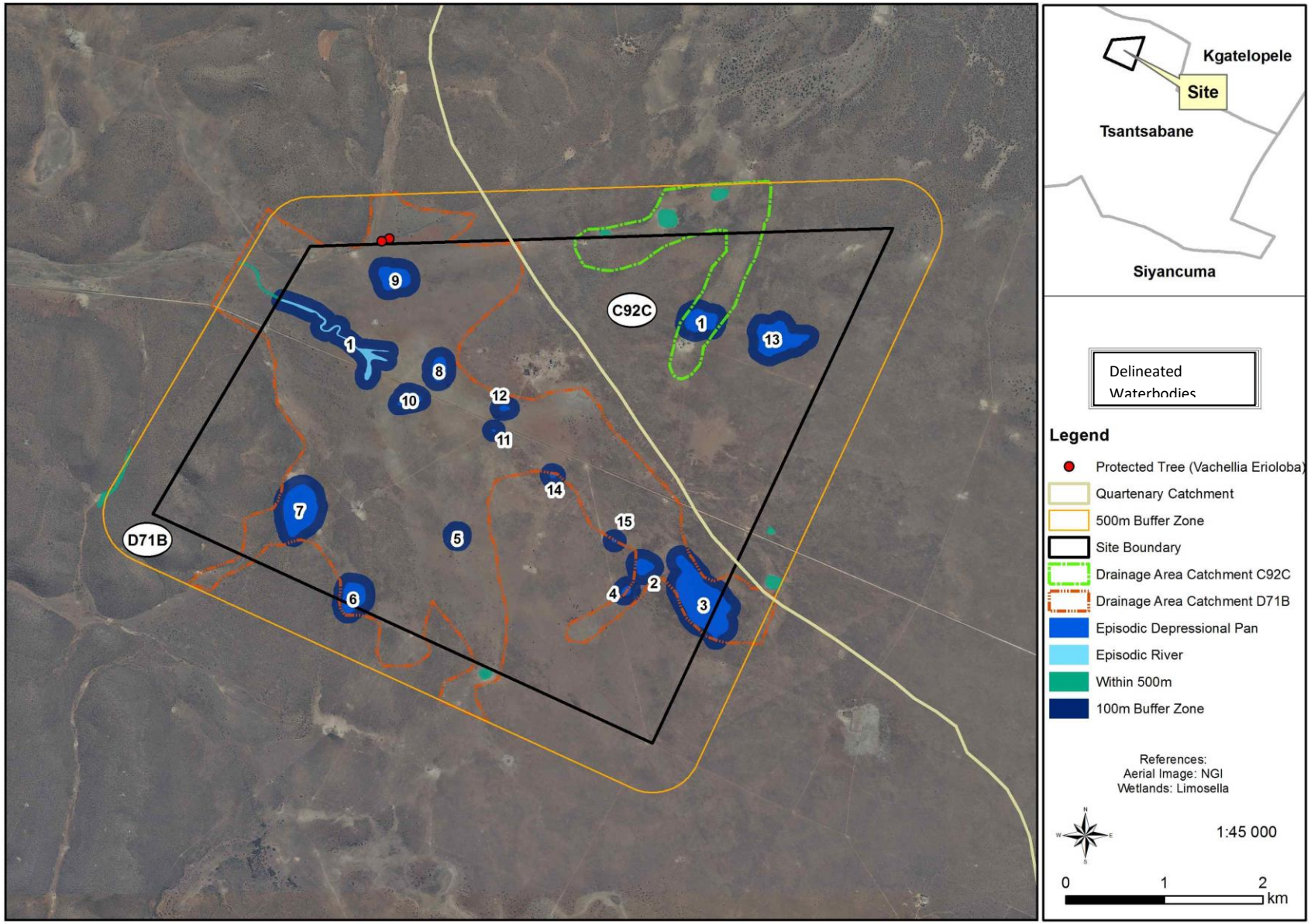

Lime Acres
R385
Kgatelopele
Site
Tsantsabane
Siyancuma
KIMBERLEY
LOCALITY MAP
Legend
Railway Lines
National Route
Arterial Route
Main Road
Site Boundary
1:155 000
0
3.5
7
km


C92C
D71B
Kgatelopele
Site
Tsantsabane
Siyancuma
KIMBERLEY
HYDROLOGY
Legend
Non Perennial River
Perennial River
Site Boundary
Quartenary Catchment
Wetlands
References:
Aerial Image: NGI
Hydrology: NFEPA; NGI
1:55 000
0
1
2
km


Kgatelopele
Site
Tsantsabane
Siyancuma
KIMBERLEY GEOLOGY
Legend
Site Boundary
DOLOMITE
IRON FORMATION
SAND
TILLITE
References:
Aerial Image: NGI
Geology: ENPAT
1:55 000
0
1
2
km


