Proposed Coal Mine on the Farm Droogenfontein 241 IR Portions 26, 46 and 47, Delmas, Mpumalanga.

Wetland and Riparian Functional Assessment
September 2013

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.

________________________ ________15 January 2014________

Antoinette Bootsma (PrSciNat) Date

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EXECUTIVE SUMMARY

Limosella Consulting was appointed by Classical Environmental Management Services (CEMS) to undertake the wetland delineation and functional assessment for the proposed Coal Mine on Droogenfontein 241 IR, Portions 26, 46 and 47, Delmas, Mpumalanga. Fieldwork was conducted on the 6th of September 2013.

The terms of reference for the current study were as follows:

- Delineate the watercourses present on the proposed site;
- Undertake the functional assessment of wetlands or the river health of riparian areas affected by the proposed development;
- Recommend suitable buffer zones; and
- Assess the possible impact that the development could have on the watercourses.

Wetland delineations discussed in this report are based on a low confidence level due to site conditions encountered during the time of the assessment. Until follow-up site visits can be undertaken these wetland areas should be considered as preliminary delineations.

During the site visit two (2) wetland areas were identified; an Unchannelled Valley Bottom Wetland with extensive associated Hillslope seepage wetlands and a Pan are both located on Portion 26. On Portion 46 & 47 no wetlands were observed to be present although a Pan was located within 500m east of portion 46 & 47. The Unchannelled Valley Bottom Wetland with seepage elements on portion 26 flows from north east to south west and ultimately flows into the Ashton Dam which is located south west of the study site. The Depression Wetland is located close to the Unchannelled Valley Bottom Wetland and is likely hydrologically connected. During the time of the study the vegetation was burnt, accurate functionality assessments could therefore not be conducted. The soil of the area was also disturbed by ploughing. It is suggested that a follow up study be undertaken during the summer after rains to refine the preliminary functional assessment presented in this report. Furthermore, it is important that seepage conditions be verified in terms of geohydrology and soil so as to ensure an accurate understanding of water movement on the study sites, and therefore appropriate mitigation measures and buffer zones.

An estimate of the Present Ecological State and Ecological Integrity and Sensitivity for preliminary wetlands discussed in this report are presented below:

Wetland Unit	Estimated PES Score	Description	EIS Score
Unchannelled Valley Bottom	C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	1.2 (Moderate)
Pan	C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	0.7 (Low/Marginal)

A minimum buffer of 50m from the edge of the confirmed wetland boundaries should be respected. These confirmed boundaries should take into account the geohydrology of the site and its relationship to a detailed understanding of the proposed activities.

For the purpose of water use licenses, the watercourse is defined as the extent of the riparian habitat *or* the 1:100 year floodline, whichever is the greatest. It is important that groundwater processes be investigated to confirm that these buffer zones are sufficient to allow for recharge.

Should interventions be planned within the wetland area or its buffer zone, they are subject to a water use license in terms of Section 21 (c) and (1) of the National Water Act in terms of its location within 500m of a wetland, as required by the Department of Water Affairs.

Table of Contents

Figures

Tables

1 INTRODUCTION

Wetlands and riparian areas perform many functions that are valuable to society including the supply of water and the improvement of water quality (DWAF 2008). The habitats created by wetlands and rivers are also important for many plant and animal species. Not all wetlands or rivers develop in the same way and may not perform ecosystem services to the same extent. Where areas of human settlement and development threaten to encroach and impact on wetlands or riparian areas, it is important that the wetland's ecological integrity be assessed (DWAF 2008). Limosella Consulting was appointed by Classical Environmental Management Services (CEMS) to undertake the wetland delineation and functional assessment for the proposed Coal Mine on Droogenfontein 241 IR, Portions 26, 46 and 47, Delmas, Mpumalanga. Fieldwork was conducted on the 6th of September 2013.

1.1 Terms of Reference

The terms of reference for the current study were as follows:

- Delineate the watercourses present on the proposed site;
- Undertake the functional assessment of the health of the wetlands or riparian areas affected by the proposed development;
- Recommend suitable buffer zones; and
- Assess the impact that the development could have on the watercourses.

1.2 Assumptions and Limitations

The Garmin Montana 650 GPS used for wetland and riparian delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by at least a five meters radius. It is also 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. Printing or other forms of reproduction may also distort the scale indicated in maps. 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.

Wetland delineations are based on vegetation gradients and the interpretation of soil and wetness indicators. Identification of wetland characteristics rely on 1) the types of vegetation, in specific the presence of hydrophytic plants (plants adapted to growing in saturated soil conditions), 2) hydromorphic soils (soils displaying characteristics such as gleying and mottling that indicate temporary or permanently saturated conditions and 3) the position of the perceived wetland in the landsape (e.g. valley bottom). However, *at the time of the survey, these indicators were not accessible*. Large parts of the site were cultivated, including the wetland areas. Ploughing hampers the recognition of wetland characteristics of the soil. In addition, at the time of the study the area was burnt and little to no vegetation remained recognisable. Both soil and vegetation indicators used to delineate wetlands were thus disturbed. It is suggested that a follow up study be conducted during the summer. Description of the depth of the regional water table and geohydrological processes falls outside the scope of the current assessment. Particularly seepage wetland areas should be verified by suitably qualified pedologists.

