Appendix D6

Kareerand Tailings Storage Facility Expansion Project.

Wetland/Riparian Delineation and Functional Assessment

-Limosella Consulting, 2020

GCS

Water & Environmental Consultants

Kareerand Tailings Storage Facility Expansion Project.

Wetland/Riparian Delineation and Functional Assessment
June 2020

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Declaration of Independence

I, **Antoinette Bootsma**, in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member; and
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement.

Antoinette Bootsma (PrSciNat)
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2020.07.01
Date

Indemnity

This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as information available at the time of study. Therefore the author reserves the right to modify aspects of the report, including the recommendations, if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although the author exercised due care and diligence in rendering services and preparing documents, she accepts no liability, and the client, by receiving this document, indemnifies the author against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the author and by the use of this document.

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EXECUTIVE SUMMARY

Limosella Consulting was appointed by Iggdrasil Scientific Services to undertake a wetland and/or riparian delineation and functional assessment for the proposed Kareerand Mineral Reclamation project, particularly focusing on an area earmarked for expansion. This report does not replace other wetland assessments conducted on the larger study area, but should rather be considered as a supporting document in the authorization process. Furthermore, this report reflects the both the first wet-season study conducted in December 2018 and the follow up study conducted in February 2019.

Fieldwork was conducted on the 10thof December 2018 and the 27th of February 2019.

Our scope of work includes:

- Review and verify the wetland assessments conducted for the Tailings Storage Facility, and in the larger study area.
- Undertake functional and integrity assessment of wetlands areas within the expansion area assessed as specified in National Water Act (NWA) Government Notice R267 (Government Gazette 40713, 24 March 2017);
- Undertake an impact assessment as specified in the NEMA 2014 EIA Regulations, as amended;
- Undertake a risk assessment following the format prescribed in Government Notice 509 published in the (Government Gazette 40229, 26 August 2016) following the 2016 version of the Risk Matrix Tool presented in appendix A of the Risk-Based Water Use Authorisation Approach and Delegation Protocol for Section 21(c) and (i), DWS; and
- Recommend suitable buffer zones as specified in NWA GN R267 (Government Gazette 40713, 24 March 2017), following Macfarlane *et al* 2015.

A review of previous wetland delineations saw only one new wetland and a river area recorded on the study site. The perennial Vaal River only enters a small section of the study site. Other wetlands as delineated in previous reports (De Castro & Brits, 2018) now extend further into the study site compared to the previous smaller study area. These wetlands are labelled as wetland 1 and wetland 9 in the previous report and both are unchanneled valley bottom wetlands. The only new wetland is located in the eastern section of the study site. This wetland is a seepage wetland that drains directly into the Vaal River. In the eastern section several smaller dams and dam like structures can be seen on aerial photography. These features are considered to be artificial and are thus not included in the function and integrity assessment although they perform some biodiversity functions such as creating specialised habitat and breeding areas, as well as providing drinking water for larger animals.

The important factors relevant to the project are summarised in the tables below:

Classification (SANBI, 2013)	PES (Macfarlane *et al*, 2007) & VEGRAI (Kleynhans et al, 2008).	EIS (DWAF, 1999) & QHI (Seaman *et al*, 2010)	WetEcoServices (3 most prominent scores)	Buffer	REC
Seepage Wetland	2.8 C	3.0 (High)	Phosphate trapping - 2.3 Maintenance of biodiversity - 2.3 Sediment trapping - 2.6	100 m	C
Vaal River	70.2 C	66.0 C	N/A		C

<table>
<tr><th rowspan="2"></th><th>Quaternary Catchment and WMA areas</th><th>Important Rivers possibly affected</th><th>Buffers</th></tr>
<tr><td>C24A, C24B and C23L – 5th WMA The Vaal Major</td><td>The wetland drains directly into the Vaal River</td><td>• 100 m</td></tr>
<tr><td>NEMA 2014 Impact Assessment</td><td colspan="3">Impacts before mitigation fall in the Medium to High categories, and impacts after mitigation fall in the Medium to Low categories. Mitigation measures to be implemented include:
• Effective stormwater and sediment management should be implemented during construction and operational phases to ensure that no polluted, sediment laden or high energy water is directed into the watercourses or waterbodies
• Changed overland water flows should be accommodated to ensure that water input from adjacent slopes occurs in a diffuse manner and does not cause scouring or downstream erosion
• Control of alien invasive plants should form part of the maintenance plan
• Corrective action should take into account hydrological analysis of flow energy and water quality where required
• Control of alien invasive plants should form part of the maintenance plan
• A wetland rehabilitation plan with plant species plan should be implemented to ensure that ecological function equal to that of the current habitat is returned
• Corrective action should take into account hydrological analysis of flow energy and water quality where required
• Independent water quality testing should inform the management plan of corrective action required where pollution or sedimentation is recorded</td></tr>
<tr><td>DWS 2016 Risk Assessment</td><td colspan="3">Risks fall in the Medium category. Activities which fall within this category should be authorised through a Water Use Licence. Further to the mitigation measures highlighted for the NEMA impact assessment, a wetland offset strategy should be formulated to address loss of wetland habitat</td></tr>
<tr><td>CBA and other Important areas</td><td colspan="3">• Heavily modified – Majority of the study site
• CBA Optimal, Other natural areas and Moderately modified are all associated with the wetlands on the study site and within 500 m.</td></tr>
<tr><td>Does the specialist support the development?</td><td colspan="3">Storage of mine waste on this site will have significant negative impacts on the environment. However, this is one aspect that should be considered in a larger picture, which includes social and economic development. Therefore we support the proposed development, given that expected impacts are considered and that independent monitoring highlights possible loss of wetland habitat which should be addressed through offsets and rehabilitation to ensure that the hydrological integrity of the catchment is maintained</td></tr>
</table>

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1 INTRODUCTION

Limosella Consulting was appointed by Iggdrasil Scientific Services to undertake a wetland and/or riparian delineation and functional assessment for the proposed Kareerand Tailings Storage Facility Expansion Project near Stilfontein, North West Province. This report reflects both the first wet-season study conducted in December 2018 and the follow up study conducted in February 2019, with a possible dry-season study to be conducted in the winter of 2019. Furthermore, this report is based on previous wetland studies in the area (De Castro & Brits Ecological Consultants, January 2018) as well as on site recordings.

Fieldwork was conducted on the 10thof December 2018 and the 27th of February 2019.

1.1 Terms of Reference

The terms of reference for the study were as follows:

- Review and verify the wetland assessments conducted for the Tailings Storage Facility, and in the larger study area.
- Undertake functional and integrity assessment of wetlands areas within the expansion area assessed as specified in National Water Act (NWA) General Notice R267 (Government Gazette 40713, 24 March 2017);
- Undertake an impact assessment as specified in the NEMA 2014 EIA Regulations, as amended;
- Undertake a risk assessment following the format prescribed in Government Notice 509 published in the (Government Gazette 40229, 26 August 2016),
- Recommend suitable buffer zones as specified in NWA GN R267 (GG 40713, 24 March 2017), following Macfarlane *et al* 2015.

1.2 Project Brief

Mine Waste Solutions (MWS), also known as Chemwes (Pty) Ltd (Chemwes), has been in business since 1964, and conducts its operations over a large area of land to the east of Klerksdorp, within the area of jurisdiction of the City of Matlosana and JB Marks Local Municipalities (LM), which fall within the Dr Kenneth Kaunda District Municipality (DM) in the North-West Province. The MWS/Chemwes Operations are located primarily to the south of the N12, east of the town of Stilfontein. The closest town is Khuma, located about 3km northwest of the facility, and other nearby towns include Stilfontein (10 km from facility) and Klerksdorp (19 km from facility) (GCS pers comm., 2019).

The operations at Mine Waste Solutions entail the collection and reprocessing of mine tailings that were previously deposited on tailings storage facilities (TSFs) in order to extract gold and uranium. High pressure water cannons are used to slurry the tailings on the Source TSFs, then slurry is pumped by a number of pump stations and pipelines to the MWS/Chemwes Processing Plant (indicated in dark green in Figure 1), and the residues from the Processing Plants are pumped to the Kareerand TSF (indicated in yellow in Figure 1). Once an old Source TSF has been completely recovered, it is cleaned-up and rehabilitated. See Figure 1 for an overview of the existing infrastructure used for this process. (GCS pers comm., 2019).

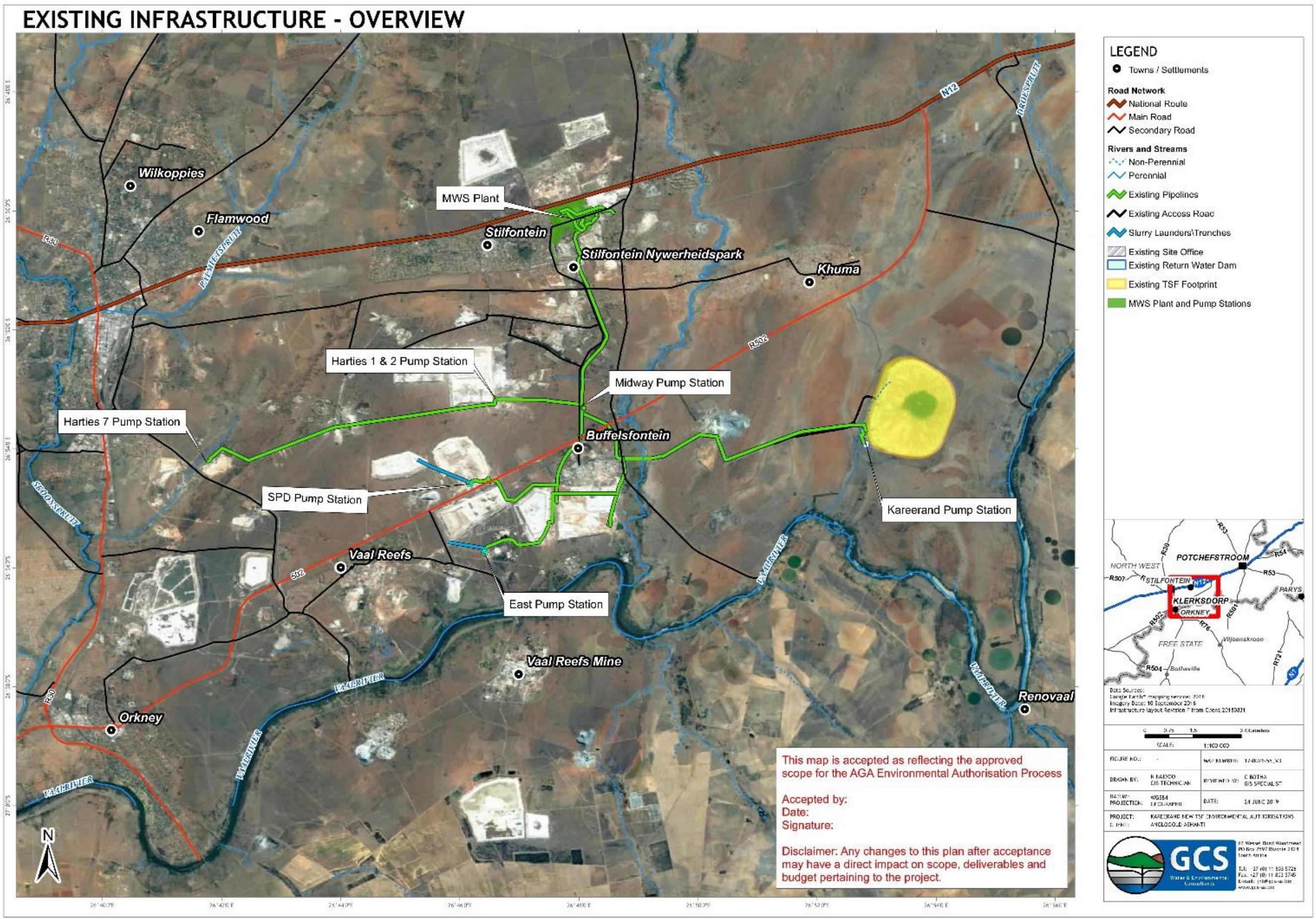


Figure 1: **Existing infrastructure**

The Kareerand TSF was designed with an operating life of 14 years, taking the facility to 2025, and total design capacity of 352 million tonnes. Subsequent to commissioning of the TSF, MWS was acquired by AngloGold Ashanti and tailings production target has increased by an additional 485 million tonnes, which will require operations to continue until 2042. The additional tailings therefore require extension of the design life of the TSF (GCS pers comm., 2019).

This project entails the expansion of the current Kareerand TSF to accommodate the increased tailings and final design capacity, along with additional pump stations and pipelines. The TSF expansion is proposed on the western edge of the current facility, and the final height of the combined facility (both expansion and current) will be 122m. The expansion footprint will add about 362 hectares to the TSF. Figure 2 depicts the site layout of all additional infrastructure across the operational footprint, while Figure 3 depicts the TSF expansion and its associated infrastructure (GCS pers comm., 2019).

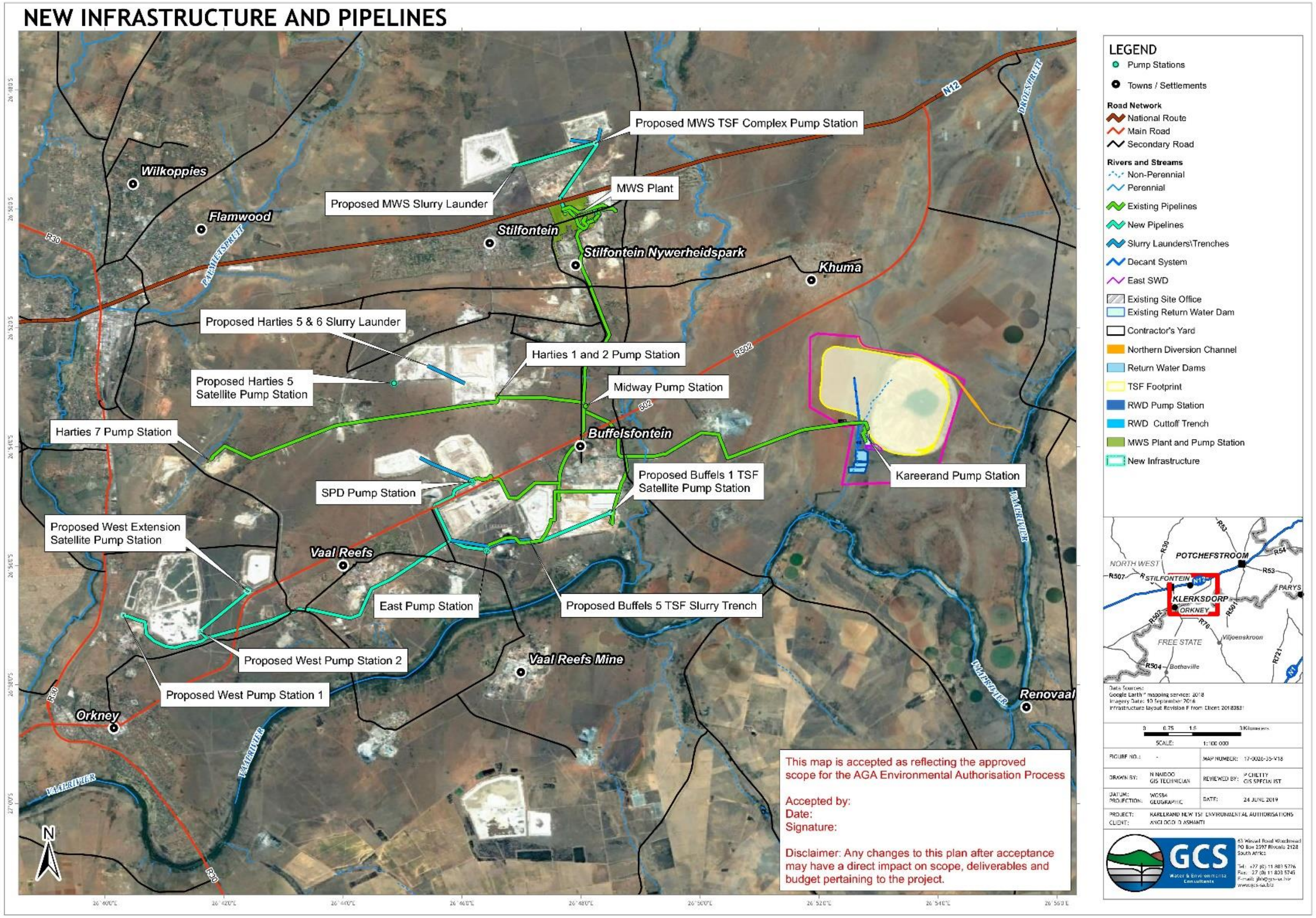


Figure 2: Site layout across operational footprint and TSF expansion footprint. The new infrastructure is noted by the word "proposed", and the new pipelines are indicated in bright blue (as opposed to existing pipelines indicated in green)