Ae216
Ib237
Ib237
Ae2
Ae215
Ae216
Ae9
Ib271
Fc4
Ae217
Ae217
Kgatelopele
Site
Tsantsabane
Siyancuma
KIMBERLEY LANDTYPE
Legend
Site Boundary
References:
Aerial Image: NGI
Land Type: ENPAT
1:55 000
0
1
2
km


Kgatelopele
Site
Tsantsabane
Siyancuma
KIMBERLEY
VEG MAP
Legend
Site Boundary
Ghaap Plateau Vaalbosveld
Kuruman Mountain Bushveld
Olifantshoek Plains Thornveld
Southern Kalahari Salt Pans
References:
Aerial Image: NGI
Veg Map: Mucina & Rutherford
1:55 000
0
1
2
km


Kgatelopele
Site
Tsantsabane
Siyancuma
C92C
D71B
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Delineated Waterbodies
Legend
Protected Tree (Vachellia Erioloba)
Quartenary Catchment
500m Buffer Zone
Site Boundary
Drainage Area Catchment C92C
Drainage Area Catchment D71B
Episodic Depressional Pan
Episodic River
Within 500m
100m Buffer Zone
References:
Aerial Image: NGI
Wetlands: Limosella
1:45 000
0
1
2
km

Annex B – Specialist CVs

Antoinette Bootsma

Rudi Bezuidenhoudt

Name:	**ANTOINETTE BOOTSMA nee van Wyk**
ID Number	7604250013088
Name of Firm:	Limosella Consulting
Position:	Director - Principal Specialist
SACNASP Status:	Professional Natural Scientist # 400222-09 Botany and Ecology
Nationality:	South African
Marital Status:	Married
Languages:	Afrikaans (mother tongue), English, basic French

EDUCATIONAL QUALIFICATIONS

- B. Sc (Botany & Zoology), University of South Africa (1997 - 2001)
- B. Sc (Hons) Botany, University of Pretoria (2003-2005). Project Title: A phytosociological Assessment of the Wetland Pans of Lake Chrissie
- Short course in wetland delineation, legislation and rehabilitation, University of Pretoria (2007)
- Short course in wetland soils, Terrasoil Science (2009)
- MSc Ecology, University of South Africa (2010 - ongoing). Project Title: Natural mechanisms of erosion prevention and stabilization in a Marakele peatland; implications for conservation management

PUBLICATIONS

- P.L. Grundling, A Lindstrom., M.L. Pretorius, A. Bootsma, N. Job, L. Delport, S. Elshahawi, A.P Grootjans, A. Grundling, S. Mitchell. 2015. Investigation of Peatland Characteristics and Processes as well as Understanding of their Contribution to the South African Wetland Ecological Infrastructure Water Research Comission KSA 2: K5/2346
- A.P. Grootjans, A.J.M Jansen , A, Snijdewind, P.C. de Hullu, H. Joosten, A. Bootsma and P.L. Grundling. (In Press). In search of spring mires in Namibia: the Waterberg area revisited
- Haagner, A.S.H., van Wyk, A.A. & Wassenaar, T.D. 2006. *The biodiversity of herpetofauna of the Richards Bay Minerals leases.* CERU Technical Report 32. University of Pretoria.
- van Wyk, A.A., Wassenaar, T.D. 2006. *The biodiversity of epiphytic plants of the Richards Bay Minerals leases.* CERU Technical Report 33. University of Pretoria.

- Wassenaar, T.D., van Wyk, A.A., Haagner, A.S.H, & van Aarde, R.J.H. 2006. *Report on an Ecological Baseline Survey of Zulti South Lease for Richards Bay Minerals*. CERU Technical Report 29. University of Pretoria

KEY EXPERIENCE

The following projects provide an example of the application of wetland ecology on strategic as well as fine scale as well as its implementation into policies and guidelines. (This is not a complete list of projects completed, rather an extract to illustrate diversity);

- More than 250 fine scale wetland and ecological assessments in Gauteng, Mpumalanga, KwaZulu Natal, Limpopo and the Western Cape. 2007, ongoing.
- Scoping level assessment to inform a proposed railway line between Swaziland and Richards Bay. April 2013.
- Environmental Control Officer. Management of onsite audit of compliance during the construction of a pedestrian bridge in Zola Park, Soweto, Phase 1 and Phase 2. Commenced in 2010, ongoing.
- Fine scale wetland delineation and functional assessments in Lesotho and Kenya. 2008 and 2009;
- Analysis of wetland/riparian conditions potentially affected by 14 powerline rebuilds in Midrand, Gauteng, as well submission of a General Rehabilitation and Monitoring Plan. May 2013.
- Wetland specialist input into the Environmental Management Plan for the upgrade of the Firgrove Substation, Western Cape. April 2013
- An audit of the wetlands in the City of Johannesburg. Specialist studies as well as project management and integration of independent datasets into a final report. Commenced in August 2007
- Input into the wetland component of the Green Star SA rating system. April 2009;
- A strategic assessment of wetlands in Gauteng to inform the GDACE Regional Environmental Management Framework. June 2008.
- As assessment of wetlands in southern Mozambique. This involved a detailed analysis of the vegetation composition and sensitivity associated with wetlands and swamp forest in order to inform the development layout of a proposed resort. May 2008.
- An assessment of three wetlands in the Highlands of Lesotho. This involved a detailed assessment of the value of the study sites in terms of functionality and rehabilitation opportunities. Integration of the specialist reports socio economic, aquatic, terrestrial and wetland ecology studies into a final synthesis. May 2007.

