Proposed Exxaro Leeuwpan Mine Expansion, Delmas, Putfontein AH, Mpumalanga Province.

Wetland/Riparian Delineation and Functional Assessment Confirmation and Update

February 2019

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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.

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2019.02.20
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.

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EXECUTIVE SUMMARY

Limosella Consulting was appointed by Nsovo Consulting to conduct an update of the 2012 Wetland Consulting Services wetland assessment for Exxaro DCM West, (approximately 4 260 hectares) for the proposed expansion of the current Leeuwpan opencast mine. A special emphasis was placed on the proposed expansion through three wetlands, two pan wetlands and one hillslope seepage wetland (smaller focus site). The current report is based on previous wetland studies conducted by Wetland Consulting Services (2012) and three site visits conducted on the 10th November 2018, the 9th of January 2019 and the 5th of February 2019. In support of the wetland assessment, a risk assessment was conducted for the proposed expansion of mining activities on the smaller focus site.

Our scope of work includes:

- Review and verification of the wetland assessments conducted for the Storage Tailings Facility, and in the larger study area;
- Undertake functional and integrity assessment of wetlands areas within the expansion area assessed as specified in General Notice 267 of 24 March 2017;
- Undertake an impact assessment as specified in the NEMA 2014 regulations;
- Undertake a risk assessment as specified in General Notice 509 in published in the Government Gazette 40713 of 24 March 2017;
- Recommend suitable buffer zones as specified in General Notice 267 of 24 March 2017, following Macfarlane *et al* 2015.

The study area comprises approximately 4272 hectares with current infrastructure of approximately 1879.04 hectares located on the study site. Roughly 44% of the study area is currently used for mining. Large sections identified as wetland in the 2012 Wetland Consulting Services report have since been transformed by mining. The total area occupied by wetlands as delineated in the current report is 1120.56 hectares which equates to 26% of the total study site or 47% of the area remaining unmined area. It should be noted that these figures exclude the wetland buffer zones, which are likely to significantly increase the no-go areas. The remaining area is used for agriculture and infrastructure associated with mining.

A special emphasis in this report is a small area that is proposed to be mined where three wetlands (two Depressional Pan wetlands and one Seepage Wetland) are also located (Specific Focus Study Site). The approximate central coordinates of the focus specific study area is 26°11'15.51"S and 28°44'29.05"E. This area has also been affected by the mine expansion and a new road has been constructed through one of the wetlands.

The wetlands identified in the 2012 Wetland Consulting Services report were verified in the current study with good accuracy for the majority of the wetlands. Some wetlands have however, irrevocably been transformed by mining activities while some were delineated smaller than in the WCS study due to transformation as a result of agricultural impacts. This is especially true for the depressional pan wetlands located within agricultural areas.

The important wetland characteristics are relevant to the project are summarised in the table below:

Nr	Affected Watercourse	Approximate Coordinates	Present Ecological State Score	Ecological Importance and Sensitivity
1	Channelled Valley Bottom Wetland	26° 9'45.28"S and 28°42'9.95"E	D - Largely modified	B - High
2	Channelled Valley Bottom Wetland	26°10'16.43"S and 28°42'1.68"E	D - Largely modified	C - Moderate
3	Unchannelled Valley Bottom Wetland	26°11'41.64"S and 28°46'33.97"E	C - Moderately modified	B - High
4	Unchannelled Valley Bottom Wetland	Crosses wetland at 28°19'16.92"S and 28°57'12.11"E	E – Greatly modified	D - Largely modified.
5	Depressional Pan	26°10'43.39"S and 28°40'48.52"E	C - Moderately modified	C - Moderate
6	Depressional Pan	26°10'40.26"S and 28°41'7.31"E	C - Moderately modified	C - Moderate
7	Depressional Pan	26°11'45.77"S and 28°45'11.11"E	D - Largely modified	D - Largely modified.
8	Depressional Pan	26°11'5.47"S and 28°45'4.84"E	E – Greatly modified	D - Largely modified.
9	Depressional Pan	26°11'3.94"S and 28°45'30.74"E	E – Greatly modified	D - Largely modified.
10	Depressional Pan	26°10'32.47"S and 28°45'23.09"E	D - Largely modified	D - Largely modified.
11	Depressional Pan	26°11'11.87"S and 28°45'54.52"E	E – Greatly modified	D - Largely modified.
12	Depressional Pan on site specific site	26°11'8.61"S and 28°44'29.97"E	D - Largely modified	D - Largely modified.
13	Depressional Pan on site specific site	26°11'13.60"S and 28°44'10.05"E	D - Largely modified	D - Largely modified.
14	Depressional Pan Wetland	26°10'29.18"S and 28°41'34.56"E	C - Moderately modified	C - Moderate
15	Depressional Pan Wetland	26° 8'57.28"S and 28°46'37.59"E	C - Moderately modified	C - Moderate
16	Depressional Pan Wetland	26° 8'59.17"S and 28°46'43.43"E	C - Moderately modified	D - Largely modified.
17	Depressional Pan Wetland	26° 8'56.70"S and 28°46'45.72"E	C - Moderately modified	D - Largely modified.
18	Depressional Pan Wetland	26° 9'9.48"S and 28°47'4.05"E	C - Moderately modified	D - Largely modified.

Nr	Affected Watercourse	Approximate Coordinates	Present Ecological State Score	Ecological Importance and Sensitivity
19	Depressional Pan Wetland	26° 9'16.21"S and 28°47'11.25"E	C - Moderately modified	D - Largely modified.
20	Depressional Pan Wetland	26° 9'9.85"S and 28°47'23.45"E 28°29'5.18"S and 29° 8'40.92"E	C - Moderately modified	D - Low/Marginal
21	Depressional Pan Wetland	26° 8'59.31"S and 28°47'8.85"E	C - Moderately modified	D - Largely modified.
22	Depressional Pan Wetland	26° 9'14.70"S and 28°47'14.89"E	C - Moderately modified	D - Largely modified.
23	Depressional Pan Wetland	26°10'27.69"S and 28°43'3.56"E	D - Largely modified	C - Moderate
24	Depressional Pan Wetland	26°11'27.01"S and 28°44'58.52"E	E – Greatly modified	D - Largely modified.
25	Seepage Wetland	26° 9'58.17"S and 28°41'14.04"E	C - Moderately modified	D - Largely modified.
26	Seepage Wetland	26°11'50.98"S and 28°45'46.79"E	D - Largely modified	D - Largely modified.
27	Seepage Wetland part of site specific site	26°11'13.41"S and 28°44'19.57"E	E – Greatly modified	D - Largely modified.
28	Seepage Wetland	26° 9'1.61"S and 28°46'55.63"E	D - Largely modified	D - Largely modified.
29	Seepage Wetland	26° 9'46.86"S and 28°42'52.35"E	D - Largely modified	C - Moderate
30	Seepage Wetland	26° 8'57.84"S and 28°43'26.19"E	C - Moderately modified	C - Moderate
31	Seepage Wetland	26°11'7.26"S and 28°43'44.82"E	E – Greatly modified	D - Largely modified.
32	Seepage Wetland	26° 9'54.13"S and 28°43'58.79"E	E – Greatly modified	D - Largely modified.

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1 INTRODUCTION

Limosella Consulting was appointed by Nsovo Consulting to conduct an update of the 2012 Wetland Consulting Services wetland delineation and assessment report for the Exxaro DCM West, (approximately 4 260 hectares) to inform the Water Use License Application (WULA) of the proposed expansion of the current Leeuwpan opencast mine. A special emphasis was placed on the proposed expansion through two wetlands, one pan wetland and one hillslope seepage wetland. The current report is based on previous wetland studies conducted by Wetland Consulting Services (2012) and three site visits conducted on the 10th November 2018, the 9th of January 2019 and the 5th of February 2019. In support of the wetland assessment, a risk assessment and the outcome is presented in this report.

1.1 Terms of Reference

The terms of reference for the study were as follows:

- Review and verification of the wetland assessments conducted for the Leeuwpan Exxaro Mine, with special emphasis on the newly planned mining area which includes two pan wetlands and a seepage wetland;
- Undertake functional and integrity assessment of wetlands areas within the expansion area assessed as specified in General Notice 267 of 24 March 2017;
- Undertake an impact assessment as specified in the NEMA 2014 regulations;
- Undertake a risk assessment as specified in General Notice 509 in published in the Government Gazette 40713 of 24 March 2017;
- Recommend suitable buffer zones as specified in General Notice 267 of 24 March 2017, following Macfarlane et al 2015.

1.2 Assumptions and Limitations

- The information provided by the client forms the basis of the planning and layouts discussed.
- All wetlands within 500m of any developmental activities should be identified as per the DWS regulations. In order to meet the timeframes constraints for the project, wetlands within the study sites were verified 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 three site visits 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, therefore vegetation identification in these areas thus have a low confidence score.
- **Some sections of the study area were not accessible during the site visit. Wetlands here have been delineated using aerial photography and other visual cues. This area should ideally be assessed during a follow up study.**

1.3 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 No. 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 and vegetation adapted to or tolerant of saturated soils (DWA, 2005).

Riparian habitat often times 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 any activity 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 of 2016 regarding 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 the registered with the responsible authority. Any activity that is not related to the rehabilitation of a wetland and which takes place within 500 m of a wetland are excluded from a GA under either of these regulations, unless the impacts score as low in the requires risk assessment matrix (DWS, 2016) Such an activity requires 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 No. 107 of 1998) [NEMA].
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).
- National Environment Management Protected Areas Act, 2003 (Act No. 57 of 2003).
- Regulations GN R.982, R.983, R. 984 and R.985 of 2014, promulgated under NEMA.
- Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983).
- Regulations and Guidelines on Water Use under the NWA.
- South African Water Quality Guidelines under the NWA.
- Mineral and Petroleum Resources Development Act, 2002 (Act No. 287 of 2002).
- GN 267 (Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals)

1.4 Locality of the study site

The study site is located east of Delmas, between the N12 and the N17 in the Mpumalanga Province. The approximate central coordinates of the study site are 26°10'20.29"S and 28°44'49.72"E (Figure 1).

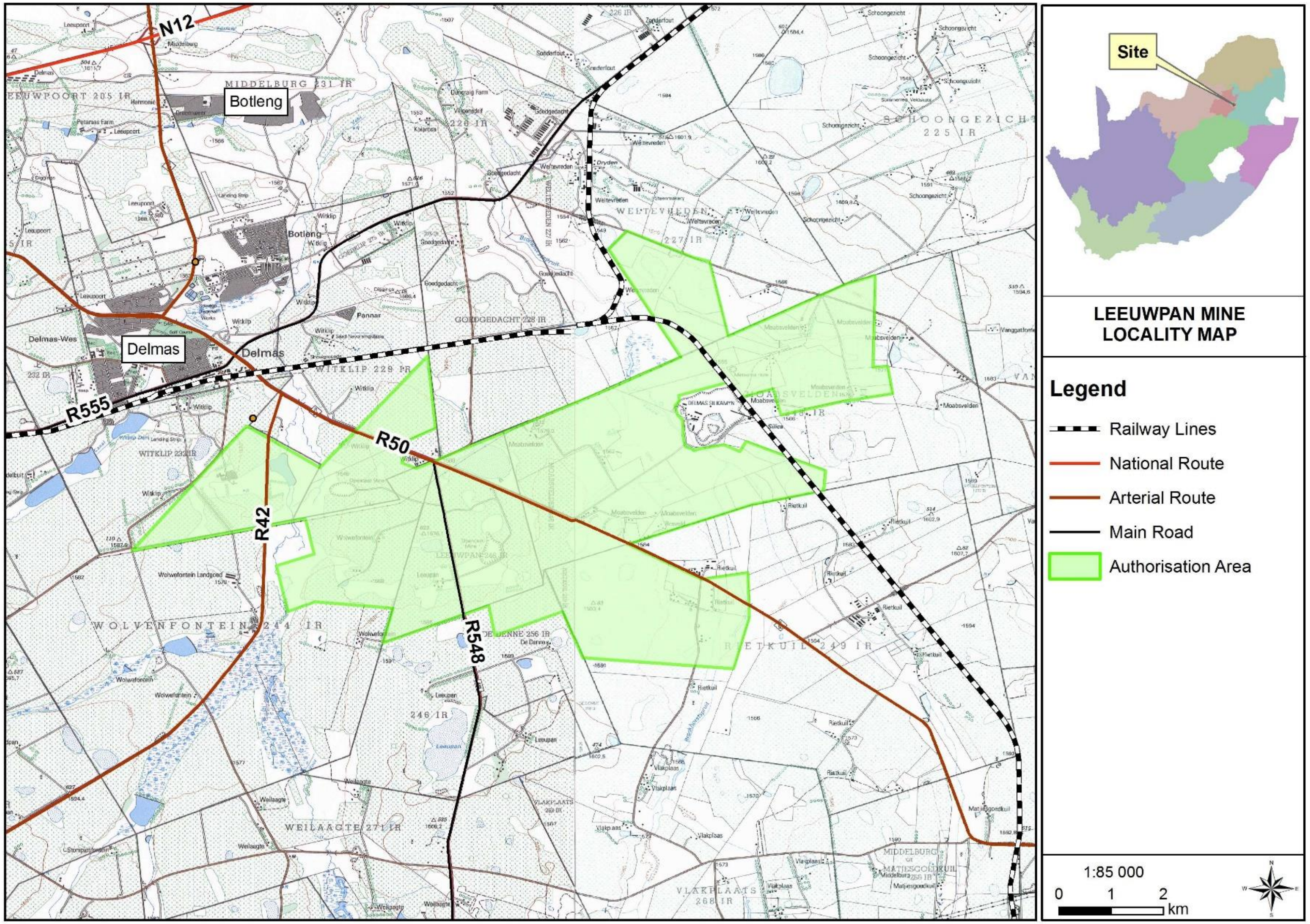


Figure 1: Locality Map

1.5 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 site is situated in Quaternary Catchment B20A. In this catchment, the precipitation rate is lower than the evaporation rate with a Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) of 0.32. 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 Government Gazette, 16 September 2016. The Quaternary Catchments B20A fall within the second WMA, the Olifants Major WMA. The major rivers that are located within this WMA include the Elands-, Wilge-, Steelpoort-, Olifants and Letaba Rivers. The main river associated with the study site is the Bronkhortspruit River and several smaller unnamed tributaries of the Bronkhorstspruit River.