1.3 Definitions and Legal Framework

In a South African legal context, the term watercourse is often used rather than the terms wetland, or river. The National Water Act (NWA) (1998) includes wetlands and rivers in the term watercourse in the following definition.

Watercourse means:

a) A river or spring;
b) A natural channel in which water flows regularly or intermittently;
c) A wetland, lake or dam into which, or from which, water flows, and
d) Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

Riparian habitat is the accepted indicator used to delineate the extent of a river's footprint (DWAF, 2005). The National Water Act, 1998 (Act No. 36 of 1998), defines a riparian habitat as follows: "Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse, which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.".

The National Water Act, 1998 (Act 36 of 1998) 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."

Authoritative legislation that lists impacts and activities on wetlands and riparian areas that requires authorisation includes:

- Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983);
- Environment Conservation Act, 1989 (Act 73 of 1989);
- National Water Act, 1998 (Act 36 of 1998);
- National Forests Act, 1998 (Act 84 of 1998);
- National Environmental Management Act, 1998 (Act No. 107 of 1998);
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004);
- GNR 1182 and 1183 of 5 September 1997, as amended (ECA);
- GNR 385, 386 and 387 of 21 April 2006 (NEMA); and
- GNR 544, 545 and 546 of 18 June 2010 (NEMA).

1.4 Locality of the study site

The study site is situated approximately 13km south west of Delmas, Mpumalanga Province (Figure 1). Portions 46 & 47 are bordered in the north by the R555 road. Portion 26 is located approximately 4km south of Portions 46 & 47. The approximate central coordinates for Portion 46 is 26°11'13.28"Sand 28°33'36.31"E, Portion 47 is 26°11'11.75"S and 28°33'39.97"E and Portion 26 is 26°13'39.07"S and 28°33'31.18"E.