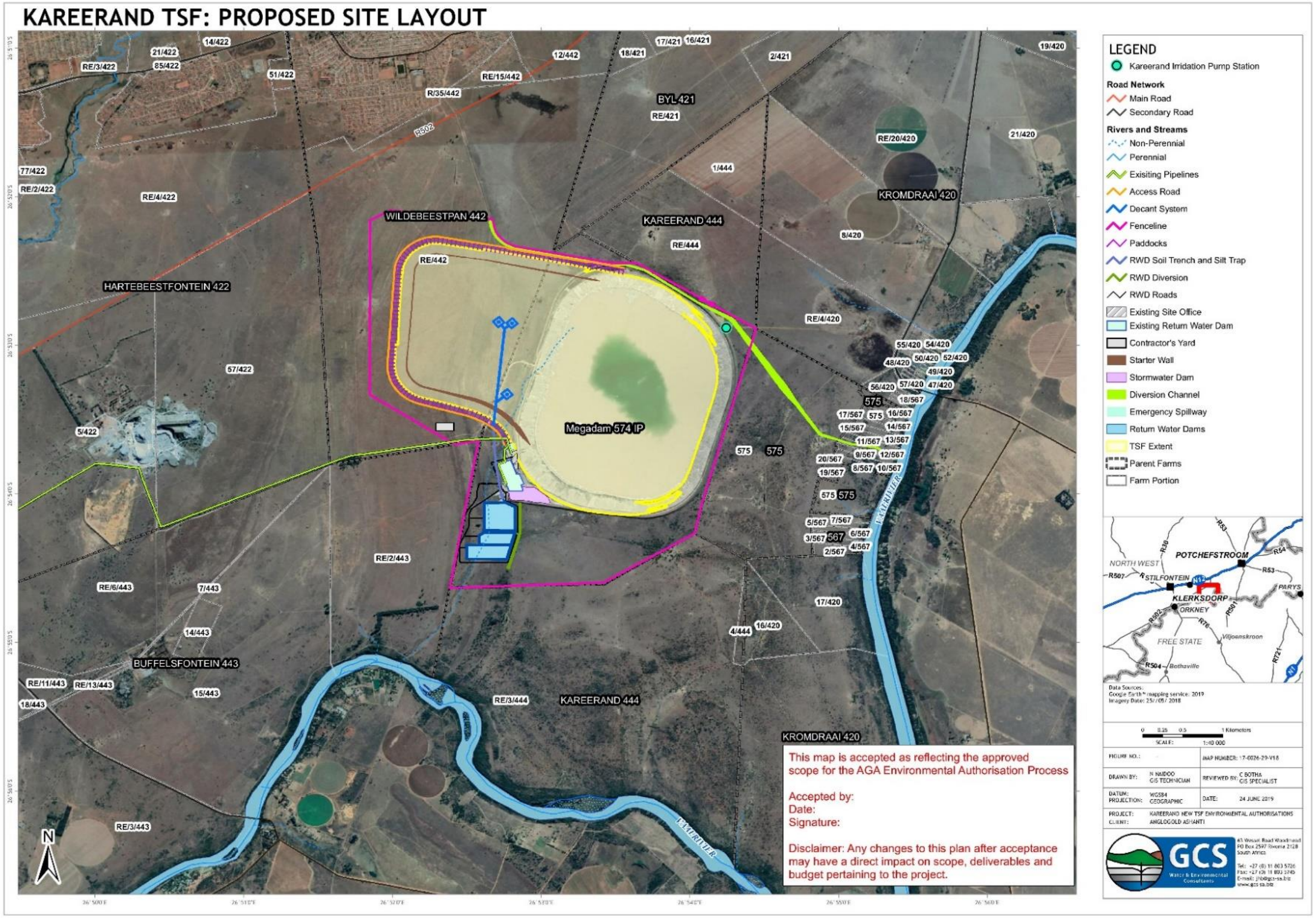


Figure 3: TSF expansion site layout in detail, including associated infrastructure

New Infrastructure

The proposed project will make use of the existing facilities as well as additional supporting infrastructure.

The details of the infrastructure which forms part of the expansion of the TSF are as follows:

- TSF expansion TSF Footprint
  - TSF will be expanded by 362 Ha
- Fences Fenceline
  - 2.4 m high game fence with appropriate signage will be installed around the perimeter of the new TSF (length of new fence = 7 km)
  - This will tie into the existing fence and is the same type of fence
- New main access road and perimeter access road Access Road
  - 8 m wide gravel access road around perimeter of TSF, to the RWDs (return water dams), pump stations (western perimeter of TSF extension) and offices
  - Total combined distance of new roads will be 11 km
  - Access ramps provide access onto tailings dam
  - Access ramps are placed near entry of delivery pipelines and valve stations
- Topsoil bund wall
  - A bund wall will be constructed around the TSF, next to the access road
  - The wall will be 6 m at highest point and 2 m at lowest point, crest width is 8 m
  - The bund wall will also be used as access road on northern side of TSF
- Stormwater diversion channels Diversion Channel RWD Diversion
  - An unlined trench on the northern side of the TSF, 6 km in length, to divert clean storm water running from the north, towards the east in the direction of the Vaal River
    - Trapezoidal in shape with side slopes of 1v:3h and base width varying from 4 m to 9m.
    - Designed to accommodate the 1:100 year storm event
    - Peak flow velocity will be 158 m^3/s during 1:100 year storm events
  - A second unlined trench next to the RWD will divert clean storm water runoff away from the RWD and solution trench and prevent it from mixing with the dirty water
  - Diversion channels will assist to minimise the water quality impact from the TSF
- Delivery pipeline
  - Three steel 500 mm tailings delivery pipes located at the toe of the facility (western edge); 13.5 km in total length
  - Will deliver slurry to the northern, western and southern side of the TSF extension
- Solution trench
  - Trench lined with 100 mm thick mesh reinforced concrete
  - Trench will be trapezoidal with 1v:5h side slopes and bottom width of 1 m

  - Around northern, western and southern side of TSF
  - Will convey decant water and storm water from the side slopes, filter discharge (seepage water) from the outer drains and surface runoff from the side slopes to the RWD.
- Seepage and dirty water collector sump
  - Constructed on northern side of TSF
  - Will collect seepage water and dirty storm water running off the TSF walls from solution trench before it is pumped back to the north-western corner
- Catchment paddocks Paddocks
  - Constructed around perimeter of facility at final outer wall toe location
  - Constructed using material from solution trench excavations and paddock basins; will be nominally compacted
  - Paddocks will be 50 m long and 20 m wide
  - Walls will be 1 m high with a crest width of 1 m and side slopes of 1v:1.5h
  - Designed to contain run-off from a 1:50 year storm event
- Starter wall Starter Wall
  - The starter wall will contain tailings deposition during early development of TSF
  - 18 m in height at lowest point, crest width of 5 m and side slopes of 1v:2h downstream and 1v:5h upstream
  - Constructed using clay-based material from basin or other construction areas (parameters: percentage passing 0.075 mm sieve= 65-85%; clay content= 10-25%; PI= 12- 20; dispersity range= non-dispersive)
- Drainage system
  - Under drainage system located within TSF footprint, consisting of toe, intermediate and central drains and drain outlets
  - Filter drain system consisting of a trench lined with Geofabric, which prevents the ingress of fine clay / sand particles into drain, thus preventing clogging
  - Drain comprises
    - Slotted pipe, which runs for a length between the outlet pipes
    - Layer of 19 mm stone, overlain by a layer of 6 mm stone, surrounds pipes
    - Layer of graded filter sand and layer of coarse tailings placed over the stone drain
  - Drain outlets constructed at approximately 50-100m intervals to collect seepage water from filter drains and convey it to solution trench
  - The existing drain outlets will connect to a collector drain system then discharge into the solution trench on the southern flank where the two facilities connect.
- Decant system

  - Gravity pipe decant system to ensure water does not accumulate on top of TSF
  - Includes permanent double intake structure and intermediate intake structures
  - Permanent intake structure consists of two penstock intakes at ground level
    - Reinforced concrete intakes (2) and stacked pre-cast concrete penstock rings (to raise structure) will cater for decanting of supernatant water up to but not exceeding 20 m
    - Above 20 m, this system will be replaced with a siphon system
    - From the permanent intake structure the supernatant water will gravitate via a concrete spigot and socket penstock outlet pipeline to the new RWDs
  - Intermediate penstock intake structures positioned at different elevations along the penstock outlet pipeline
    - Ensure effective decanting of supernatant water during the development phase of TSF
    - Minimise delay in water returned to the reclamation sites
  - Intermediate intake structures will be constructed with a reinforced concrete base and a single intake tower raised with standard pre-cast penstock rings. These structures will be sealed as the TSF rises and pool moves to final intake structure position.
- Catwalk
  - Timber catwalk and floating walkway structure for access from pool wall to penstock intermediate and permanent intake structures respectively
  - Catwalk height will be raised when necessary and the floating walkway will increase with the dam pool level
  - Catwalk constructed from timber supports spaced at 2.5 m centres and three (3) 230 x 76 mm gum pole planks (4.8 m standard lengths) will be used for the walkway.
  - Floating walkway constructed from Jet floats with 4.5 mm thick aluminium chequer decking plate
- Energy dissipater
  - Concrete energy dissipater box where penstock outlet pipe daylights
  - Should reduce velocity of water from penstock before it flows into silt trap
- Silt trap RWD Soil Trench and Silt Trap
  - Concrete-lined silt trap with twin compartments between penstock outlet and RWD
  - Sluice gates at inlets and outlets; outlet trench to RWD also to be constructed
  - Designed to settle grain of size 0.006 mm and specific gravity of 2.7; average settling time for this particle will be 12 minutes
  - Should reduce volume of suspended solids flowing into RWD
- Storm water dam Stormwater Dam
  - Storm water dam will be located between TSF and RWDs and will contain dirty water running off the TSF
  - Capacity will be 155 000 m^3 and will cover 6.6 Ha

Return Water Dams

- RWD and related infrastructure
  - New RWDs with a combined capacity of 837 000 m³ (area of 30 Ha), south of the TSF and existing RWD complex
  - RWD will have three compartments (one for operation, the other two for dirty water containment)
  - Will be lined with double HDPE liner system and leakage-detection material (Hi-drain); double liner will consist of 2 mm geomembrane and 1.5 HDPE geomembrane
  - Sump structure will be constructed downstream of RWD for decanting via pump station
  - RWD will be 7 m at highest point (this will require a Dam Safety application), with crest of 3 m and side slopes of 1v:3h downstream and upstream
- Contractors yard Contractor's Yard
  - Contractor's yard will be located on the south western side of the TSF extent on the right of the access road travelling south.
  - Contractor's yard will include the following infrastructure: site office, workshop, fuel storage facilities, wash bays, change houses, septic tanks.
- RWD emergency spillway Emergency Spillway
  - Trapezoidal with 1:1.5 side slopes
  - Will cater for 1:100 year storm event
  - 1000 mm freeboard before wall crest is overtopped
- Pump Stations
  - Three main pump stations: one at the MWS complex, two at the outlying western TSFs
  - Three satellite pump stations: one at the Harties TSFs (probably at a later stage), one at the outlying western TSFs and one at the Buffels TSFs
- Process water pipelines New Pipelines
  - Extended from the existing SPD and East Complex pump stations to the western outlying TSFs
  - Connecting MWS TSFs and MWS plant
- Slurry pipelines New Pipelines
  - Extended from the existing SPD and East Complex pump stations to the western outlying TSFs
  - Connecting MWS TSFs and MWS plant
- Slurry launders Slurry Launders\Trenches
  - Connecting the Buffels TSF to the East Complex pump station
  - Connecting Harties TSFs with the Harties 1 & 2 pump station
  - Connecting MWS TSFs to the proposed MWS pump station

The additional infrastructure required across the operational footprint will include new pump stations, new satellite pump stations, slurry launders and connecting slurry and process water pipelines. As indicated in in the figures above, in the centre of operations, existing infrastructure (pump stations and main slurry and process water pipelines) will be utilised to process adjacent resources. Buffels 5 TSF will be connected to the East Complex Pump Station via a new slurry trench and Buffels 1 TSF will be pumped via a satellite pump station to the Buffels 5 TSF slurry trench feed. At the Harties 1 & 2 Pump Station, located centre to north of Harties 5 & 6 TSF will be directed via a slurry launder to the pump station and may require, at a later date, a satellite pump station to aid in reclamation of tailings that cannot be gravity fed. In the west, three new pump stations (West Pump Station 1, West Pump Station 2 and a satellite pump station) will be constructed, with main slurry and process water pipelines extended from the existing SPD and East Complex Pump Stations in the east to the west, allowing for the use of the SPD and East Complex Pump Stations as booster pump stations. In the north, the MWS 4 & 5 TSF's will be reclaimed and directed to a new pump station via slurry launders. New process water and slurry piping will be installed between the MWS 4 & 5 Pump Station and the MWS plant. In total, three new main pump stations and three new satellite pump stations will be built.

1.3 Assumptions and Limitations

- The information provided by the client forms the basis of the planning and layouts discussed.
- All wetlands within 500 m of any developmental activities should be identified as per the DWS authorization regulations. In order to meet the timeframes and budget constraints for the project, wetlands within the study sites were delineated on a fine scale based on detailed soil and vegetation sampling. Wetlands that fall outside of the site, but that fall within 500 m of the proposed activities were delineated based on desktop analysis of vegetation gradients visible from aerial imagery.
- The detailed field study was conducted from on once-off field trip and thus would not depict any seasonal variation in the wetland plant species composition and richness.
- Description of the depth of the regional water table and geohydrological and hydropedological processes falls outside the scope of the current assessment
- Floodline calculations fall outside the scope of the current assessment.
- A Red Data scan, fauna and flora, and aquatic assessments were not included in the current study
- Species composition described for landscape units aimed at depicting characteristic species and did not include a survey for cryptic or rare species.
- The recreation grade GPS used for wetland and riparian delineations is accurate to within five meters.
- Wetland delineation plotted digitally may be offset by at least five meters to either side. Furthermore, it is important to note that, during the course of 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.
- The calculation of buffer zones does not take into account climate change or future changes to watercourses resulting from increasing catchment transformation.

- Although the study was conducted in the summer, it occurred during a drought in the region and consequently the wetland systems were very dry.
- Sections of the study site were recently burnt and heavily grazed. Vegetation identifications in these areas, thus have a low confidence score.
- **Previously inaccessible areas were visited during the February 2019 site visit.**

1.4 Definitions and Legal Framework

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

The National Water Act, 1998 (Act 36 of 1998) [NWA] 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 Department of Water and Sanitation (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 (DWA, 2005).

Riparian habitat often performs important ecological and hydrological functions, some similar to those performed by wetlands (DWA, 2005). Riparian habitat is also the accepted indicator used to delineate the extent of a river's footprint (DWAF, 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 certain activities related to a watercourse:
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 Government Notice 509 regarding General Authorisation (GA) for water uses as defined in Section 21(c) and (i). This notice grants General Authorisation (GA) for the above water uses on certain conditions. This regulation also stipulates that water uses must be 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 is excluded from a GA under these regulations, unless the impacts score as low in the required risk assessment matrix (DWS, 2016) Activities that do not score low require a Water Use Licence (WUL) from the relevant authority.

Conditions for impeding or diverting the flow of water or altering the bed, banks, course or characteristics of a watercourse (Section 21(c) and (i) activities) include:
9. (3) (b). The water user must ensure that the selection of a site for establishing any impeding or diverting the flow or altering the bed, banks, course or characteristics of a watercourse works:
(i) is not located on a bend in the watercourse;
(ii) avoid high gradient areas, unstable slopes, actively eroding banks, interflow zones, springs, and seeps.

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 South African Wetlands Conservation Programme (SAWCP).
- National Environmental Management Act, 1998 (Act 107 of 1998) [NEMA].
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).
- National Environment Management Protected Areas Act, 2003 (Act 57 of 2003).
- EIA Regulations GN R.982, R.983, R. 984 and R.985 of 2014 (as amended) 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.
- Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002).
- GN R267 (Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals)

1.5 Locality of the study site

The study site is located between Potchefstroom and Klerksdorp, directly south of Khuma. The study site is bordered in the north by the regional road, the R502. Sections of its eastern and southern boundaries are bordered by the Vaal River. The study site comprises 4201 hectares. The approximate central coordinates are 26°53'35.12"S and 26°52'56.24"E (Figure 4).