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 and perennial streams and numerous wetlands are located within the study site. The wetland vegetation associated with the study site is predominantly Mesic Highveld grassland Group 4 with a small section located in Group 3.

Regional Vegetation:

According to the Vegetation Map of South Africa, Lesotho and Swaziland *sensu* Mucina & Rutherfors (2006), the majority of the study site is located on an area classified as Eastern Highveld Grassland with a small area (associated with the western tributary) located on Soweto Highveld Grassland. Furthermore, one small section (now mined) is classified as Eastern Temperate Freshwater Wetlands (Table 1).

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

Name of Vegetation type (Mucina & Rutherford, 2006)	Eastern Highveld Grassland	Soweto Highveld Grassland	Eastern Temperate Freshwater Wetlands
Relation to Study Site	Majority of the study site	Western Section Associated with the tributary of the Bronkhorstspruit River	One small section now mined

Name of Vegetation type (Mucina & Rutherford, 2006)	Eastern Highveld Grassland	Soweto Highveld Grassland	Eastern Temperate Freshwater Wetlands
Code as used in the Book	Gm 12	Gm 8	AZf 3
Conservation Target (percent of area)	24%	24%	24%
Description of conservation status	Endangered	Endangered	
Threats and uses	Some 44% transformed primarily by cultivation, plantations, mines, urbanisation and by building of dams. Cultivation may have had a more extensive impact, indicated by land-cover data. No serious alien invasions are reported, but *Acacia mearnsii* can become dominant in disturbed sites.	Almost half of the area already transformed by cultivation, urban sprawl, mining and building of road infrastructure. Some areas have been flooded by dams	Some 15% has been transformed to cultivated land, urban areas or plantations. In places intensive grazing and use of lakes and freshwater pans as drinking pools for cattle or sheep cause major damage to the wetland vegetation.

Geology and soils:

The geology of the site is underlain by Dwyka Group, Karoo Supergroup and Malmani Subgroup, Chuniespoort Group in the west as well as a small section of Malmani Subgroup, Chuniespoort Group located in the east. The remainder of the study area is underlain by the Madzanringwe Formationm, Karoo Supergroup. The northernmost section of the site is underlain by Pretoria Group, Transvaal Supergroup (Figure 4).

The regional soil classification for the area is summarised in the table and figures below (Figure 5, Figure 6 & Table 2):

Table 2: Soil types associated with the proposed study site and surroundings.

Soil Class (ARC, 2013) & Soil/Landtype	Description	Relevance to wetlands (Fey, 2005)	Relevance to Specific Study Site Area
S2	Freely drained, structureless soils, Favourable physical properties. May have restricted soil depth, excessive drainage, high erodibility, low natural fertility	None	Middle northern section

Soil Class (ARC, 2013) & Soil/Landtype	Description	Relevance to wetlands (Fey, 2005)	Relevance to Specific Study Site Area
S3	Red or yellow structureless soils with a plinthic horizon,	Favourable water-holding properties, Imperfect drainage unfavourable in high rainfall areas	Majority of the study site
S11	Poorly drained swelling clay soils	Wetness; very plastic and sticky	Small area associated with the western tributary of the Bronkhorstspruit River.
Ea15	One or more of: vertic, melanic, red structured diagnostic horizons, undifferentiated. Alluvium; dolerite; sandstone and shale of the Ecca Group, Karoo Sequence.	None	Small area associated with the western tributary of the Bronkhorstspruit River
Bb3	Plinthic catena: dystrophic and/or mesotrophic; red soils not widespread, upland duplex and margalitic soils rare. Shale, sandstone, clay, conglomerate, limestone and marl of the Ecca Group; shale and tillite of the Dwyka	None	Majority of the study site
Ba2	Plinthic catena: dystrophic and/or mesotrophic; red soils widespread, upland duplex and margalitic soils rare. Shale and sandstone of the Ecca Group, Karoo Sequence; dolerite; granite and gneiss.	None	Middle northern section

Mpumalanga 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 sectors 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 critical biodiversity areas (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 is 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 has 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 promoting the effective management of biodiversity as required in Section 41(a) of the 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 predominantly located on heavily/moderately modified areas with some areas described as "other natural areas". Only three small sections are described as a CBA (Figure 7).

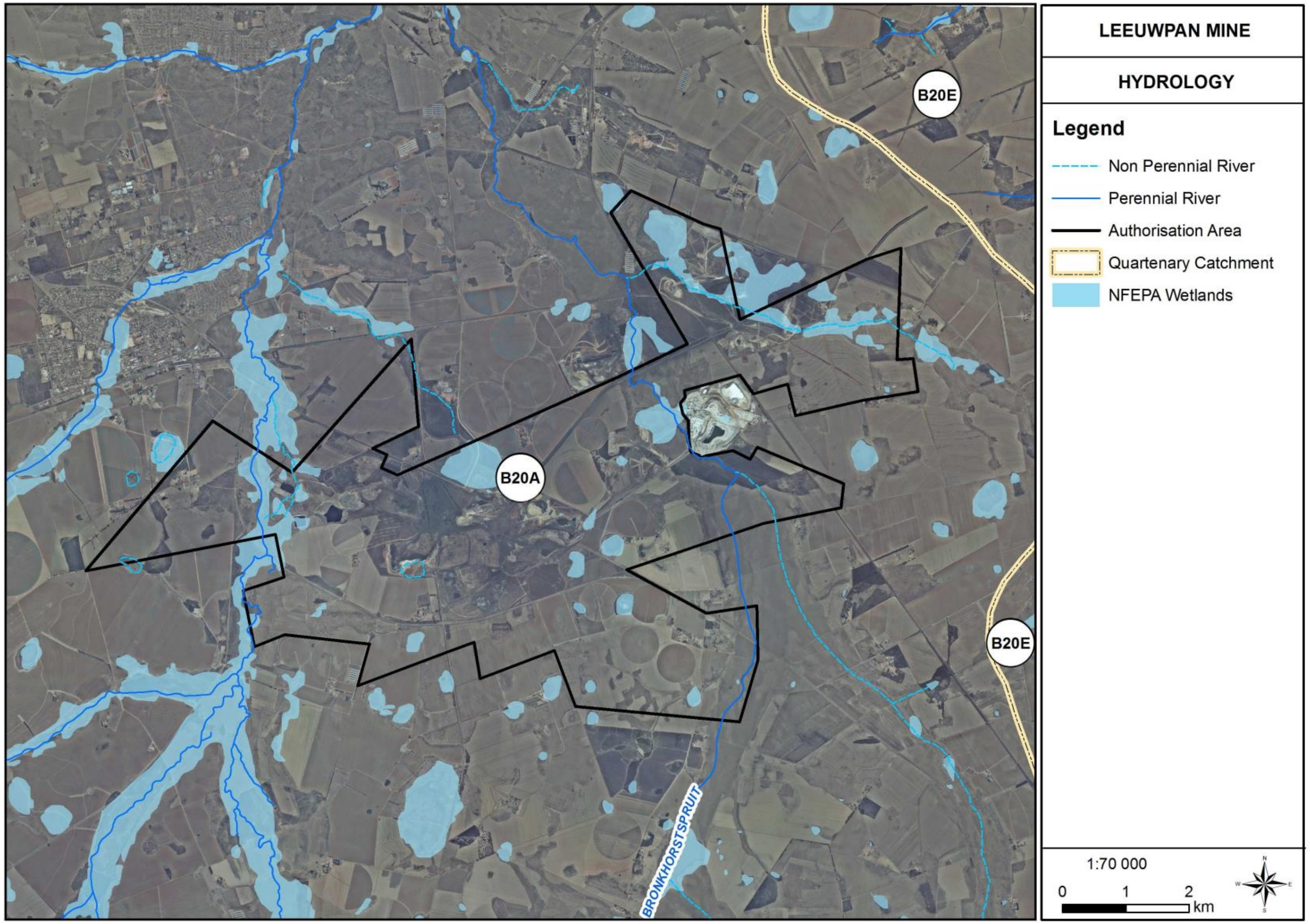


Figure 2: Regional hydrology

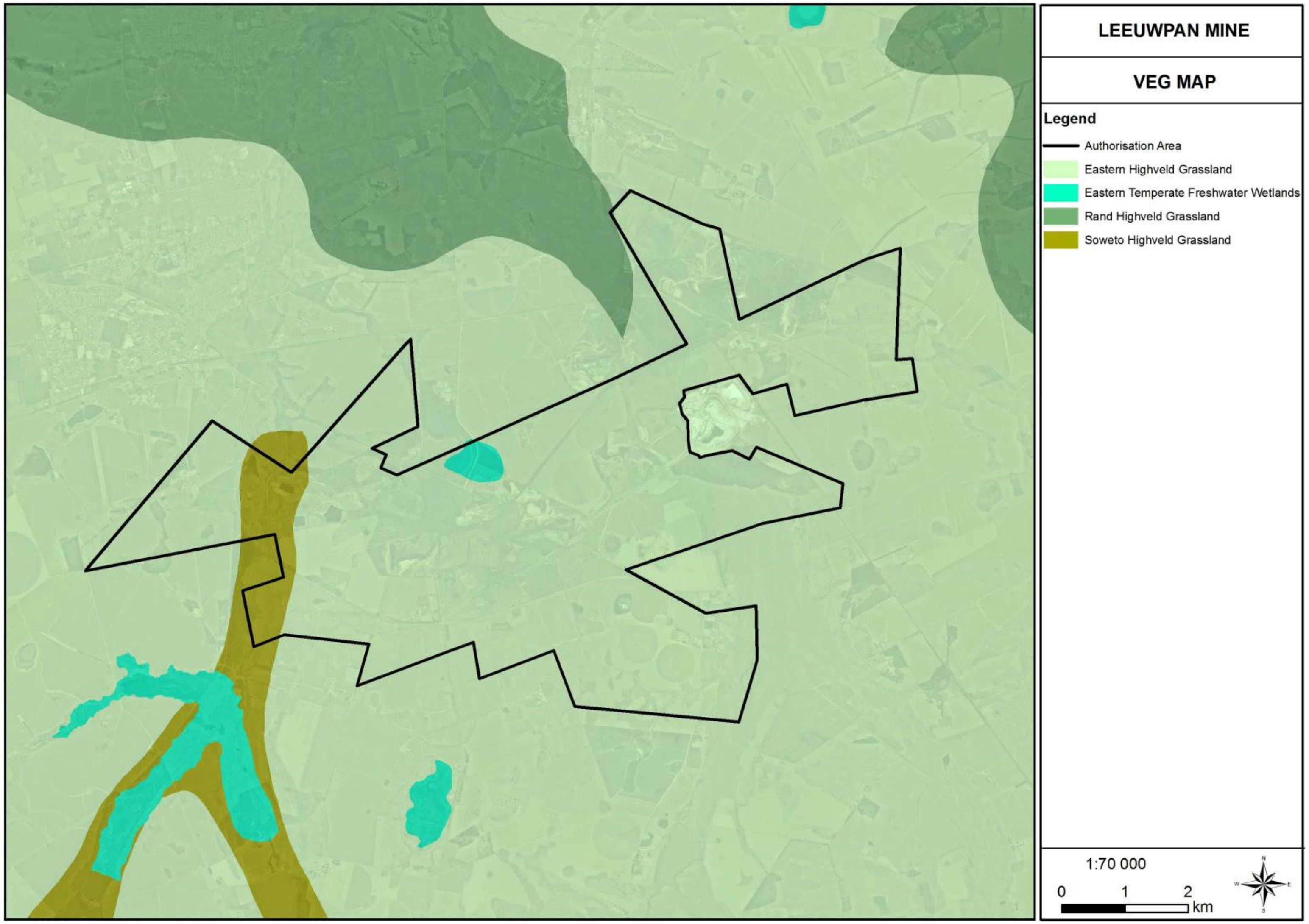


Figure 3: Vegetation of the study site.

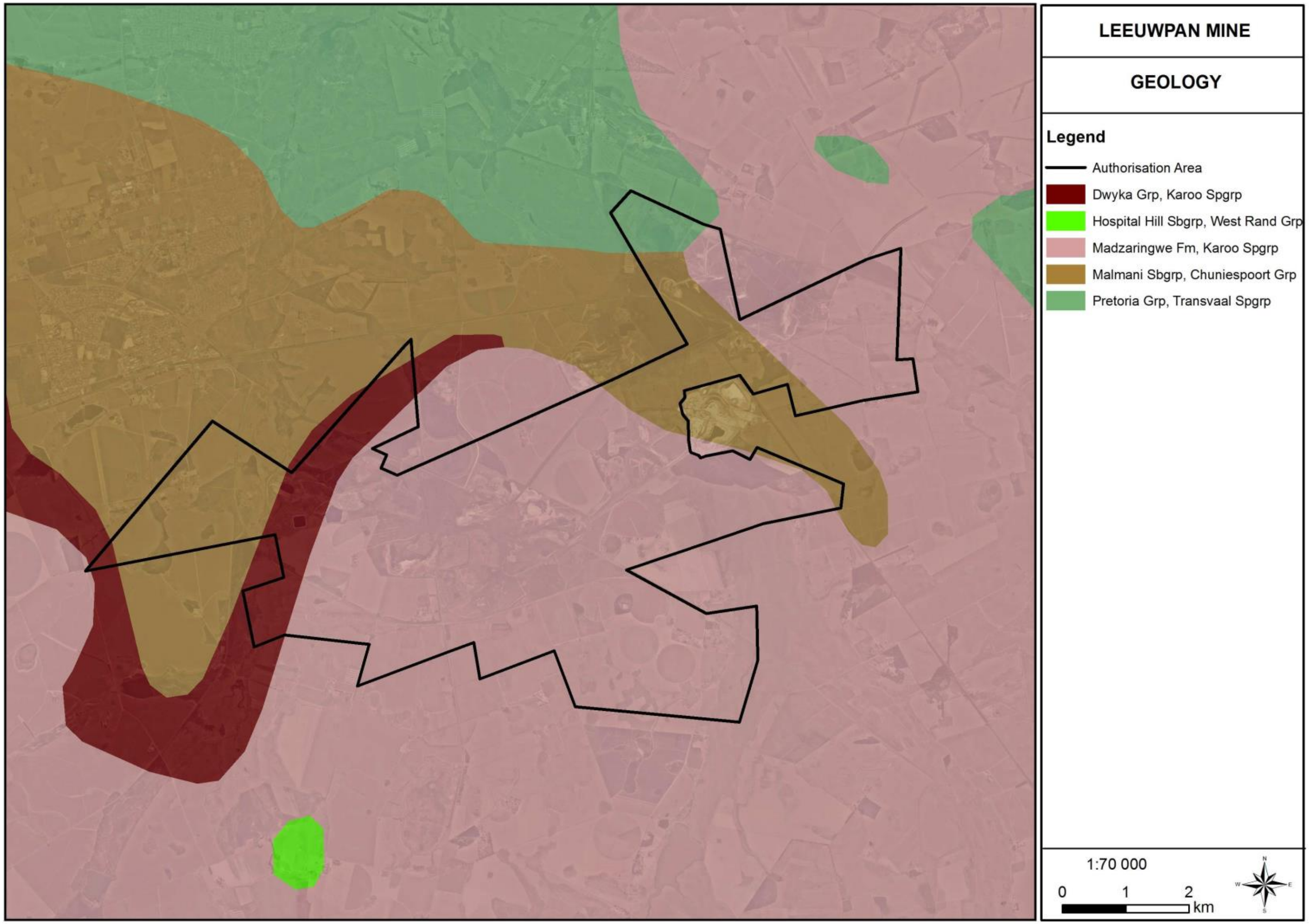


Figure 4: Regional geology of the area (ENPAT).