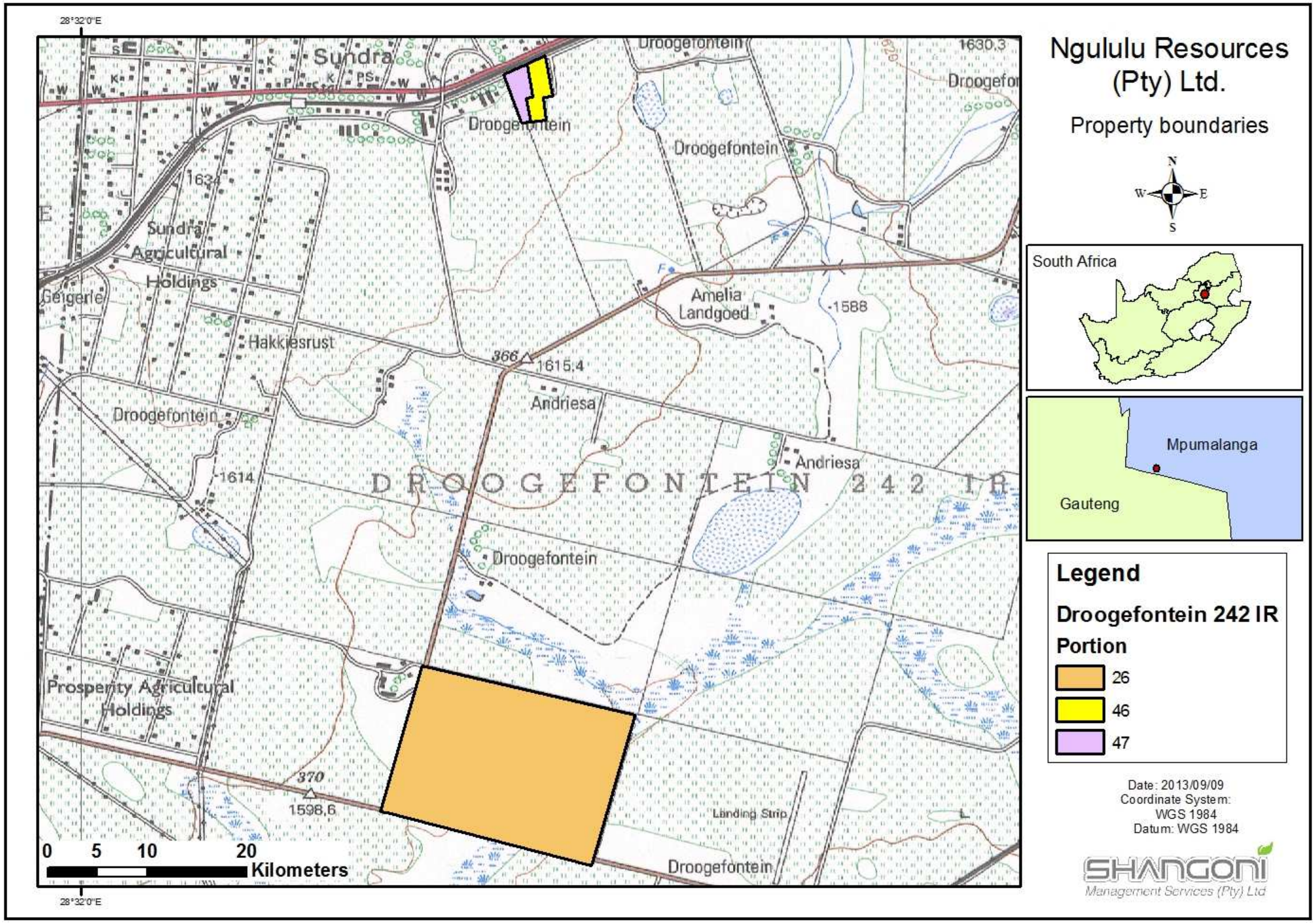


Figure 1: Locality Map

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 C21E Quaternary Catchment. In this catchment, the precipitation rate is lower than the evaporation rate (Table 1). 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.

Table 1: Characteristics of the Quaternary Catchments relevant to the assessment of wetland health (Adapted from Schultze [1997])

Catchment	Mean Annual Precipitation MAP (mm)	Potential Evaporation PET (mm)	Median Annual Simulated Runoff (mm)
C21E	675.9	2089.4	0.32

Hydrology:

Surface water spatial layers such as the National Freshwater Ecosystems Priority Areas (NFEPA) Wetland Types for South Africa (SANBI, 2010) were consulted for the presence of wetlands, perennial and non-perennial rivers on or in proximity to the site. As per these layers, Portions 46 & 47 contained no watercourses, while Portion 26 is covered in a large wetland area with a non-perennial river located just north of Portion 26 (Figure 2).

Regional Vegetation:

The study area falls within the Savanna and Grassland Biome of South Africa (Mucina and Rutherford, 2006). A biome is made up of various vegetation types, based largely on soil, topography and climate variations within the biomes. The study sites are located across three (3) vegetation types namely Soweto Highveld Grassland, Andestine Mountain Bushveld and Eastern Highveld Grassland (Figure 3). Another vegetation type namely Eastern Temperate Freshwater Wetlands is located within the surrounding area.

A section of Portion 26 is located on the vegetation type classified as Soweto Highveld Grassland (Mucina & Rutherford, 2006). This vegetation type is associated with the gently to moderately undulating landscape of the Highveld Plateau supporting short to medium-high, dense, tufted grassland, dominated by a variety of grasses. In undisturbed areas grassland is interrupted by small wetlands and narrow stream alluvia and occasional ridges or rocky outcrops. Soweto Highveld Grassland is considered Endangered as only a handful of patches are statutorily, or privately, conserved. A small section of Portion 26 and the entire Portion 46 & 47 is located across the Eastern Highveld Grassland vegetation type which comprises of short dense grassland and small, scattered rocky outcrops are characterised by wiry, sour grasses and some woody species. This vegetation unit is poorly conserved with much of its area transformed by cultivation, grazing, 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 Eastern 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). Portion 26 also spans the vegetation type known as Andesite Mountain Bushveld which is characterised by dense and medium tall thorny bushveld with a well-developed grass layer on hill slopes and some valleys with undulating landscape. The vegetation type is under pressure from cultivation and urbanisation with some of the unit fringing on major urban areas.

Although The Eastern Temperate Freshwater Wetlands vegetation type does not occur on the study site it does occur within close proximity. The Eastern Temperate Freshwater Wetlands occur in flat landscapes or shallow depressions filled with water. The water bodies contain aquatic zones and outer parts with hygrophilous vegetation of temporary flooded grasslands (Mucina & Rutherford, 2006). This vegetation unit is also classified as Endangered (Mucina & Rutherford, 2006).

