Update of The Wetland Assessment for Proposed Township Development On The Remainder Of The Farm Leeupoort No 283js And Prt 79 Of The Farm Blesboklaagte No 296js, Emalahleni, Mpumalanga

Wetland Delineation and Functional Assessment Update

November 2018

Drafted by

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Declaration of Independence

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

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

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Antoinette Bootsma (PrSciNat)	Date
Ecologist/Botanist	
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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 (Pty) Ltd was appointed by Labesh Consulting to undertake an update of a wetland delineation and functional assessment for the proposed township development north of eMalahleni in the Mpumalanga Province. The study site is approximately 506.8 ha. Fieldwork was initially conducted on the 2nd of May 2014. A follow-up site assessment was undertaken on the 8th of November 2018 to inform an update of the wetland assessment report for this project.

The terms of reference for the study were as follows:

- Delineate the wetland and riparian areas;
- Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
- 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, both generic (as required in GDARD, 2014) and scientific as specified in General Notice 267 of 24 March 2017, following Macfarlane *et al* 2015 ; and
- Discuss appropriate mitigation and management procedures relevant to the conserving wetland areas on the site.

Three (3) wetland areas were recorded on the study site. The wetland areas were classified as an unchannelled valley bottom wetland, and two seepage wetlands. The unchannelled valley bottom forms part of the Blesbokspruit River and both the seepage wetlands drain directly into the Blesbokspruit River.

The previous study (2014) indicated an additional two seepage areas. Upon further investigation and the additional use of historical aerial imagery, it was found that these areas are unlikely to be functioning wetland areas. The area previously described as a degraded seepage wetland was reclassified as a disturbed area with many quarries, diggings and other disturbances. These disturbances have led to numerous areas of standing water and wetland vegetation and although these areas contribute to habitat for faunal and floral species it is unlikely to contribute to wetland functionality. Furthermore, an additional seepage area was recorded. This area was previously overgrazed with little species remaining. In the 2018 fieldwork, numerous obligate wetland species were recorded here including *Juncus effusus and Juncus rigidus*.

The hydrology and geomorphology of the wetland system as a whole has been significantly impacted by the quarrying, diggings and sand mining as well as damming of the unchannelled valley bottom wetland. The vegetation of the wetland system has also been impacted by the quarrying as well as overgrazing. The 2018 study therefore concludes that the seepage area found in 2014 is not currently a functional wetland although it may have been in the past. Implications for development are that the delineated functional wetland as confirmed in 2018 (the channelled valley bottom wetland, seepage 1 and 2), together with their recommended buffer zones should be excluded from the development footprint. The seepage area identified in 2014 and omitted from the 2018 delineation may be included in the development layout given that strict mitigation measures ensure that no negative impact results to the downstream wetlands.

A summary of the functional assessment scores obtained for the wetland and watercourses are presented in the table below. A summary of the important findings discussed in this assessment are also provided.

Classification (SANBI, 2013)	**PES (Macfarlane *et al*, 2007) and VEGRAI (Kleynhans et al, 2008).**	**EIS (DWAF, 1999) and QHI (Seaman *et al*, 2010)**	**WetEcoServices (3 most prominent scores)**	**Scientific Buffer (Macfarlane *et al* 2015)**		**REC**
				Construction	**Operational**	
Unchannelled Valley Bottom Wetlands	3.5 C	3.7 (Very High)	Sediment Trapping – 3.0 Stream Flow Regulation – 2.7 Natural Resources – 2.3	37 m	17 m	C
Seepage Wetland 1	3.4 C			51 m	22 m	C
Seepage Wetland 2	3.6 C			51 m	22 m	C

<table>
<tr><td rowspan="2"></td><td>Quaternary Catchment and WMA areas</td><td colspan="3">Important Rivers possibly affected</td></tr>
<tr><td>B11K– 2nd WMA - Olifants</td><td colspan="3">Drains directly into the Blesbokspruit on the study site</td></tr>
<tr><td rowspan="11">NEMA 2014 Impact Assessment</td><td colspan="2">The impact scores for the following aspects are relevant:</td><td>Without Mitigation</td><td>With Mitigation</td></tr>
<tr><td rowspan="2">Changes to flow dynamics</td><td>Construction Phase</td><td>H</td><td>L</td></tr>
<tr><td>Operation Phase</td><td>H</td><td>L</td></tr>
<tr><td rowspan="2">Sedimentation</td><td>Construction Phase</td><td>M</td><td>L</td></tr>
<tr><td>Operation Phase</td><td>M</td><td>L</td></tr>
<tr><td rowspan="2">Establishment of alien plants</td><td>Construction Phase</td><td>M</td><td>L</td></tr>
<tr><td>Operation Phase</td><td>M</td><td>L</td></tr>
<tr><td rowspan="2">Loss of wetland habitat</td><td>Construction Phase</td><td>L</td><td></td></tr>
<tr><td>Operation Phase</td><td>L</td><td></td></tr>
<tr><td rowspan="2">Pollution of watercourses</td><td>Construction Phase</td><td>M</td><td>L</td></tr>
<tr><td>Operation Phase</td><td>M</td><td>L</td></tr>
</table>

DWS Impact assessment	The construction related activities associated with the development fall in the **low** category. The operation phase falls in the **medium** category largely because of the permanent changes to the catchment with regards to surface flow and recharge properties. However, provision is made for a lowering of the risk score by 25 points if additional detailed mitigation measures are implemented. Stormwater management should demonstrate a neutral effect on the regional hydrograph, alien plants and pollution should be shown to be effectively controlled and the development footprint should remain outside the delineated wetlands and their buffer zones. If the details of these aspects of mitigation are found suitable, the DWS may allow authorisation through a General Authorization (GA).
Does the specialist support the development?	Yes. However it should be done in a manner that does not further alter the natural watercourses, or the biodiversity status of the surrounding habitat.
Recommendations	• The development should take into account the qualified presence of sensitive and protected flora, fauna and avifauna species. • Design of structures should aim to have the least impact on habitat quality and hydrology of the watercourses and should include attenuation structures to contribute to regional flood control and rehabilitation • Maintain sewage infrastructure to ensure that leaks do not enter the watercourses • Implement the principles of Sustainable Urban Drainage • Control of alien invasive plants should form part of the maintenance plan • Ensure that overgrazing in the wetland does not occur • Install and maintain litter traps

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1 INTRODUCTION

Limosella Consulting (Pty) Ltd was appointed by Labesh Consulting to undertake an update of a wetland delineation and functional assessment for the proposed township development north of eMalahleni in the Mpumalanga Province. Fieldwork was initially conducted on the 2nd of May 2014. A follow-up site assessment was undertaken on the 8th of November 2018 to inform an update of the wetland assessment report for this project.

1.1 Terms of Reference

The terms of reference for the study were as follows:

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- Discuss appropriate mitigation and management procedures relevant to the conserving wetland areas on the site.

1.2 Assumptions and Limitations

- The information provided by the client forms the basis of the planning and layouts discussed.
- All wetlands within 500 m of any developmental activities should be identified as per the DWS authorization regulations. In order to meet the timeframes and budget constraints for the project, wetlands within the study sites were delineated on a fine scale based on detailed soil and vegetation sampling. Wetlands that fall outside of the site, but that fall within 500 m of the proposed activities were delineated based on desktop analysis of vegetation gradients visible from aerial imagery.
- The detailed field study was conducted from a once off field trip and thus would not depict any seasonal variation in the wetland plant species composition and richness.
- Description of the depth of the regional water table and geohydrological and hydropedological processes falls outside the scope of the current assessment. This is particularly relevant to the degraded area discussed in this report. Although our study concludes that this area is not a wetland, this should ideally be verified through a hydropedological 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.

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 situated approximately 6 km north of the town of eMalahleni in the Mpumalanga Province. The site is located north of the R544 road. The southern border of the study site is formed by the residential area of Pine Ridge. The approximate central coordinates of the main site are 25°48'28.50"S and 29°12'17.03"E.

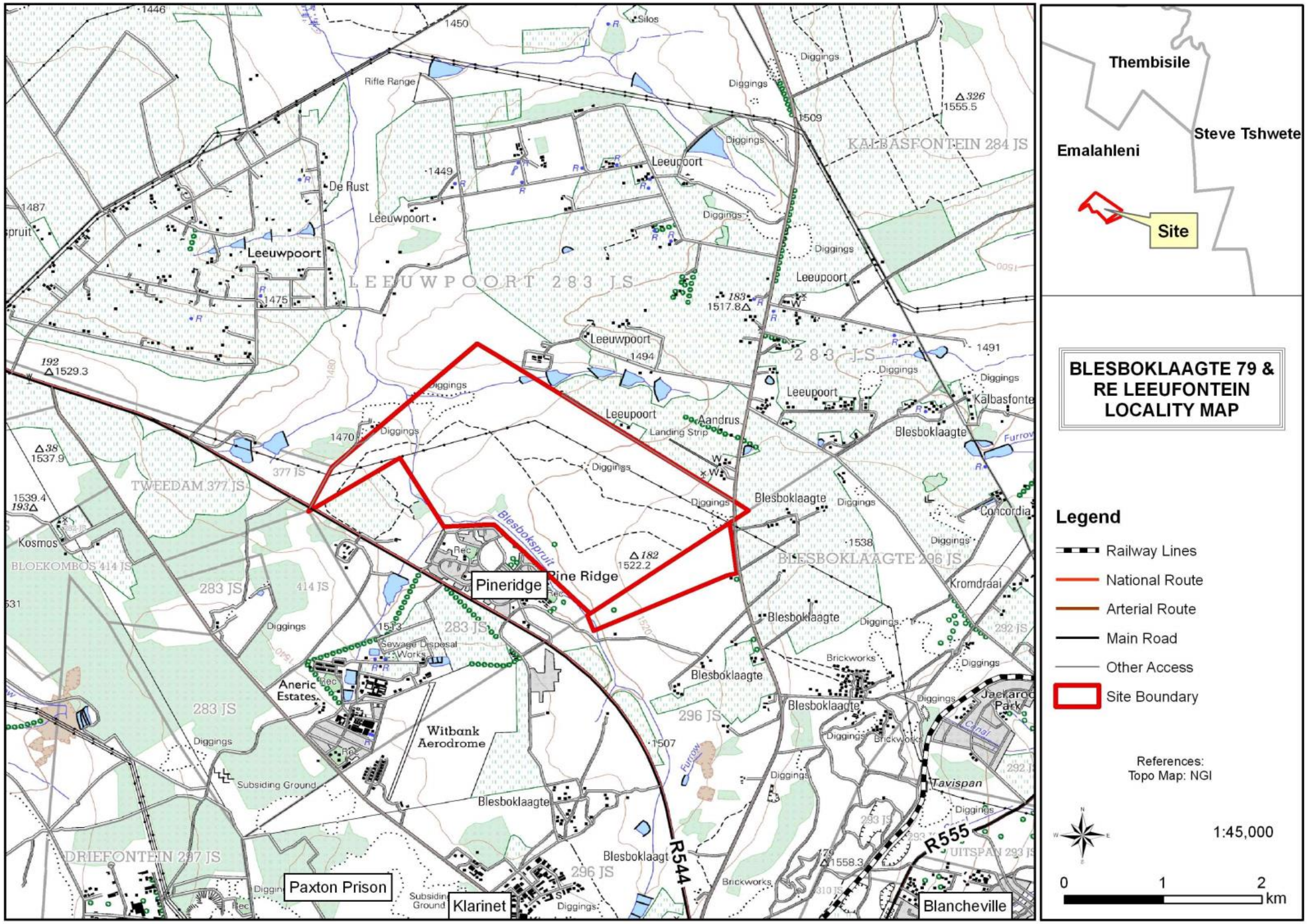


Figure 1: Locality Map

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:

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 the Quaternary Catchment B11K. In this catchment, the precipitation rate is lower than the evaporation rate with a Mean Annual Precipitation (MAP) to Potential Evapotranspiration (PET) of 0.31. Consequently, wetlands 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 Nr. 40279, dated 16 September 2016. According to this publication, Quaternary Catchment B11K fall within the second WMA, the Olifants WMA. The major rivers that are located within this WMA include the Elands-, Wilge-, Steelpoort-, Olifants and Letaba Rivers. The Blesbokspruit River, a first order river, is located on the study site and flows north into the Klip River which eventually flows into the Olifants River.

Hydrology:

According to the NFEPA (National Freshwater Ecological Protected Areas) a perennial river known as the Blesbokspruit River flows through the site in the west and forms the border of the study site in the south. It also dissects the northern corner of the study site. The NFEPA layers also indicate a wetland area around the Blesbokspruit River (Figure 2).