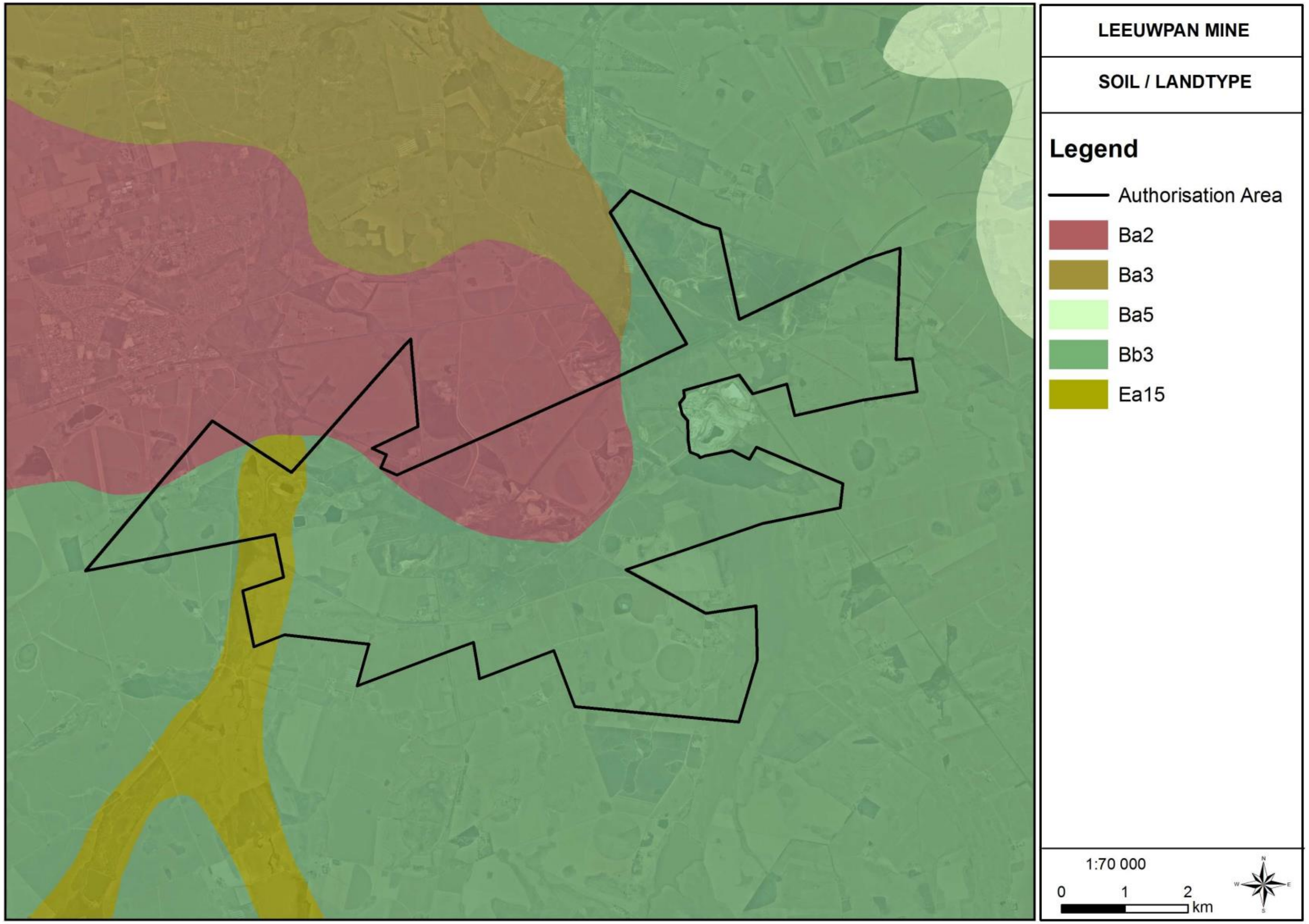


Figure 5: Regional soil of the area.

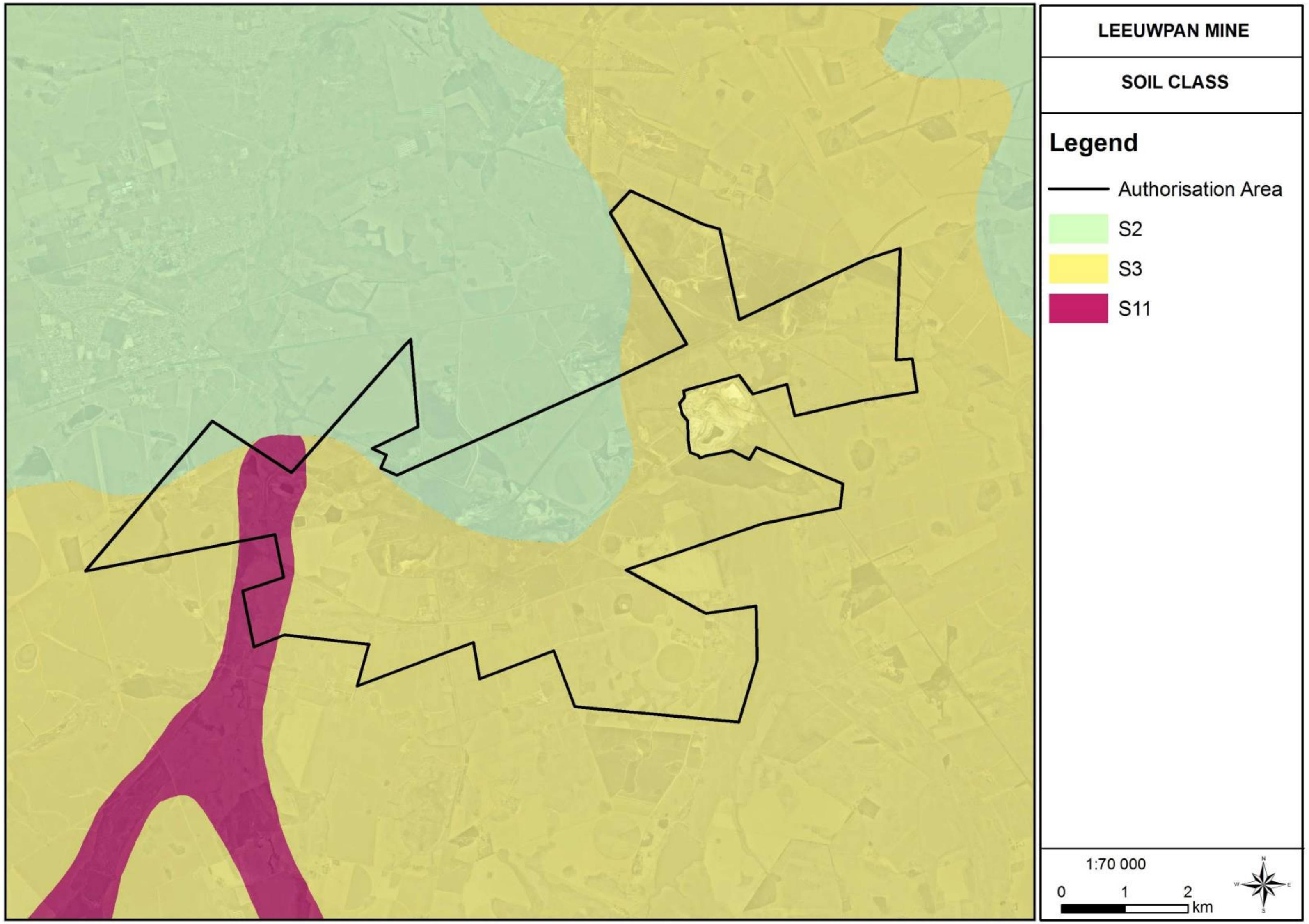


Figure 6: Soil class of the mining area and surrounding area.

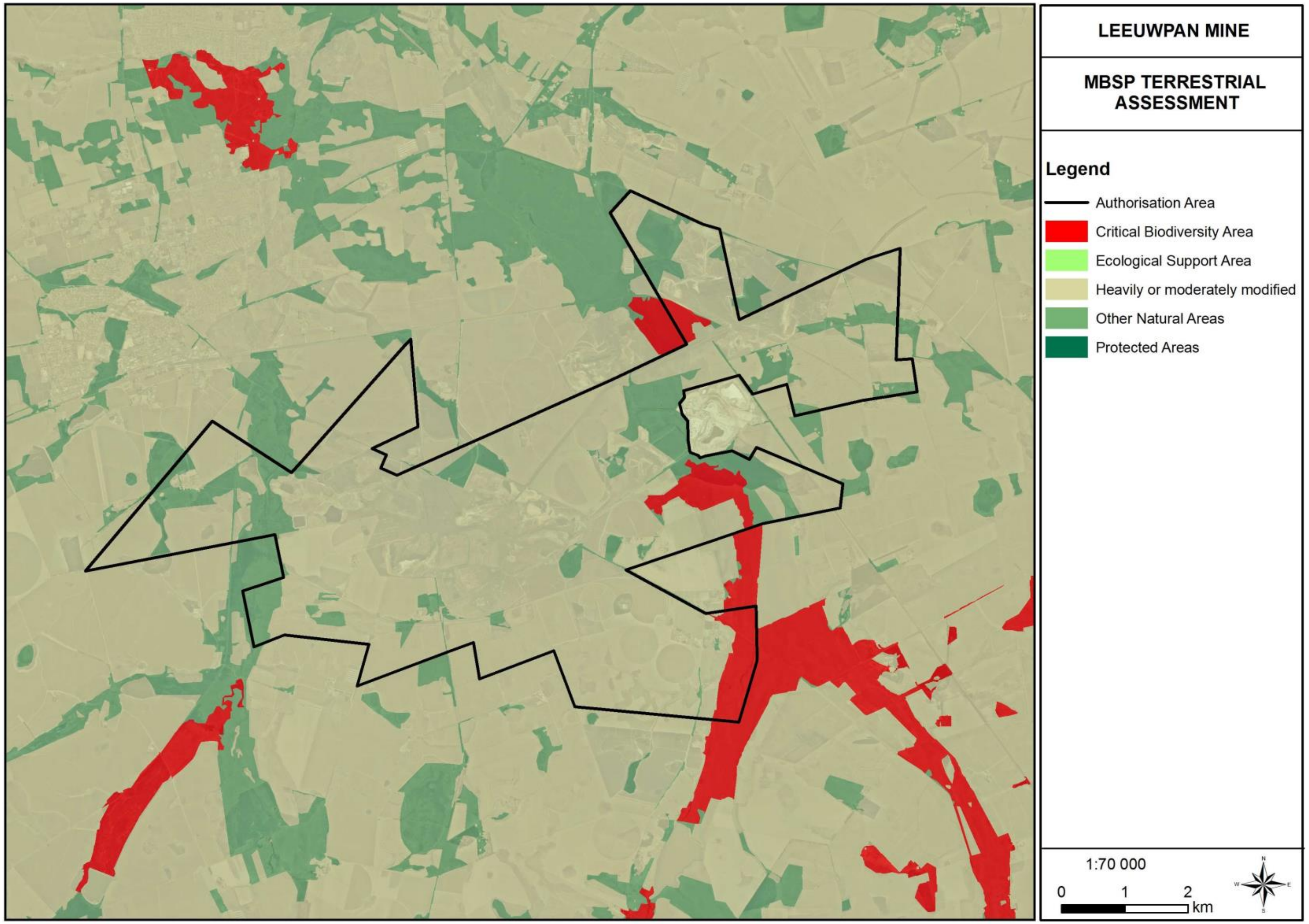


Figure 7: Mpumalanga Conservation Areas associated with the study site.

2 METHODOLOGY

The delineation method documented by the Department of Water Affairs and Forestry 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 the *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 hand held 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 utilizes 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. The wetland delineation and assessment report submitted by the TUT (2009) was also used as a reference against which field data collected during the current assessment was verified.

<u>Desktop Delineation</u>

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;
- SA Water Resources, such as National Freshwater Ecosystem Priority Areas (NFEPA);
- 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.

<u>Ground Truthing</u>

Wetlands were identified based on one or more of the following characteristic attributes (DWAF, 2005) (Figures 8 & Figure 9):

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur (Figure 7 and Figure 8);
- 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.