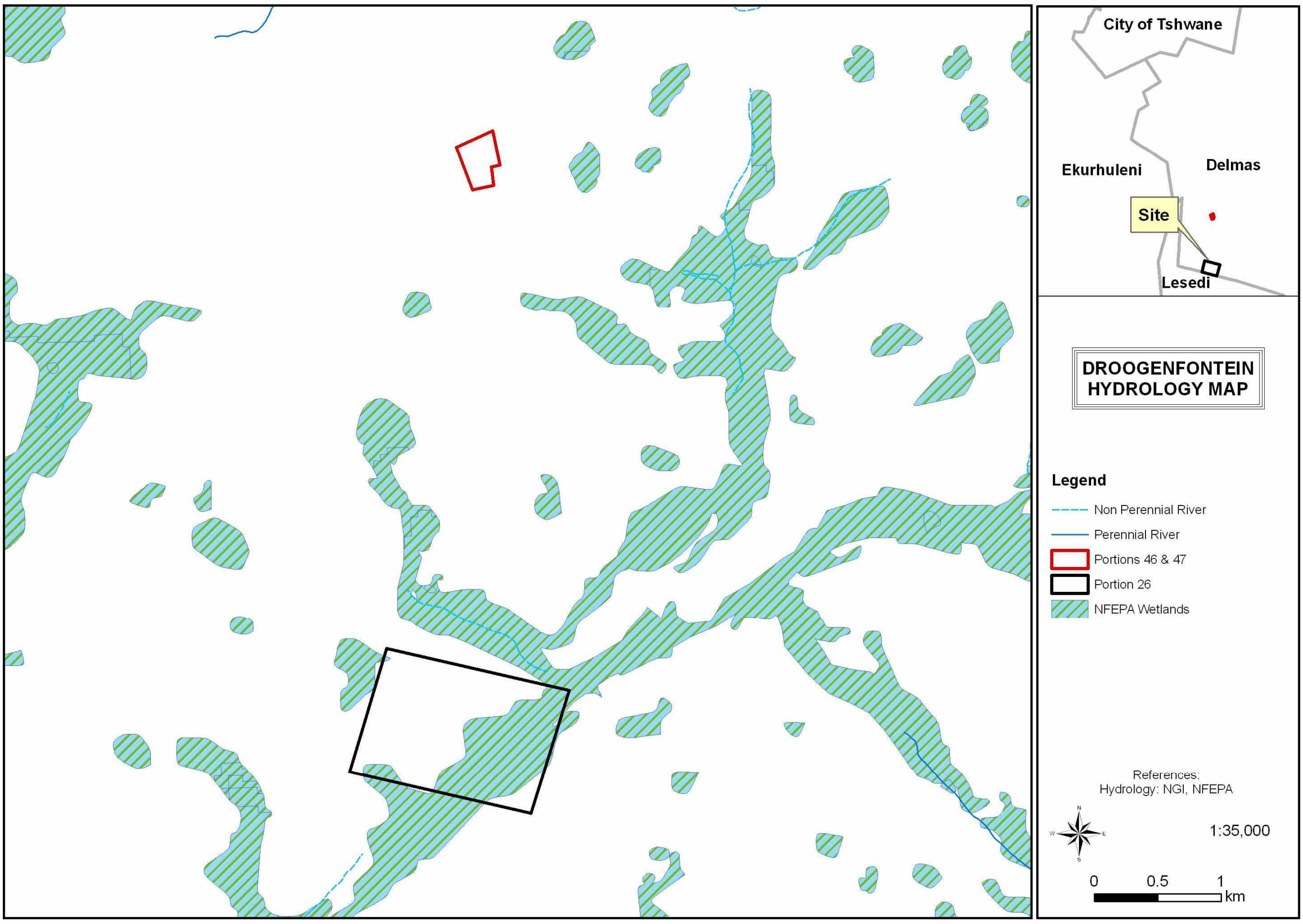


Figure 2: Hydrology of the study site and surrounds as per existing spatial layers.

<u>Geology and soils:</u>

The geology underlying the Portions 26, 46 & 47 is comprised mainly of Arenite (ENPAT, 2001). Arenite (wind-blown sands) weathers to form deep sandy soils which are highly mobile when disturbed and could therefore result in erosion problems during and after the proposed activities. As per Mucina and Rutherford (2006), the geology underlying the Andesite Mountain Bushveld comprise tholeitic basalts of the Klipriviersberg

Group, dark shale micaceous sandstone and siltstone, thin coal seams of the Madzaringwe formation, as well as andesite and conglomerate of the Pretoria group. Weathering of these give rise to shallow rocky, clayey soils mainly of Mispah and Glenrosa soil forms. The eastern Highveld Grassland is found on red to yellow sandy soils derived from shales and sandstones of the Madzaringwe Formation (Mucina & Rutherford, 2006). The Soweto Highveld Grassland is also found on shale, sandtone and mudstone of the Madzaringwe Formation, or the intrusive Karoo Suite dolerites (Mucina & Rutherford, 2006).

Portions 46 & 47 and a small section of Portion 26 is located on a S3 soil class which contain red or yellow structureless soils with a plinthic horizon. In plinthic soils an absolute enrichment with iron oxides can occur in situations where intermitted wetness from a fluctuating water table gives rise to mottling (Fey, 2010). Portion 26 is also contains S3 soils as well as S2 and S11 soil classes. S2 soil class may have restricted depth and excessive drainage. S2 soils have low natural fertility and a high erosion potential. Soils in the S 11 soil class are poorly drained swelling clay soils of high natural fertility. The soil is wet; very plastic and sticky (Agricultural Geo-Referenced Information System, date unknown).

Land-type data was used to provide an additional general description of soils in the study area (land-types are areas with largely uniform soils, topography and climate). Portions 46 & 47 as well as a small section of Portion 26 are located on the land type Bb3. The Bb land types contain plinthic catena, associated with wetland soils. Portion 26 is also located on the land type Ba1 and Ea15. In land types Ba, plinthic catena soils dominate. Plinthic soil forms could form perched aquifers and therefore wetland conditions. In the land type Ea, soils are dark or red coloured, strongly to very strongly structured soils (topsoil and subsoil) of varying depths, with high clay contents (mostly clay loam to clay texture) and a high fertility status. However, they are often difficult to cultivate, especially the dark clays. The soils have a high water-holding capacity and mostly contain a high percentage of swelling clay minerals, which pose a hazard for construction (Agricultural Geo- Referenced Information system, (unknown).