Regional Vegetation:

The vegetation type occurring in the study area is classified as Rand Highveld Grassland (Mucina & Rutherford, 2006). Rand Highveld Grassland comprises species rich, wiry, sour grassland alternating with low, sour shrubland on rocky outcrops and steeper slopes. This vegetation unit is poorly conserved with much of its area transformed by cultivation, plantations, urbanisation or dam-building and mining. Where disturbances occurred, the invasive exotic tree *Acacia mearnsii* (Black Wattle) can become dominant and displace the natural vegetation. Due to the extensive usage of the areas once covered by Rand Highveld Grassland vegetation types, the remaining portions are of high conservation value and sensitivity and are thus classified as endangered vegetation types (Mucina & Rutherford, 2006).

Geology and soils:

The geology underlying the western section of the study site is comprised mainly of Arenite (ENPAT, 2001). Arenite (wind-blown sands) weather to form deep sandy soils which are highly mobile when disturbed and could therefore result in erosion problems during and after the proposed activities. The eastern section of the study site is underlain by Tillite.

S2 soil forms are characteristic of this area. S2 soils may have restricted depth and excessive drainage. S2 soils have low natural fertility and a high erosion potential (www.agis.agric.za).

Mpumalanga Biodiversity Conservation Plan (MBCP)

The Mpumalanga Biodiversity Conservation Plan_reflects only a small area in the west of the study site as important and necessary in terms of conservation while the majority of the site is classified as least concern with a few small areas classified as areas where no natural habitat remains (Figure 3).

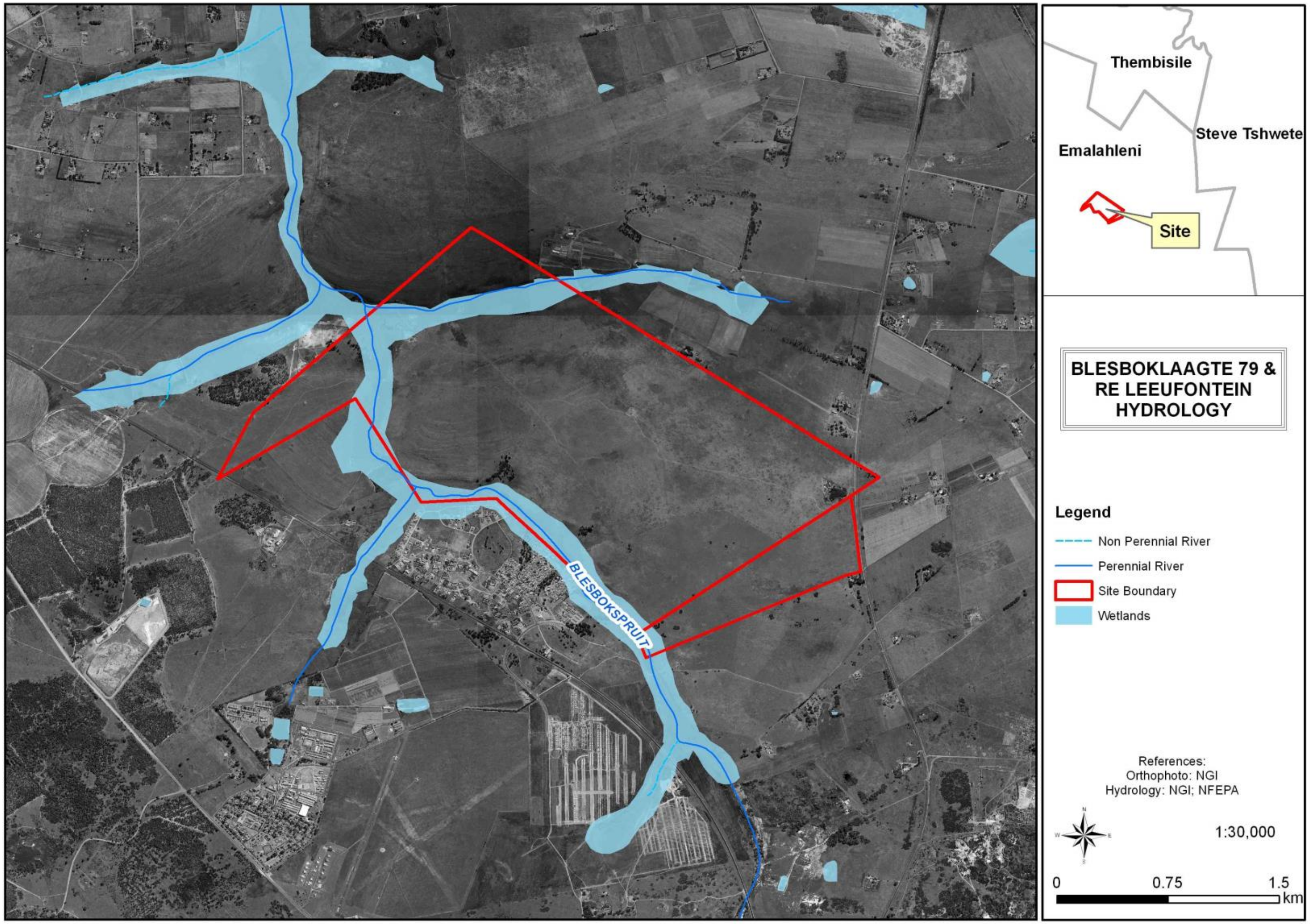


Figure 2: Hydrology of the study site and surrounds as per existing spatial layers.

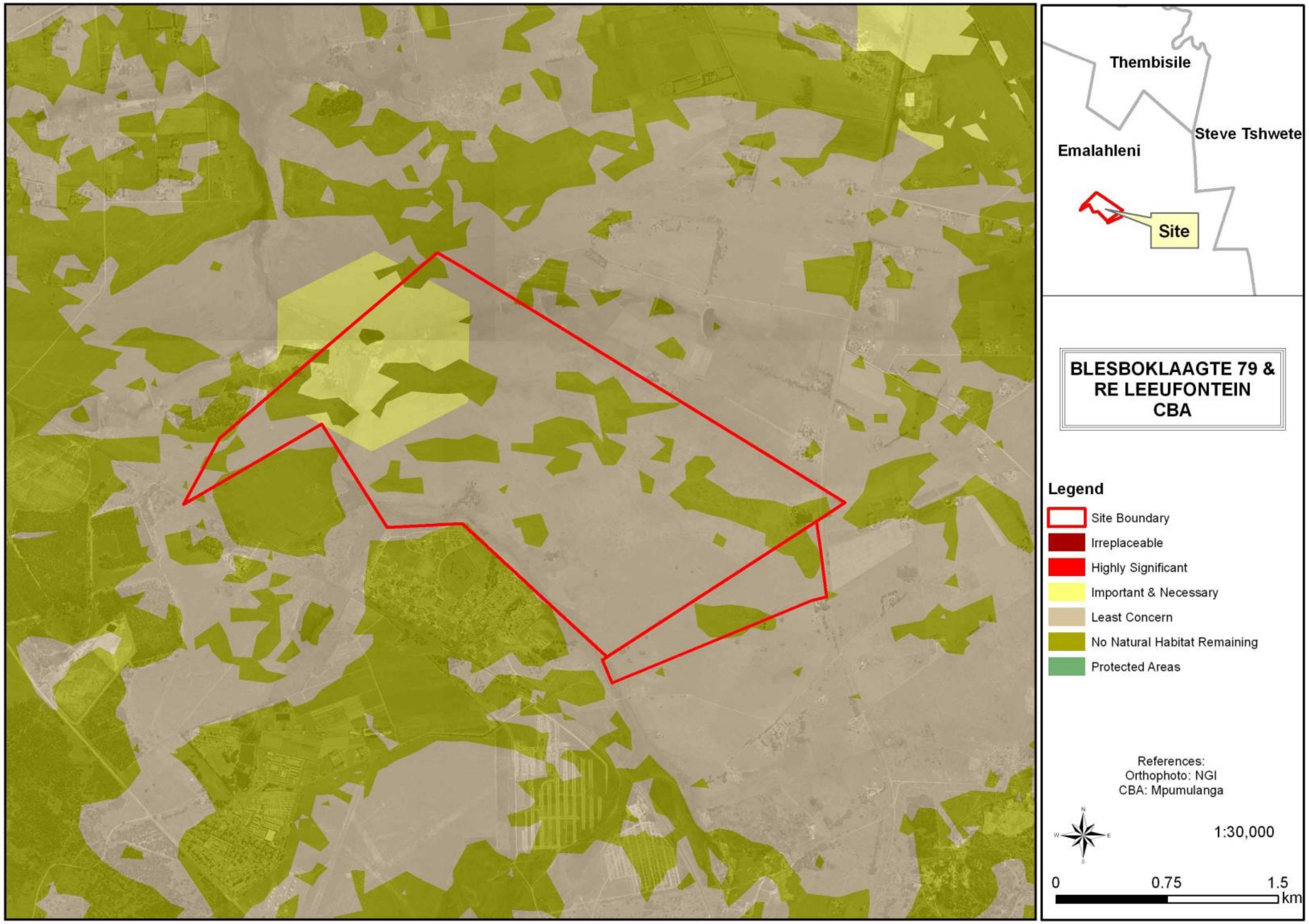


Figure 3: Conservation plan of Mpumalanga Province indicating different areas of importance.

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 all,* 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 identified based on the following characteristic attributes (DWAF, 2005) (Figure 4):

- 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.

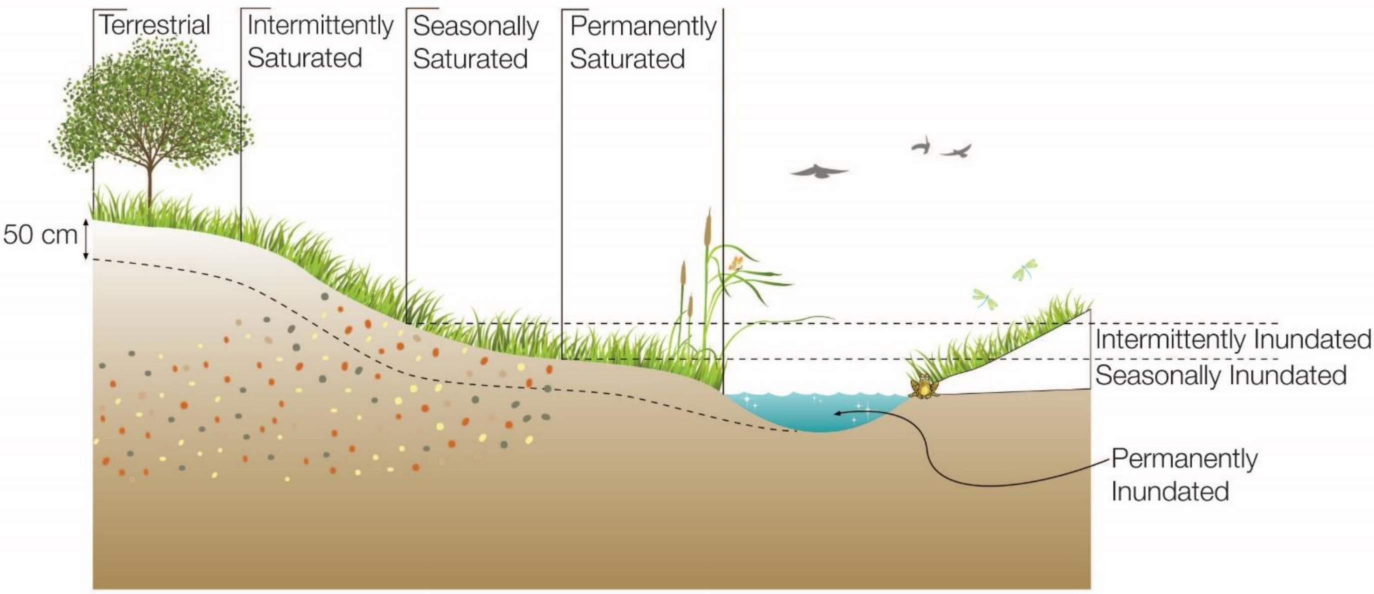


Figure 4: Typical cross section of a wetland (Ollis, 2013)

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 has also been referred to as active features or wet bank (Van Niekerk and Heritage, 1993). It includes the area from the water level at low flow, to those features that are hydrologically activated for the greater part of the Year (WRC Report No TT 333/08 April, 2008). The non-marginal zone is the combination of the upper and lower zones (Figure 5).