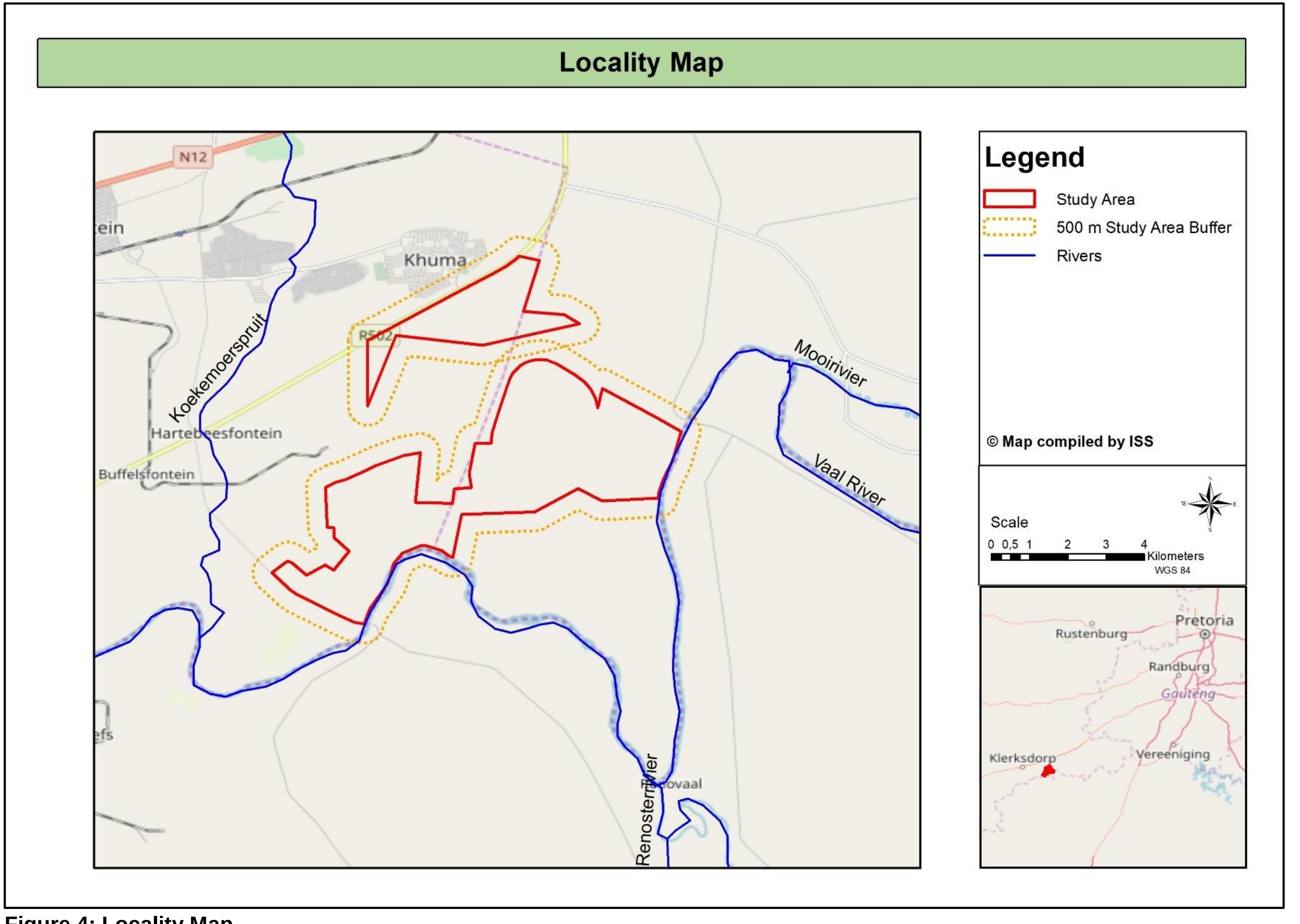


Figure 4: Locality Map

1.6 Description of the Receiving Environment

A review of available literature and spatial data formed the basis of a characterisation of the biophysical environment in its theoretically undisturbed state and consequently an analysis of the degree of impact to the ecology of the study site in its current state.

Quaternary Catchments and Water Management Area (WMA):

As per Macfarlane et al, (2009) one of the most important aspects of climate affecting a wetland's vulnerability to altered water inputs is the ratio of Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) (i.e. the average rainfall compared to the water lost due to the evapotranspiration that would potentially take place if sufficient water was available). The majority of the site is situated in Quaternary Catchment C24B with small sections in the west located in catchment C24A as well as a small area in the east located in catchment C23L. In these catchments, the precipitation rate is lower than the evaporation rate with Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) ratios of 0.24 (C24A), 0.22 (C24B) and 0.25 (C23L). Consequently, watercourses in this area are sensitive to changes in regional hydrology, particularly where their catchment becomes transformed and the water available to sustain them becomes redirected.

Nine Water Management Areas (WMA) were established by, and their boundaries defined in NWA GN 1056 (GG 40279, 16 September 2016). The Quaternary Catchments C23L, C24A and C24B fall within the fifth WMA, the Vaal Major WMA. The major rivers that are located within this WMA include the Wilge-, Liebenbergsvlei-, Mooi-, Renoster-, Vals-, Sand-, Vet-, Harts-, Molopo and Vaal Rivers.

All the watercourses flow directly or indirectly into the Vaal River. This river of strategic importance is the third largest river in South Africa after the Orange River (2200 km long) and the Limpopo River (1750 km long) and was established as the main source of water for the greater Witswatersrand area after the gold rush during the 19th Century (http://www.randwater.co.za).

Hydrology:

Surface water spatial layers such as the National Freshwater Ecosystems Priority Areas (NFEPA) Wetland Types for South Africa (SANBI, 2010) were consulted for the presence of wetlands and rivers. A number of small non-perennial streams and one small pan are located within the study site with the large Vaal River located just south and east of the study site (Figure 5).

Regional Vegetation:

According to the Vegetation Map of South Africa, Lesotho and Swaziland *sensu* Mucina & Rutherford (2006), the majority of the study site is located on an area classified as Rand Highveld Grassland with a small section in the east located on Vaal Reefs Dolomite Sinkhole Woodland (Table 1).

Table 1: Conservation status of the vegetation associated with the study site (Mucina & Rutherford, 2006)

Name of Vegetation type (Mucina & Rutherford, 2006)	Rand Highveld Grassland	Vaal Reefs Dolomite Sinkhole Woodland
Relation to Study Site	Majority of the study site	Eastern section
Code as used in the Book	Gm 11	Gh 12
Conservation Target (percent of area)	24%	24%
Description of conservation status	Endangered	Vulnerable
Name of the biome	Grassland	Grassland
Threats and uses	Almost half has been transformed mostly by cultivation, plantations, urbanisation or dam-building. Scattered aliens (most prominently *Acacia mearnsii*) occur in about 7% of this unit	Almost a quarter has been transformed already—mainly by mining, cultivation, urban sprawl and road-building. The region of this unit contains possibly the highest concentration of mines of any other vegetation in South Africa.

Geology and soils:

The geology of the site is Vaalian Erathem in the east, Pretoria Group, Transvaal Supergroup in the middle and southern areas and Malmani Subgroup, Chunniespoort Group in the far western areas (Figure 7). The soil of the study site is regionally classified as Fa13 and Bc25 (Figure 8).

- Fa13: Soils: Glenrosa and/or Mispah forms (other soils may occur), lime rare or absent in the entire landscape; geology: Dolomite and chert belonging to the Chuniespoort Group; chert gravels are abundant on middleslopes, footslopes and valley bottoms. Glenroasa soil form is described as a potential seasonal to temporary wetland soil. This soil form is characterised by a surface horizon which is maintained by biological activity and underlying rock or saprolite. Saprolite refers to a horizon of weathering rock which still has distinct affinities with the parent rock.

- Bc25: Soils: Plinthic catena: eutrophic; red soils widespread, upland duplex and margalitic soils rare; geology: Diabase and Hekpoort lava predominantly. Shale, slate and quartzite of the Pretoria Group. Ecca shale and sandstone in the south. Quartzite usually forms crests and scarps. Footslopes usually on diabase, lava, shale and slate.

North West Conservation Plan

Critical Biodiversity Areas (CBA's) are terrestrial and aquatic features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services (SANBI 2007). These form the key output of a systematic conservation assessment and are the biodiversity sector's inputs into multi-sectoral planning and decision making. CBA's are therefore 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 (Desmet *et al*, 2009).

In addition, the assessment also made provision for Ecological Support Areas (ESA's), which 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, flood mitigation or carbon sequestration. The degree of restriction on land use and resource use in these areas may be lower than that recommended for CBA's (Desmet *et al*, 2009).

The biodiversity map indicates where Critical Biodiversity Areas (CBA's) occur. CBA's are Terrestrial (T) and Aquatic (A) features in the landscape that are critical for retaining biodiversity and supporting continued ecosystem functioning and services (SANBI 2007). The CBA's are ranked as follows:

- CBA 1 (including protected areas (PA), terrestrial (T1) and aquatic (A1) areas) which are natural landscapes with no disturbances and which are irreplaceable in terms of reaching conservation targets within the district
- CBA2 (including terrestrial (T2) and aquatic (A2)) which are near natural landscapes with limited disturbances which have intermediate irreplaceability with regards to reaching conservation targets
- In addition, Ecological Support Areas (ESA's) that support key biodiversity resources (e.g. water) or ecological processes (e.g. movement corridors) in the landscape are also mapped. ESA's are functional landscapes that are moderately disturbed but maintain basic functionality and connect CBA's.

The spatial priorities are accompanied by a set of land-use guidelines with the purpose of promoting the effective management of biodiversity as required in Section 41(a) of the National Environmental Management: Biodiversity Act (Act 10 of 2004, as amended) and in terms of the National Environmental Management Act (Act 107 of 1998, as amended). The guidelines provide advice on which land-uses and activities are most compatible with maintaining the ecological integrity of CBAs and ESAs, and other parts of the landscape, based on the desired management objectives for the land and the anticipated impact of each land-use activity on biodiversity patterns and ecological processes (MPSP, 2015).

Based on the described methods the study site is located within the following terrestrial section classified as (Figure 9):

- CBA 2 Majority of the site.
- ESA1 Northern and southern sections of the study site.
- ESA2 Small scattered areas.

It is also located within some aquatic section classified as (Figure 10):

- CBA 1 Majority of the study site.
- CBA 2 Very small sections in the west.

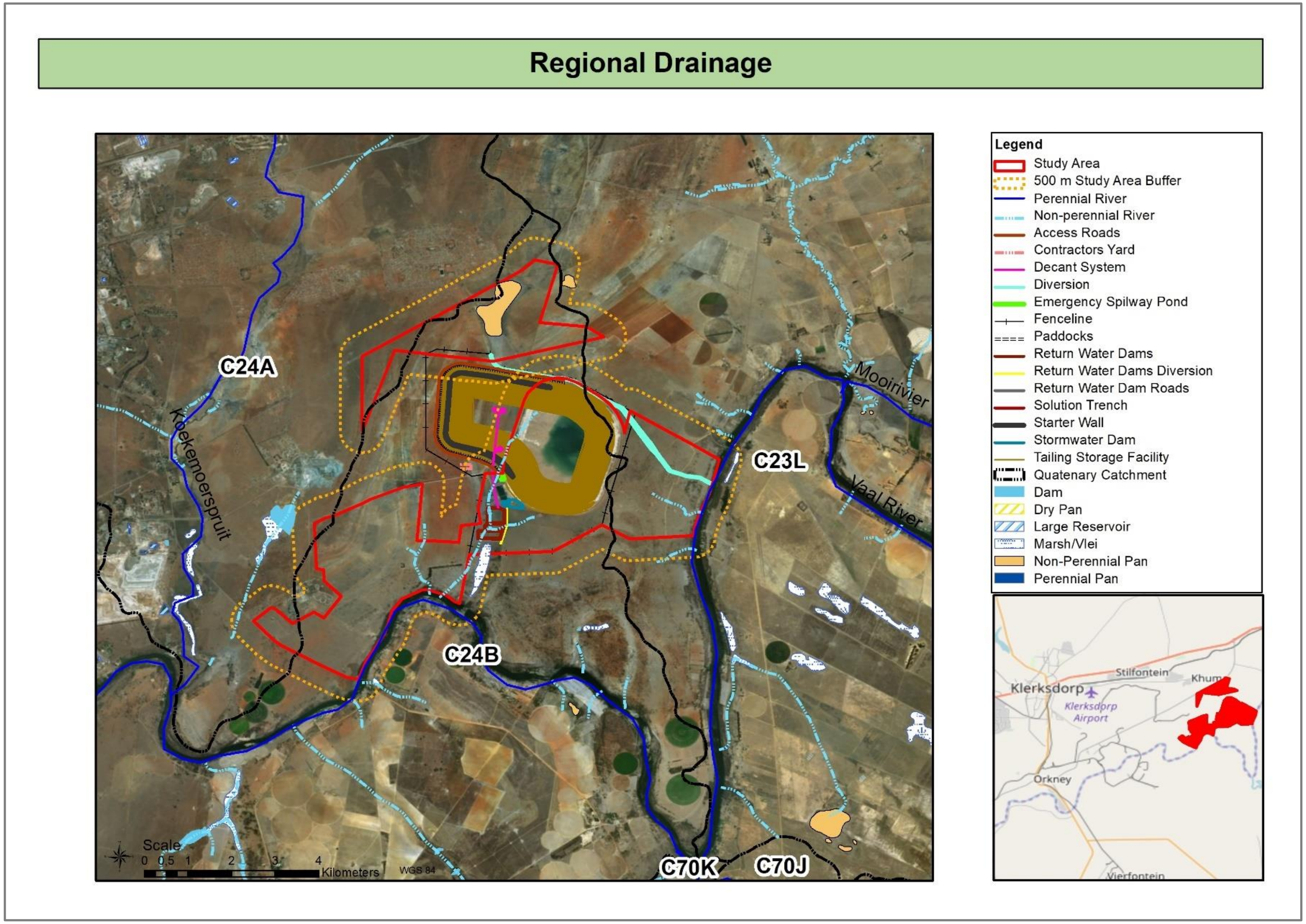


Figure 5: Regional hydrology

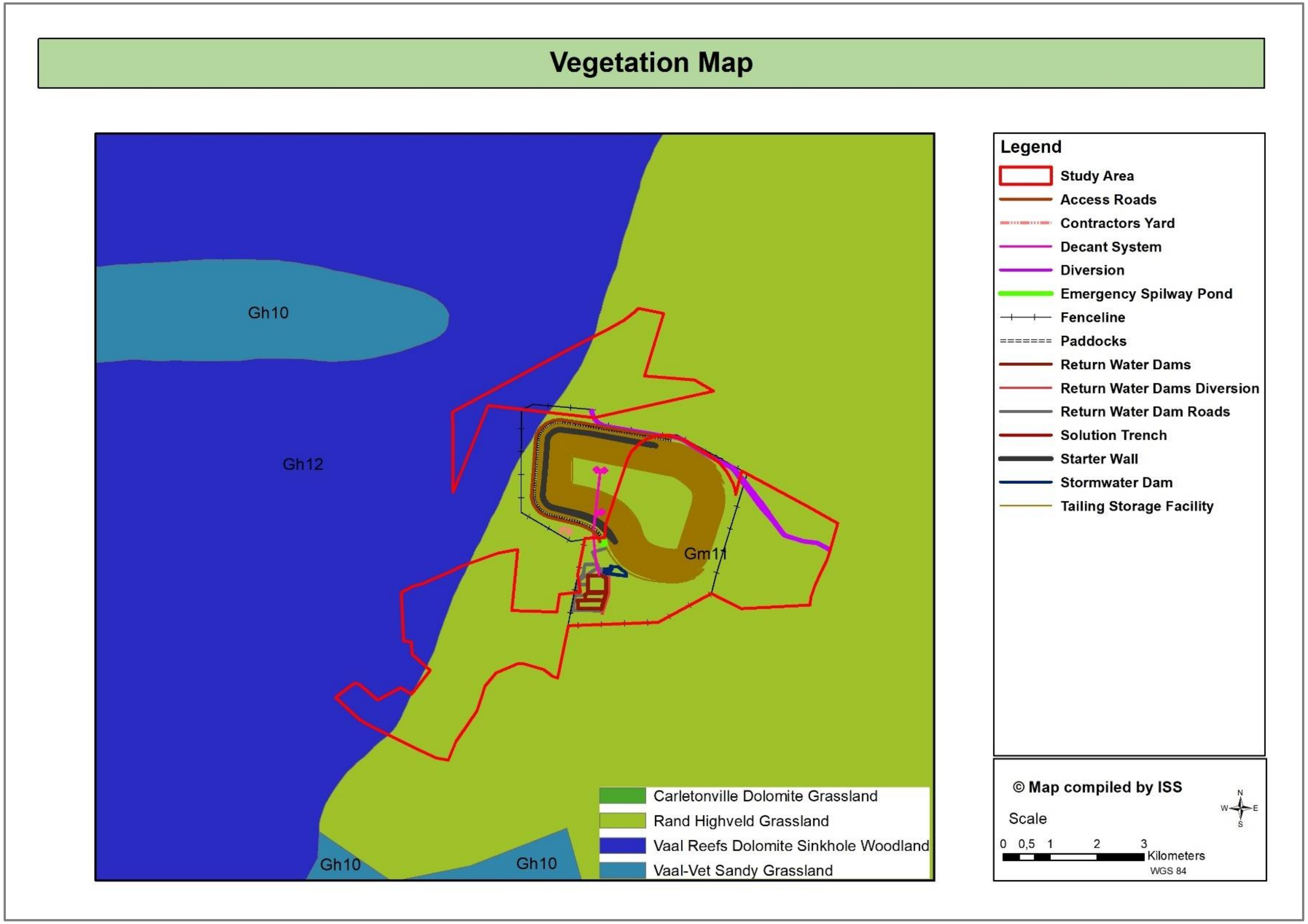


Figure 6: Vegetation of the study site.