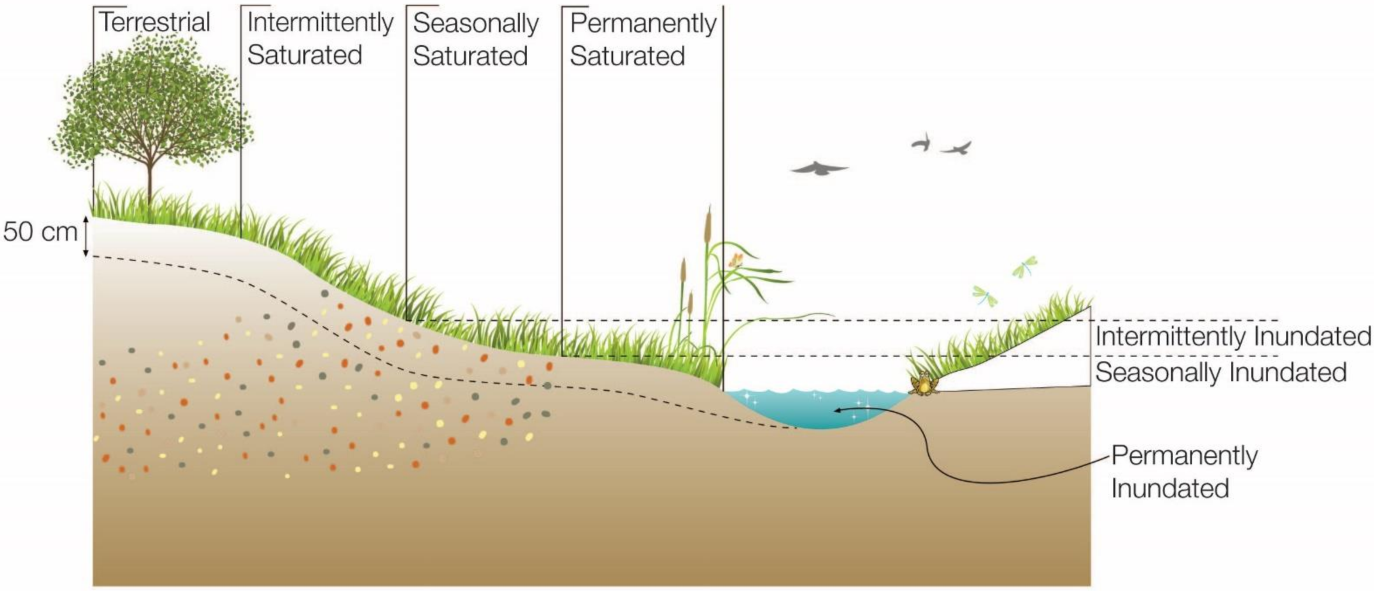


Figure 8: Typical cross section of a wetland (Ollis, 2013)

<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 10).

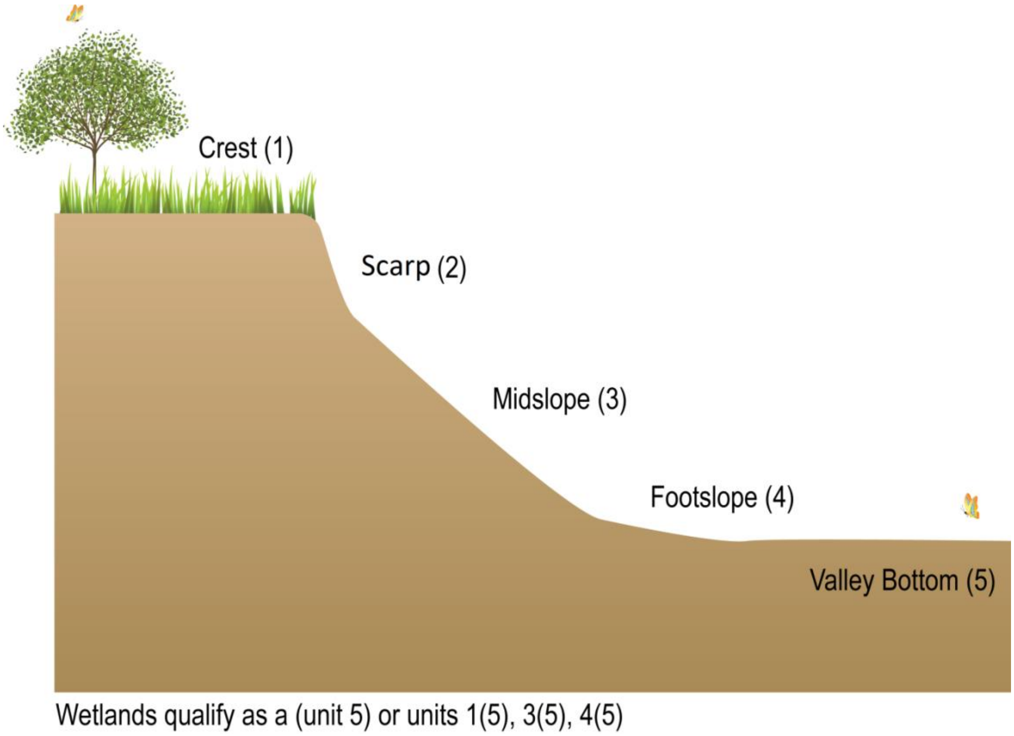


Figure 9. Terrain units (DWAF, 2005).

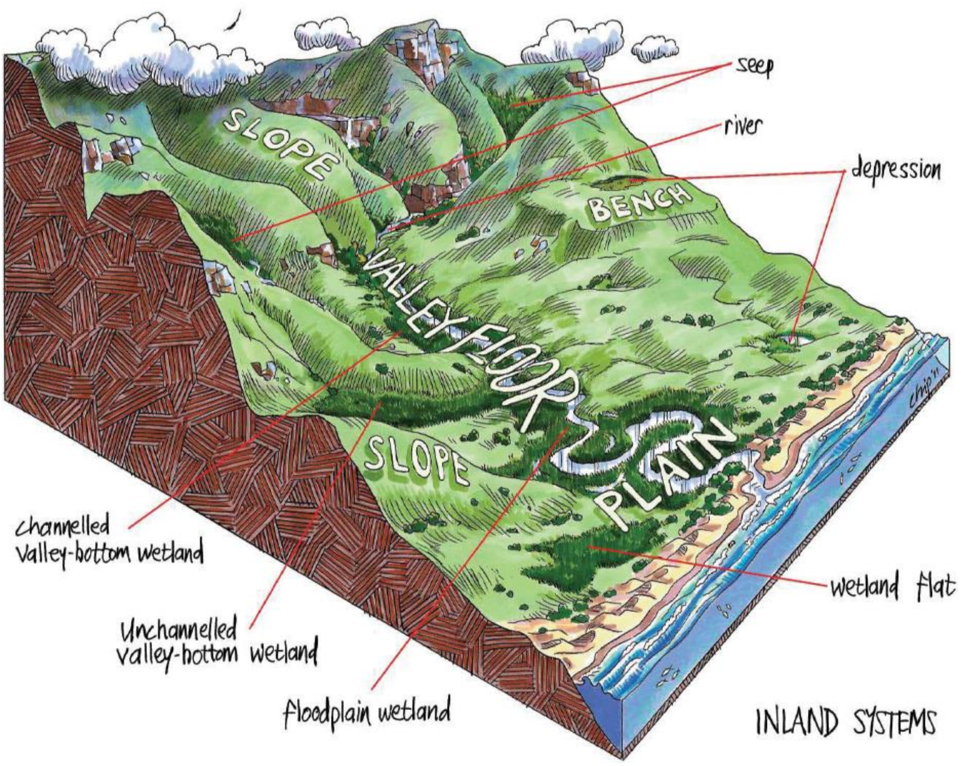


Figure 10: Wetland Units based on hydrogeomorphic types (Ollis *et al.* 2013)

Difficult to Delineate Wet Areas

Table 3 summarises the types of difficult wetland/ wetland-like areas and the best approach to take in such circumstances.

Table 3: 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 (e.g. annual vegetation or seasonal saturation)	• Thoroughly document soil and landscape conditions, develop rationale for considering the area to be a wetland. • Recommend that the site be revisited in the wet season.
Some, or all, wetland indicators are absent due to human disturbance (e.g. vegetation has been cleared, wetland has been ploughed or filled)	• Thoroughly document landscape conditions and any remnant vegetation, soil, hydrology indicators, develop rationale for considering the area to be wetland. • Certain cases (illegal fill) may justify that the fill be removed and the wetland rehabilitated.

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 11).

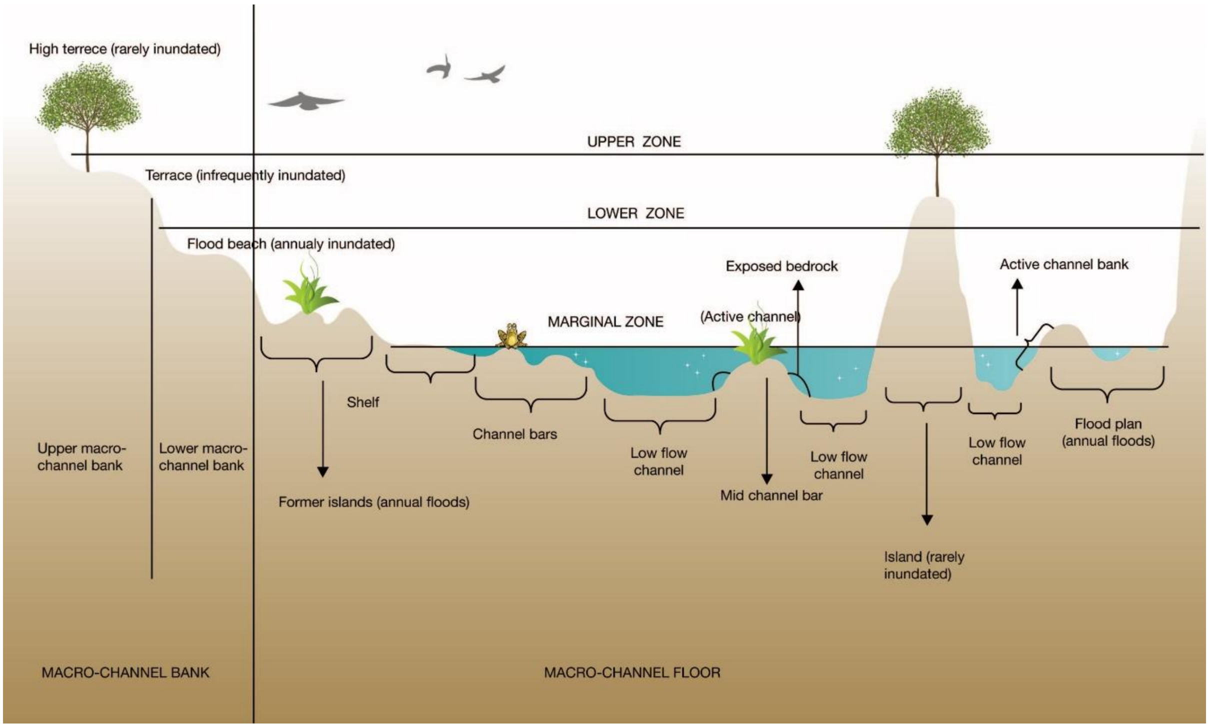


Figure 11: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans *et al*, 2007)

The vegetation of riparian areas is divided into three zones, the marginal zone, lower non-marginal zone and the upper non-marginal zone (Table 4). The different zones have different vegetation growth.

Table 4: Description of riparian vegetation zones (Kleynhans *et al*, 2007).

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

Riparian Area:

A riparian area can be defined as a linear fluvial, eroded landform which carries channelized flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The "river" includes both the active channel (the portion which carries the water) as well as the riparian zone (Figure 12) (Kotze, 1999).

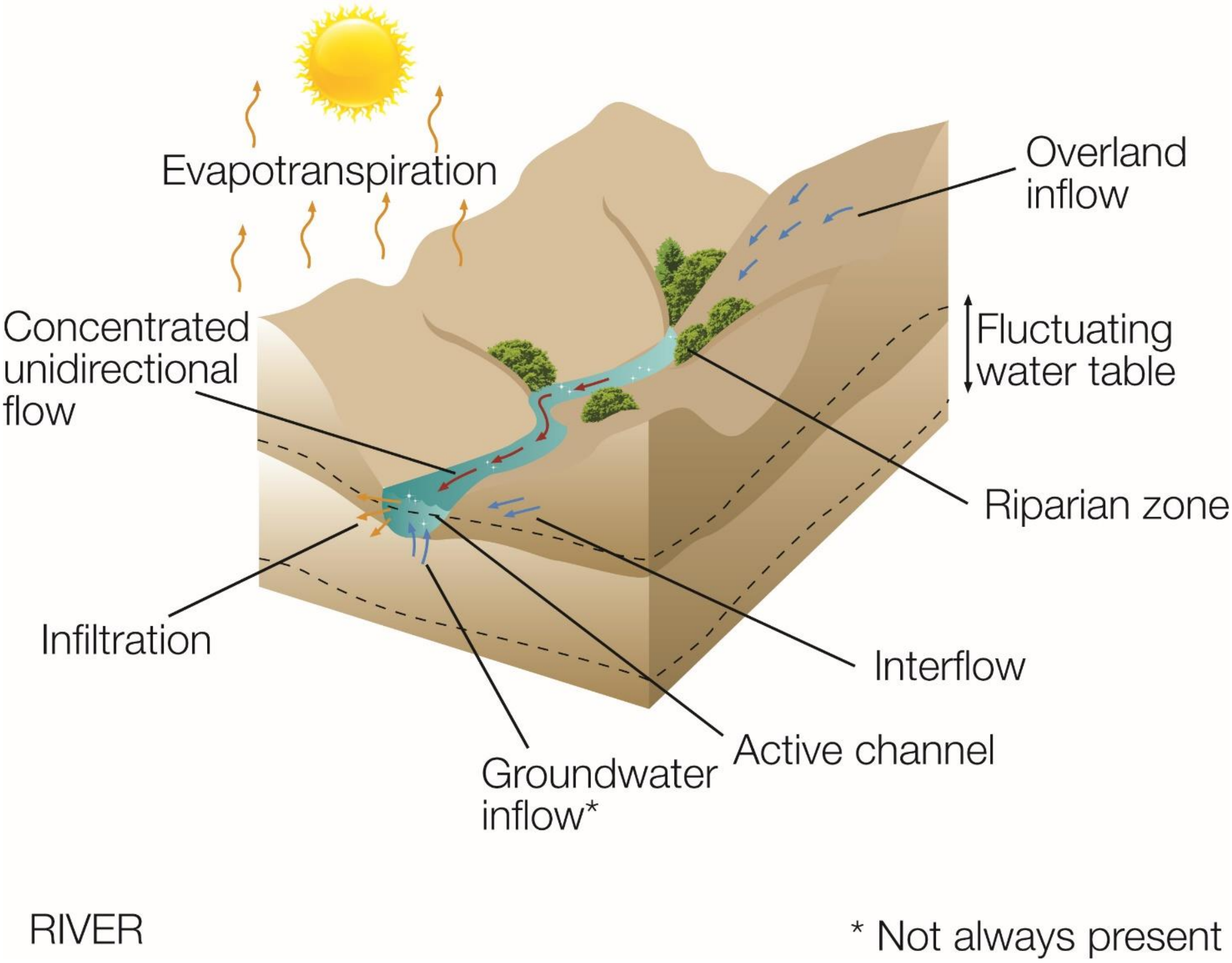


Figure 12: A schematic representation of the processes characteristic of a river area (Ollis *et al*, 2013).