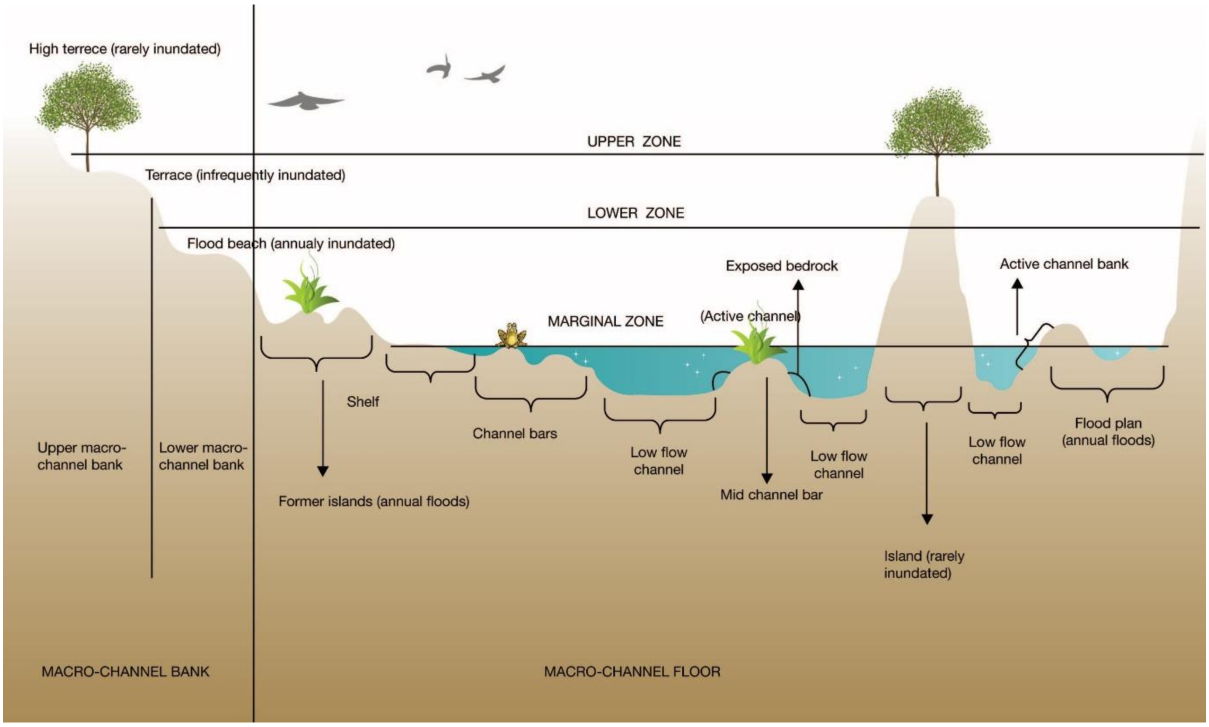


Figure 5: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhanset al., 2007)

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.

Channelled valley bottom wetland:

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 (Figure 6).

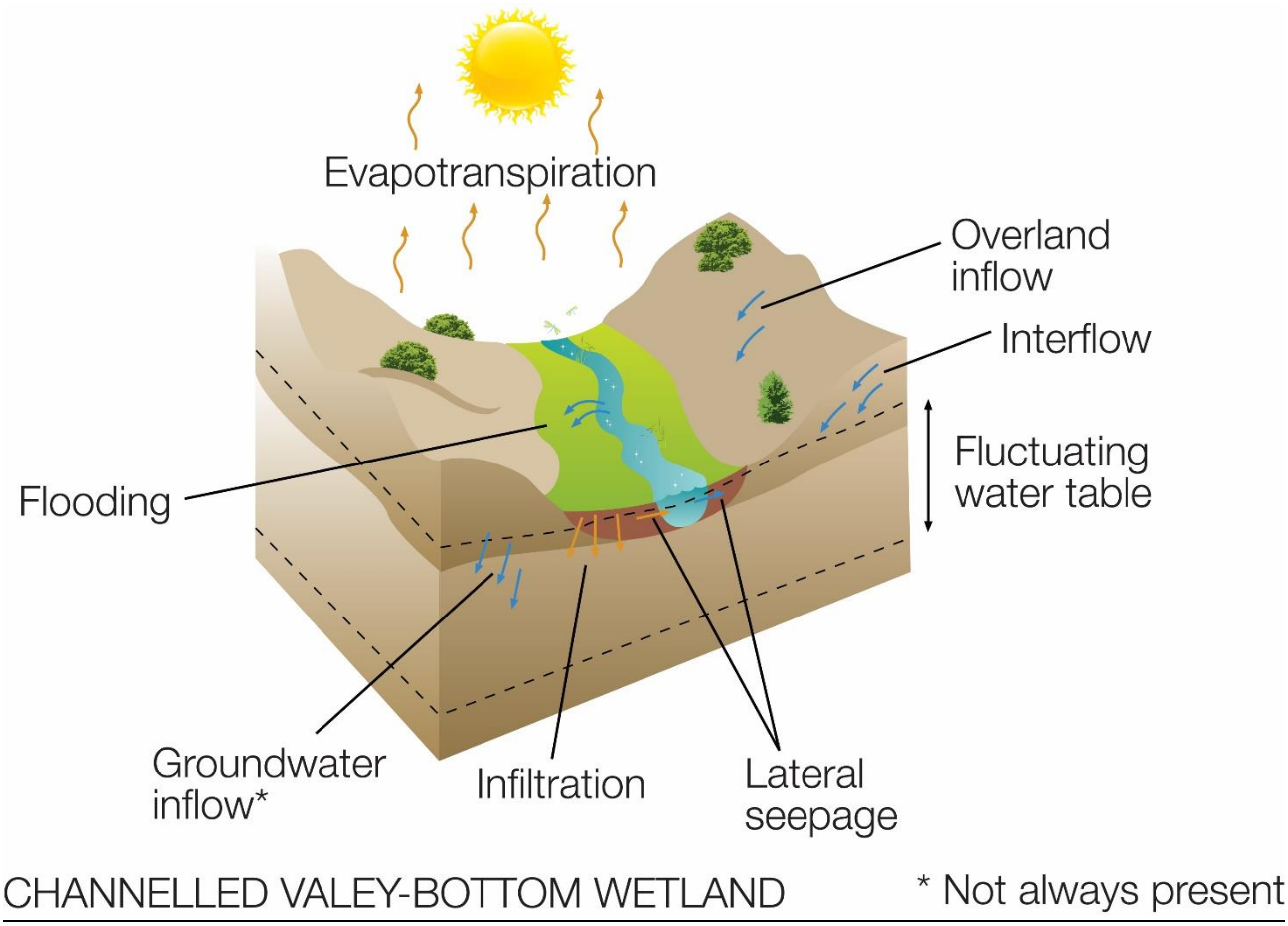


Figure 6: A schematic representation of the processes characteristic of channelled valley bottom wetlands (Ollis *et al*, 2013).

Seepage Wetland:

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 wetlands (Figure 7). 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 (Frey, 1999).

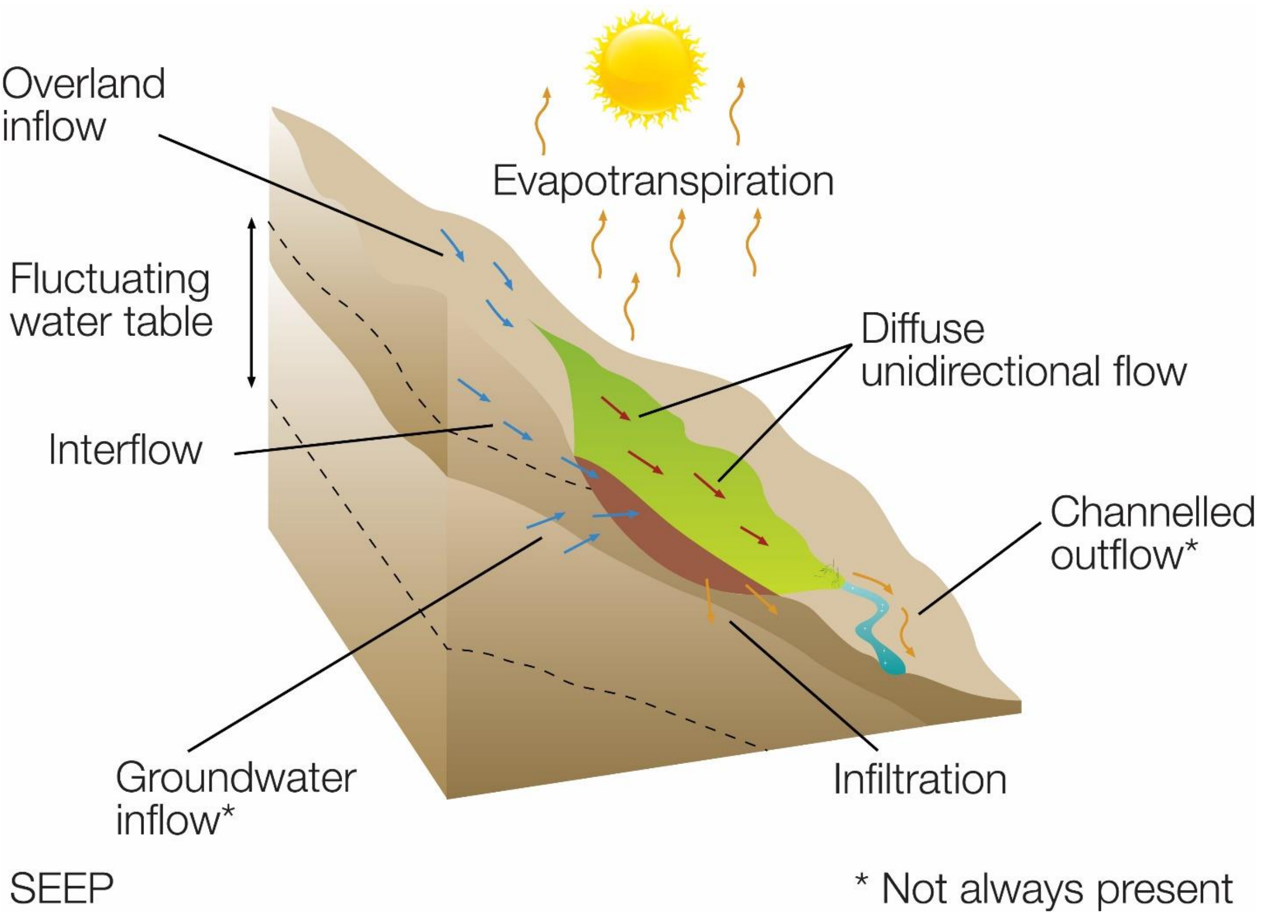


Figure 7: A schematic representation of the processes characteristic of Seepage Wetlands (Ollis *et al*, 2013).

Although the majority of the wetlands found on the study site were natural wetlands some areas did prove to be difficult, this includes areas in the unchannelled valley bottom wetland were quarrying has taken place as well as other quarry areas south of the study site were artificial wetlands have formed. The highlighted areas indicate the difficult scenarios faced during the delineation process (Table 1).

Table 1: 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.

Type of "difficult site"	Approach
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.

The degraded area is thus unlikely to contribute to the functionality of the adjacent wetlands and likely does not function as a wetland anymore. This area has undergone extensive diggings where water collects and contributes to isolated wetland features such as plant species adapted to growing in moist or wet conditions. Based on historical aerial imagery it is however unlikely that this area was part of the larger surrounding wetland systems. However, it is important to note that hydropedological investigations of this area may reflect significant soil-water interactions that fall outside the scope of this report.

2.3 Buffer Zones

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 developed and 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. Operational and construction phase buffers are calculated. The Operational phase buffer indicates the area up to which development can occur. The construction phase buffer indicates an area that should be considered as sensitive, in which particular care should be taken to prevent degradation to downstream areas as specified in the EMP. 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 buffer zone applicable to the proposed project following Macfarlane *et al* (2015) are 15m for the operational phase and 28 m for the construction phase based on the education subsector of civic and social infrastructure and includes educational facilities and associated buildings. The buffer zones for the valley bottom wetland south of the study site are 15 m and 26 m respectively which does not encroach onto the study site.