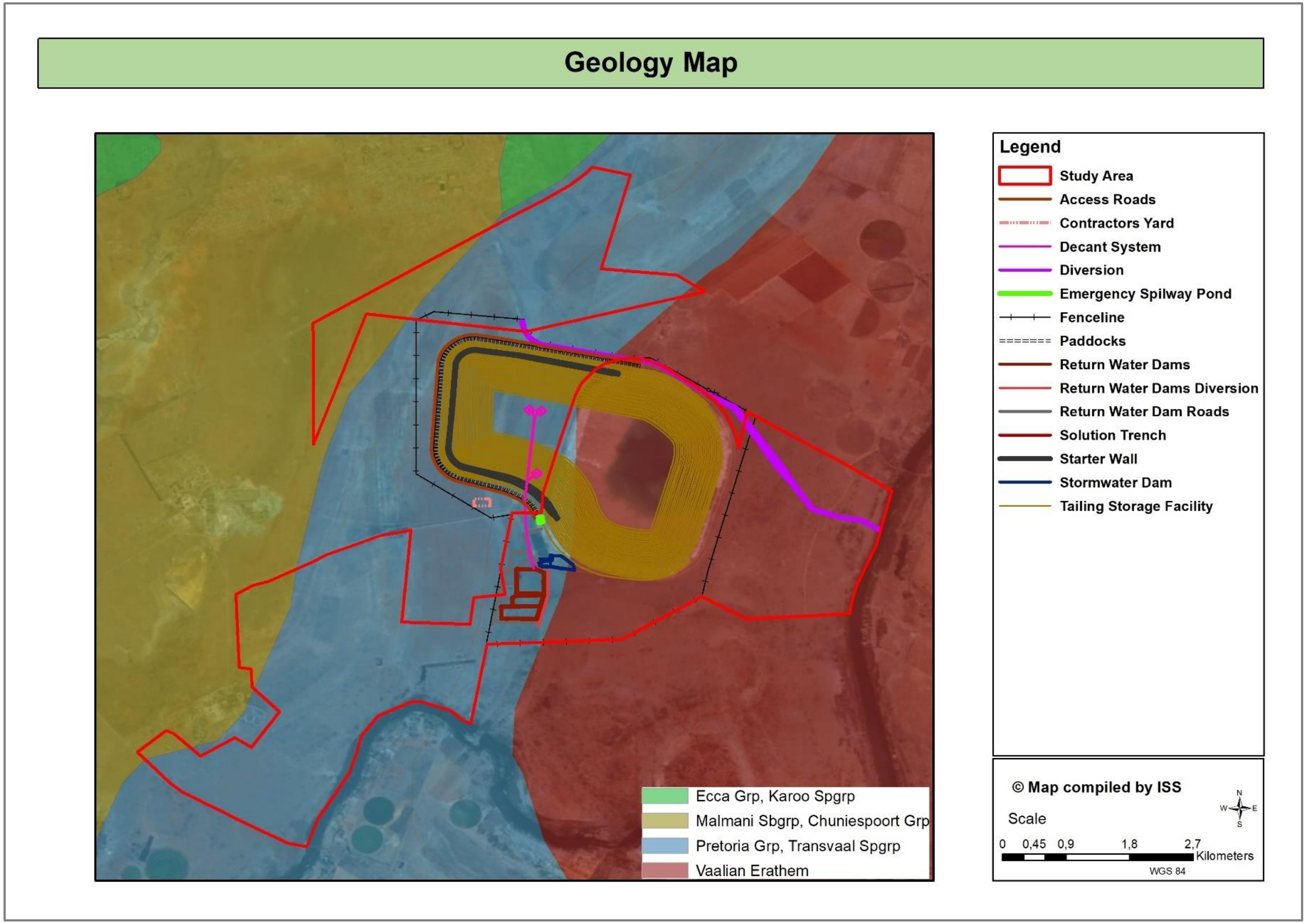


Figure 7: Regional geology of the area (ENPAT).

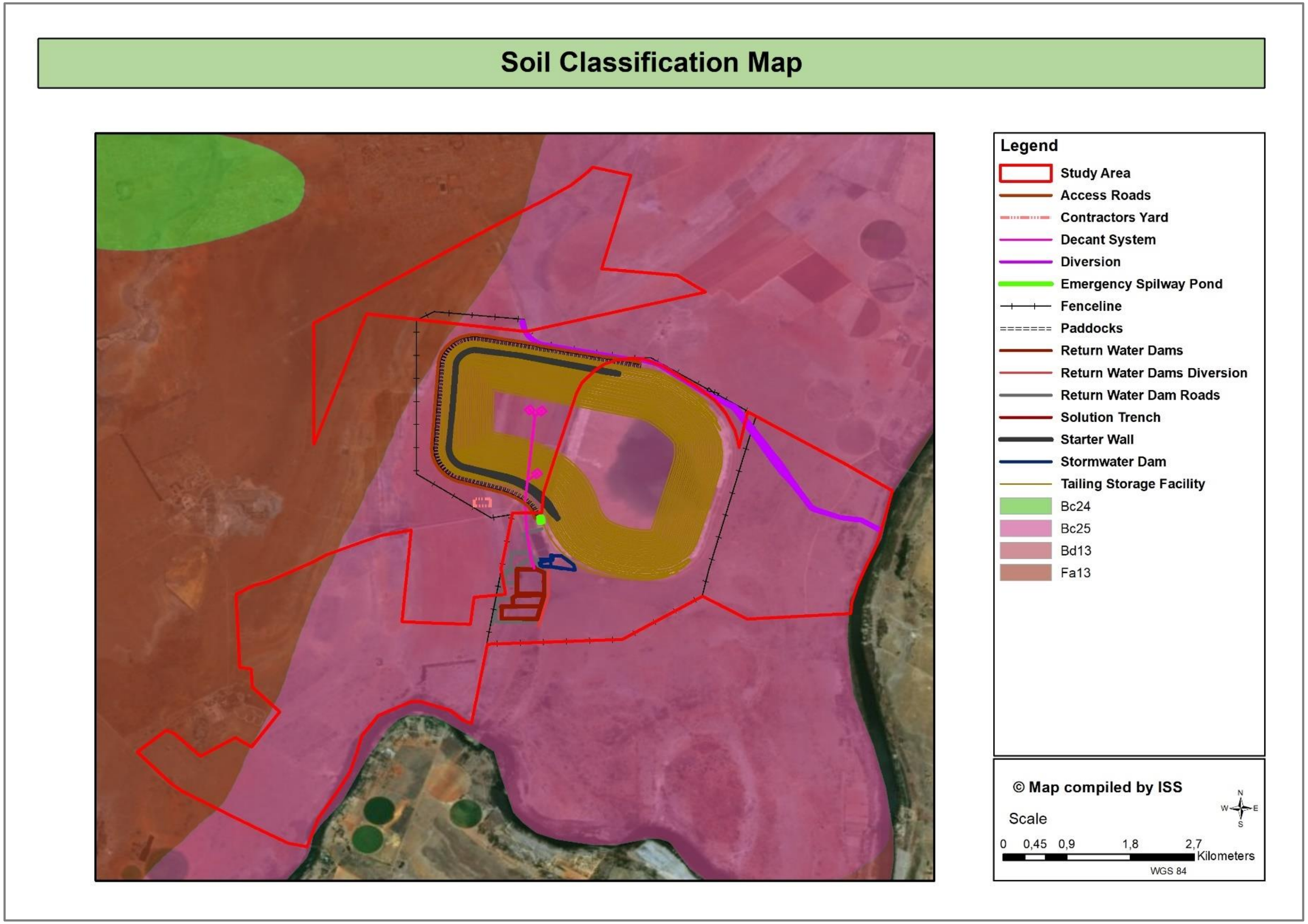


Figure 8: Regional soil of the area.

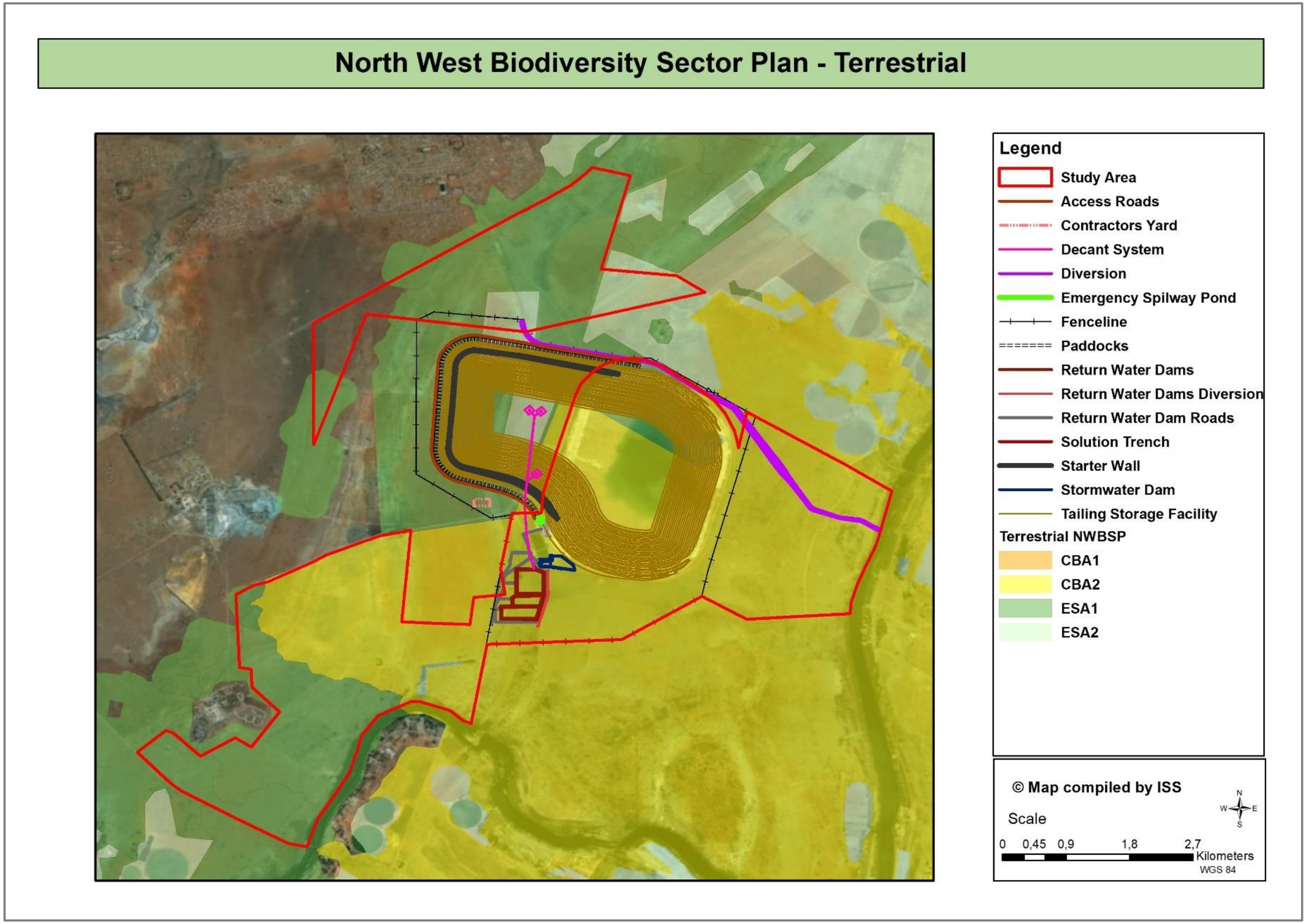


Figure 9: North West Terrestrial Conservation Areas associated with the study site.

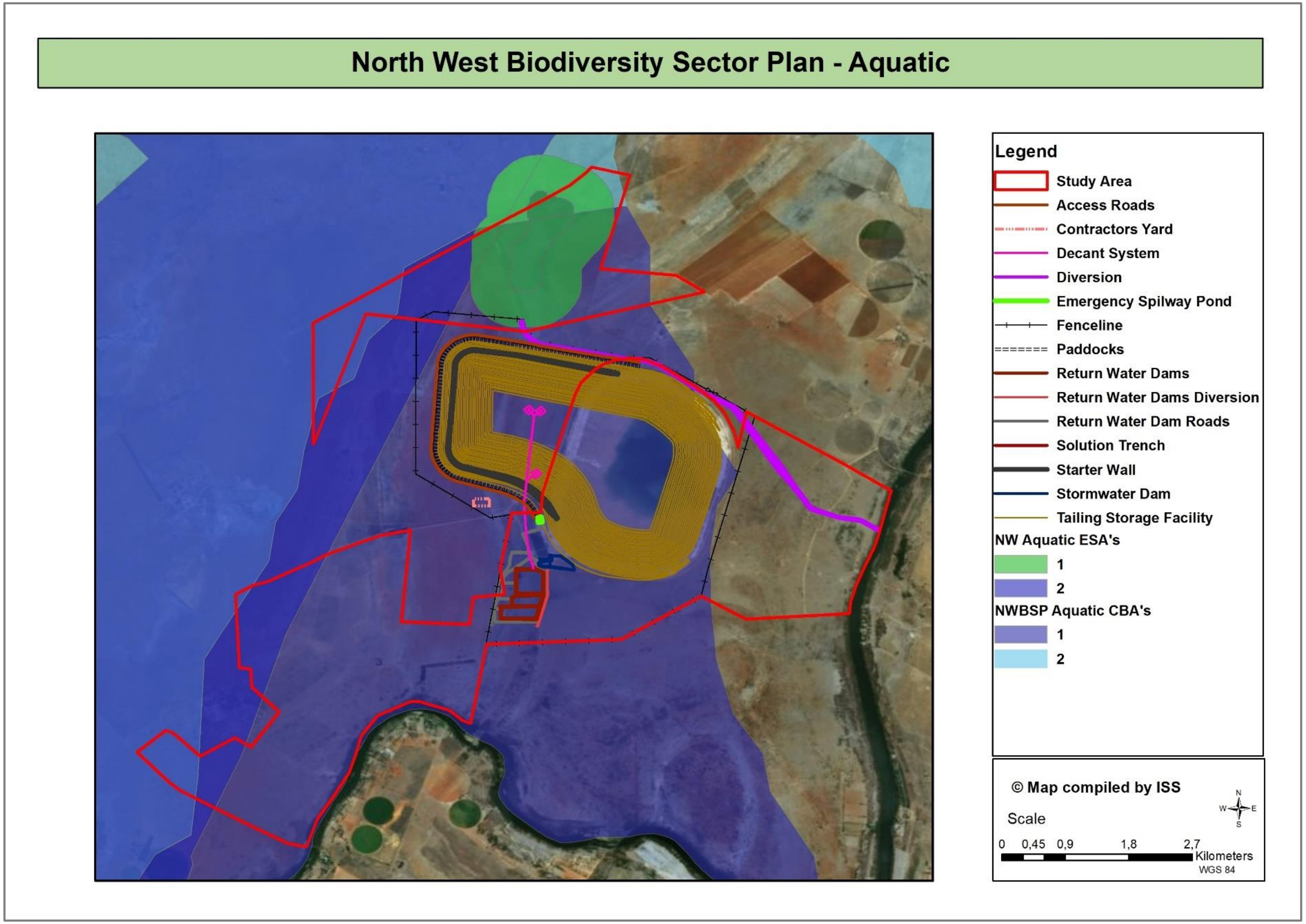


Figure 10:North West Aquatic Conservation Areas associated with the study site.

2 METHODOLOGY

The delineation method documented by the Department of Water and Sanitation in their document "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008), and the Minimum Requirements for Biodiversity Assessments (GDACE, 2009) as well as "Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems" (Ollis *et al,* 2013) was followed throughout the field survey. These guidelines describe 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 handheld Garmin Montana 650 was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and available GIS data were used as reference material for the mapping of the preliminary watercourse boundaries. These were converted to digital image backdrops and delineation lines and boundaries were imposed accordingly after the field survey.

2.1 Wetland and Riparian Delineation

Wetlands are delineated based on scientifically sound methods, and utilizing a tool from the Department of Water and Sanitation 'A practical field procedure for identification and delineation of wetlands and riparian areas' (DWAF, 2005) as well as the "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008). The delineation of the watercourses presented in this report is based on both desktop delineation and groundtruthing.

Desktop Delineation

A desktop assessment was conducted with wetland and riparian units potentially affected by the proposed activities identified using a range of tools, including:

- 1: 50 000 topographical maps;
- S A Water Resources; and
- 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.