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 13). 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.

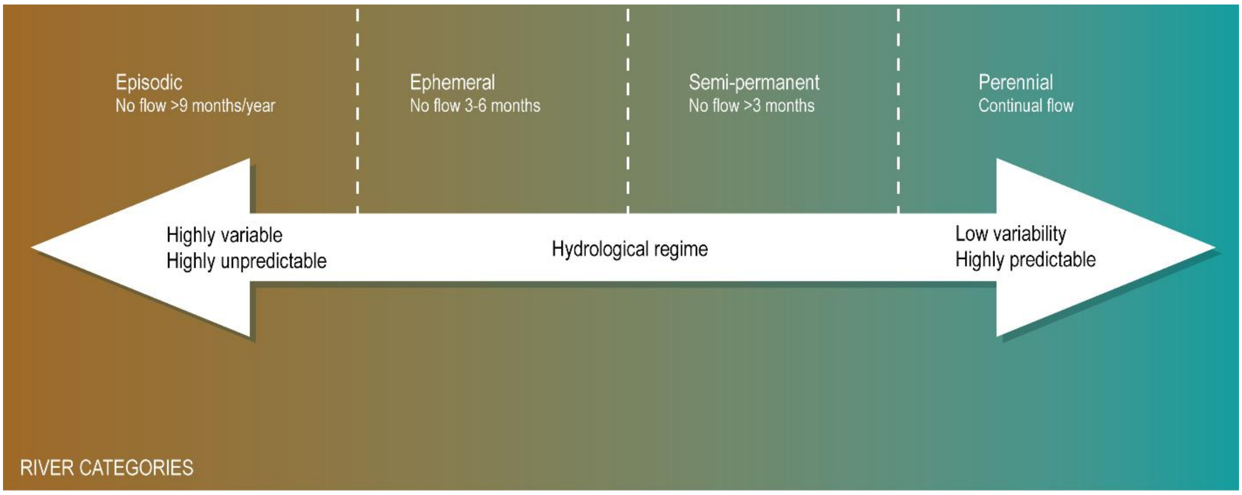


Figure 13: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman *et al*, 2010).

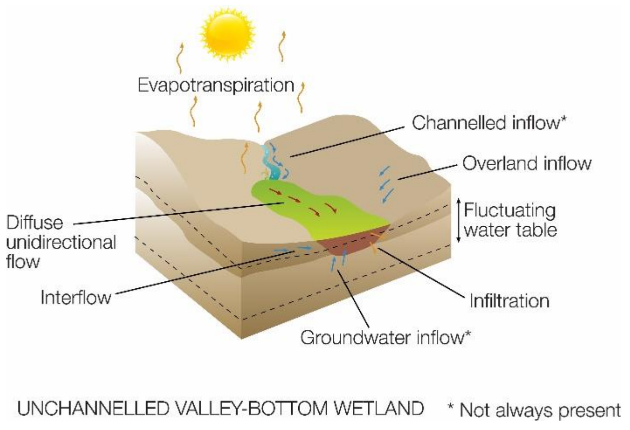
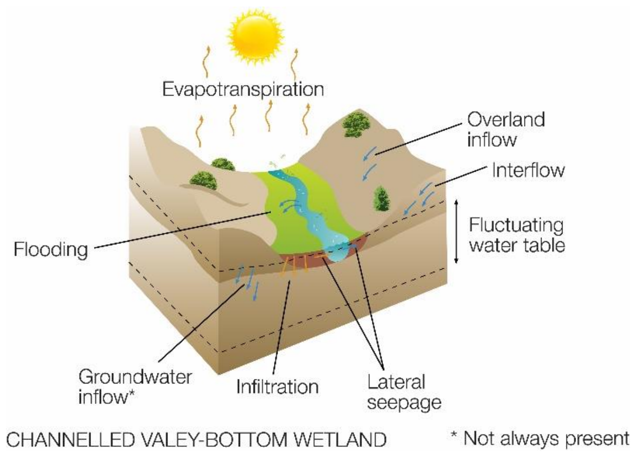
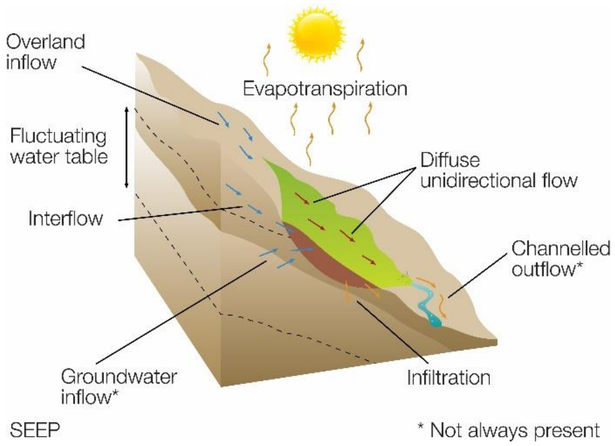
2.2 Wetland Classification and Delineation

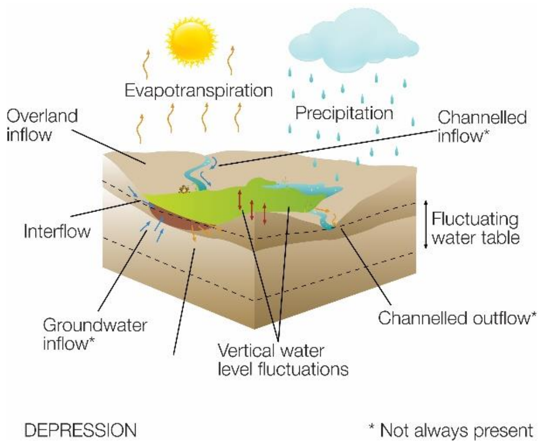
The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification (SANBI, 2009). The current wetland study follows the same approach by classifying wetlands in terms of a functional unit in line with a level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

- Geomorphic setting - This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
- Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; 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 5):

Table 5: Wetland Types and descriptions

<table>
<tr><th>Wetland Type:</th><th>Description:</th></tr>
<tr><td>Valley bottom without a channel

</td><td>Linear fluvial, net depositional valley bottom surfaces which do not have a channel. The valley floor is a depositional environment composed of fluvial or colluvial deposited sediment. These systems tend to be found in the upper catchment areas, or at tributary junctions where the sediment from the tributary smothers the main drainage line.</td></tr>
<tr><td>Valley bottom with a channel

</td><td>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.</td></tr>
<tr><td>Seepage Wetlands

</td><td>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).</td></tr>
</table>

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 include (i) maintaining basic hydrological processes; (ii) reducing impacts on water resources from upstream activities and adjoining landuses; (iii) providing habitat for various aspects of biodiversity. A brief description of each of the functions and associated services is outlined in Table 6 below.

Table 6: 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.

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 “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 ‘Mining - Worst Case Scenario) (Table 7):

Table 7: Indicating the calculated buffer zones (Macfarlane *et al*, 2015).

Wetland	Construction Phase	Operational Phase
Seepage Wetlands	50 m	79 m
Depressional Pan Wetlands	42 m	80 m
Unchannelled Valley Bottom Wetlands	58 m	92 m
Channelled Valley Bottom Wetlands	62 m	98 m

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

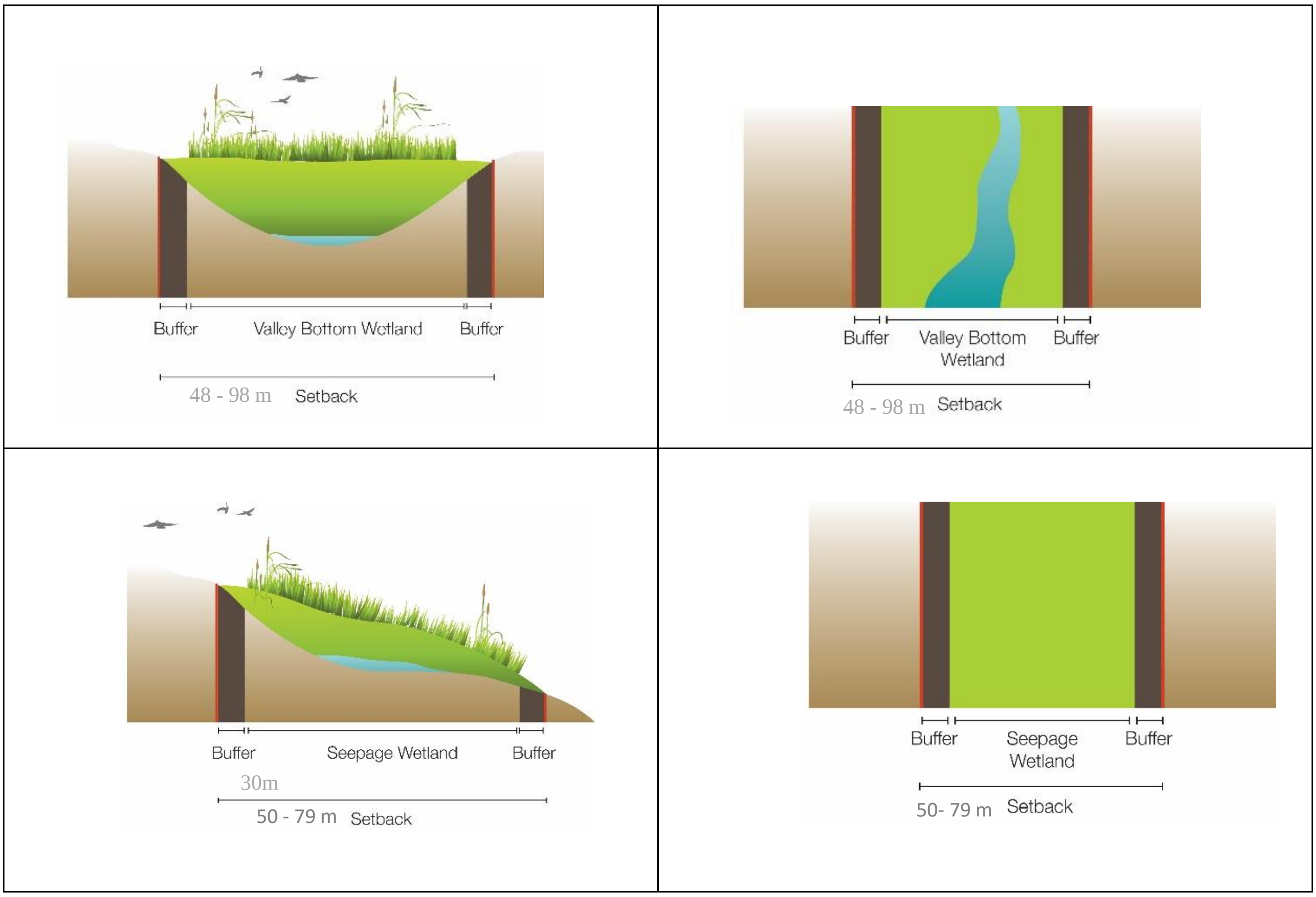


Figure 14: A represent the buffer zone setback for the watercourse types discussed in this report

2.4 Impact Assessments

2.4.1 <u>NEMA (2014) Impact Ratings</u>

As required by the 2014 NEMA regulations, impact assessment should provide quantified scores indicating the expected impact, including the cumulative impact of a proposed activity. This assessment follows the format presented below (Table 8 & Table 9):

Table 8: Criteria for Assessment of Impacts

Severity (Magnitude)	
The severity of the impact is considered by examining whether the impact is destructive or benign, whether it destroys the impacted environment, alters its functioning, or slightly alters the environment itself. The intensity is rated as	
(I)nsignificant	The impact alters the affected environment in such a way that the natural processes or functions are not affected.
(M)oderate	The affected environment is altered, but functions and processes continue, albeit in a modified way.
(V)ery High	Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.
Duration	

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

In order to assess each of these factors for each impact, the following ranking scales were used (Table 9).

Table 9: Assessment Criteria: Ranking Scales

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

Details of the significance of the various impacts identified are presented in Table 10 and Table 11.

Determination of Significance – With Mitigation

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

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

Identifying the Potential Impacts without Mitigation Measures (WOM)

Following the assignment of the necessary weights to the respective aspects, criteria are summed and multiplied by their assigned probabilities, resulting in a value for each impact (prior to the implementation of mitigation measures). Significance without mitigation is rated on the following scale (Table 10):

Table 10: Significance Rating Scales without mitigation

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

Identifying the Potential Impacts with Mitigation Measures (WM)

In order to gain a comprehensive understanding of the overall significance of the impact, after implementation of the mitigation measures, it will be necessary to re-evaluate the impact. Significance with mitigation is rated on the following scale (Table 11):

Table 11: Significance Rating Scales with mitigation

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

2.4.2 DWS (2016) Impact Ratings

Risk-based management has value in providing an indication of the potential for delegating certain categories of water use “risks” to DWS regional offices (RO) or Catchment Management Agencies (CMA). Risk categories obtained through this assessment serve as a guideline to establish the appropriate channel of authorisation of these water uses.

The DWS has therefore developed a risk assessment matrix to assist in quantifying expected impacts. The scores obtained in this assessment are useful in evaluating how the proposed activities should be authorised. The formula used to derive a risk score is as follows:

RISK = CONSEQUENCE x LIKELIHOOD

CONSEQUENCE = SEVERITY + SPATIAL SCALE + DURATION

LIKELIHOOD = FREQUENCY OF THE ACTIVITY + FREQUENCY OF THE IMPACT +LEGAL ISSUES + DETECTION

Table 12 below provides a description of the classes into which scores are sorted, and their implication for authorisation.