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

Episodic/Drainage Line

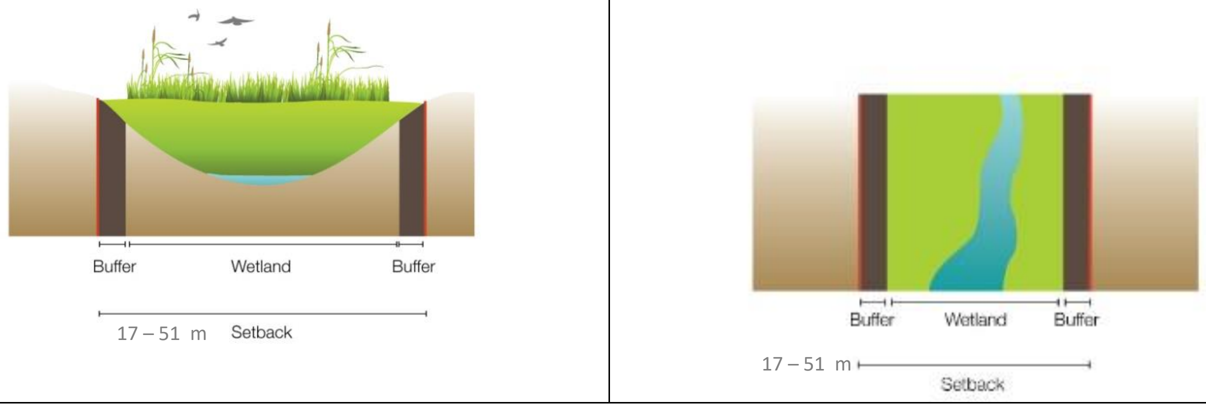


Figure 8: A represent the buffer zone setback for the watercourse types discussed in this report

2.5 Impact Assessments

2.5.1 NEMA (2014) Impact Ratings

As required by the 2014 NEMA regulations, impact assessment should provide quantified scores indicating the expected impact, including the cumulative impact of a proposed activity. This assessment follows the format presented below (Table 2 & Table 3):

Table 2: 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 3).

Table 3: 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 9 and Table 10.

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 4):

Table 4: 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 5):

Table 5: 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.

2.5.2 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 6 below provides a description of the classes into which scores are sorted, and their implication for authorisation.

Table 6: 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

2.6 Wetland or Riparian 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.

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 watercourse unit. The aspect of 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), WetEcoServices (Kotze *et al*, 2006), EIS (DWAF, 1999), Quick Habitat Integrity (Seaman *et al*, 2010), VEGRAI (Kleynhans *et al*, 2008).

2.6.1 Present Ecological Status (PES) – WET-Health

The Present Ecological Score is based on the ability of the wetland to preform indirect benefits (Table 7).

Table 7: Indirect Benefits provided by wetland habitats (Macfarlane *et al*, 2007).

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

A summary of the three components of the WET-Health namely Hydrological; Geomorphological and Vegetation Health assessment for the wetlands found on site is described in Table 8. 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 8: 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 9.

Table 9: 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	(↓↓)

2.6.2 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 (Table 10).

Table 10: Direct human benefits associated with wetland habitats (Macfarlane *et al*, 2007).

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

The Ecological Importance and Sensitivity of the wetland is represented are described in the results section. Explanations of the scores are given in Table 11.

Table 11: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999)

Ecological Importance and Sensitivity Categories	Rating	Recommended Ecological Management Class
Very High Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers	>3 and <=4	A

Ecological Importance and Sensitivity Categories	Rating	Recommended Ecological Management Class
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	>1 and <=2	C
Low/Marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers	>0 and <=1	D

2.6.3 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).

2.6.4 WetEcoServices

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.

3 RESULTS

3.1 Land Use and Land Cover

The study site is currently disturbed by a large area of quarrying (sand mining) in the east. Large sections of the quarry and surrounding study site was used for illegal dumping. The majority of the active and historical quarry areas had signs of wetness and some larger areas had standing water. Although these areas are unlikely to form part of the larger wetland area it does provide shelter and habitat for numerous fauna and flora spices. From historical aerial imagery (1941) it is evident that activities in this area have cleared potential habitat for many decades (Figure 9). From an archaeological point of view numerous areas were recorded that could possibly have been historical cattle pens or huts (Figure 10). This should ideally be confirmed by an archaeologist. Large numbers of cattle were also observed which is likely to have an impact on the study area and the wetlands. Furthermore, various infrastructures such as roads, paths, pylons and telephone poles were found throughout the study site.

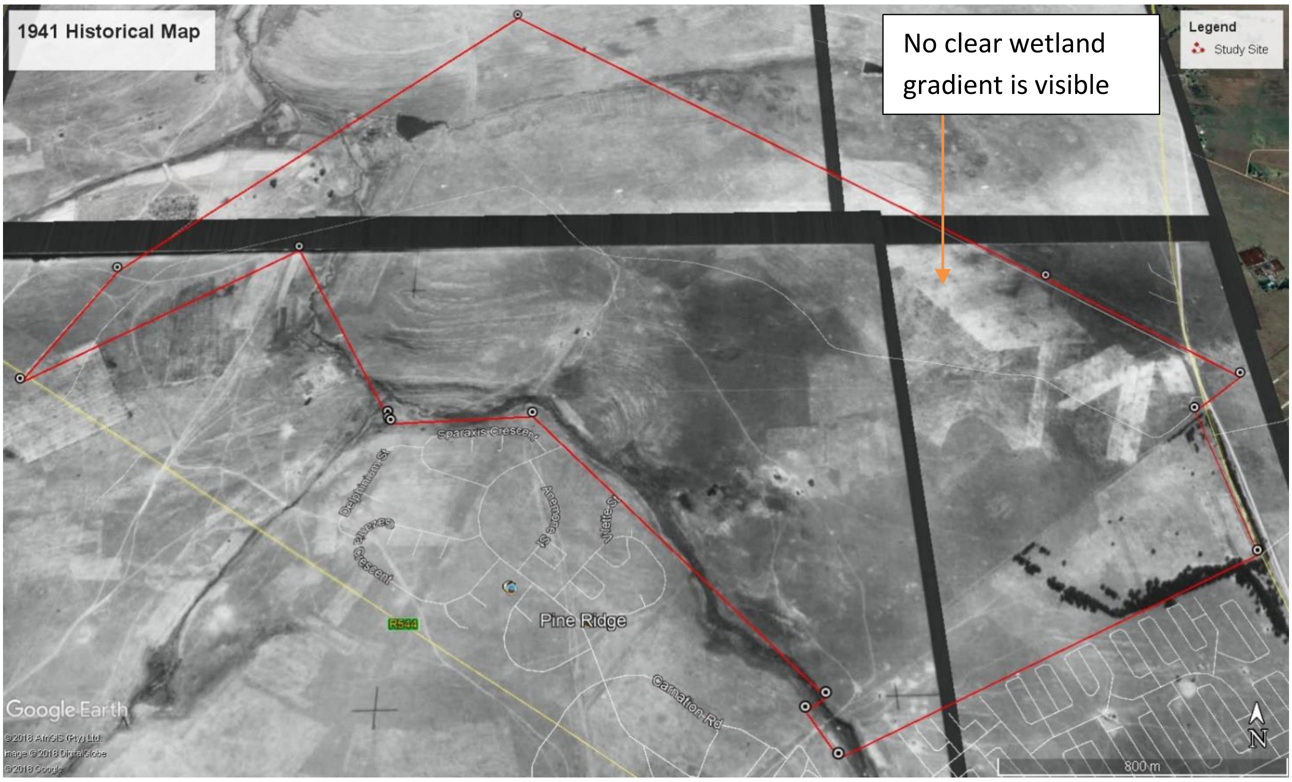


Figure 9: 1941 map if the study area indicating clear wetness gradient in some areas and none in the area previously thought to be a historical seepage area.

Figure 10: Map and corresponding photos showing clear circles of possible archaeological interest.

3.1.1 Soil and Vegetation Indicators

Soil

The soil of the western section was predominantly sandy soil. Within the wetland areas the top layer (1-10 cm) was brown with grey sandy soil underneath (10-50 cm). Adjacent to the channelled valley bottom there was a sediment layer. In some areas a thin layer of dark organic material was evident. Farther away from the wetland the soil was a sandy soil ranging from orange to red soil with some areas being rocky. In the eastern section of the study site large areas of the wetland had been disturbed by various activities including quarrying and soil samples often lacked wetland indicators. In the less disturbed areas in the eastern section the soil ranged from rocky to sandy. Mottling and gleying were found throughout the channelled valley bottom area as well as the seepage areas except in some of the quarry areas. Iron oxidation was especially evident in some of the seepage areas higher up. Where water seeped out of the soil large areas could be seen with iron oxidation. Sediment deposit into the wetland was evident throughout the system (Table 12).

The soil profile of the quarry area (historical and current) was greatly disturbed.

Table 12: Summary of the wetland soil conditions on site (Adapted from Job, 2010).

Site Conditions:	
Do normal circumstances exist on the site?	Yes
Is the site significantly disturbed (difficult site)?	Quarry and sand mining areas
Indicators of soil wetness within 50 cm of soil surface:	
Sulfidic odour (a slight sulfidic odour was noted in permanent zone)	No
Mineral and Texture	Sand
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	Yes
Flat	No
Associated with a river	Drains directly into the Blesbokspruit River

<u>Vegetation</u>

The channelled valley bottom section of the wetland was colonised by obligate wetland plants such as *Typha capensis* and *Phragmites australis* with small patches of exotic woody vegetation found adjacent to the channelled valley bottom area. The seepage areas had a higher density of grasses and sedges. Exotic species were found throughout the study site and especially at a high density and frequency in the quarry area. Large sections of the wetland system were fringed on the edges by *Seriphium plumosum* which is likely due to overgrazing. Some areas located within the seepage wetland in the east had a low density of vegetation and erosion gullies were prominent. Some important species such as *Kniphofia albescens* were recorded in the valley bottom wetland and a vegetation study is suggested to confirm the position and extent of conservation-worthy species.

Exotic plants include:

- *Seriphium plumosum.*
- *Senecio gregatus.*
- *Asclepias fruticosa.*
- *Pennisetum clandestinum.*
- *Tagetes minuta.*
- *Bidens pilosum.*
- *Pennisetum clandestinum.*
- *Datura ferox.*
- *Cyperus rotundus* subsp. *Rotundus.*
- *Cynodon dactylon.*
- *Verbena bonariensis.*
- *Datura stramonium.*
- *Cirsium vulgare.*
- *Eucalyptus sp.*

Wetland indicators include (Figure 11):

- *Phragmites australis.*
- *Typha capensis.*
- *Juncus rigidus.*
- *Kniphofia albescens.*
- *Paspalum urvillei.*
- *Imperata cylindrica*
- *Persicaria lapathifolia.*
- *Nymphaea nouchali.*
- *Andropogon eucomus.*
- *Haplocarpha scaposa.*
- *Cyperus marginatus.*
- *Fimbristylis complanata* subsp. *Complanata.*

Figure 11: Vegetation composition of the unchannelled valley bottom wetland and the seepage wetlands.

3.2 Wetland Classification and Delineation

Three (3) wetland areas were recorded on the study site. The wetland areas were classified as an unchannelled valley bottom wetland, and two seepage wetlands. The unchannelled valley bottom forms part of the Blesbokspruit River and both the seepage wetlands drains directly into the Blesbokspruit River.

The 2014 study indicated an additional two seepage areas (Figure 12). However, upon further investigation and the additional use of historical aerial imagery, it was found that these areas are unlikely to be functioning wetland areas. The area previously described as a degraded seepage wetland was reclassified as a disturbed area with many quarries, diggings and other disturbances. These disturbances have led to numerous pockets of standing water and wetland vegetation and although these areas contribute to habitat for faunal and floral species they are unlikely to contribute to wetland functionality. Furthermore, and additional seepage area, overlooked in the 2014 study, was recorded. This area was previously overgrazed with little species remaining. In the 2018 fieldwork, numerous wetland species was recorded here such as *Juncus effusus and Juncus rigidus*. Figure 13 shows the wetland areas as they were determined in 2018.