Ground Truthing

Wetlands were identified based on one or more of the following characteristic attributes (DWAF, 2005) (Figures 11 & Figure 12):

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

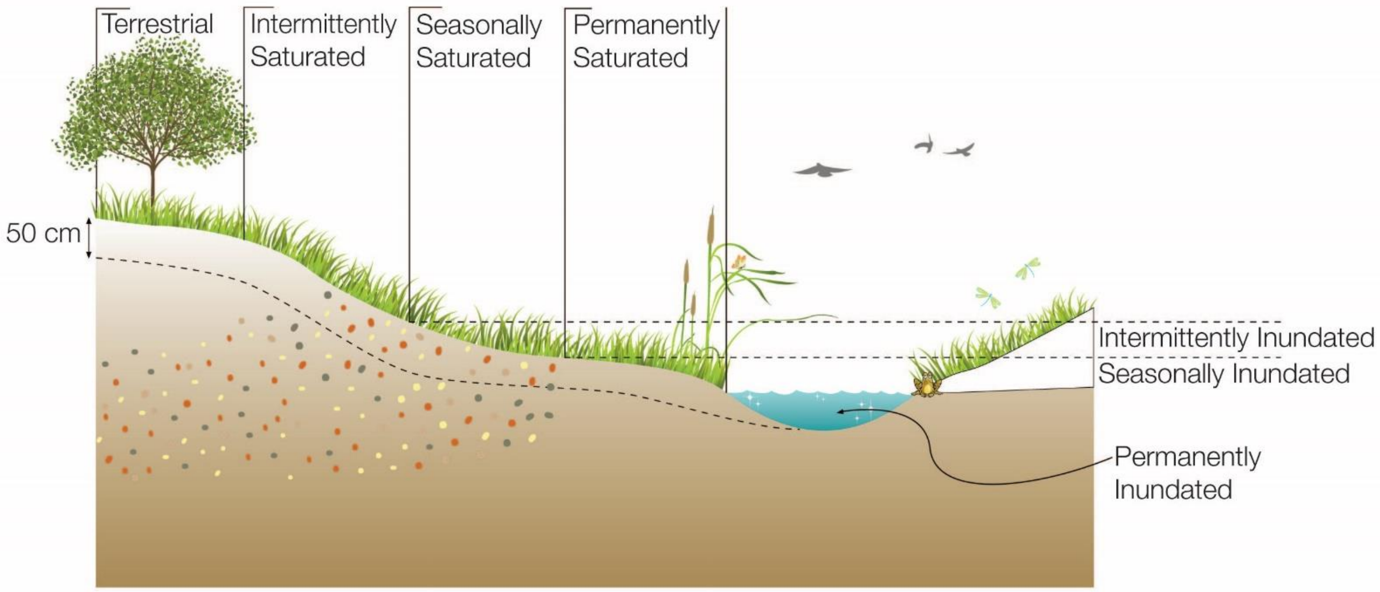


Figure 11: Typical cross section of a wetland (Ollis, 2013)

<u>The Terrain Unit Indicator</u>

The terrain unit indicator (Figure 9) 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. 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 13).

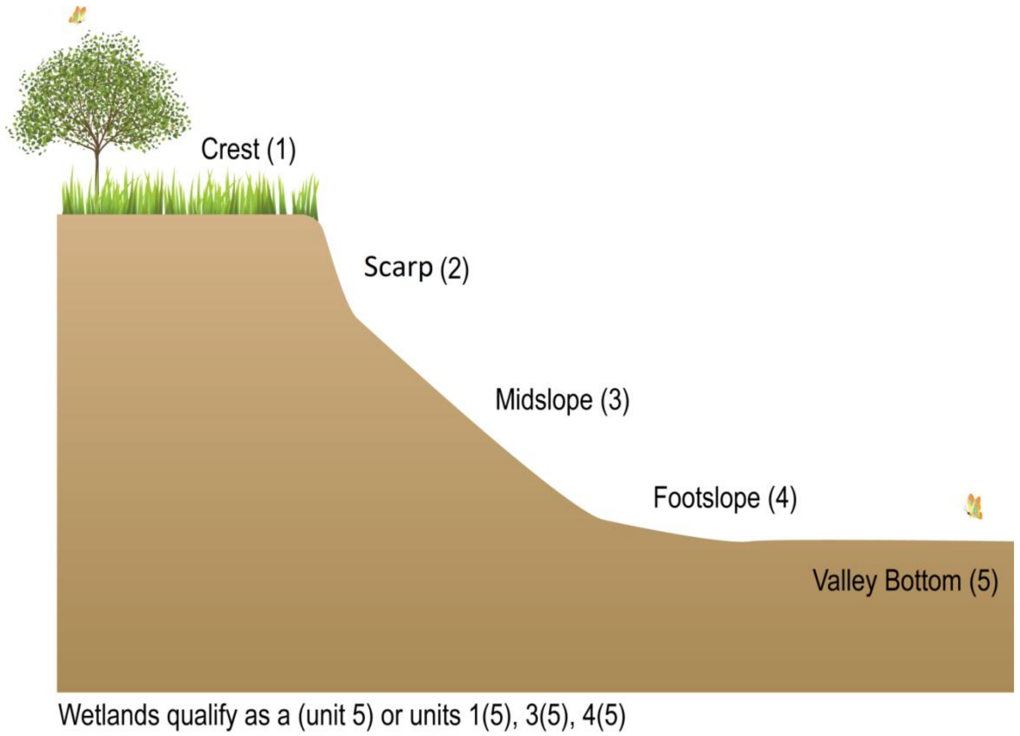


Figure 12. Terrain units (DWAF, 2005).

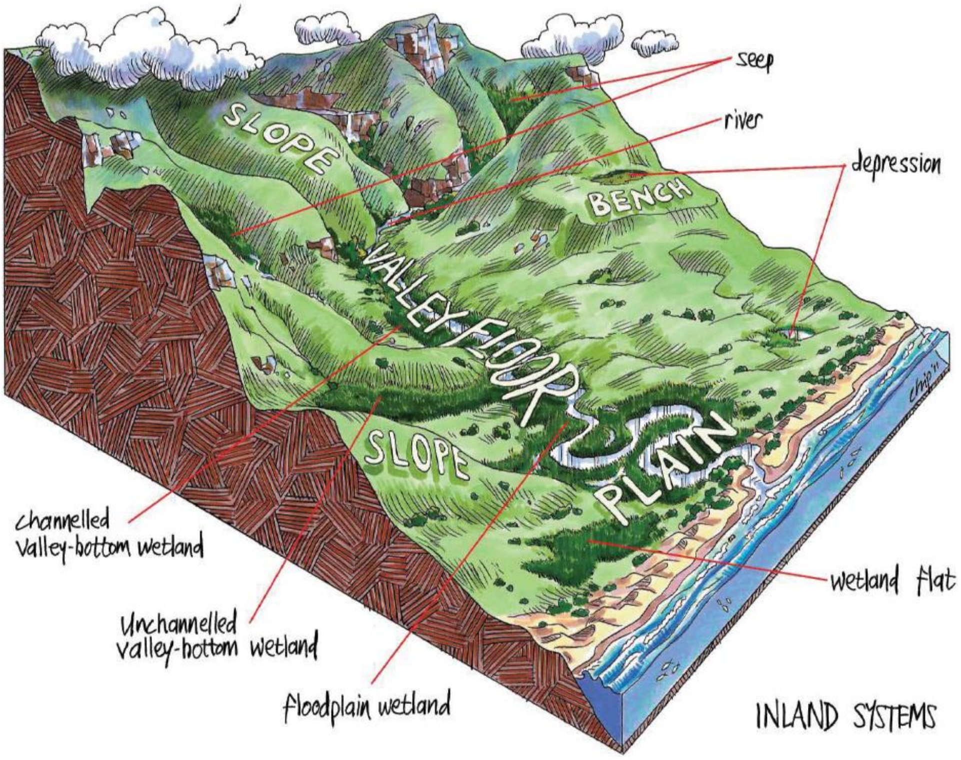


Figure 13: Wetland Units based on hydrogeomorphic types (Ollis *et al.* 2013)

Difficult to Delineate Wet Areas

Table 2 summarises the types of difficult wetland/ wetland-like areas and the best approach to take in such circumstances.

Table 2: List of types of sites that are difficult to delineate. (Job, 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	• Thoroughly document soil and landscape conditions, develop rationale for considering the area to be a wetland.

Type of "difficult site"	Approach
(e.g. annual vegetation or seasonal saturation)	• 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.

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 (DWAF, 2008). The marginal zone includes the area from the water level at low flow, to those features that are hydrologically activated for the greater part of the Year (WRC Report No TT 333/08 April, 2008). The non-marginal zone is the combination of the upper and lower zones (Figure 14).

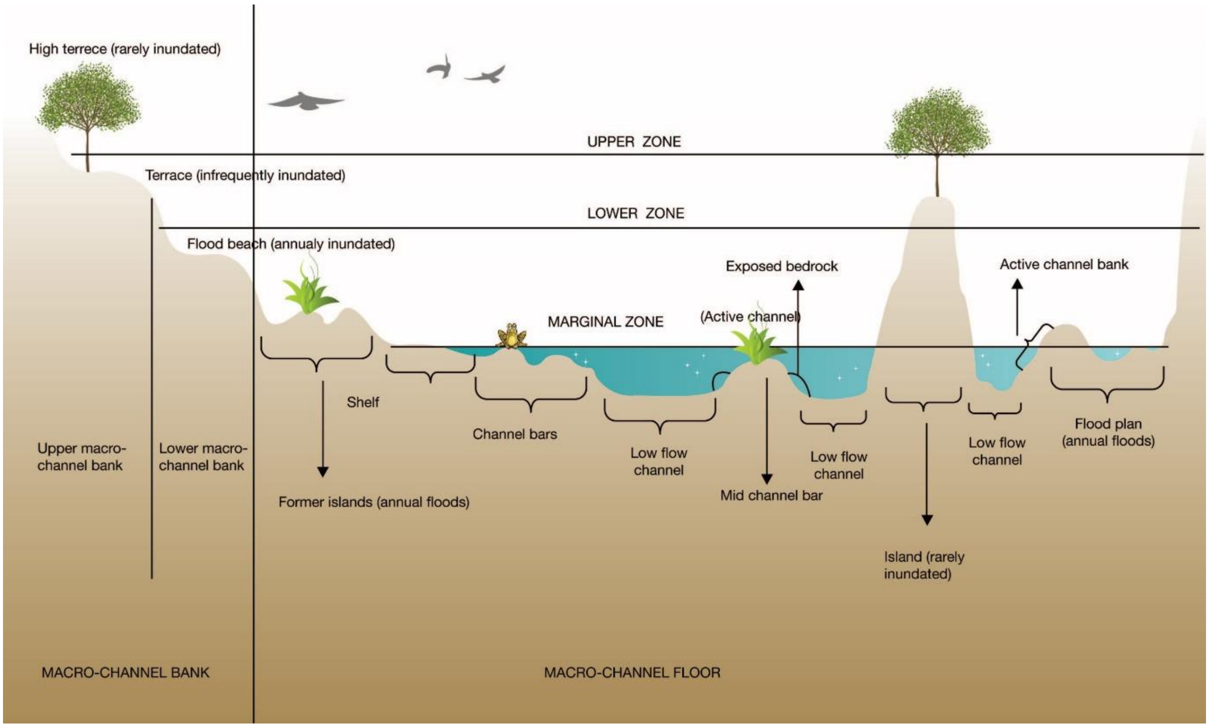


Figure 14: Schematic diagram illustrating an example of where the three zones would be placed relative to geomorphic diversity (Kleynhans *et al*, 2007)

The vegetation of riparian areas is divided into three zones, the marginal zone, lower non-marginal zone and the upper non-marginal zone (Table 3). The different zones have different vegetation growth.

Table 3: 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 hydrologically activated (inundated or moistened) on an ephemeral basis. Presence of riparian and terrestrial species Terrestrial species with increased stature

<u>Riparian Area:</u>

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 15) (Kotze, 1999).

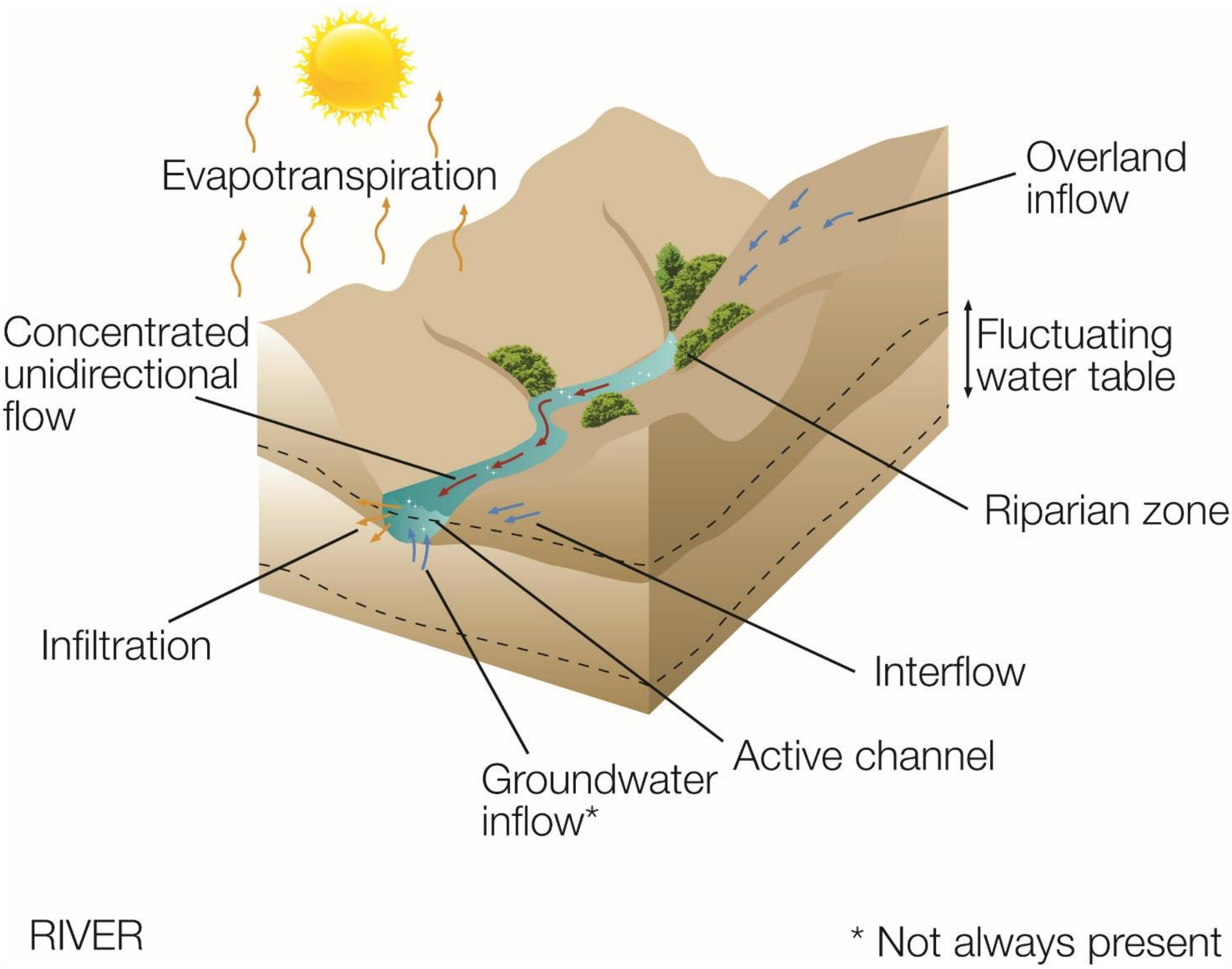


Figure 15: A schematic representation of the processes characteristic of a river area (Ollis *et al*, 2013).

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 16). 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 riparian areas recorded on site are thus classified as episodic streams due to the high elevation of these streams.

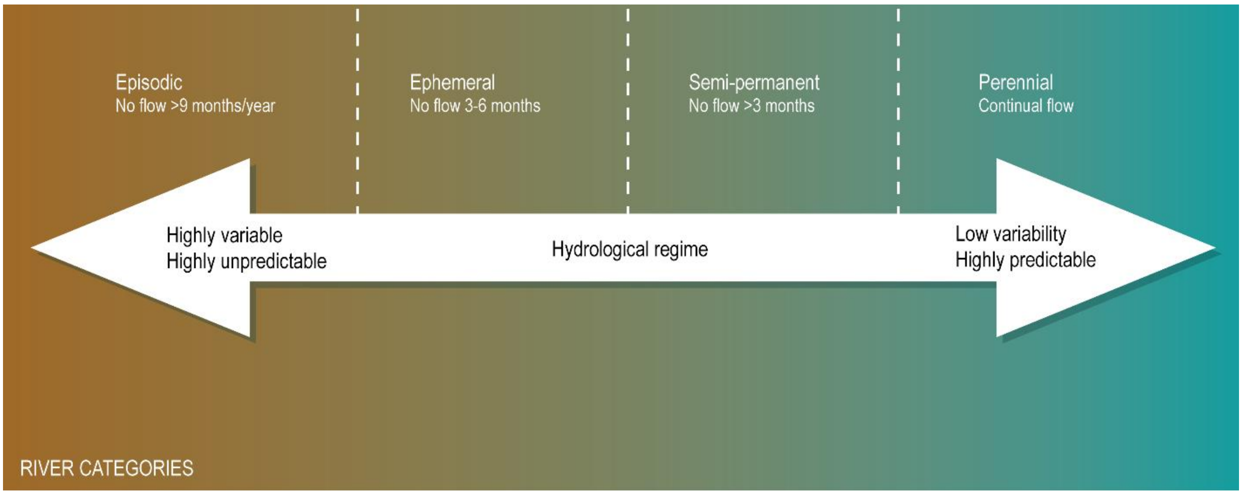


Figure 16: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman *et al*, 2010).