Table 12: An extract from DWS (2016) indicating the risk scores and classes as well as the implication for the appropriate authorization process

RATING	CLASS	MANAGEMENT DESCRIPTION	AUTHORISATION	DELEGATION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands are excluded.	GA	Regional Head
56 – 169	(M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.	WUL	Regional Head
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.	WUL	Director General

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, surface and groundwater volumes, amongst others, 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 assessment for the wetlands found on site is described in Table 13. 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 13: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*, 2007)

Description	Impact Score Range	PES Score	Summary
Unmodified, natural.	0.0.9	A	Very High
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B	High
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C	Moderate
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D	Moderate
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E	Low
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8.10	F	Very Low

A summary of the change class, description and symbols used to evaluate wetland health are summarised in Table 14.

Table 14: 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 represented are described in the results section. Explanations of the scores are given in Table 15.

Table 15: 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 16).

Table 16: 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 categories 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 a A, B, C or D category, 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 category is in 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 4272 hectares with current infrastructure of approximately 1879.04 hectares located on the study site. Roughly 44% of the study area is currently used for mining. Large section identified as wetland in WCS, (2012) has been irrevocably transformed by mining (Figure 16). The total area occupied by wetlands as delineated in the current report is 1120.56 hectares which equates to 26% of the total study site or 47% of the currently unmined area. It should be noted that these figures exclude the wetland buffer zones, which are likely to significantly increase this number. The remaining area is used for agriculture, infrastructure and some small structures. The land has thus been significantly changed from its original state (Figure 15).

A special emphasis in this report is a small area that is proposed to be mined where three wetlands (Two Depressional Pan wetlands and One Seepage Wetland) are also located (Specific Focus Study Site).

The approximate central coordinates of the focus specific study area are 26°11'15.51"S and 28°44'29.05"E (Figure 16). This area has also been affected by the expanding mine and a new road has been constructed through one of the wetlands (Figure 17).

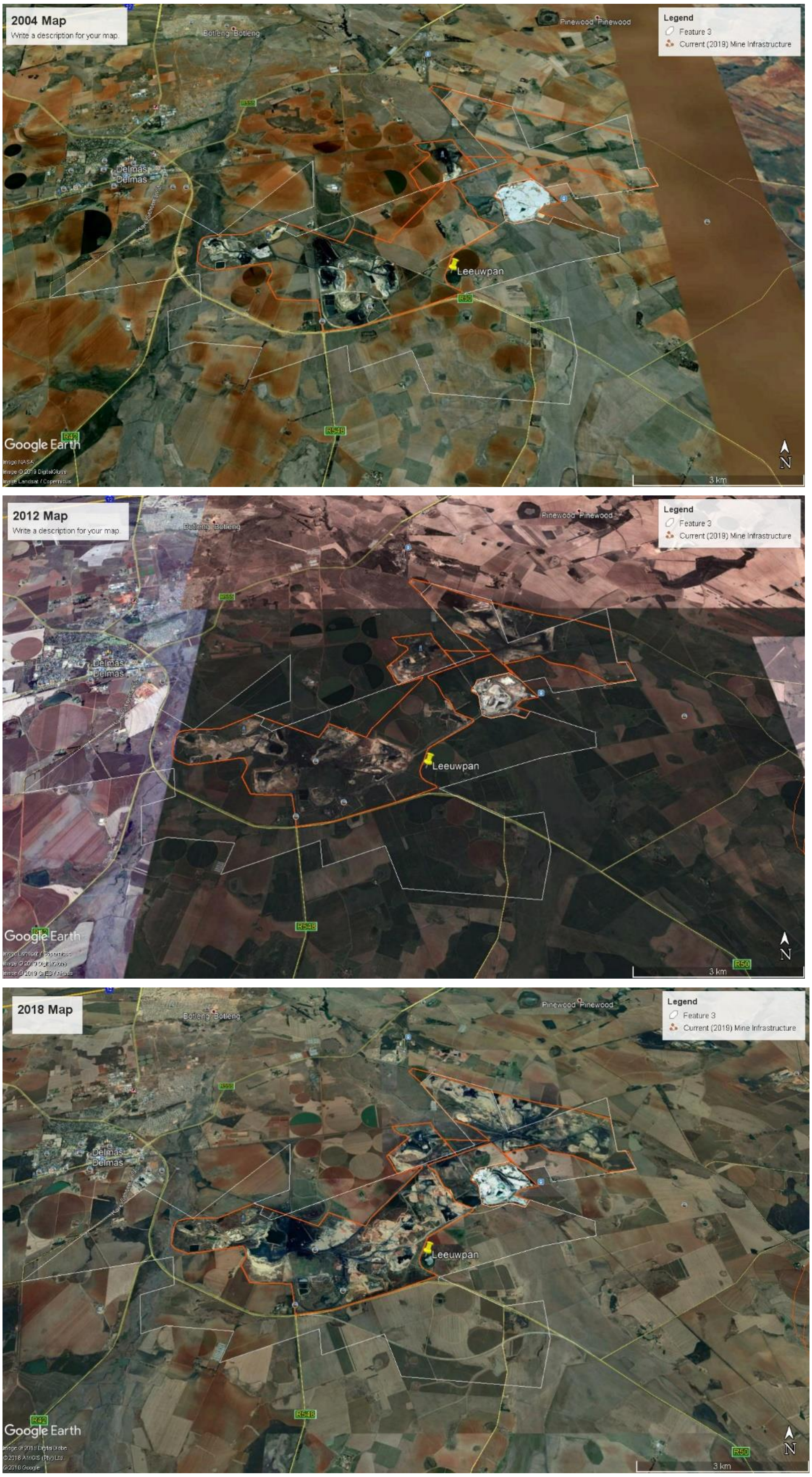


Figure 15: Aerial maps of 2004, 2012 (when WCS study was done) and 2018 comparing the increase in mining infrastructure. The orange polygon indicates the current mining footprint.

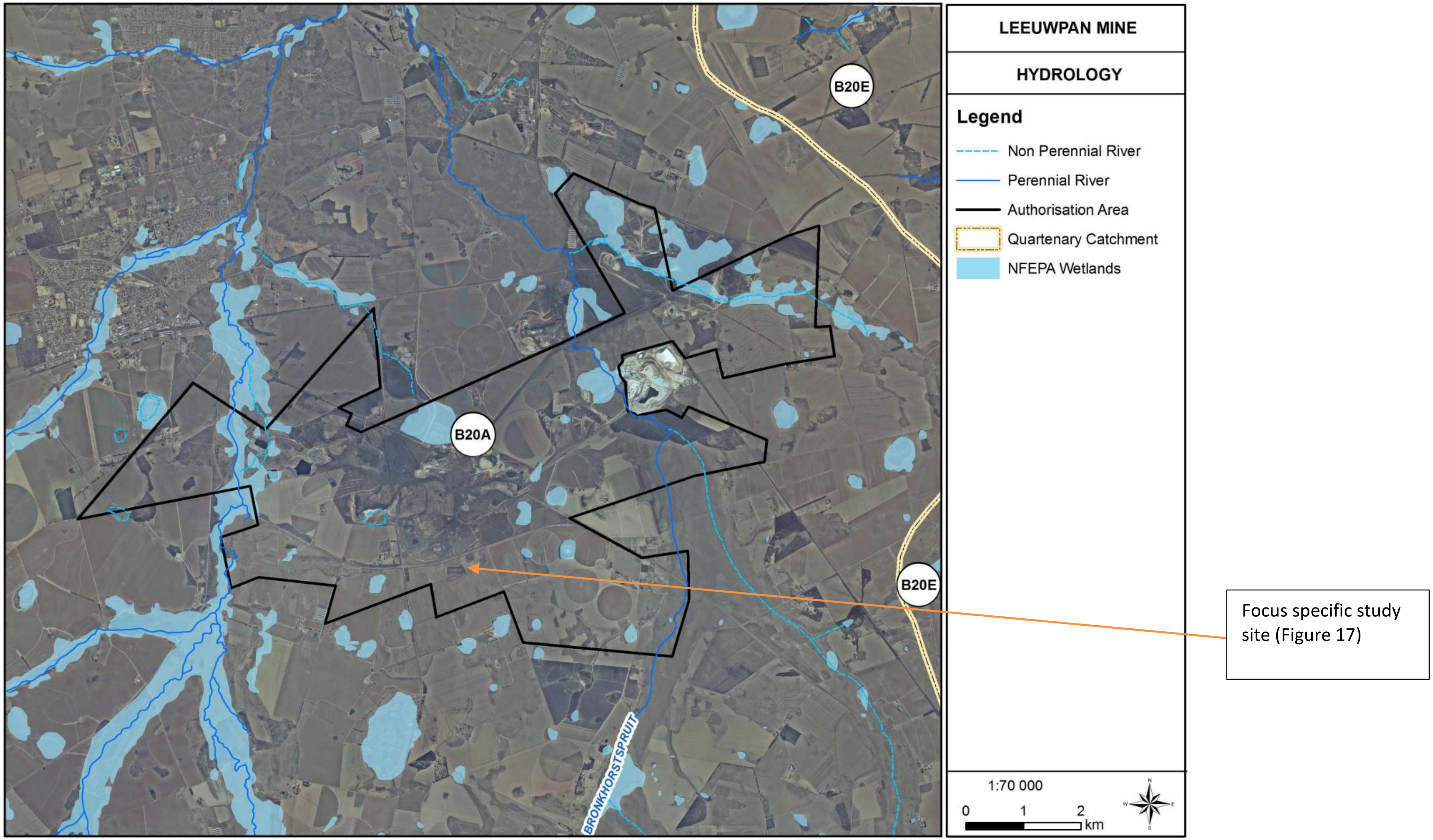


Figure 16: Study area as well as the Focus specific site area.

Figure 17: Focus specific study area (Blue triangle) indicated for new mining showing the change from 2011 (Top) to the current state (2018).

3.1.1 Watercourses

The wetlands identified in the WCS (2012) report were verified in the current study with good accuracy for the majority of the wetlands. Some wetlands have however irrevocably been transformed by mining activities while some were delineated smaller than in the WCS study due to transformation as a result of agricultural impacts. This is especially true for the depressional pan wetlands located within agricultural areas. The layers associated with this report should be compared to the WCS (2012) layers to compare the described differences in watercourses. The wetlands delineated and confirmed in the current study are represented in the figure below (Figure 18 & 19).

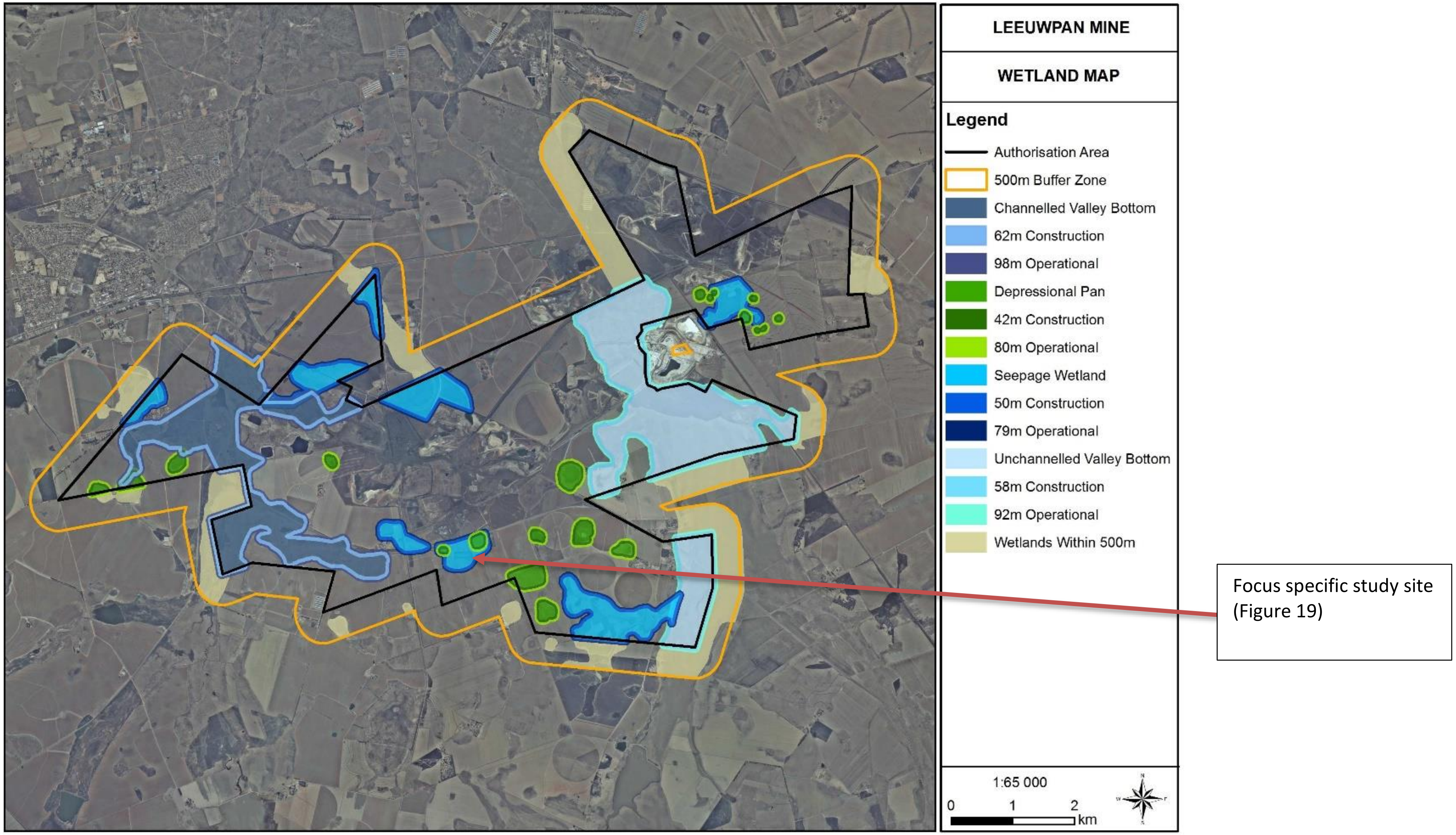


Figure 18: The Current 2019 wetland delineation and confirmation (with regards to previous studies) including buffer zones.