Mpumalanga Conservation Plan:

The Mpumalanga Biodiversity Conservation Plan (MBCP) groups the biodiversity assets of Mpumalanga into conservation categories based on its importance and contribution to reach the conservation targets of resources. Portion 26 is situated in an area where there is mostly no natural habitat remaining, a small area classified as Important and Necessary lies in the centre and an area classified as Least Concern is located in the east of the site. The eastern section of Portion 26 is located within an area classified as Irreplaceable in which it is imperative to reach conservation targets. Portions 46 & 47 are situated on an area with no natural habitat remaining.

2 METHODOLOGY

The delineation method documented by the Department of Water affairs and Forestry in their document "A practical field procedure for identification and delineation of wetlands and riparian areas" (DWAF, 2005), and the Minimum Requirements for Biodiversity Assessments (GDACE, 2009) 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 3):

- 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.

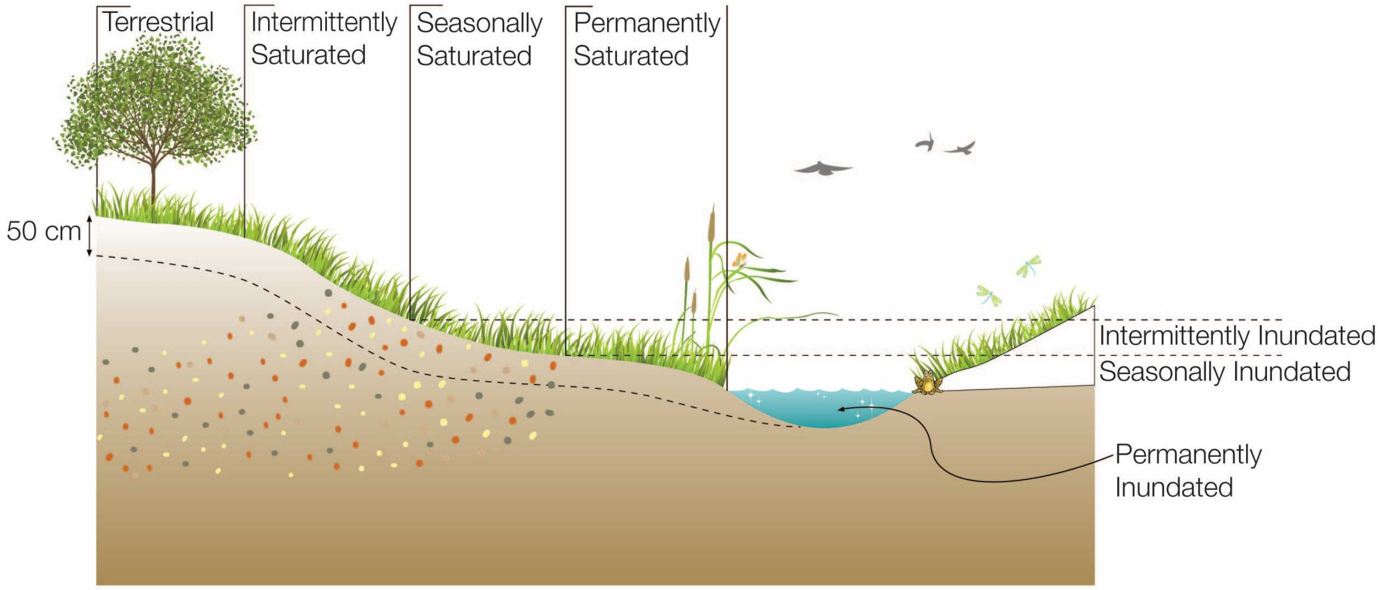


Figure 3: Typical cross section of a wetland (Ollis, 2013)

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, if present (the greenline concept may be used in the absence of base flow (Cagney, 1993), 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 4).