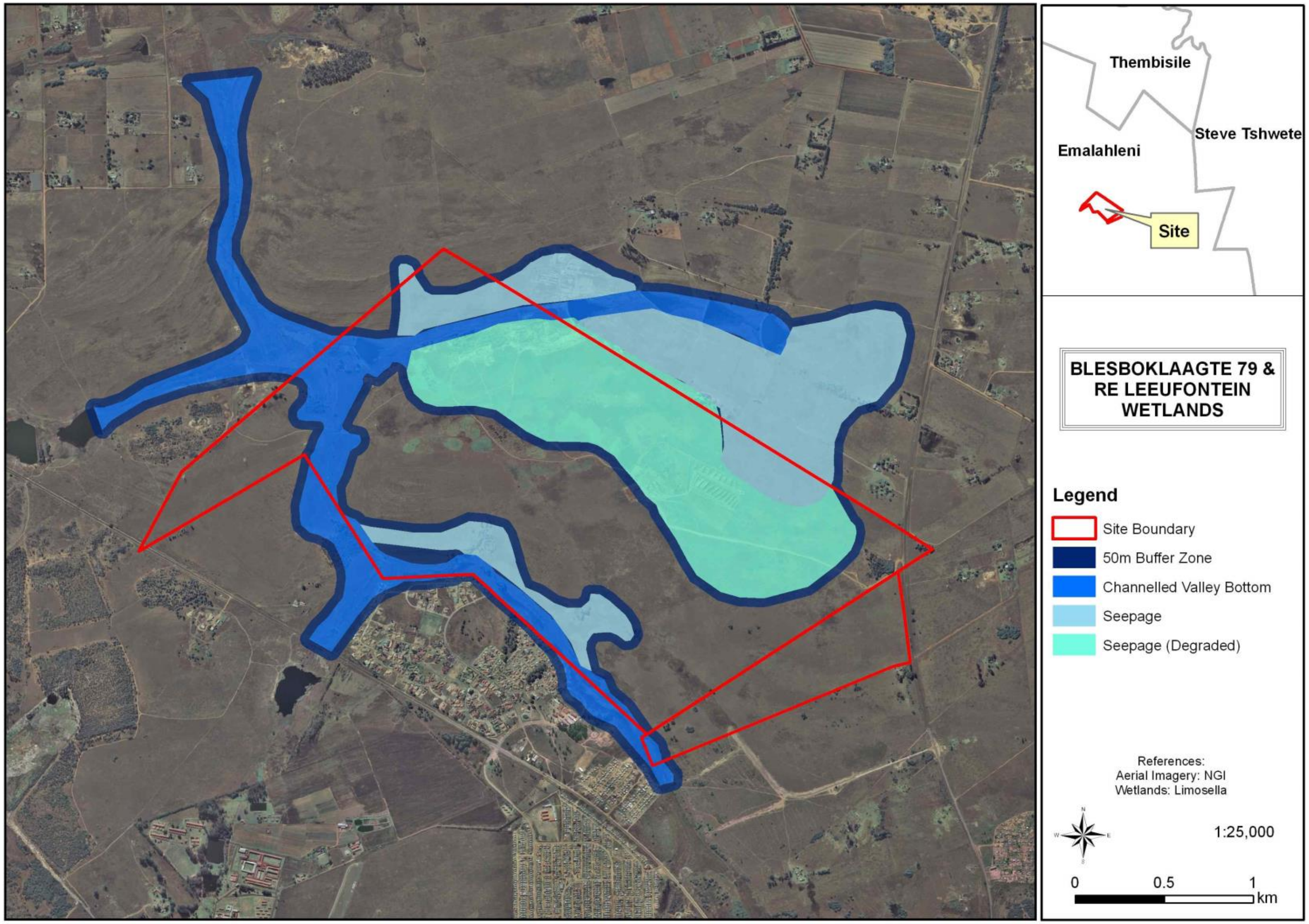


Figure 12: 2014 Delineation of wetlands together with associated buffer zones.

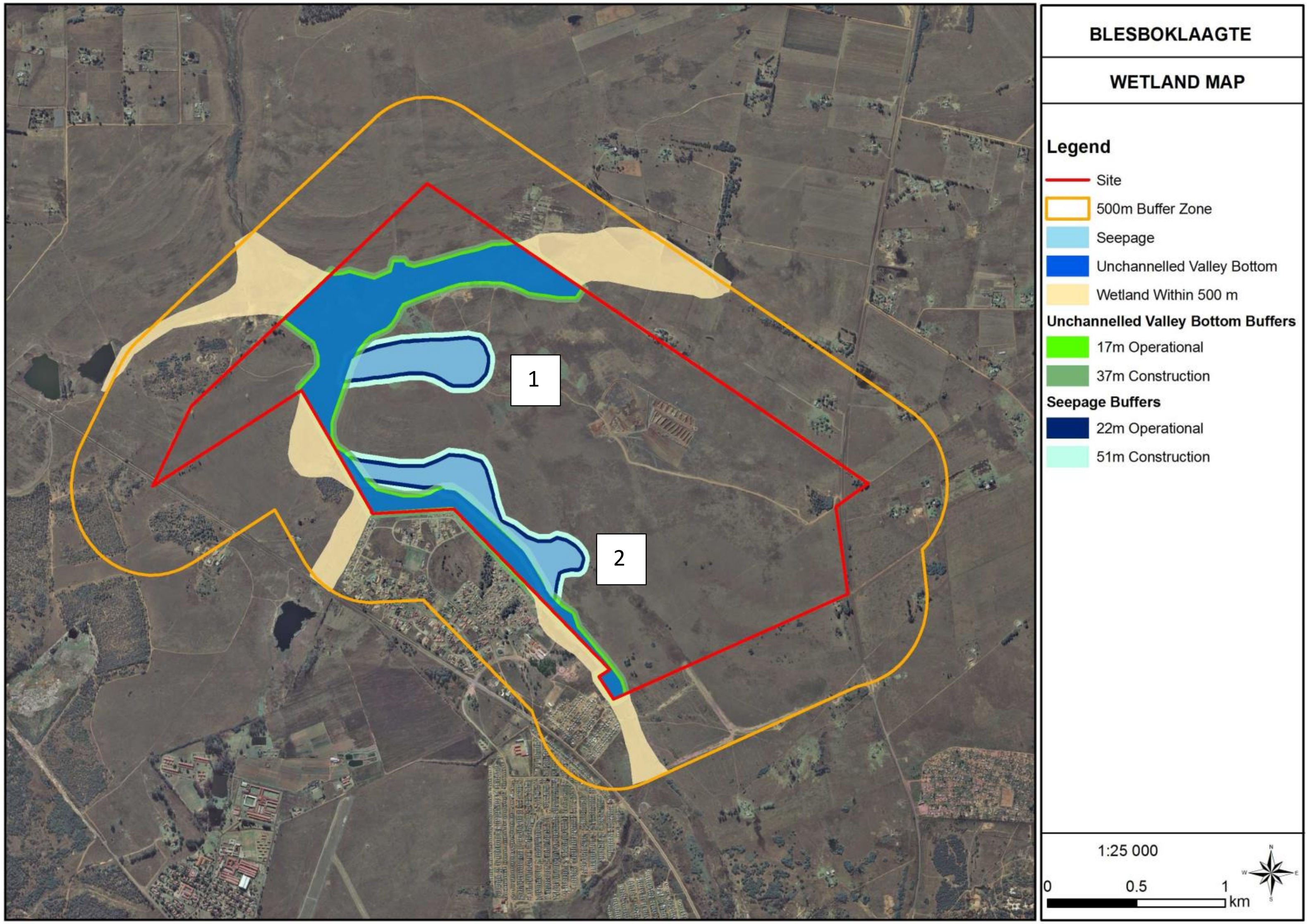


Figure 13: 2018 Delineation of wetlands together with associated buffer zones. The wetlands are further discussed in the sections below.

Wetlands associated with the study site

Unhannelled Valley Bottom

The unchannelled valley bottom wetland found on the site extends through the northern section of the study site as well as bordering the southern section of the study site. The wetland has been impacted by roads, grazing and some patches of exotic woody vegetation such as *Eucalyptus sp.* and *Acacia mearnsii.* The main impact associated with this wetland is the numerous areas where the wetland has been dammed up, thus altering its natural flow characteristics, preventing the transportation of sediment through the wetland as well as preventing the migration of faunal species through the wetland (Figure 14).

Figure 14: Damming of the channelled valley bottom.

In the northern corner of the study site a large section of exposed soil was recorded. This is due to ongoing sand mining and associated activities in the wetland. The close association with the town of Pine Ridge also has an impact on the wetland by creating footpaths, dumping and fringing construction of houses. The wetland vegetation here is mostly intact with dense stands of *Phragmites australis* reeds. Sediment deposition was seen on the edges of the wetland suggesting that the wetland contributes to sediment trapping in conjunction with the associated seepage areas (Figure 15).

Figure 15: Channelled Valley Bottom (Blue) in relation to the study area (Red).

<u>Seepage Area 1</u>

This seepage area is located in approximately the middle of the study area (Figure 16). The area is generally overgrazed with some sections dominated by *Seriphium plumosum* (Bankrupt Bush) although wetland species such as *Kyllinga melanosperma, Cyperus sp,* and *Juncus sp.* were recorded here.

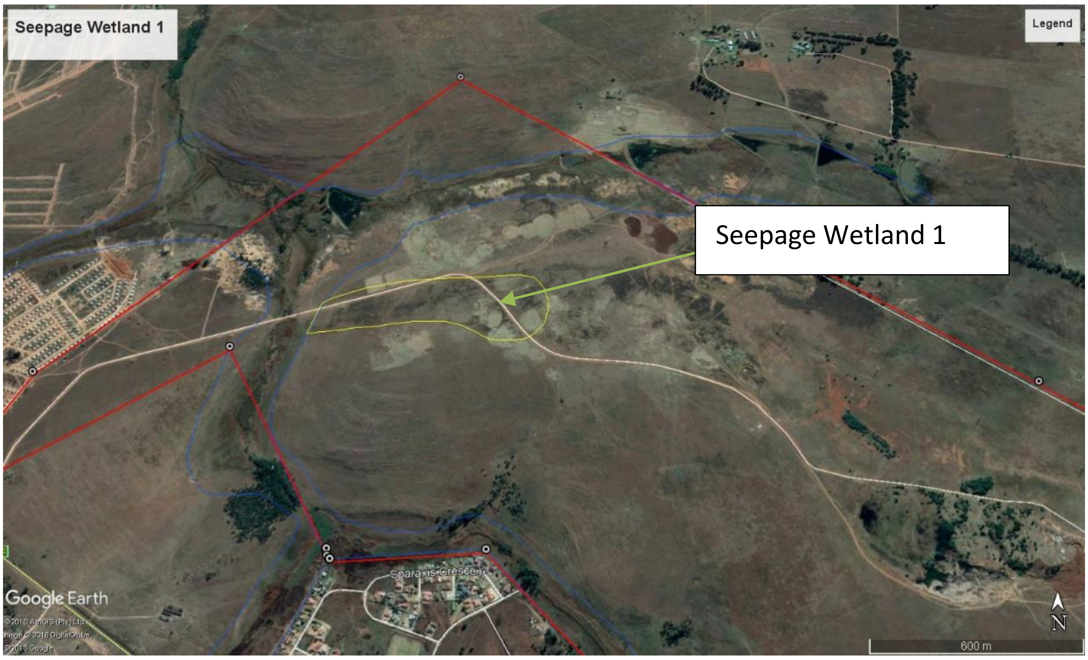


Figure 16: Seepage area (Yellow) in relation to the unchannelled Valley Bottom (Blue) and the study area (Red).

<u>Seepage Area 2</u>

This seepage area drains into the unchannelled valley bottom wetland and is located on a sloped area with somewhat steep gradients (Figure 17). The western section of the seepage wetland includes a concentrated flow path of a drainage area between mountainous areas.

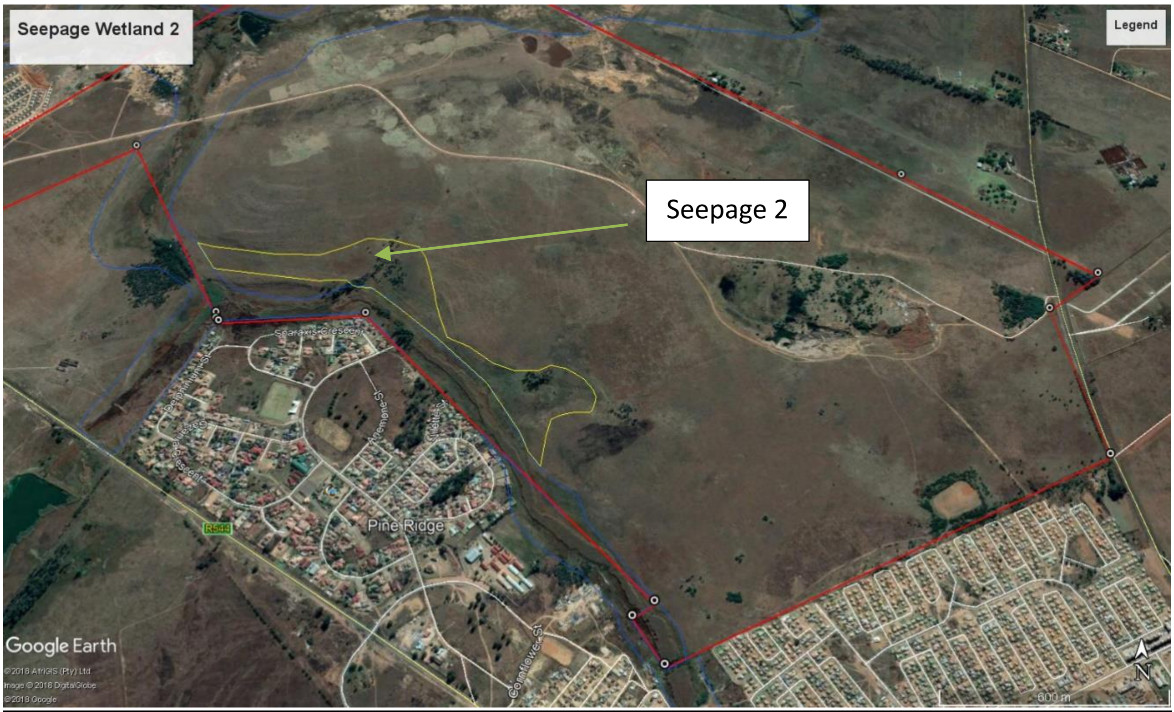


Figure 17: Seepage area (Yellow) in relation to the Channelled Valley Bottom (Blue) and the study area (Red).