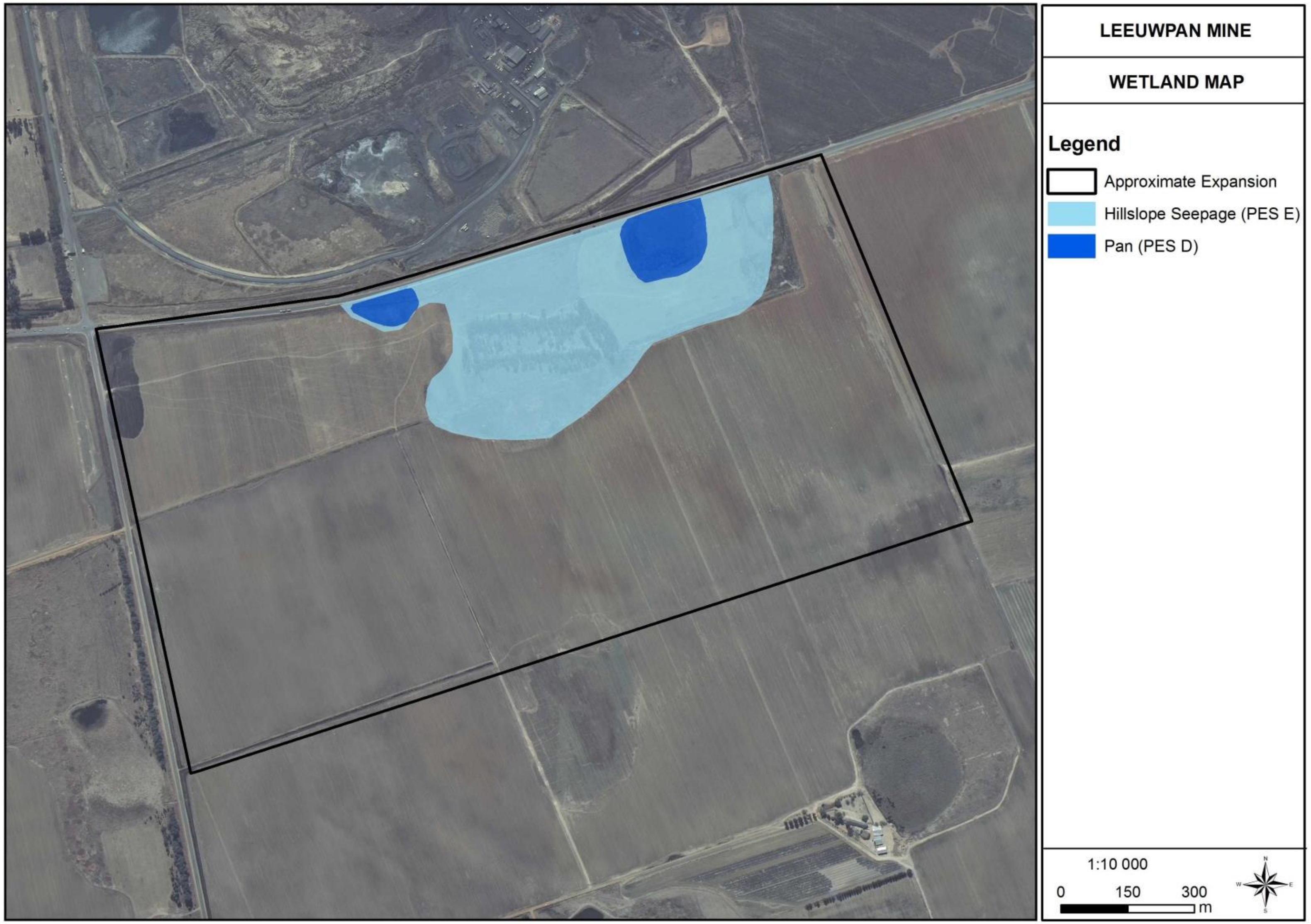


Figure 19: Focus specific study area without buffer zones.

3.1.2 Soil Indicators

Soil

Soil samples were taken throughout the wetlands of the study site to confirm the presence of wetland characteristics (Redoximorphic features) such as mottling, a gleyed matrix and Mangenese and/or Iron concretions. The wetlands of the study site were characterised by seasonal and permanent wet zones. The dominant soil form in the wetlands sampled were vertic dark clay soil, moderately to highly structured located in the tributary of the Bronkhorstspruit river. Several wetlands have been partially or completely mined with a greatly disturbed soil profile. The dominant soil features of the wetlands on the study site is visually represented in the table and figures below (Table 17, Figure 20).

Table 17: 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)?	Some areas
Indicators of soil wetness within 50 cm of soil surface:	
Sulfidic odour (a slight sulfidic odour was noted in permanent zone)	Yes
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 – Bronkhosrtspruit

Figure 20: Soil characteristics of the unchannelled valley bottom wetlands on the study site.

3.1.3 Vegetation Indicators

Since the study focused on confirming the presence of wetlands as delineated in the previous report (WCS, 2012) a complete plant species list is not available for all the wetlands. For the site specific area where mining is proposed a more detailed study was conducted. Some of the species recorded on the new study site pans and the seepage wetland includes *Hypoxis rigidula, Haplocarpha scaposa, Agapanthus africanus, Berkheya radula, Cyperus denudatus, Gladiolus crassifolius, Kyllinga erecta, Leersia hexandra, Ranunculus multifidus, Schoenoplectus decipiens, Oenothera rosea* and *Monopsis decipiens* (Figure 21). Some of the invasive species include a large patch of *Eucalyptus grandis* in the seepage wetland. The majority of pans in the area was dominated by *Leersia hexandra* as well some of *Phragmites australis* in the permanent wet areas. A complete list of species recorded in the wetlands and surroundings is available in previous reports (WCS, 2012).

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 267 published in the Government Gazette 40713 of 24 March 2017 regarding Section 21(c) and (i). 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 wetlands scored low in regards to cultural significance. The area has a low population density and the surroundings are actively mined and is not accessible to the general public. The new portion of the study site is directly adjacent to a mine and thus has been greatly impacted, furthermore, a new road goes through the study area and specifically the seepage wetland. Due to the close proximity of mines in the area the majority of wetlands are likely to contribute to water quality enhancement. 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 (especially depressional pan 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 including mining infrastructure, grazing, invasive species and erosion.

3.2.1 Present Ecological State & Ecological Importance and Sensitivity (EIS)

The components of the EIS and the PES score is summarised in Table 18 and Figure 23 & 24 below.

Table 18: The PES and EIS scores of the possibly affected watercourses on the study area as well as the three wetlands on the site specific study site where the proposed open cast mine is proposed.

Nr	Affected Watercourse	Approximate Coordinates	Present Ecological State Score	Ecological Importance and Sensitivity
1	Channelled Valley Bottom Wetland	26° 9'45.28"S and 28°42'9.95"E	D - Largely modified	B - High
2	Channelled Valley Bottom Wetland	26°10'16.43"S and 28°42'1.68"E	D - Largely modified	C - Moderate

Nr	Affected Watercourse	Approximate Coordinates	Present Ecological State Score	Ecological Importance and Sensitivity
3	Unchannelled Valley Bottom Wetland	**26°11'41.64"S and 28°46'33.97"E**	**C - Moderately modified**	**B - High**
4	Unchannelled Valley Bottom Wetland	**Crosses wetland at 28°19'16.92"S and 28°57'12.11"E**	**E – Greatly modified**	**D - Largely modified.**
5	Depressional Pan	**26°10'43.39"S and 28°40'48.52"E**	**C - Moderately modified**	**C - Moderate**
6	Depressional Pan	**26°10'40.26"S and 28°41'7.31"E**	**C - Moderately modified**	**C - Moderate**
7	Depressional Pan	**26°11'45.77"S and 28°45'11.11"E**	**D - Largely modified**	**D - Largely modified.**
8	Depressional Pan	**26°11'5.47"S and 28°45'4.84"E**	**E – Greatly modified**	**D - Largely modified.**
9	Depressional Pan	**26°11'3.94"S and 28°45'30.74"E**	**E – Greatly modified**	**D - Largely modified.**
10	Depressional Pan	**26°10'32.47"S and 28°45'23.09"E**	**D - Largely modified**	**D - Largely modified.**
11	Depressional Pan	**26°11'11.87"S and 28°45'54.52"E**	**E – Greatly modified**	**D - Largely modified.**
12	Depressional Pan on site specific site	**26°11'8.61"S and 28°44'29.97"E**	**D - Largely modified**	**D - Largely modified.**
13	Depressional Pan on site specific site	**26°11'13.60"S and 28°44'10.05"E**	**D - Largely modified**	**D - Largely modified.**
14	Depressional Pan Wetland	**26°10'29.18"S and 28°41'34.56"E**	**C - Moderately modified**	**C - Moderate**
15	Depressional Pan Wetland	**26° 8'57.28"S and 28°46'37.59"E**	**C - Moderately modified**	**C - Moderate**
16	Depressional Pan Wetland	**26° 8'59.17"S and 28°46'43.43"E**	**C - Moderately modified**	**D - Largely modified.**
17	Depressional Pan Wetland	**26° 8'56.70"S and 28°46'45.72"E**	**C - Moderately modified**	**D - Largely modified.**
18	Depressional Pan Wetland	**26° 9'9.48"S and 28°47'4.05"E**	**C - Moderately modified**	**D - Largely modified.**
19	Depressional Pan Wetland	**26° 9'16.21"S and 28°47'11.25"E**	**C - Moderately modified**	**D - Largely modified.**
20	Depressional Pan Wetland	**26° 9'9.85"S and 28°47'23.45"E**	**C - Moderately modified**	**D - Low/Marginal**

Nr	Affected Watercourse	Approximate Coordinates	Present Ecological State Score	Ecological Importance and Sensitivity
		28°29'5.18"S and 29° 8'40.92"E		
21	Depressional Pan Wetland	26° 8'59.31"S and 28°47'8.85"E	C - Moderately modified	D - Largely modified.
22	Depressional Pan Wetland	26° 9'14.70"S and 28°47'14.89"E	C - Moderately modified	D - Largely modified.
23	Depressional Pan Wetland	26°10'27.69"S and 28°43'3.56"E	D - Largely modified	C - Moderate
24	Depressional Pan Wetland	26°11'27.01"S and 28°44'58.52"E	E – Greatly modified	D - Largely modified.
25	Seepage Wetland	26° 9'58.17"S and 28°41'14.04"E	C - Moderately modified	D - Largely modified.
26	Seepage Wetland	26°11'50.98"S and 28°45'46.79"E	D - Largely modified	D - Largely modified.
27	Seepage Wetland part of site specific site	26°11'13.41"S and 28°44'19.57"E	E – Greatly modified	D - Largely modified.
28	Seepage Wetland	26° 9'1.61"S and 28°46'55.63"E	D - Largely modified	D - Largely modified.
29	Seepage Wetland	26° 9'46.86"S and 28°42'52.35"E	D - Largely modified	C - Moderate
30	Seepage Wetland	26° 8'57.84"S and 28°43'26.19"E	C - Moderately modified	C - Moderate
31	Seepage Wetland	26°11'7.26"S and 28°43'44.82"E	E – Greatly modified	D - Largely modified.
32	Seepage Wetland	26° 9'54.13"S and 28°43'58.79"E	E – Greatly modified	D - Largely modified.

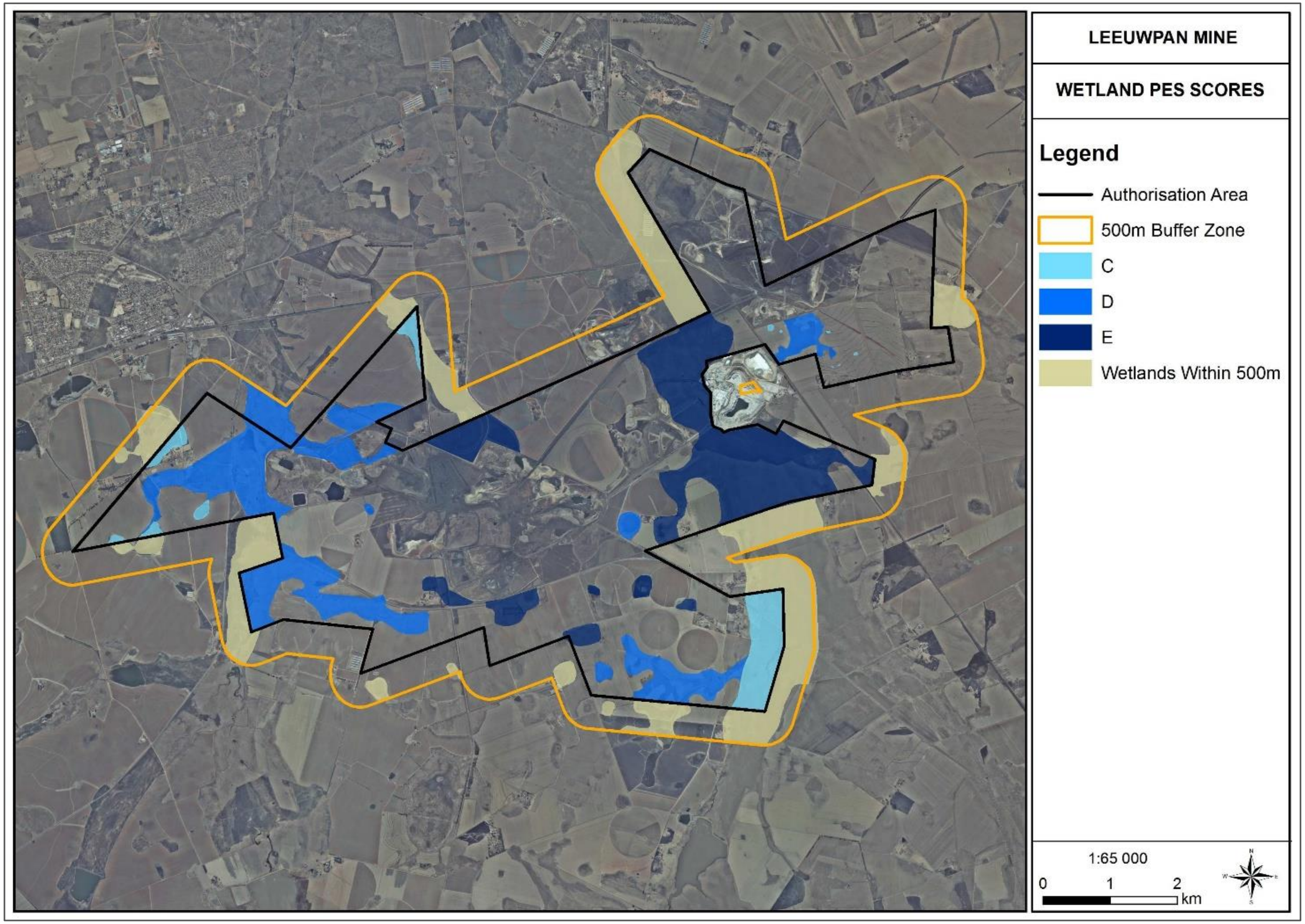


Figure 23: The wetland PES scores relative to the study area.