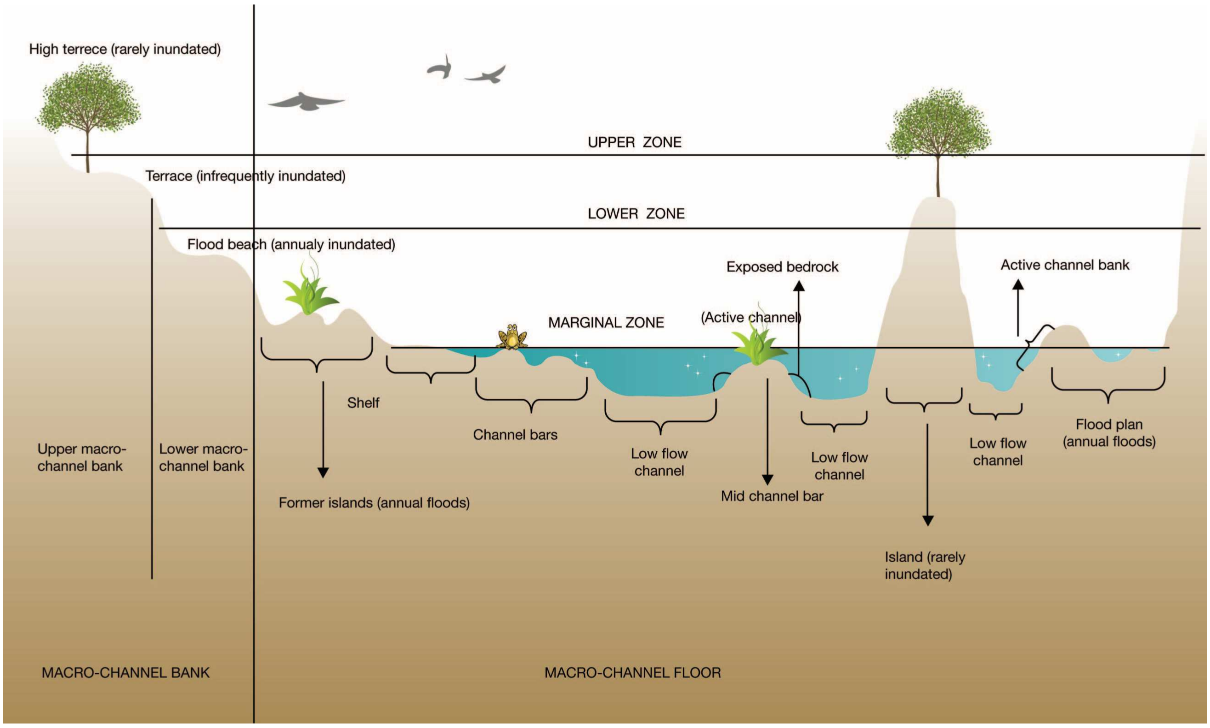


Figure 4: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans*et al*., 2007)

Thirty-Seven (37) points were sampled during the course of the field investigation to determine compliance with the definition of wetland /riparian conditions. Details recorded at each sample point are presented in Appendix B.

3 RESULTS

3.1 Land Use and Land Cover

Numerous small holdings are located on Portions 46 & 47, while Portion 26 is predominantly used for agricultural activities. Cultivation has encroached into wetland areas. Historic aerial imagery indicate that from 2002 no significant changes have occurred on the study sites. The surrounding area and catchment have been transformed into agricultural land. A colliery is also located within the catchment approximately 6km west. Ashton Dam is located south west of the study sites.

3.2 Wetland Delineation

Two (2) wetland areas were recorded on Portion 26, and no wetland areas were found on Portions 46 or 47. However a manmade dam structure is located on Portion 46. Based on distinguishable wetland indicators, the wetlands found on Portion 26 is classified as an Unchannelled Valley Bottom Wetland with Hillslope seepage zones and a Pan Wetland (Figure 5). The Unchannelled Valley Bottom wetland flows from north east to south west and ultimately extend to Ashton Dam. Only a small portion of the pan wetland is located on the study site. The wetland areas were burnt during the site visit and vegetation could thus not be sampled, while adequate soil sampling was hampered by past cultivation of some of the wetland areas. Another pan wetland was recorded within 500m east of Portions 46 & 47.