In summary, the hydrology and geomorphology of the wetland system as a whole has been significantly impacted by the quarrying, diggings and sand mining as well as the damming of the unchannelled valley bottom wetland. The vegetation of the wetland system has also been impacted by the quarrying as well as overgrazing. The 2018 study therefore concludes that the seepage area found in 2014 is not currently a functional wetland although it may have been in the past.

The impacts are represented in the PES score below (Table 13)

Table 13: Summary of hydrology, geomorphology and vegetation health assessment for the Wetland system on the study site (*Macfarlane et al*, 2009).

Wetland Unit	Ha	Extent (%)	Hydrology		Geomorphology		Vegetation		Overall Score	
			Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Unchannelled Valley Bottom	128	40	3.7	-1	3.2	-1	3.5	-2	3.5	-2
			C	↓	C	↓	C	↓↓	C	↓↓
Seepage 1	24	7	3.6	0	2.4	0	4.2	-1	3.4	0

			C	→	**B**	→	**D**	↓	**C**	→
Seepage 2	17	6	3.0	0	3.0	0	5.0	0	3.6	0
			C	→	**C**		**D**	→	**C**	→

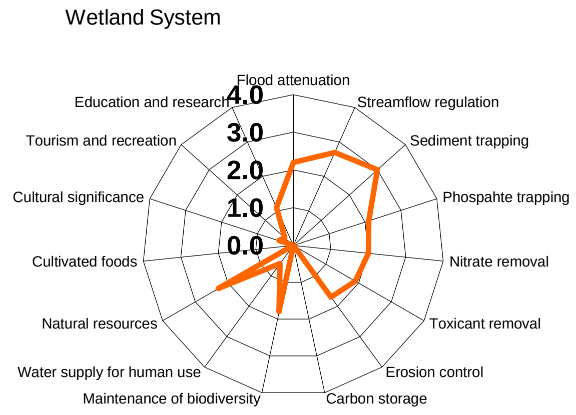
The EIS score of **2.3** falls into a category characterised by high ecological importance and sensitivity and is considered to ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers. Wetlands in this category further play a small role in moderating the quantity and quality of water in major rivers (DWAF, 1999) (Table 7).

Table 14: Combined EIS scores obtained for the Wetland system on the study site. (DWAF, 1999).

WETLAND IMPORTANCE AND SENSITIVITY	**Importance**	**Confidence**
Ecological importance & sensitivity	2.3	3.0
Hydro-functional importance	2.3	3.0
Direct human benefits	0.7	3.0
Highest score	**2.3 (High)**	

The ecosystem services provided by this wetland according to the WetEcoservices assessment are summarised in Table 15 below (Kotze *et al* 2005).

Table 15: Results and brief discussion of the Ecosystem Services provided by the Wetland system on the study site.



Function	Score	Significance
Flood attenuation	2.2	Moderately High
Stream flow regulation	2.7	Moderately High
Sediment trapping	3.0	High
Phosphate trapping	2.1	Moderately High
Nitrate removal	2.0	Moderately High
Toxicant removal	1.9	Moderately Low
Erosion control	1.7	Moderately Low
Maintenance of biodiversity	1.8	Moderately Low
Water supply for human use	0.6	Low
Natural resources	2.3	Moderately High
Cultivated foods	0.0	Low
Cultural significance	1.9	Low
Tourism and recreation	0.3	Low
Education and research	1.1	Moderately Low

3.3 Impacts and Mitigation

A development has several impacts on the surrounding environment and particularly on a wetland. The development changes habitats, the ecological environment, infiltration rates, amount of runoff and runoff intensity of stormwater, and therefore the hydrological regime of the area. A range of management measures are available to address threats posed to water resources. It is important to note that this section aims to highlight areas of concern. The details of the mitigation measures that are finally put in place should ideally be based on these issues, but must necessarily take into consideration the physical and economical feasibility of mitigation. It is important that any mitigation be implemented in the context of an Environmental Management Plan to in order to ensure accountability and ultimately the success of the mitigation.

No detailed method statements or proposed layouts were made available for consideration when assessing the potential risks. The confidence level with which the risk assessment was done is ***Low***

It is important to note that the impact assessments focus on the watercourses and wetland and do not assess the potential impacts to other ecological features of the site.

The activities discussed in this report include the construction of residential housing and associated activities such as access roads and services. The main expected impact associated with the proposed development is related to stormwater discharge into the watercourses. This is due to the change in the current mostly vegetated catchment of the watercourses to hard impermeable surfaces that generate greater water run-off compared to natural vegetated areas. It is therefore important to plan stormwater management accordingly. If stormwater discharge is concentrated to a few point-specific discharges it could lead to channelisation and possible erosional gullies. This is closely linked to the particular soil properties on the site. Housing developments may also impact on water recharge into the soil profiles.

3.3.1 NEMA (2014) Impact Assessment

Suggested mitigation/management measures are summarised in Tables 16 to 20.

Table 16: Changes in water flow regime impact ratings

Nature: Changing the quantity and fluctuation properties of the watercourse by for example restricting water flow or increasing flood flows		
ACTIVITY: The sources of this impacts includes the compaction of soil, the removal of vegetation, surface water redirection during construction activities. Permanent changes to water flows during the operational phase are related to changes stormwater flows		
	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Definite (5)	Probable (3)
Duration	Long term (4)	Medium-term (3)
Extent	Regional (3)	Limited to Local Area (2)
Magnitude	Moderate (6)	Low (4)

Significance	**65 (high)**	**27 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Definite (5)	Probable (3)
Duration	Medium-term (3)	Medium-term (3)
Extent	Regional (3)	Limited to Local Area (2)
Magnitude	Moderate (6)	Low (4)
Significance	**60 (high)**	**27 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	High	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Effective stormwater management should be a priority during both construction and operational phase. This should be monitored as part of the EMP.
- An environmentally friendly stormwater design should be formulated based on empirical data showing how a neutral effect on the regional hydrograph will be achieved.
- High energy stormwater input into the watercourses should be prevented at all cost. Changes to natural flow of water (surface water as well as water flowing within the soil profile) should be taken into account during the design phase and mitigated effectively
- Implement the principles set out in The South African Guidelines for Sustainable Drainage Systems (SuDS) (Armitage *et al*, 2013)
- Monitoring for local and downstream impacts during the construction as well as operational phases are imperative and should form part of the EMP

Cumulative impacts: Construction and operational activities may result in cumulative impact to the water courses within the local catchments and beyond. It is very imperative that effective protective measures should be put into place and monitored. A rehabilitation plan should be put into action should any degradation be observed as a result from stormwater or sediment input. Increases in stormwater flows will definitely cause permanent degradation downstream unless mitigated at the design level.

Residual Risks: Impacts to the flow characteristics of this watercourse are likely to be permanent unless rehabilitated.

Table 17: Changes in sediment entering and exiting the system impact ratings

Nature: Changes in sediment entering and exiting the system.

Activity: Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount). Construction and operational activities will result in earthworks and soil disturbance as well as the removal of natural vegetation. This could result in the loss of topsoil, sedimentation of the watercourse and increase the turbidity of the water. Possible sources of the impacts include:

- Earthwork activities during construction
- Clearing of surface vegetation will expose the soils, which in rainy events would wash through the watercourse, causing sedimentation. In addition, indigenous vegetation communities are unlikely to colonise eroded soils successfully and seeds from proximate alien invasive trees can spread easily into these eroded soil.
- Disturbance of soil surface
- Disturbance of slopes through creation of roads and tracks adjacent to the watercourse
- Erosion (e.g. gully formation, bank collapse)

	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Highly probable (4)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Limited to Local Area (2)	Limited to the local area (2)
Magnitude	High (8)	Low (4)
Significance	**52 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Probable (3)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Regional (3)	Limited to the local area (2)
Magnitude	Low (4)	Low (4)
Significance	**30 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	High	Low
Can impacts be mitigated?	Yes	

Mitigation: • Avoid construction related activities in the delineated wetlands and their buffer zones. • Consider the various methods and equipment available and select whichever method(s) that will have the least impact on watercourses. • Water may seep into trenching and earthworks. It is likely that water will be contaminated within these earthworks and should thus be cleaned or dissipated into a structure that allows for additional sediment input and slows down the velocity of the water thus reducing the risk of erosion. Effective sediment traps should be installed. • Construction in and around watercourses must be restricted to the dryer winter months where possible. • Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area (DWAF, 2005). • Remove only the vegetation where essential for construction and do not allow any disturbance to the adjoining natural vegetation cover. • Rehabilitation plans must be submitted and approved for rehabilitation of damage during construction and that plan must be implemented immediately upon completion of construction. • Cordon off areas that are under rehabilitation as no-go areas using danger tape and steel droppers. If necessary, these areas should be fenced off to prevent vehicular, pedestrian and livestock access. • During the construction phase measures must be put in place to control the flow of excess water so that it does not impact on the surface vegetation. • Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. • Runoff from the construction area must be managed to avoid erosion and pollution problems. • Maintain buffer zones to trap sediments • Monitoring should be done to ensure that sediment pollution is timeously addressed
Cumulative impacts: Expected to be high. Should mitigation measure not be implemented sediment input may significantly alter the wetland and downstream watercourses. Reversing this process is unlikely and should be prevented in the first place.
Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

Table 18: Introduction and spread of alien vegetation impact ratings.

Nature: Introduction and spread of alien vegetation.

Activity: The moving of soil and vegetation resulting in opportunistic invasions after disturbance and the introduction of seed in building materials and on vehicles. Invasions of alien plants can impact on hydrology, by reducing the quantity of water entering a watercourse, and outcompete natural vegetation, decreasing the natural biodiversity. Once in a system alien invasive plants can spread through the catchment. If allowed to seed before control measures are implemented alien plans can easily colonise and impact on downstream users.

	Without mitigation	**With mitigation**
CONSTRUCTION PHASE		
Probability	Probable (3)	Probable (3)
Duration	Medium-term (3)	Short duration (2)
Extent	Regional (4)	Local (2)
Magnitude	Low (4)	Low (4)
Significance	**33 (moderate)**	**24 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Probable (3)	Possible (2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Regional (4)	Limited to Local Area (2)
Magnitude	Low (4)	Low (4)
Significance	**33 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Implement an Alien Plant Control Plan
- Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area and returning it where possible afterwards.
- Monitor the establishment of alien invasive species within the areas affected by the construction and maintenance and take immediate corrective action where invasive species are observed to establish.
- Rehabilitate or revegetate disturbed areas

Cumulative impacts: Regular monitoring should be implemented during construction, rehabilitation including for a period after rehabilitation is completed.

Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

Table 19: Loss and disturbance of watercourse habitat and fringe vegetation impact ratings

Nature: Loss and disturbance of watercourse habitat and fringe vegetation.

Activity: Direct development within watercourse areas, including crossings. Loss and disturbance of watercourse habitat and fringe vegetation due to direct development on the watercourse as well as changes in management, fire regime and habitat fragmentation.