- Ecological studies on a strategic scale to inform an Environmental Management Framework for the Emakazeni Municipality and an Integrated Environmental Management Program for the Emalahleni Municipality. May and June 2007.

Name:	**RUDI BEZUIDENHOUDT**
ID Number	880831 5038 081
Name of Firm:	Limosella Consulting
Position:	Wetland Specialist
SACNASP Status:	Cert. Nat. Sci (Reg. No. 500024/13)
Nationality:	South African
Marital Status:	Single
Languages:	Afrikaans (mother tongue), English

EDUCATIONAL QUALIFICATIONS

- B.Sc. (Botany & Zoology), University of South Africa (2008 - 2012)
- B.Sc. (Hons) Botany, University of South Africa (2013 – Ongoing)
- Introduction to wetlands, Gauteng Wetland Forum (2010)
- Biomimicry and Constructed Wetlands. Golder Associates and Water Research Commission (2011)
- Wetland Rehabilitation Principles, University of the Free State (2012)
- Tools for Wetland Assessment, Rhodes University (2011)
- Wetland Legislation, University of Free-State (2013)
- Understanding Environmental Impact Assessment, WESSA (2011)
- SASS 5, Groundtruth (2012)
- Wetland Operations and Diversity Management Master Class, Secolo Consulting Training Services (2015)
- Tree Identification, Braam van Wyk – University of Pretoria (2015)
- Wetland Buffer Legislation – Eco-Pulse & Water Research Commission (2015)
- Wetland Seminar, ARC-ISCW & IMCG (2011)
- Tropical Coastal Ecosystems, edX (2015 – ongoing)

KEY EXPERIENCE

- **Wetland Specialist**

This entails all aspects of scientific investigation associated with a consultancy that focuses on wetland specialist investigations. This includes the following:

- Approximately 200+ specialist investigations into wetland and riparian conditions on strategic, as well as fine scale levels in Gauteng, Limpopo, North-West Province Mpumalanga KwaZulu Natal, North-West Province, Western Cape, Eastern Cape & Northern Cape
- Ensuring the scientific integrity of wetland reports including peer review and publications.

- **Biodiversity Action Plan**

This entails the gathering of data and compiling of a Biodiversity action plan.

- **Wetland Rehabilitation**

This entailed the management of wetland vegetation and rehabilitation related projects in terms of developing proposals, project management, technical investigation and quality control.

- **Wetland Ecology**

Experience in the delineation and functional assessment of wetlands and riparian areas in order to advise proposed development layouts, project management, report writing and quality control.

- **Environmental Controlling Officer**

Routine inspection of construction sites to ensure compliance with the City's environmental ordinances, the Environmental Management Program and other laws and by-laws associated with development at or near wetland or riparian areas.

- Soweto Zola Park 2011-2013
- Orange Farm Pipeline 2010-2011

- **Wetland Audit**

Audit of Eskom Kusile power station to comply with the Kusile Section 21G Water Use Licence (Department of Water Affairs, Licence No. 04/B20F/BCFGIJ/41, 2011), the amended Water Use Licence (Department of water affairs and forestry, Ref. 27/2/2/B620/101/8, 2009) and the WUL checklist provided by Eskom.

- Kusile Powerstation 2012-2013.

EMPLOYEE EXPERIENCE:

- **GIS Specialist – AfriGIS**

  January 2008 – August 2010

  Tasks include:

- GIS Spatial layering
- Google Earth Street View Mapping
- Data Input

- **Wetland Specialist - Limosella Consulting**

  September 2010 – Ongoing

  Tasks include:

- GIS Spatial layering
- Wetland and Riparian delineation studies, opinions and functional assessments including data collection and analysis
- Correspondence with stakeholders, clients, authorities and specialists
- Presentations to stakeholders, clients and specialists
- Project management
- Planning and executing of fieldwork
- Analysis of data
- GIS spatial representation
- Submission of technical reports containing management recommendations
- General management of the research station and herbarium
- Regular site visits
- Attendance of monthly meetings
- Submission of monthly reports

MEMBERSHIPS IN SOCIETIES

- Botanical Society of South African
- SAWS (South African Wetland Society) Founding member
- SACNASP (Cert. Nat. Sci. Reg. No. 500024/13)