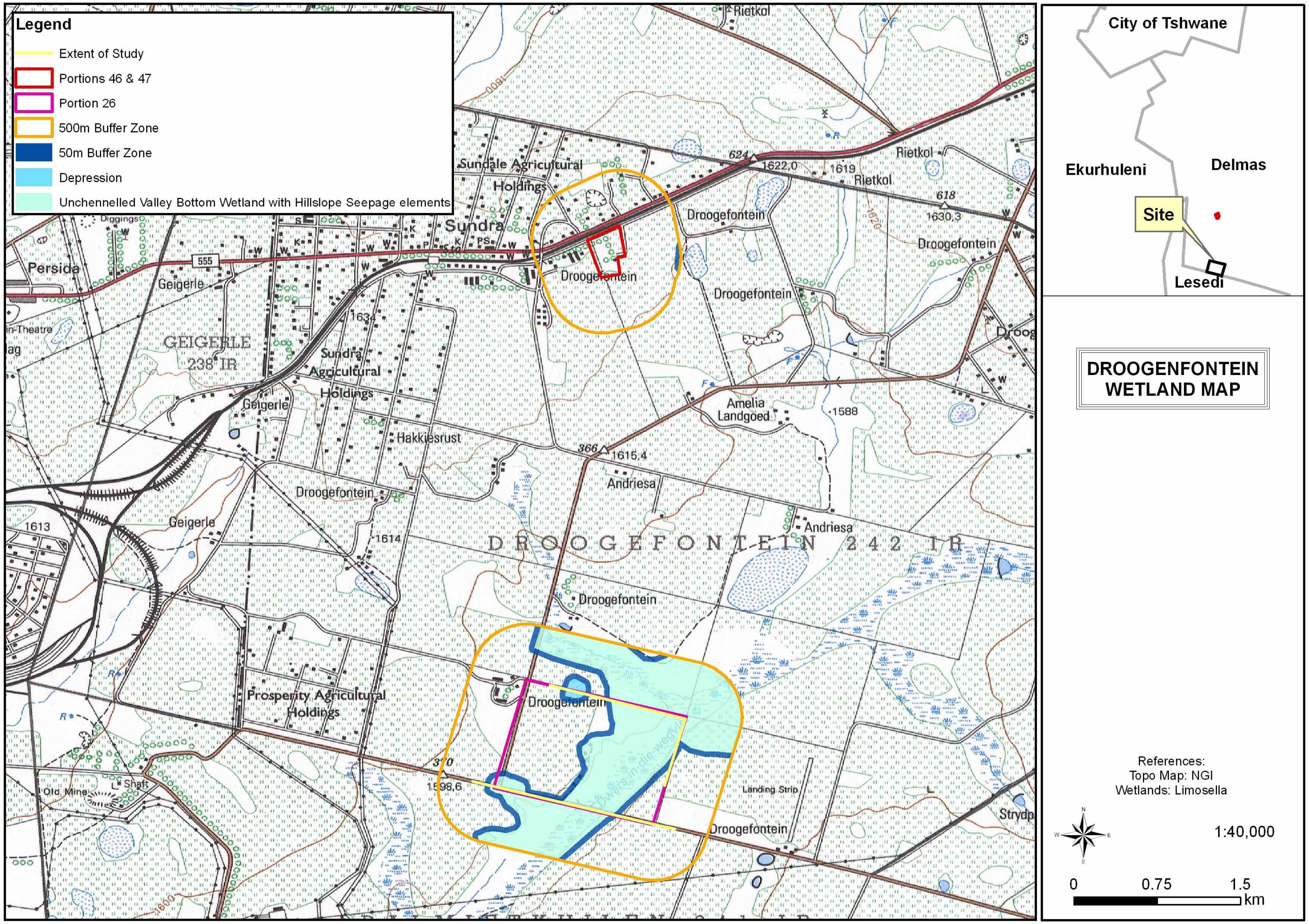


Figure 5: Wetlands and associated buffer zones.

3.2.1 Wetland Vegetation

The vegetation of the study site was dry and burnt and few species could be identified (Figure 6). Adequate vegetation sampling could thus not take place. Furthermore the areas surrounding the wetland areas were ploughed recently and no vegetation occurred in these areas.