	Without mitigation	With mitigation
CONSTRUCTION PHASE		
Probability	Possible (2)	Improbable (1)
Duration	Medium-term (3)	Short term (2)
Extent	Local Area (2)	Local Area (2)
Magnitude	High (8)	Low (4)
Significance	**26 (low)**	**8 (low)**
Status (positive or negative)	Negative	Negative
OPERATIONAL PHASE		
Probability	Possible (2)	Improbable (1)
Duration	Medium-term (3)	Short-term (2)
Extent	Local Area (2)	Local Area (2)
Magnitude	High (8)	Low (4)
Significance	**26 (low)**	**8 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	

Mitigation:

- No development should occur within the delineated wetland and buffer zones
- Demarcate the watercourse areas and buffer zones to limit disturbance, clearly mark these areas as no-go areas
- Weed control in buffer zone
- Monitor rehabilitation and the occurrence of erosion twice during the rainy season for at least two years and take immediate corrective action where needed.
- Monitor the establishment of alien invasive species within the areas affected by the construction and take immediate corrective action where invasive species are observed to establish
- Operational activities should not take place within watercourses or buffer zones, nor should edge effects impact on these areas
- Operational activities should not impact on rehabilitated or naturally vegetated areas

Cumulative impacts: Expected to be moderate. May result in a high degree of irreplaceable loss of resources.

Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary.

Table 20: Changes in water quality due to pollution impact ratings.

Nature: Changes in water quality due to pollution.

Activity: Construction and operational activities may result in the discharge of solvents and other industrial chemicals, leakage of fuel/oil from vehicles and the disposal of sewage resulting in the loss of sensitive biota in the wetlands/rivers and a reduction in watercourse function as well as human and animal waste.

	Without mitigation	**With mitigation**
	CONSTRUCTION PHASE	
Probability	Probable (3)	Possible(2)
Duration	Medium-term (3)	Medium-term (3)
Extent	Regional (3)	Local Area (2)
Magnitude	High (8)	Low (4)
Significance	**42 (moderate)**	**18 (low)**
Status (positive or negative)	Negative	Negative
	OPERATIONAL PHASE	
Probability	Highly probable (4)	Probable (3)
Duration	Medium-term (3)	Short-term (2)
Extent	Local Area (2)	Local Area (2)
Magnitude	High (8)	Low (4)
Significance	**52 (moderate)**	**24 (low)**
Status (positive or negative)	Negative	Negative
Reversibility	Low	Moderate
Irreplaceable loss of resources?	Low	Low
Can impacts be mitigated?	Yes	

Mitigation:

- Provision of adequate sanitation facilities located outside of the watercourse or its associated buffer zone.
- Implementation of appropriate stormwater management around the excavation to prevent the ingress of run-off into the excavation and to prevent contaminated runoff into the watercourse.
- The development footprint must be fenced off from the watercourses and no related impacts may be allowed into the watercourse e.g. water runoff from cleaning of equipment, vehicle access etc.
- After construction, the land must be cleared of rubbish, surplus materials, and equipment, and all parts of the land shall be left in a condition as close as possible to that prior to use.
- Maintenance of construction vehicles / equipment should not take place within the watercourse or watercourse buffer.
- Maintenance of buffer zones to trap sediments with associated toxins
- Ensure that no operational activities impact on the watercourse or buffer area. This includes edge effects.
- Control of waste discharges and do not allow dirty water from operational activities to enter the watercourse
- Ensure that no operational activities impact on the watercourse or buffer area. This includes edge effects, failure of infrastructure such as sewage pipes. Implement litter traps at all watercourse crossings
- Treatment of pollution identified should be prioritized accordingly.

Cumulative impacts: Expected to be moderate. Once in the system it may take many years for some toxins to be eradicated.

Residual Risks: Expected to be limited provided that the mitigation measures are implemented correctly and effective rehabilitation of the site is undertaken where necessary. Littering and failure of services during the operation phase of the development should particularly be addressed.

3.3.2 DWS (2016) Impact Register and Risk Assessment

An extract from the Risk Matrix spreadsheet presented in Table 21 below show the expected risk score categories which can be used to guide decision-making with regards to the authorization of the proposed activities through a Water Use Licence or General Authorization.

Table 21: The severity score derived from the DWS (2016) risk assessment matrix for the proposed residential development construction and operational phases

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

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

Phases	Activity	Aspect	Impact	Flow Regime (Severity)	Physico & Chemical (Water Quality) (Severity)	Habitat (Geomorph+Veg etation) (Severity)	Biota (Severity)	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 of Residential development infrastructure including access roads and services	Clear vegetation	Changes to flow characteristics in the wetland, compaction of soils, sedimentation, pollution and alien invasive plant establishment, erosion downstream	1	2	2	2	2	1	1	3.8	1	2	5	2	10	37.5	L	80%	• No development should occur within the delineated wetland and buffer zones • Implement best practice and mitigation measures as specified in the rehabilitation plan • Implement the principles set out in The South African Guidelines for Sustainable Drainage Systems (SuDS) (Armitage et al, 2013) • An environmentally friendly stormwater design should be formulated based on empirical data showing how a neutral effect on the regional hydrograph will be achieved. • Implement effective rehabilitation to reverse construction related impacts	N	PES: C EIS: B REC: C
		Create temporary crew camps		1	1	2	1	1	1	2	4.3	1	2	5	2	10	42.5	L	80%		N	
		Earthworks including installation of services		2	2	1	1	2	2	2	5.5	1	2	5	2	10	55	L	80%		N	
		Stormwater Management		2	2	1	1	2	1	2	4.5	1	4	5	2	12	54	L	80%		N	
		Upgrade roads with watercourse crossings		2	2	2	1	2	1	2	4.8	1	2	5	2	10	47.5	L	80%		N	
O	Opeartion of the Residential development	Day to day operation of the resiential and commercial infrastructure including roads, stormwater system and services	Increased high energy stormwater input, pollution, invasion of alien invasive species	2	2	1	1	2	2	2	5.5	5	2	5	2	14	77	M	80%	• Design of structures should aim to have the least impact on habitat quality and hydrology of thewatercoursesand should include attenuation structures to contribute to regional flood control and rehabilitation • Maintain sewage ingrastructure to *ensure* that leaks do not enter the watercousre • Implement the principles of Susuainable Urban Draingae • Control of alien invasive plants should form part of the maintenance plan • Ensure that overgrazing in the wetland does not occur • Install litter traps	Y	PES: C EIS: B REC: C
		Maintenenace		1	1	1	1	1	2	1	4	1	2	5	2	10	40	L	80%		N	

4 CONCLUSION

Three (3) wetland areas were recorded on the study site. The wetland areas were classified as an unchannelled valley bottom wetland, and two seepage wetlands. The unchannelled valley bottom wetland forms part of the Blesbokspruit River and both the seepage wetlands drain directly into the Blesbokspruit River.

The 2014 study indicated an additional two seepage areas. Upon further investigation and the additional use of historical aerial imagery, it was found that these areas are unlikely to be functioning wetland areas. The area previously described as a degraded seepage wetland was reclassified as a disturbed area with many quarries, diggings and other disturbances. These disturbances have led to numerous areas of standing water and wetland vegetation and although these areas contribute to habitat for faunal and floral species it is unlikely to contribute to wetland functionality. Furthermore, and additional seepage area was recorded. This area was previously overgrazed with little species remaining. In the 2018 fieldwork, numerous wetland plant species were recorded here including *Juncus effusus and Juncus rigidus*.

The hydrology and geomorphology of the wetland system as a whole has been significantly impacted by the quarrying, diggings and sand mining as well as damming of the unchannelled valley bottom wetland. The vegetation of the wetland system has also been impacted by the quarrying as well as overgrazing. The 2018 study therefore concludes that the seepage area found in 2014 is not currently a functional wetland although it may have been in the past. Implications for development are that the delineated functional wetland as confirmed in 2018 (the channelled valley bottom wetland, seepage 1 and 2), together with their recommended buffer zones should be excluded from the development footprint. The seepage area identified in 2014 and omitted from the 2018 delineation may be included in the development layout given that strict mitigation measures ensure that no negative impact results to the downstream wetlands.

A summary of the functional assessment scores obtained for the wetlands are presented in Table 22. Table 23 presents a summary of the important findings of this assessment

Table 22: Summary of scores obtained for the wetland and watercourses on this site.

Classification (SANBI, 2013)	PES (Macfarlane *et al*, 2007) and VEGRAI (Kleynhans et al, 2008).	EIS (DWAF, 1999) and QHI (Seaman *et al*, 2010)	WetEcoServices (3 most prominent scores)	Scientific Buffer (Macfarlane *et al* 2015)		REC
				Construction	Operational	
Unchannelled Valley Bottom Wetlands	3.5 C	3.7 (Very High)	Sediment Trapping – 3.0 Stream Flow Regulation – 2.7 Natural Resources – 2.3	37 m	17 m	C
Seepage Wetland 1	3.4 C			51 m	22 m	C

Classification (SANBI, 2013)	PES (Macfarlane *et al*, 2007) and VEGRAI (Kleynhans et al, 2008).	EIS (DWAF, 1999) and QHI (Seaman *et al*, 2010)	WetEcoServices (3 most prominent scores)	Scientific Buffer (Macfarlane *et al* 2015)		REC
				Construction	Operational	
Seepage Wetland 2	3.6 C			51 m	22 m	C

Table 23: Summary of important findings

	Quaternary Catchment and WMA areas		Important Rivers possibly affected	
	B11K– 2nd WMA - Olifants		Drains directly into the Blesbokspruit on the study site	
NEMA 2014 Impact Assessment	The impact scores for the following aspects are relevant:		Without Mitigation	With Mitigation
	Changes to flow dynamics	Construction Phase	H	L
		Operation Phase	H	L
	Sedimentation	Construction Phase	M	L
		Operation Phase	M	L
	Establishment of alien plants	Construction Phase	M	L
		Operation Phase	M	L
	Loss of wetland habitat	Construction Phase	L	
		Operation Phase	L	
	Pollution of watercourses	Construction Phase	M	L
		Operation Phase	M	L
DWS Impact assessment	The construction related activities associated with the development fall in the **low** category. The operation phase falls in the **medium** category largely because of the permanent changes to the catchment with regards to surface flow and recharge properties. However, provision is made for a lowering of the risk score by 25 points if additional detailed mitigation measures are implemented. Stormwater management should demonstrate a neutral effect on the regional hydrograph, alien plants and pollution should be shown to be effectively controlled and the development footprint should remain outside the delineated wetlands and their buffer zones. If the details of these aspects of mitigation are found suitable, the DWS may allow authorisation through a General Authorization (GA).			

Does the specialist support the development?	Yes. However it should be done in a manner that does not further alter the natural watercourses, or the biodiversity status of the surrounding habitat.
Recommendations	• The development should take into account the qualified presence of sensitive and protected flora, fauna and avifauna species. • Design of structures should aim to have the least impact on habitat quality and hydrology of the watercourses and should include attenuation structures to contribute to regional flood control and rehabilitation • Maintain sewage infrastructure to ensure that leaks do not enter the watercourses • Implement the principles of Sustainable Urban Drainage • Control of alien invasive plants should form part of the maintenance plan • Ensure that overgrazing in the wetland does not occur • Install and maintain litter traps

REFERENCES

Armstrong A. (2009). WET-Legal:Wetland rehabilitation and the law in South Africa. WRC Report TT 338/09. Water research Comission, Pretoria

Brinson, M. (1993). A hydrogeomorphic classification for wetlands. Prepared for US Army Corps of Engineers. 101pp. Wetlands Research Programme Technical Report WRP-DE-4

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

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

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

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

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

Ewart-Smith J., Ollis D., Day J. and Malan H. (2006). National Wetland Inventory: Development of a Wetland Classification System for South Africa. Water Research Council project number K8/652

Fey M. (2005). Soils of South Africa: Systematics and environmental significance. Lombardi Trust. Draft submitted for comment

Fey M. (2010). Soils of South Africa: The distribution, properties, classification, genesis, use and environmental significance.

Gauteng Department of Agriculture Conservation & Environment (2002). Gauteng Agricultural Potential Atlas. Johannesburg

Gauteng Department of Agriculture, Conservation & Environment (2012) GDARD Minimum Requirements for Biodiversity Assessments Version 3. Directorate Nature Conservation, Johannesburg.

Gauteng Department of Agriculture and Rural Development, (2011): Gauteng Conservation Plan Version 3 ArcGIS Spatial data

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

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

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

Kotze D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.S. and Collins, N.B. (2005). WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands

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

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

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

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

Vermaak, JF, Swanepoel, JH and Schoonbee, HJ., (1981). The Phosphorous cycle in Germiston Lake. 1. Investigational objectives and aspects of the limnology of the Lake. Water SA Vol 7(3) p160-165.