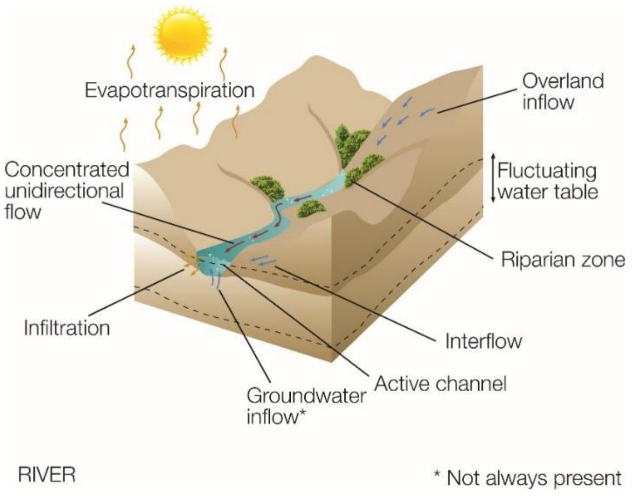
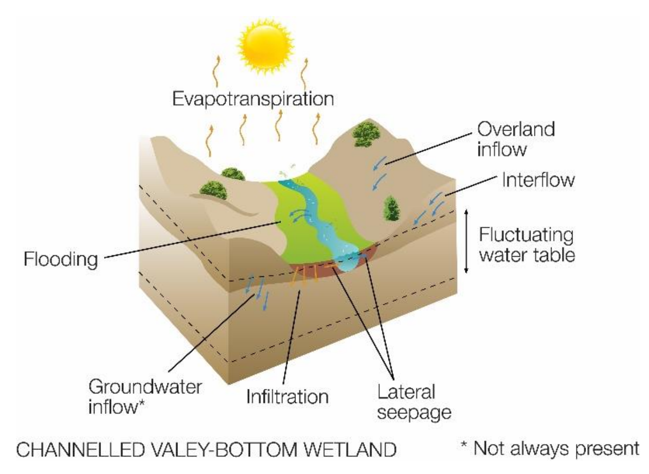
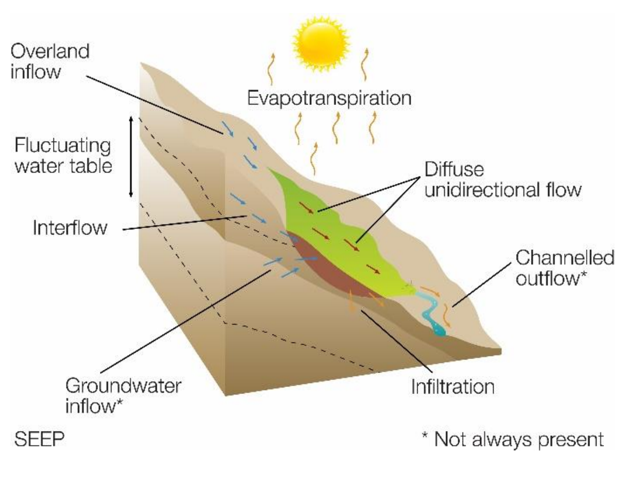
2.2 Wetland Classification and Delineation

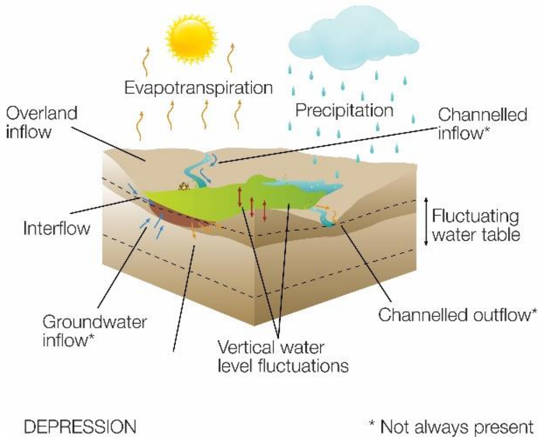
The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification (SANBI, 2009). The current wetland study follows the same approach by classifying wetlands in terms of a functional unit in line with a level three category recognised in the classification system proposed bySANBI (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.; and
- Hydrodynamics - This refers to how water moves through the wetland.

The classification of wetland areas found within the study site and/or within 500 m of the study site (adapted from Brinson, 1993; Kotze, 1999; Marneweck and Batchelor, 2002 and DWAF, 2005) are as follows (Table 4):

Table 4: Wetland Types and descriptions

Wetland Type:	**Description:**
Riparian habitat 	Linear fluvial, eroded landforms which carry 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.
Valley bottom with a channel 	Linear fluvial, net depositional valley bottom surfaces which have a straight channel with flow on a permanent or seasonal basis. Episodic flow is thought to be unlikely in this wetland setting. The straight channel tends to flow parallel with the direction of the valley (i.e. there is no meandering), and no ox-bows or cut-off meanders are present in these wetland systems. The valley floor is, however, a depositional environment such that the channel flows through fluvially-deposited sediment. These systems tend to be found in the upper catchment areas.
Seepage Wetlands 	Seepage wetlands are the most common type of wetland (in number), but probably also the most overlooked. These wetlands can be located on the mid- and footslopes of hillsides; either as isolated systems or connected to downslope valley bottom weltands. They may also occur fringing depressional pans. Seepages occur where springs are decanting into the soil profile near the surface, causing hydric conditions to develop; or where through flow in the soil profile is forced close to the surface due to impervious layers (such as plinthite layers; or where large outcrops of impervious rock force subsurface water to the surface).

Wetland Type:	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.

2.3 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 (DWAF, 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 stormwater runoff, peak discharges, and frequency and severity of flooding is therefore often characteristic of transformed catchments. 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.

Buffer zones have been shown to perform a wide range of functions and have therefore been widely proposed as a standard measure to protect water resources and their associated biodiversity. These functions include (i) maintaining basic hydrological processes; (ii) reducing impacts on water resources from upstream activities and adjoining landuses and (iii) providing habitat for various aspects of biodiversity. A brief description of each of the functions and associated services is outlined in Table 5 below.

Table 5: Generic functions of buffer zones relevant to the study site (adapted from Macfarlane *et al*, 2010)

Primary Role	Buffer Functions
Maintaining basic aquatic processes, services and values.	• Groundwater recharge: Seasonal flooding into wetland areas allows infiltration to the water table and replenishment of groundwater. This groundwater will often discharge during the dry season providing the base flow for streams, rivers, and wetlands.
Reducing impacts from upstream activities and adjoining land uses	• Sediment removal: Surface roughness provided by vegetation, or litter, reduces the velocity of overland flow, enhancing settling of particles. Buffer zones can therefore act as effective sediment traps, removing sediment from runoff water from adjoining lands thus reducing the sediment load of surface waters.

Primary Role	Buffer Functions
	• Removal of toxics: Buffer zones can remove toxic pollutants, such hydrocarbons that would otherwise affect the quality of water resources and thus their suitability for aquatic biota and for human use. • Nutrient removal: Wetland vegetation and vegetation in terrestrial buffer zones may significantly reduce the amount of nutrients (N & P), entering a water body reducing the potential for excessive outbreaks of microalgae that can have an adverse effect on both freshwater and estuarine environments. • Removal of pathogens: By slowing water contaminated with faecal material, buffer zones encourage deposition of pathogens, which soon die when exposed to the elements.
Providing habitat for various aspects of biodiversity.	• The buffer zone is essentially a terrestrial area and therefore provides habitat to terrestrial species. It does however protect wetland dependent species from edge effects. Several terrestrial species forage in adjacent wetland areas so that an ecological continuum is created

Despite limitations, buffer zones are well suited to perform functions such as sediment trapping, erosion control and nutrient retention which can significantly reduce the impact of activities taking place adjacent to water resources. Buffer zones are therefore proposed as a standard mitigation measure to reduce impacts of land uses / activities planned adjacent to water resources. These must however be considered in conjunction with other mitigation measures.

Tools for calculating buffer zones have 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 tool 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 recommended calculated buffer zone applicable to the proposed project (based on the activity class ‘Plant and plant waste from mining operations’ - high risk activities):

- All Wetlands and Rivers delineated 100 m buffer.

Previous wetland reports from the area suggest wetland buffers of between 100-200 m. For the wetlands recorded on site and the Perennial River a 100 m buffer zone is suggested. Should further details of the nature of the proposed activities become available, as well as the recommendations from hydrological/hydropedological reports, the buffer zones can be recalculated to better reflect the exact activities. It should be noted that some activities may increase the size of the required buffer zones while some could possible reduce the overall buffer zone size.

It should be noted that the buffer calculation tool does not take into account the effects of climate change or cumulative impacts to floodflows resulting from transformed catchments. Therefore, a conservative approach *to the application of buffer zones is encouraged. Furthermore, the buffer recommended in this report should be reviewed to include possible sensitive fauna species.*

Figure 17 images represent the buffer zone setback for the wetland types discussed in this report.

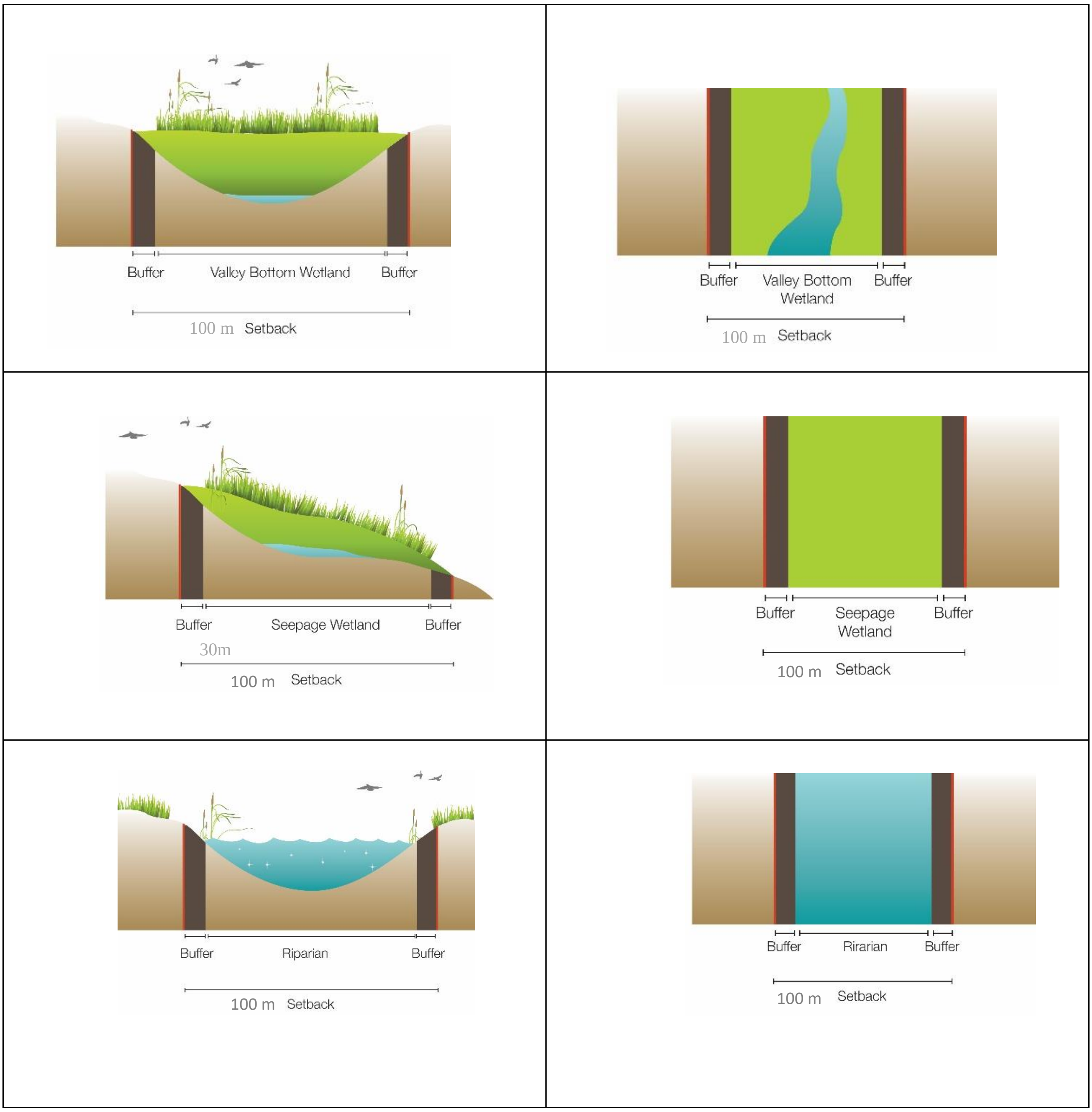


Figure 17: The buffer zone setback for the watercourse types discussed in this report

2.4 Impact Assessments

2.4.1 <u>NEMA EIA Regulations (2014 as amended) Impact Ratings (as received from GCS)</u>

The following methodology was used to rank these impacts. Clearly defined rating and rankings scales (In order to assess each of these factors for each impact, the ranking scales in Table 6 to 12 were used.

to assess the impacts associated with the proposed activities. The impacts identified by each specialist study and through public participation were combined into a single impact rating table for ease of assessment.

Each impact identified was rated according the expected magnitude (severity), duration, spatial scale and probability (likelihood) of the impact.

Consequence is then determined as follows:

Consequence = Severity + Spatial Scale + Duration

The Risk of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

Likelihood = Frequency of activity + frequency of impact + legal issues + detection

The risk is then based on the consequence and likelihood.

Risk = Consequence x likelihood

In order to assess each of these factors for each impact, the ranking scales in Table 6 to 12 were used.

Table 6: Severity.

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful / within a regulated sensitive area	5

Table 7: Spatial Scale - How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface right)	2
Local (within 5km)	3
Regional / neighboring areas (5km to 50km)	4
National	5

Table 8: Duration

One day to one month (immediate)	1
One month to one year (Short term)	2

One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity (permanent)	5

Table 9: Frequency of the activity - How often do you do the specific activity?

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Table 10: Frequency of the incident/impact - How often does the activity impact on the environment?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table 11: Legal Issues - How is the activity governed by legislation?

No legislation	1
Fully covered by legislation	5

Table 12: Detection - How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property?

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

Environmental effects will be rated as either of high, moderate or low significance on the basis provided in Table **13**12.

Table 13: Impact Ratings.

RATING	CLASS
1 – 55	(L) Low Risk
56 – 169	M) Moderate Risk
170 – 600	(H) High Risk

2.5 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 Present Ecological Status (PES) score (Macfarlane *et al*, 2007) and an Environmental Importance and Sensitivity category (EIS) (DWAF, 1999). The impacts observed for the affected wetland are summarised for each wetland under section 3.2. 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. Collection of empirical data is precluded at this level of investigation due to project constraints including time and budget. Water quality values, species richness and abundance indices as well as, surface and groundwater volumes, amongst other measures, should ideally be used rather than a subjective scoring system such as is presented here.

The functional assessment methodologies presented below take into consideration subjective recorded impacts to determine the scores attributed to each functional Hydrogeomorphic (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, WET-Health (Macfarlane *et al*, 2007), EIS (DWAF, 1999) and WetEcoServices, (Kotze *et al*, 2006).

2.5.1 Present Ecological Status (PES) – WET-Health

A summary of the three components of the WET-Health, namely Hydrological; Geomorphological and Vegetation Health assessments for the wetlands found on site is described in Table 14. A Level 1 assessment was used in this report. Level 1 assessment is used in situations where limited time and/or resources are available.

Table 14: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*, 2007)

Description	Impact Score Range	PES Score	Health category
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 change class, description and symbols used to evaluate wetland health are summarised in Table 15.

Table 15: 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	(↓↓)

2.5.2 Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) score forms part of a larger assessment called the Wetland Importance and Sensitivity 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 Department of Water and Sanitation.

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 (DWAF, 1999). This classification of water resources allows for an appropriate management class to be allocated to the water resource and 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.

The Ecological Importance and Sensitivity of the wetlands is described in the results section. Explanations of the scores are given in Table 16.

Table 16: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999)

Ecological Importance and Sensitivity Categories	Rating
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
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
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
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

2.5.3 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 17).

Table 17: 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

2.5.4 Quick Habitat Integrity Model

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) according to the following metrics (Seaman *et al*, 2010):

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

2.5.5 Recommended Ecological Category (REC)

The REC is determined by the Present Ecological State of the water resource and the importance and/or sensitivity of the water resource. Water resources which have Present Ecological State in an E or F ecological category are deemed unsustainable by the DWS. In such cases the REC must automatically be increased to a D.

Where the PES is in the A, B, C, D or E,the EIS components must be checked to determine if any of the aspects of importance and sensitivity (Ecological Importance; Hydrological Functions and Direct Human Benefits) are high or very high. If this is the case, the feasibility of increasing the PES (particularly if the PES is in a low C or D category) should be evaluated. This is recommended to enable important and/or sensitive wetland water resources to maintain their functionality and continue to provide the goods and services for the environment and society.