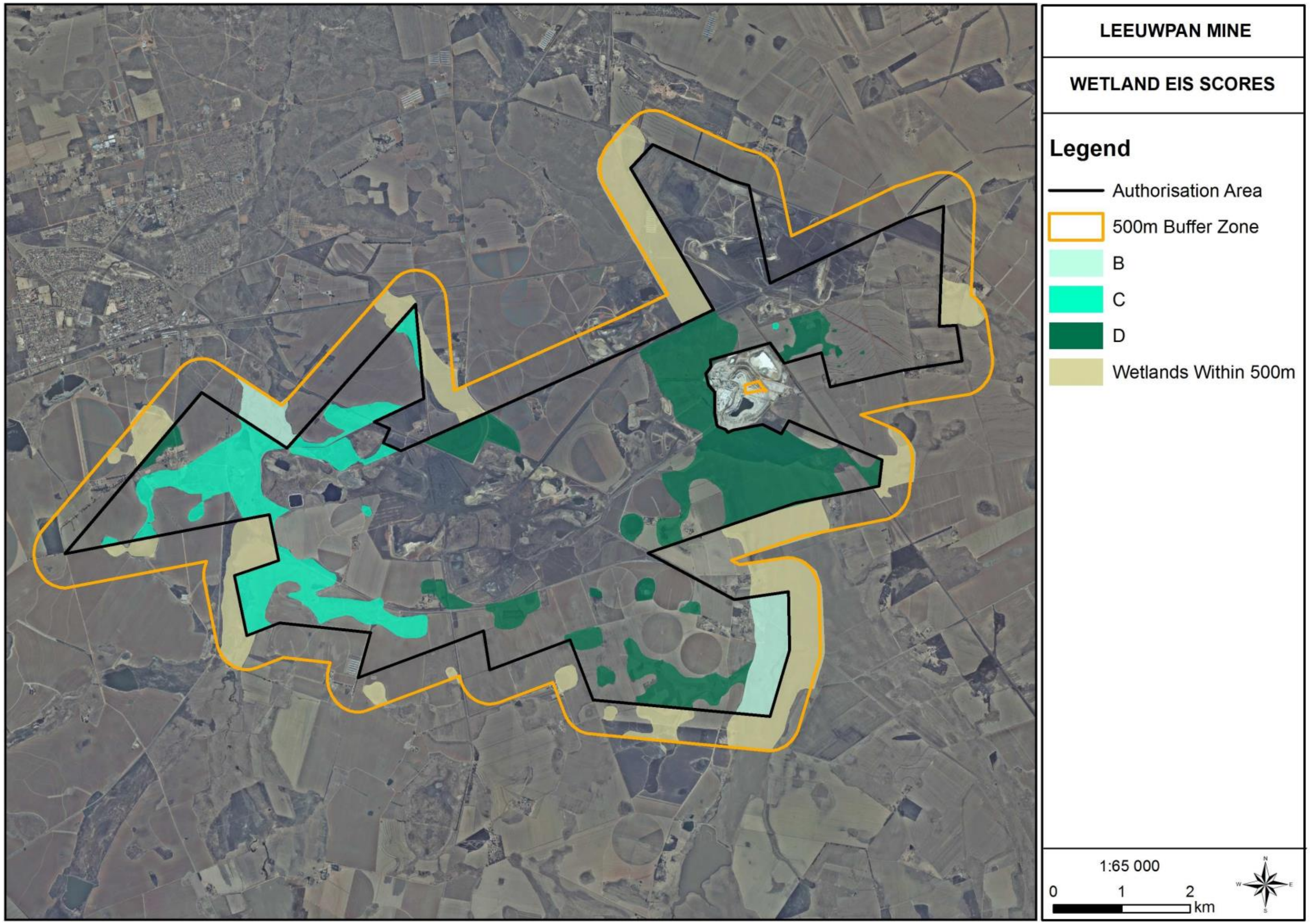


Figure 24: The wetland EIS scores relative to the study site.

3.3 Impacts and Mitigations

Development has several impacts on the surrounding environment and particularly on a wetland. Particularly mining affects surface and subsurface water flow in a catchment and consequently affects recharge and discharge of water and the hydrological expression in wetlands. Ideally, the outcome of the geohydrological assessment should further inform the final impact and risk assessments. For the majority of the study area the activities were not stipulated, however for the one site specific area the mine has proposed to mine through the two depressional pan wetlands and the seepage wetland.

The mine expansion is proposed to mine through the three wetlands located in the smaller focus area as well as the old road directly north of the wetlands. Based on on-site meetings the idea is to mine through these wetlands and reinstate the soil in the same layers as it was removed with similar vegetation in order to reinstate these wetlands. It is highly unlikely that this approach will reinstate the lost wetlands and is thus not a recommended method. If the proposed mining action will be done through wetlands and these wetlands are lost the only remedial action is to offset these wetlands which should ideally be the last option (Figure 25).

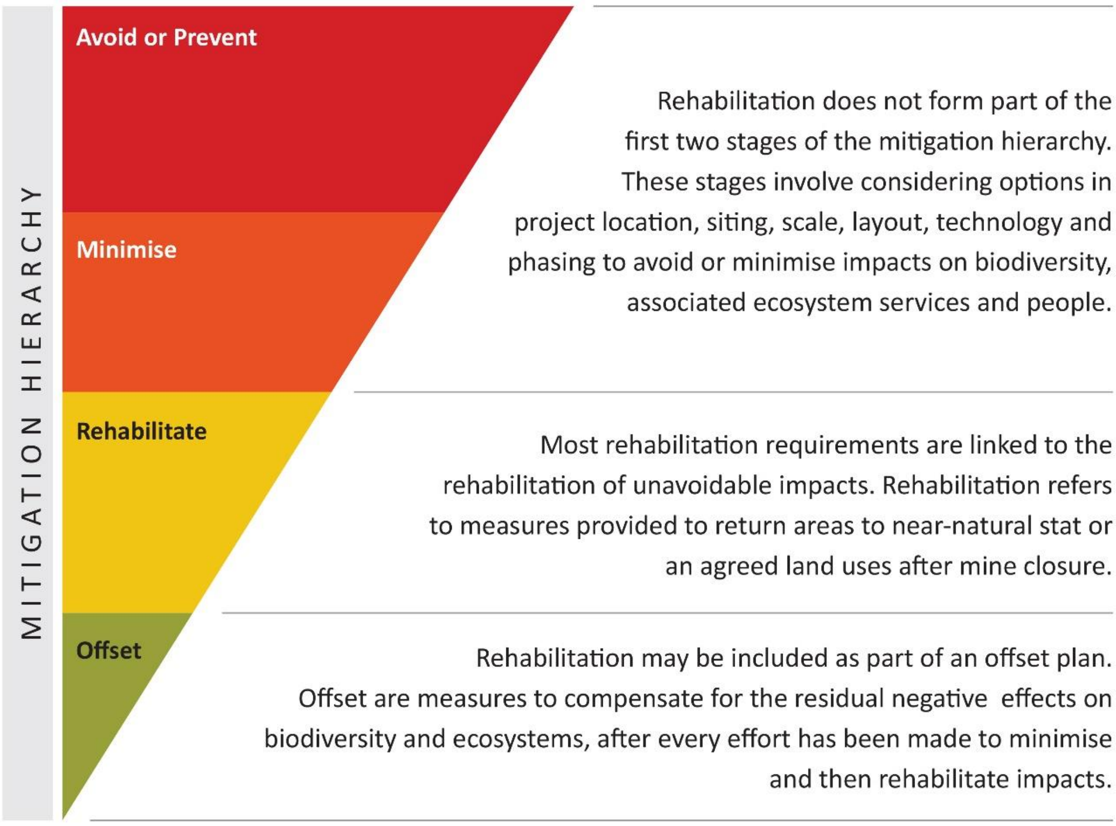


Figure 25: Mitigation hierarchy (SANBI, 2012).

The potential risk associated with open cast mining (smaller focus site) and general mining is extensive and explained in detail in the wetland assessment report (WCS, 2012). The impact and risk assessments conducted in this assessment are presented in Table 19 & 20 below.

Table 19: Impact scores before and after implementation of mitigation

Impact description					Signicance before mitigation		Signicance after mitigation		Mitigation measures	Action plan	Responsible person
No.	Phases	Activity	Aspect	Impact							
Wetland	0	0	0	0	0	0	0	0	0	0	0
0	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	-	M	-	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
0	Operation	Plant operation	Permanent location of tailing facilities in the catchment of the waterbodies	Permanentchanges to the catchment of waterbodies in terms of water inflitration and surface water flow rates	-	H	-	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	Environmental Management Plan	Mine manager
0	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	-	M	-	L	• 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
0	Operation	Plant operation	Permanent presence of pipelines and access roads	Changes in sediment and stormwater entering the system	-	M	-	L	• 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
0	Construction	Removal of vegetation and land preparation	Preparation of the footprint of all new infrastructure	Introduction and spread of alien plants	-	H	-	M	Ensure the implementation of an effective Alien Plant Control Plan	Environmental Management Plan	Mine manager
0	Operation	Plant operation	Inadequate infrastructure and maintenance of vehicles	Changes in water quality due to foreign materials and increased nutrients	-	M	-	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	Environmental Management Plan	Mine manager

Table 20: The severity score derived from the DWS (2016) risk assessment matrix for the operation phase of the open cast mine on the smaller focus site.

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

				Severity																		
Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level	Control Measures	Borderline LOW MODERATE Rating Classes	PES AND EIS OF WATERCOURSE
C	Construction phase of an open cast mine through a pan and seepage wetland	Clear vegetation	Permanent loss of wetland habitat, compaction of soils, sedimentation, pollution and alien invasive plant establishment	5	5	5	5	5	1	3	9	1	5	5	2	13	117	M	80%	•Proposed excavations and infilling should be signed off by a hydropedologist. This is to advise on the impact of moisture displacement the proposed activities may have on the sustainability of infrastructure development and the environment. • Development should include measures to ensure that the flowpaths and storage mechanisms in the soil should be disturbed as little as possible, to sustain hydrological and biogeochemical connectivity.	N	PES: D/E EIS: C/D REC: D
		Establishment of access roads		2	2	2	1	2	1	1	3.8	1	2	5	2	10	37.5	L	80%		N	
O	Opeartion of the open cast mine through a pan and seep wetland	Day to day operation of the mine	Permanent loss of wetland habitat and hydrological connectivity in the landscape, pollution, invasion of alien invasive species	5	5	5	5	5	2	5	12	5	5	5	2	17	204	H	80%	•Particular note should be taken of the soil characteristics including their erodibility and recharge properties. Permanent changes to regional hydrology should be quantified. • Control of alien invasive plants should form part of the maintenance plan • The likelihood of reestablishment of wetland function after mining, through rehabilitation should be investigated in a multidisciplinary team and should be based on relevant case studies where this has been achieved in the past. • A wetland offset strategy should be formulated	N	PES: D/E EIS: C/D REC: D

4 CONCLUSION

The study area comprises approximately 4272 hectares with current infrastructure of approximately 1879.04 hectares located on the study site. Roughly 44% of the study area is currently used for mining. Large sections identified as wetland in the 2012 Wetland Consulting Services report have since been transformed by mining. The total area occupied by wetlands as delineated in the current report is 1120.56 hectares which equates to 26% of the total study site or 47% of the area remaining unmined area. It should be noted that these figures exclude the wetland buffer zones, which are likely to significantly increase the no-go area number. The remaining area is used for agriculture and infrastructure associated with mining.

A special emphasis in this report is a small area that is proposed to be mined where three wetlands (two depressional pan wetlands and one seepage wetland) are also located (Specific Focus Study Site). The approximate central coordinates of the focus specific study area is 26°11'15.51"S and 28°44'29.05"E. This area has also been affected by the expanding mine and a new road has been constructed through one of the wetlands.

The wetlands identified in the 2012 Wetland Consulting Services report were verified in the current study with good accuracy for the majority of the wetlands. Some wetlands have however irrevocably been transformed by mining activities while some were delineated smaller than in the WCS study due to transformation as a result of agricultural impacts. This is especially true for the depressional pan wetlands located within agricultural areas. The layers associated with this report should be compared to the WCS (2012) layers to compare the described differences in watercourses.

The risk assessment reflects a **Medium** score during the construction phase and a **High** score during operation of the mine. This is because the wetlands affected by mining will be permanently changed, particularly in terms of their hydrology. The following is important to note regarding open cast mining through wetlands:

- The effective recreation of wetlands after open cast mining is not represented in the literature.
- Regional hydropedology should be understood to understand what the effect of the loss of these wetlands will have on the surrounding landscape
- Wetland loss will need to be offset with input from the DWS.

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

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. *In Press.* Ecohydrological analysis of the Matlabas Mountain mire, South Africa. Mires and Peat
- 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

- **Wetland Specialist**

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

- Approximately 200+ specialist investigations into wetland and riparian conditions on strategic, as well as fine scale levels in Gauteng, Limpopo, North-West Province Mpumalanga KwaZulu Natal, North-West Province, Western Cape, Eastern Cape & Northern Cape

- Ensuring the scientific integrity of wetland reports including peer review and publications.

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

➢ **<u>Wetland Audit</u>**

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:

➢ **<u>GIS Specialist – AfriGIS</u>**

January 2008 – August 2010

Tasks include:

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

➢ **<u>Wetland Specialist - Limosella Consulting</u>**

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