APPENDIX A: 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

Appendix B: Survey Data

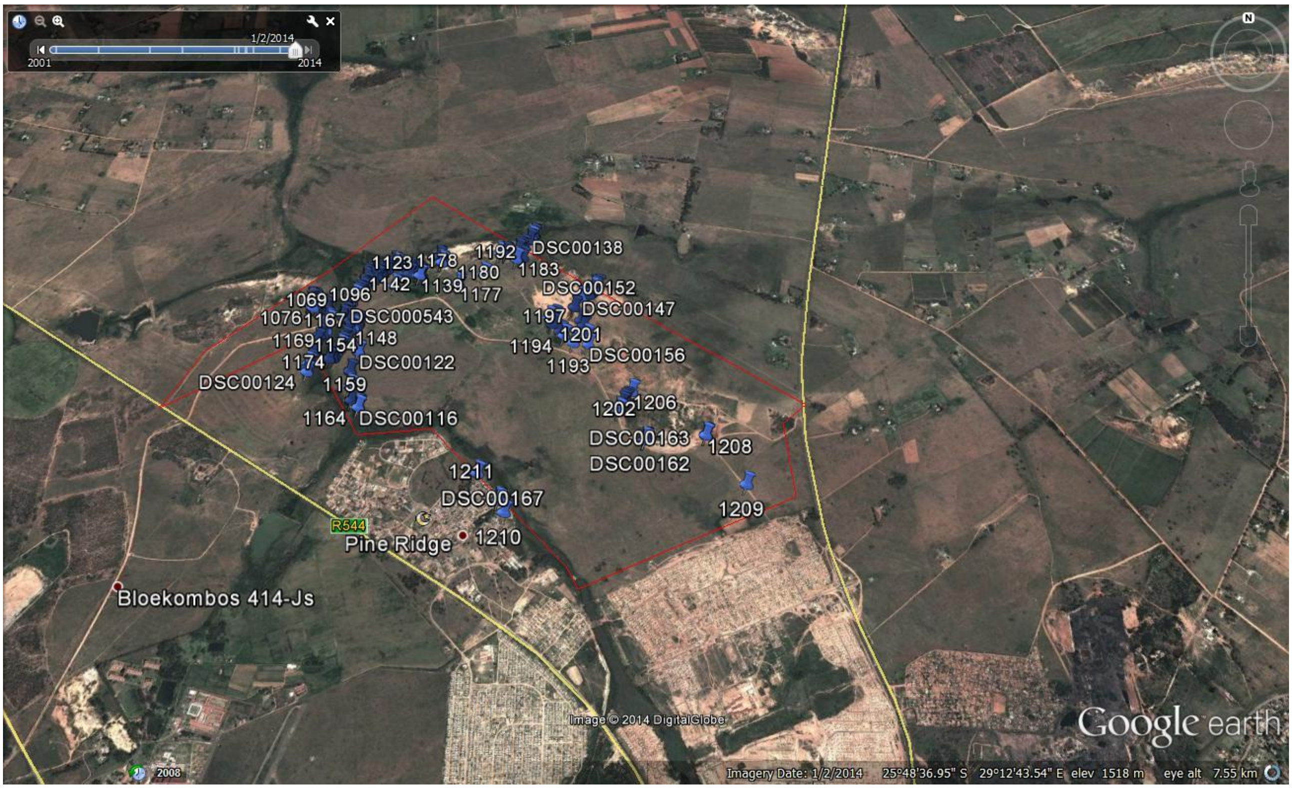


Figure 18: Map indicating location of sample points.

Table 24: Sample area coordinates.

Point	Latitude	Longitude	Elevation
1059	-25.8045	29.19135	1461.143
1060	-25.8045	29.19122	1461.927
1061	-25.8045	29.19095	1463.222
1062	-25.8045	29.1908	1463.832
1063	-25.8043	29.19065	1463.829
1064	-25.8041	29.19058	1464.234
1065	-25.8041	29.19081	1463.908
1066	-25.8042	29.19088	1466.418
1067	-25.8041	29.19068	1465.286
1068	-25.8041	29.19067	1465.62
1069	-25.8043	29.19066	1466.138
1070	-25.8044	29.19052	1465.845
1071	-25.8044	29.19057	1464.635
1072	-25.8044	29.19061	1465.043
1073	-25.8045	29.19067	1465.938
1074	-25.8046	29.19073	1464.632
1075	-25.8046	29.19078	1465.302
1076	-25.8047	29.19083	1465.952
1077	-25.8047	29.19111	1463.3
1078	-25.8047	29.19128	1463.906
1079	-25.8047	29.19137	1463.888
1080	-25.8047	29.19148	1462.254
1081	-25.8047	29.19167	1462.169
1082	-25.8048	29.19176	1462.264
1083	-25.8049	29.19184	1462.376
1084	-25.805	29.19172	1464.047
1085	-25.805	29.19163	1465.032
1086	-25.8051	29.19166	1463.702
1087	-25.8052	29.19165	1464.819
1088	-25.8053	29.19172	1463.063
1089	-25.8054	29.19181	1462.842
1090	-25.8054	29.19183	1463.351
1091	-25.8052	29.19278	1461.007
1092	-25.805	29.19307	1461.418
1093	-25.805	29.19289	1459.798
1094	-25.8046	29.19309	1462.258
1095	-25.8043	29.19321	1461.066
1096	-25.8039	29.19337	1459.599
1097	-25.8037	29.19345	1459.961
1098	-25.8036	29.19359	1460.327
1099	-25.8034	29.19378	1460.735

1100	-25.8033	29.1938	1460.811
1101	-25.8032	29.19385	1461.208
1102	-25.803	29.19396	1461.672
1103	-25.803	29.19403	1461.732
1104	-25.8028	29.19442	1463.488
1105	-25.8027	29.1939	1461.149
1106	-25.8026	29.19394	1461.303
1107	-25.8025	29.194	1460.324
1108	-25.8024	29.19415	1463.687
1109	-25.8023	29.19429	1460.791
1110	-25.8024	29.19451	1462.42
1111	-25.8025	29.19457	1463.797
1112	-25.8025	29.19465	1465.704
1113	-25.8025	29.19476	1464.794
1114	-25.8025	29.1949	1465.84
1115	-25.8021	29.19507	1464.745
1116	-25.8021	29.19523	1464.651
1117	-25.802	29.1953	1464.486
1118	-25.8019	29.19538	1464.847
1119	-25.8019	29.19546	1464.779
1120	-25.8019	29.19553	1465.31
1121	-25.8016	29.19565	1463.342
1122	-25.8016	29.19565	1464.791
1123	-25.8017	29.19584	1464.75
1124	-25.8018	29.19612	1467.395
1125	-25.8019	29.19618	1465.393
1126	-25.802	29.19622	1468.639
1127	-25.8022	29.19622	1469.26
1128	-25.8023	29.19633	1469.699
1129	-25.8024	29.1964	1470.663
1130	-25.8024	29.19651	1470.812
1131	-25.8024	29.19662	1471.699
1132	-25.8024	29.19672	1472.675
1133	-25.8023	29.1968	1470.49
1134	-25.8022	29.19692	1471.888
1135	-25.8021	29.19702	1471.474
1136	-25.8023	29.19715	1472.714
1137	-25.8023	29.19724	1472.786
1138	-25.8023	29.19729	1473.083
1139	-25.8025	29.19741	1474.758
1140	-25.8025	29.19743	1474.689
1141	-25.8025	29.19754	1475.979
1142	-25.8032	29.19585	1470.839

1143	-25.8056	29.19328	1467.073
1144	-25.8056	29.19354	1469.118
1145	-25.8057	29.19387	1472.133
1146	-25.8058	29.19384	1470.908
1147	-25.8059	29.19374	1471.035
1148	-25.806	29.19359	1469.963
1149	-25.8062	29.19341	1471.247
1150	-25.8064	29.1932	1469.671
1151	-25.8067	29.19313	1470.13
1152	-25.807	29.19305	1468.753
1153	-25.8071	29.19301	1470.462
1154	-25.8073	29.19295	1470.794
1155	-25.8077	29.19277	1472.861
1156	-25.8079	29.19266	1470.521
1157	-25.808	29.1926	1471.264
1158	-25.808	29.19254	1470.463
1159	-25.8099	29.19391	1477.901
1160	-25.8102	29.19419	1479.511
1161	-25.8105	29.19439	1480.193
1162	-25.8107	29.19446	1478.936
1163	-25.811	29.19454	1479.011
1164	-25.8112	29.1946	1479.618
1165	-25.8108	29.19411	1477.408
1166	-25.8076	29.19413	1476.672
1167	-25.8056	29.19204	1470.826
1168	-25.8059	29.19186	1470.893
1169	-25.8062	29.1919	1468.791
1170	-25.8065	29.19152	1471.987
1171	-25.8068	29.19146	1471.802
1172	-25.8077	29.19136	1472.919
1173	-25.8083	29.19126	1473.161
1174	-25.8084	29.19113	1473.963
1175	-25.8087	29.19107	1474.12
1176	-25.8065	29.19173	1469.173
1177	-25.8032	29.19999	1482.255
1178	-25.8016	29.19876	1475.852
1179	-25.8012	29.19853	1474.866
1180	-25.8025	29.20155	1484.009
1181	-25.801	29.20263	1482.361
1182	-25.801	29.20291	1482.514
1183	-25.8014	29.20362	1486.179
1184	-25.8014	29.20366	1485.34
1185	-25.8013	29.20388	1486.271

1186	-25.8013	29.20404	1486.313
1187	-25.8008	29.20369	1482.642
1188	-25.8007	29.20386	1482.581
1189	-25.8005	29.20403	1482.261
1190	-25.8001	29.2044	1481.466
1191	-25.7997	29.20466	1484.694
1192	-25.801	29.2025	1482.005
1193	-25.8072	29.20754	1505.238
1194	-25.8067	29.20693	1500.966
1195	-25.8065	29.20668	1500.658
1196	-25.806	29.20615	1499.195
1197	-25.8055	29.20595	1498.223
1198	-25.8048	29.20752	1498.568
1199	-25.8035	29.20879	1495.028
1200	-25.8058	29.20795	1504.035
1201	-25.8068	29.20835	1504.161
1202	-25.8116	29.21044	1520.322
1203	-25.8111	29.21061	1519.796
1204	-25.8109	29.2108	1518.145
1205	-25.8108	29.21089	1518.579
1206	-25.8104	29.2112	1518.837
1207	-25.8133	29.21203	1525.656
1208	-25.8131	29.21564	1529.183
1209	-25.8159	29.21792	1532.872
1210	-25.8174	29.20387	1500.969
1211	-25.8152	29.20216	1496.876

APPENDIX C: Abbreviated CV 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.
- van Wyk, A.A., Wassenaar, T.D. 2006. *The biodiversity of epiphytic plants of the Richards Bay Minerals leases.* CERU Technical Report 33. University of Pretoria.

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

KEY EXPERIENCE

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

- More than 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

RUDI BEZUIDENHOUDT

RUDI BEZUIDENHOUDT
880831 5038 081
Limosella Consulting
Wetland Specialist
Cert. Nat. Sci (Reg. No. 500024/13)
South African
Single
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 – 2015)
- M.sc Aquatic Ecology, University of Johannesburg (2017-)
- 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)
- Invasive Species Training, SAGIC (2016)

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.

Major Projects Involve:

- Numerous Eskom Powerline Projects some spanning more than one Province.
- Proposed New Kruger National Camp and Infrastructure (2016)
- Numerous Mining Projects
- Numerous Water infrastructure upgrades
- Numerous Residential and Housing Developments

BIODIVERSITY ACTION PLAN

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

WETLAND REHABILITATION

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

COURSES PRESENTED

- Riparian Vegetation Response Assessment Index (VEGRAI) Training presented to DWA (2017)
- Numerous Wetland Talks

WETLAND ECOLOGY

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

ENVIRONMENTAL CONTROL OFFICER:

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

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

WETLAND AUDIT:

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

- Kusile Powerstation 2012-2013.

INVASIVE SPECIES CONTROL PLAN

Libradene Filling Station, Boksburg, Gauteng

PUBLICATIONS

Bezuidenhoudt. R., De Klerk. A. R., Oberholster. P.J. (2017). Assessing the ecosystem processes of ecological infrastructure on post-coal mined land. COALTECH RESEARCH ASSOCIATION NPC. University of South Africa. Council for Scientific Industrial Research.

Employee Experience:
GIS Specialist – AfriGIS
January 2008 – August 2010
Tasks include:

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

Wetland Specialist - Limosella Consulting
September 2010 – Ongoing
Tasks include:

- Wetland and Riparian delineation studies, opinions and functional assessments including data collection and analysis.
- Rehabilitation Reports
- Invasive species surveys and control plans
- 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 (Reg. No. 500024/13)