If:

- PES is in an E or F category:
  The REC should be set at, at least a D, since E and F EC's are considered unsustainable.
  - The PES category is in an A, B, C or D , AND the EIS criteria are low or moderate OR the EIS criteria are high or even very high, but it is not feasible or practicable for the PES to be improved:
- The REC is set at the current PES.
  - The PES is a B, C or D category, AND the EIS criteria are high or very high AND it is feasible or practicable for the PES to be improved:
- The REC is set at least one Ecological Category higher than the current PES." (Rountree *et al,* 2013).

3 RESULTS

3.1 Land Use, Cover and Ecological State

The study area comprises approximately 4201 hectares with infrastructure of approximately 610 hectares located on the study site. The construction of this infrastructure only occurred in 2011. Prior to construction the study site was mostly open with some farming occurring with associated infrastructure such as roads and cultivated fields. The majority of the region is undeveloped with isolated game farms. The northern section of the study area borders on the Khuma Township and is not fenced off. This area is used as communal grazing lands and is heavily grazed. Since the 2018 wetland assessment, the size of the study area has increased to include sections of private land which were not accessible during the December 2018 site assessment. **During the February 2019 site visit these previously inaccessible areas were visited.**

3.1.1 Watercourses

In the current study, one new wetland and a river were recorded in addition to the 2018 delineation by De Castro & Brits. The perennial Vaal River enters a small section of the study site as it was defined for this study. Other wetlands as delineated in previous reports (De Castro & Brits, 2018) now extend further into the study site compared to the previous smaller study area. These wetlands are labelled as wetland 1 and wetland 9 in the De Castro & Brits (2018) report (Figure 19) and both are unchannelled valley bottom wetlands. The only new wetland is located in the eastern section of the study site. This wetland is a seepage wetland that drains directly into the Vaal River. In the eastern section several smaller dams and dam like structures were recorded during the follow up site visit. These areas are likely artificial although they do provide some biodiversity support such as habitat for several species as well as drinking water for larger animals.

Northeast of the Tailings Storage Facility a non-perennial pan is shown on regional hydrology layers. This area is known as Wildebeespan. Detailed soil and vegetation assessments in this area on the 10thof December 2018 and the 27th of February 2019 did not reflect conclusive wetland indicators although it is likely that moist soil may be elevated during very wet seasons. In some areas soils with high clay content will swell and may occasionally support facultative wetland species. This moisture is however not sufficient for the area to be classified as a wetland following the definition in the DWS guidelines. Figure 18 shows the characteristics of this area.

Figure 18: The Wildebeespan area showing short, sparse terrestrial plant species with clay rich soils.

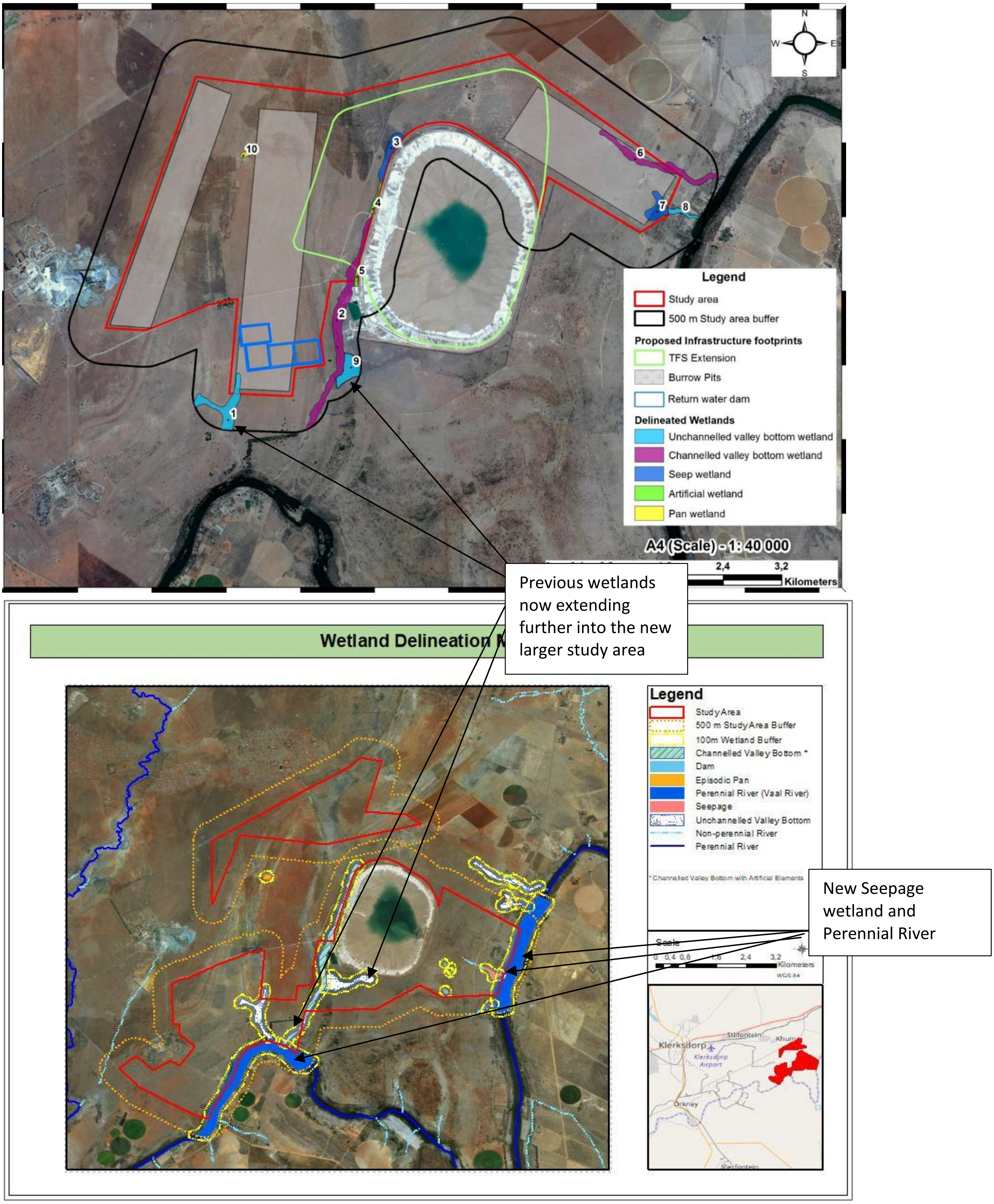


Figure 19: De Casto & Brits 2018 delineation (top) compared to the current February 2019 map (bottom) indicating the larger study area and one new wetland.

3.1.2 Soil Indicators

Soil

Soil samples were taken throughout the wetlands of the study site to determine the presence of wetland characteristics (Redoximorphic features) such as mottling, a gleyed matrix and manganese and/or Iron concretions. The wetlands of the study site were characterised by seasonal and permanent wet zones. A pebble layer was prominent in southern unchannelled valley bottom wetland. The dominant soil form in the wetlands sampled was dark clay soil, moderately to highly structured. Another characteristic feature of the small pan wetland includes the presence of an impermeable ferricrete layer within the soil profile. Red soils were not widespread on the study site. The dominant soil features of the wetlands on the study site are visually represented in the figures below (Figure 20). The Vaal River had large areas of bedrock as well as pebbles and boulders. Sandy alluvial deposits were found on the banks of the river.

The soil characteristics are summarised in the table below (Table 18).

Table 18: Summary of the wetland soil conditions adjacent to the site (Adapted from Job, 2010).

Site Conditions:	
Do normal circumstances exist on the site?	Yes
Is the site significantly disturbed (difficult site)?	No
Indicators of soil wetness within 50 cm of soil surface:	
Sulfidic odour (a slight sulfidic odour was noted in permanent zone)	No
Mineral and Texture	Clay
Gley	Yes
Mottles or concretions	Yes
Organic streaking or oxidised rhizopheres	Yes
High organic content in surface layer	No
Setting (In bold):	
crest (1) scarp (2) midslope (3) footslope (4) **valley bottom (5)**	
Additional indicators of wetland presence:	
Concave	No
Bedrock	No
Dense clay	No
Flat	No
Associated with a river	Yes – Vaal River

Figure 20: Soil characteristics of the unchannelled valley bottom wetlands on the study site. Note the structured, heavy dark clay

3.1.3 Vegetation Indicators

Some important species recorded in the other wetlands that could likely occur in the seepage wetland include *Crinum bulbispermum, Hypoxis hemerocallidea* and *Eucomis autumnalis.* The Vaal River had a clear riparian layer for the majority of the study area although a large number of the woody species recorded were exotic. A visual summary of the wetlands in the initial study (Figure 18) and the follow up site visit (Figure 21) is provided in the figures below. A complete list of species recorded in the wetlands and surroundings is available in previous reports (De Castro & Brits, 2018).

Figure 21: General characteristics of the wetlands and the Vaal River on the study site.

3.2 Wetland Functional Assessment

The Department of Water and Sanitation authorisations related to wetlands are regulated by Government Notice R267 published in the Government Gazette 40713 of 24 March 2017. Page 196 of this notice provides a detailed terms of reference for wetland assessment reports and includes the requirement that the ecological integrity and function of wetlands be addressed.

Although it is our opinion that this section should draw from site specific fauna and flora data, this requirement is addressed through the WetEcoServices toolkit (Kotze *et al*. 2006). This wetland assessment method is an Excel based tool which is based on the integral function of wetlands in terms of their hydrogeomorphic setting. Each of seven benefits are assessed based on a list of characteristics (e.g. slope of the wetland) that are relevant to the particular benefit. Scores are subjectively awarded to characteristics of the wetland and its catchment relative to the proposed activity.

The WetEcoServices assessment of each HGM unit is presented in Appendix B. The wetlands scored low with regards to cultural significance. The area has a low population density, the surroundings are actively mined and it is not accessible to the general public. The new portion of the study site is used as a game farm and thus has the potential for tourism. Due to the close proximity of mines in the area the seepage wetland is likely to contribute to water quality enhancement. This follows from the mechanism of the Wetecoservices tool which shows that the wetland unit can provide this service because the threat of the mine creates an opportunity for this service. The impacts associated with the wetlands are predominantly mining related and include sedimentation, erosion, pollution, loss of biodiversity and wetland loss (Figure 22). Agriculture adjacent to the wetlands also impacts on them though input of nutrients and pesticides and altered soil characteristics (for example compaction and recharge properties).

Figure 22: Images of impacts recorded within and surrounding the wetland areas tyre tracks through wetlands, and reclamation infrastructure.

3.2.1 Scores

The seepage wetland scored a PES of **C - Moderately modified.** A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact. The wetland is likely to deteriorate slightly over the next 5 years. The components of the PES score are reflected in Table 19 below and include the hydrology, geomorphology and vegetation components of wetland integrity. The results for the functional and integrity scores for the other wetland on the larger study site are presented in the De Castro & Brits (2018) wetland assessment report.

Table 19: Summary of hydrology, geomorphology and vegetation health assessment for the unchannelled valley bottom wetland and seepage wetland (Macfarlane *et al*, 2009).

Wetland Unit	Hydrology		Geomorphology		Vegetation		Overall Score	
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Seepage Wetland	3.1	-1	3.1	0	2.2	-1	2.8	-1
PES Category and Projected Trajectory	**C**	**↓**	**C**	**→**	**C**	**↓**	**C**	**↓**

Ecological Importance and Sensitivity (EIS)

The EIS score of **3.0** falls into a category characterised by **High/Very High** ecological importance and sensitivity. Wetlands in this category 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 (DWAF, 1999) (Table 20).

Table 20: Combined EIS scores obtained for the Seepage wetland adjacent to the study site. (DWAF, 1999).

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	3.0	3.0
Hydro-functional importance	2.1	2.5
Direct human benefits	1.5	3.0
Highest EIS Score	**3.0 (High)**	

The ecosystem services provided by the wetland adjacent to the study site are summarised in Table 21 below. The scores are listed from lowest to highest. The threats to the wetlands are very high as a result of the adjacent reclamation and agriculture.

Table 21: Results and brief discussion of the Ecosystem Services provided by the seepage wetland

Function	Score	Significance
Cultural significance	0.0	Low
Education and research	0.0	Low
Carbon storage	0.3	Low
Natural resources	0.4	Low
Cultivated foods	0.4	Low
Water supply for human use	0.8	Low
Erosion control	1.0	Moderately Low
Tourism and recreation	1.1	Moderately Low
Flood attenuation	1.5	Moderately Low
Streamflow regulation	1.5	Moderately Low

Function	**Score**	**Significance**
Threats	2.0	Moderate
Opportunities	2.0	Moderate
Nitrate removal	2.2	Moderately High
Toxicant removal	2.2	Moderately High
Phosphate trapping	2.3	Moderately High
Maintenance of biodiversity	2.3	Moderately High
Sediment trapping	2.6	Moderately High

Riparian Vegetation Response Assessment Index (VEGRAI) & Quick Habitat Integrity (QHI)

VEGRAI and the Quick Habitat Integrity (QHI) assessment was done do determine the Ecological Category (EC) of the Vaal River (Tables 22 and 23): An VEGRAI score of **C** was calculated for the Vaal River: **C – Moderately Modified – A moderate loss of natural habitat, biota and basic ecosystem functions has occurred.**

Table 22: Results and brief discussion of the VEGRAI scores obtained by the Vaal River associated with the proposed development site (Kleynhans *et al*, 2008).

LEVEL 3 ASSESSMENT					
METRIC GROUP	**CALCULATED RATING**	**WEIGHTED RATING**	**CONFIDENCE**	**RANK**	**% WEIGHT**
MARGINAL	60.0	17.1	2.5	2.0	40.0
NON MARGINAL	74.3	53.1	2.5	1.0	100.0
					140.0
LEVEL 3 VEGRAI (%)				70.2	
VEGRAI EC				**C**	
AVERAGE CONFIDENCE				2.5	

Table 23: QHI for the perennial watercourse associated with the proposed development site (Seaman *et al*, 2010).

QUATERNARY CATCHMENT	RIVER	Bed modification (0-5)	Flow modification (0-5)	Inundation (0-5)	Riparian/Bank condition (0-5)	Water quality modification (0-5)	DESKTOP HABITAT INTEGRITY	INSTREAM EC%	INSTREAM EC	Vegetation Rating (0-5)	ECOSTATUS %	ECOSTATUS EC	CONFIDENCE (1-5)
C24B & C23L	Vaal River	1	4	3	1	2	**64.0**	**64.0**	**C**	2	**66.0**	**C**	**3**

3.3 Summary of Findings

Table 24 provides a summary of the results recorded for the wetland potentially affected by proposed development.

Table 24: Summary of results for each wetland unit discussed

Classification (SANBI, 2013)	PES (Macfarlane *et al*, 2007) & VEGRAI (Kleynhans et al, 2008).	EIS (DWAF, 1999) & QHI (Seaman *et al*, 2010)	WetEcoServices (3 most prominent scores)	Buffer	REC
Seepage Wetland	2.8 C	3.0 (High)	Phosphate trapping - 2.3 Maintenance of biodiversity - 2.3 Sediment trapping - 2.6	100 m	C
Vaal River	70.2 C	66.0 C	N/A		C

3.4 Impacts and Mitigations

Development has several impacts on the surrounding environment and particularly on a wetland. Reclamation particularly affects surface and subsurface water flow in a catchment and consequently affects recharge and discharge of water and the hydrological expression in wetlands. The proposed layout provided in Figure 20 was considered in the impact assessment presented below (Table 25). The DWS Risk Assessment is presented in Table 26. Ideally, the outcome of a geohydrological assessment should further inform the final impact and risk assessments.

The layout considered includes the following aspects as described in section 1.2. These are illustrated in (Figure 23) below.

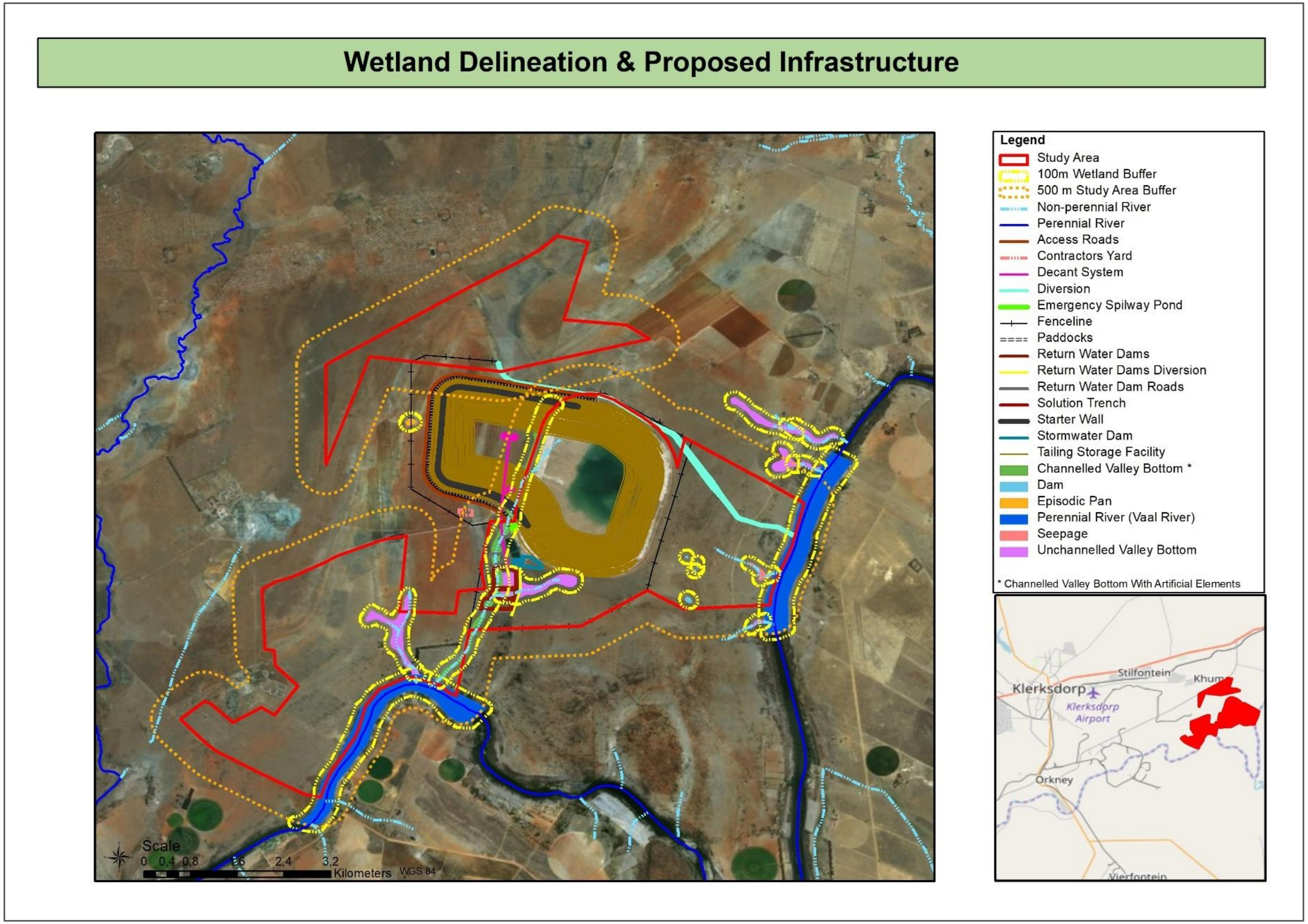


Figure 23: The proposed layout relative to wetlands discussed in this report

Table 25: Impact scores before and after implementation of mitigation

				Impact before mitigation					Impact after mitigation							
Phases	Activity	Aspect (cause of the impact)	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Severity	Consequence	Likelihood	Significance	Risk Rating	Mitigation Measures	Action plan	Responsible person
Construction	Site clearing / preparation	Compaction of soil and the clearing of vegetation during construction of pipelines, berms and access roads	Changes in water flow regime, increased high energy surfacewater runoff, decreased vegetation germination potential, sediment pollution	3	9	14	126	M	3	7	12	84	M	• Effective stormwater and sediment management should be implemented during construction phases to ensure that no polluted, sediment laden or high energy water is directed into the watercourses or waterbodies • Changed overland water flows should be accommodated to ensure that water input from adjacent slopes occurs in a diffuse manner and does not cause scouring or downstream erosion • Control of alien invasive plants should form part of the maintenance plan • Corrective action should take into account hydrological analysis of flow energy and water quality where required	Environmental Management Plan	Mine manager
Residual				3	9	12	112	M	3	7	12	84	M			
Cumulative				3	9	14	112	M	3	7	12	84	M			
Construction	Site clearing / preparation	Compaction of soil and the clearing of vegetation during construction of pipelines and access roads	Changes in sediment deposition and high energy flows causing erosion	3	9	13	117	M	2	4	11	44	L			
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	6	16	144	M	2	4	11	44	L			
Construction	Site clearing / preparation	Preparation of the footprint of all new infrastructure	Introduction and spread of alien plants	4	13	14	182	H	2	9	12	108	M	Ensure the implementation of an effective Alien Plant Control Plan	Environmental Management Plan	Mine manager
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	7	12	84	M	2	4	11	44	L			
Construction	Site clearing / preparation	Preparation of the footprint of all new infrastructure	Loss and disturbance of watercourse habitat and fringe vegetation	3	7	13	91	M	1	6	12	72	M	• Drying out of wetlands and loss of hydrological zonation (loss of temporary and seasonal wetland zones) should be monitored		
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	7	12	84	M	2	4	11	44	L			
Construction	Heavy machinery and vehicle movement	Leaking of hydrocarbons and inappropriate ablutions, littering	Changes in water quality due to foreign materials	4	10	12	120	M	1	5	10	50	L	• Corrective action should take into account hydrological analysis of flow energy and water quality where required • Independant water quality testing should inform themanagement plan of corective action required where pollution or sedimentation is recorded	Environmental Management Plan	Mine manager
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	7	12	84	M	2	4	11	44	L			
Operation	Plant operation	Permanent location of tailing facilities in the catchment of the waterbodies	Permanent changes to the catchment of waterbodies in terms of water inflitration and surface water flow rates	3	12	16	192	H	3	10	15	150	M	•Effective stormwater management plan should ensure that no sediment polllution or erosion result from inappropriate high energy water flows • Control of alien invasive plants should form part of the maintenance plan • A wetland rehabilitation plan with plant species plan should be implemented to ensure that ecological function equal to the current habitat is returned • Corrective action should take into account hydrological analysis of flow energy and water quality where required • Independant water quality testing should inform themanagement plan of corective action required where pollution or sedimentation is recorded		
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	7	12	84	M	2	4	11	44	L			
Operation	Plant operation	Permanent presence of pipelines and access roads	Changes in sediment and stormwater entering the system	3	9	16	144	M	2	5	13	65	M	• Changed overland water flows should be accommodated to ensure that water input from adjacent slopes occurs in a diffuse manner and does not cause scouring or downstream erosion • Corrective action should take into account hydrological analysis of flow energy and water quality where required	Environmental Management Plan	Mine manager
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	7	12	84	M	2	4	11	44	L			
Operation	Plant operation	Daily movement of vehicles, changed natural ecological processes	Introduction and spread of alien plants	3	12	14	168	M	1	9	14	126	M	Ensure the implementation of an effective Alien Plant Control Plan		
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	7	12	84	M	2	4	11	44	L			
Operation	Plant operation	Presence of new infrastructure in the proximity of watercourses and waterbodies	Loss and disturbance of watercourse habitat and fringe vegetation	2	9	13	117	M	1	9	12	108	M	• A wetland rehabilitation plan with plant species plan should be implemented to ensure that ecological function equal to the current habitat is returned • Corrective action should take into account hydrological analysis of flow energy and water quality where required • Independant water quality testing should inform themanagement plan of corective action required where pollution or sedimentation is recorded	Environmental Management Plan	Mine manager
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	7	12	84	M	2	4	11	44	L			
Operation	Plant operation	Inadequate infrastructure and maintenance of vehicles	Changes in water quality due to foreign materials	3	7	12	84	M	1	6	12	72	M	• Corrective action should take into account hydrological analysis of flow energy and water quality where required • Independant water quality testing should inform themanagement plan of corective action required where pollution or sedimentation is recorded		
Residual				3	7	12	84	M	2	4	11	44	L			
Cumulative				3	7	12	84	M	2	4	11	44	L			

Table 26: Impact scores before and after implementation of mitigation

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

NAME and REGISTRATION No of SACNASP Professional member: A Bootsma SACNASP # 400222/09

Phases	Activity	Aspect	Impact	Severity																		
				Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
C	Construction phase of the Tailings Storage Facility	Clear vegetation	Transformation of wetland and adjacent terrestrial habitat, changes to topography and surface water runoff, pollution and alien invasive plant establishment	2	2	4	3	3	1	2	5.8	1	3	5	2	**11**	**63.25**	**M**	**80%**	• Effective stormwater and sediment management should be implemented during construction phases to ensure that no polluted, sediment laden or high energy water is directed into the watercourses or waterbodies • Changed overland water flows should be accommodated to ensure that water input from adjacent slopes occurs in a diffuse manner and does not cause scouring or downstream erosion • Control of alien invasive plants should form part of the maintenance plan • Corrective action should take into account hydrological analysis of flow energy and water quality where required	N	PES:C EIS: B/C REC: C
		Establishment of access roads, RWD diversion, Stormwater Dam, Return Dams		4	3	4	1	3	1	2	6	1	3	5	2	**11**	**66**	**M**	**80%**		N	
O	Opeartion of the Tailings Storage Facility	Day to day operation of the facility	Permanent loss of wetland habitat and hydrological connectivity throughloss of wetlands, pollution, invasion of alien invasive species	5	3	4	3	4	2	3	8.8	5	5	5	2	**17**	**148.8**	**M**	**80%**	• Effective stormwater and sediment management should be implemented during construction phases to ensure that no polluted, sediment laden or high energy water is directed into the watercourses or waterbodies • Changed overland water flows should be accommodated to ensure that water input from adjacent slopes occurs in a diffuse manner and does not cause scouring or downstream erosion • Control of alien invasive plants should form part of the maintenance plan • Corrective action should take into account hydrological analysis of flow energy and water quality where required • A wetland rehabilitation plan with plant species plan should be implemented to ensure that ecological function equal to the current habitat is returned • A wetland offset strategy should be formulated to adress loss of wetland habitat	N	PES:C EIS: B/C REC: C

4 CONCLUSION

In addition to the wetlands recorded in the De Castro & Brits (2018) study, only one new wetland and a river were recorded on the study area earmarked for Kareerand Tailings Storage Facility Expansion Project. The perennial Vaal River only enters a small section of the larger study site. Other wetlands as delineated in previous reports (De Castro & Brits, 2018) now extend further into the larger study site compared to the previous smaller study area. These wetlands are labelled as wetland 1 and wetland 9 in De Castro & Brits (2018) and both are unchannelled valley bottom wetlands. The only new wetland is located in the eastern section of the study site. This wetland is classified as a seepage wetland that drains directly into the Vaal River. In the eastern section several smaller dams and dam-like structures can be seen on aerial photography. These features are considered to be artificial and are thus not included in the function and integrity assessment during this phase of the report, although they perform some biodiversity functions such as habitat and breeding areas, as well as drinking water for larger animals.

The important factors relevant to the project are summarised in the tables below (Tables 27 & 28):

Table 27: Summary of wetland characteristics.

Classification (SANBI, 2013)	PES (Macfarlane *et al*, 2007) & VEGRAI (Kleynhans et al, 2008).	EIS (DWAF, 1999) & QHI (Seaman *et al*, 2010)	WetEcoServices (3 most prominent scores)	Calculated Buffer (Macfarlane *et al*, 2015)	REC
Seepage Wetland	2.8 C	3.0 (High)	Phosphate trapping - 2.3 Maintenance of biodiversity - 2.3 Sediment trapping - 2.6	100 m	C
Vaal River	70.2 C	66.0 C	N/A		C

Table 28: Summary of findings

	Quaternary Catchment and WMA areas	Important Rivers possibly affected	Buffers
	C24A, C24B and C23L – 5th WMA The Vaal Major	The wetland drains directly into the Vaal River	• 100 m
NEMA 2014 Impact Assessment	Impacts before mitigation fall in the Medium to High categories, and impacts after mitigation fall in the Medium to Low categories. Mitigation measures to be implemented include: • Effective stormwater and sediment management should be implemented during construction and operational phases to ensure that no polluted, sediment laden or high energy water is directed into the watercourses or waterbodies • Changed overland water flows should be accommodated to ensure that water input from adjacent slopes occurs in a diffuse manner and does not cause scouring or downstream erosion • Control of alien invasive plants should form part of the maintenance plan • Corrective action should take into account hydrological analysis of flow energy and water quality where required • Control of alien invasive plants should form part of the maintenance plan • A wetland rehabilitation plan with plant species plan should be implemented to ensure that ecological function equal to that of the current habitat is returned • Corrective action should take into account hydrological analysis of flow energy and water quality where required • Independent water quality testing should inform the management plan of corrective action required where pollution or sedimentation is recorded		
DWS 2016 Risk Assessment	Risks fall in the Medium category. Activities which fall within this category should be authorised through a Water Use Licence. Further to the mitigation measures highlighted for the NEMA impact assessment, a wetland offset strategy should be formulated to address loss of wetland habitat		
CBA and other Important areas	• Heavily modified – Majority of the study site • CBA Optimal, Other natural areas and Moderately modified are all associated with the wetlands on the study site and within 500 m.		
Does the specialist support the development?	Storage of mine waste on this site will have significant negative impacts on the environment. However, this is one aspect that should be considered in a larger picture, which includes social and economic development. Therefore we support the proposed development, given that expected impacts are considered and that independent monitoring highlights possible loss of wetland habitat which should be addressed through offsets and rehabilitation to ensure that the hydrological integrity of the catchment is maintained		

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APPENDIX A: Abbreviated CVs of participating specialists

Name:	**ANTOINETTE BOOTSMA nee van Wyk**
ID Number	7604250013088
Name of Firm:	Limosella Consulting
SACNASP Status:	Professional Natural Scientist # 400222-09 Botany and Ecology

EDUCATIONAL QUALIFICATIONS

- MSc Ecology, University of South Africa (2017) Awarded with distinction. Project Title: Natural mechanisms of erosion prevention and stabilization in a Marakele peatland; implications for conservation management
- Short course in wetland soils, Terrasoil Science (2009)
- Short course in wetland delineation, legislation and rehabilitation, University of Pretoria (2007)
- B. Sc (Hons) Botany, University of Pretoria (2003-2005). Project Title: A phytosociological Assessment of the Wetland Pans of Lake Chrissie
- B. Sc (Botany & Zoology), University of South Africa (1997 - 2001)

PUBLICATIONS

- A.A. Boostma, S. Elshehawi, A.P. Grootjans, P.L Grundling, S. Khosa, M. Butler, L. Brown, P. Schot. *In Press.* Anthropogenic disturbances of natural ecohydrological processes in the Matlabas mountain mire, South Africa. South African Journal of Science
- 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. (2014). In search of spring mires in Namibia: the Waterberg area revisited. Mires and Peat. Volume 15, Article 10, 1–11, http://www.mires-and-peat.net/, ISSN 1819-754X © 2015 International Mire Conservation Group and International Peat Society

- 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.
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- 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 90 external peer reviews as part of mentorship programs for companies including Gibb, Galago Environmental Consultants, Lidwala Consulting Engineers, Bokamoso Environmental Consultants, 2009 ongoing
- More than 300 fine scale wetland and ecological assessments in Gauteng, Mpumalanga, KwaZulu Natal, Limpopo and the Western Cape 2007, ongoing
- Strategic wetland specialist input into the Open Space Management Framework for Kyalami and Ruimsig, City of Johannesburg, 2016
- Fine scale wetland specialist input into the ESKOM Bravo Integration Project 3, 4, 5 and Kyalami – Midrand Strengthening.
- Wetland/Riparian delineation and functional assessment for the proposed maintenance work of the rand water pipelines and valve chambers exposed due to erosion in Casteel A, B and C in Bushbuckridge Mpumalanga Province
- Wetland/Riparian delineation and functional assessment for the Proposed Citrus Orchard Establishment, South of Burgersfort (Limpopo Province) and North of Lydenburg (Mpumalanga Province).
- 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

➢ **<u>Wetland Specialist</u>**

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.

Large Eskom projects include:

- Eskom 88kV Rigi – Sonland
- Eskom 88kV Simmerpan Line
- Eskom 88kV Meteor Line
- Eskom 88kV Kookfontein – Jaguar
- Eskom 132kV Dipomong
- Eskom 132kV Everest – Merapi
- Eskom 132kV Vulcan – Enkangala
- Eskom 400kV Helios – Aggenys
- Eskom 400kV Hendrina – Gumeni
- Eskom 765kV Aries – Helios
- Eskom 765kV Aries – Kronos
- Eskom 765kV Kronos – Perseus
- Eskom 765kV Perseus – Gamma
- Eskom 765kV Helios – Juno
- Eskom 765kV Aries- Helios

➢ **<u>Biodiversity Action Plan</u>**

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

➢ **<u>Wetland Rehabilitation</u>**

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

➢ **<u>Wetland Ecology</u>**

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.

➢ **<u>Environmental Controlling Officer</u>**

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)

APPENDIX B: GLOSSARY OF TERMS

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
Hydrophyte	any plant that grows in water or on a substratum that is at least periodically deficient in oxygen as a result of soil saturation or flooding; plants typically found in wet habitats
Hydromorphic soil	soil that in its undrained condition is saturated or flooded long enough during the growing season to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils)
Seepage	A type of wetland occurring on slopes, usually characterised by diffuse (i.e. unchannelled, and often subsurface) flows
Sedges	Grass-like plants belonging to the family Cyperaceae, sometimes referred to as nutgrasses. Papyrus is a member of this family.
Soil profile	the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991)
Wetland:	"*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*." (National Water Act; Act 36 of 1998).
Wetland delineation	the determination and marking of the boundary of a wetland on a map using the DWAF (2005) methodology. This assessment includes identification of suggested buffer zones and is usually done in conjunction with a wetland functional assessment. The impact of the proposed development, together with appropriate mitigation measures are included in impact assessment tables