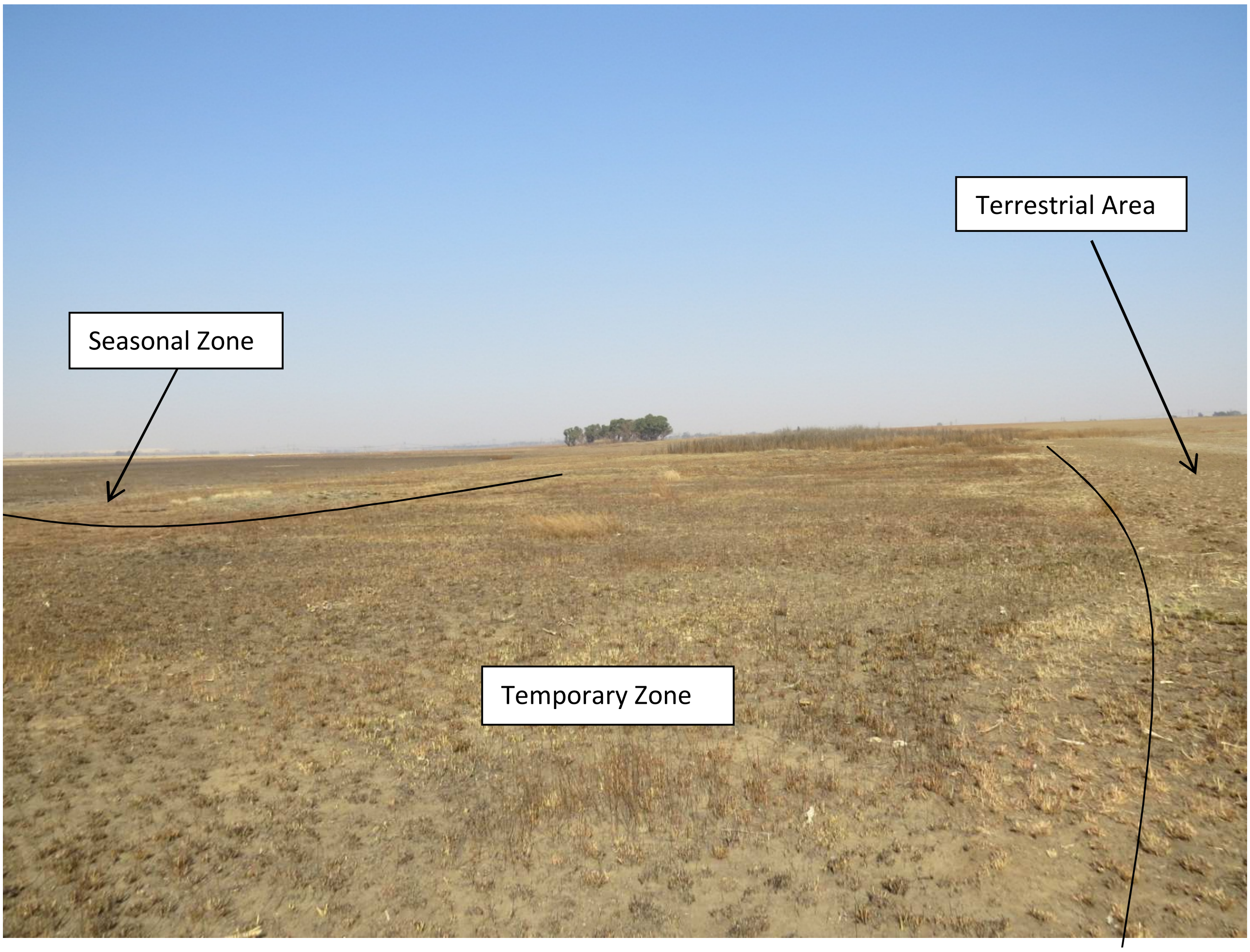


Figure 6: Study site with burnt vegetation indicating wetland zonation

3.2.2 Wetland Soil / Hydromorphic Soils

The soil of the study sites ranged from a sandy top soil to loam and clay soil. In the centre of the Unchannelled Valley Bottom Wetland a thick organic layer was found with predominantly clay soils (Figure 7). Further from the centre of the Unchannelled Valley Bottom the soils were sandy to loam (Figure 8). Although the ploughed area adjacent the wetland areas were disturbed, mottling could be found at a depth of deeper than 80cm. It is thus possible that the wetland extended further before the farming activities took place. However this should be confirmed by a hydrologist. The north western section adjacent to the Unchannelled Valley Bottom was characterised by red soils. The soil ranged from very hard clay to more moist and wet clay soils.

Figure 7: Clay soils with root oxidation found towards the centre of the Unchannelled Valley Bottom Wetland

Figure 8: Sandier soil found further from the wetland centre, note the mottling

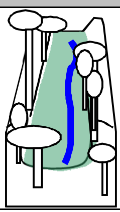
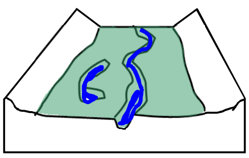
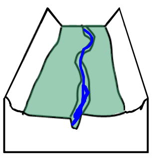
3.3 Classification

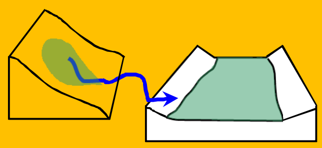
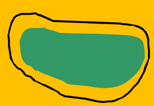
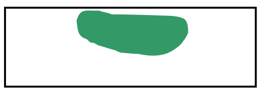
The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification (SANBI, 2009). The current wetland study follows the same approach by classifying wetlands in terms of a functional unit in line with a level 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.

Table 2 describes the classification of wetlands on site as an Unchannelled Valley Bottom wetland with Hillslope seepage elements and a Pan Wetland. The Pan Wetland is likely to be hydrologically connected to adjacent valley bottom wetland through diffuse subsurface flow paths.

Table 2: Classification of wetland and riparian areas (adapted from Brinson, 1993; Kotze, 1999, Marneweck and Batchelor, 2002 and DWAF, 2005). The highlighted section refers to the classification of the wetlands on the study site

Hydro-geomorphic types	Description
Riparian habitat 	Linear fluvial, eroded landforms which carry channelized flow on a permanent, seasonal or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The "river" includes both the active channel (the portion which carries the water) as well as the riparian zone.
Meandering Floodplain 	Linear fluvial, net depositional valley bottom surfaces which have a meandering channel which develop upstream of a local (e.g. resistant dyke) base level, or close to the mouth of the river (upstream of the ultimate base level, the sea) . The meandering channel flows within an unconfined depositional valley, and ox-bows or cut-off meanders evidence of meandering – are usually visible at the 1:10 000 scale (i.e. observable from 1:10 000 orthomaps). The floodplain surface usually slopes away from the channel margins due to preferential sediment deposition along the channel edges and areas closest to the channel. This can result in the formation of backwater swamps at the edges of the floodplain margins.
Valley bottom with a channel 	Linear fluvial, net depositional valley bottom surfaces which have a straight channel with flow on a permanent or seasonal basis. Episodic flow is thought to be unlikely in this wetland setting. The straight channel tends to flow parallel with the direction of the valley (i.e. there is no meandering), and no ox-bows or cut-off meanders are present in these wetland systems. The valley floor is, however, a

Hydro-geomorphic types	Description
	depositional environment such that the channel flows through fluvially-deposited sediment. These systems tend to be found in the upper catchment areas.
Valley bottom without a channel with Hillslope Seepage elements 	**Linear fluvial, net depositional valley bottom surfaces which do not have a channel. The valley floor is a depositional environment composed of fluvial or colluvial deposited sediment. These systems tend to be found in the upper catchment areas, or at tributary junctions where the sediment from the tributary smothers the main drainage line.** **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. They may also occur fringing depression pans. Seepages occur where springs are decanting into the soil profile near the surface, causing hydric conditions to develop; or where through flow in the soil profile is forced close to the surface due to impervious layers (such as plinthite layers; or where large outcrops of impervious rock force subsurface water to the surface).**
Depression pans 	**Small (deflationary) depressions which are circular or oval in shape; usually found on the crest positions in the landscape. The topographic catchment area can usually be well-defined (i.e. a small catchment area following the surrounding watershed). Although often apparently endorheic (inward draining), many pans are "leaky" in the sense that they are hydrologically connected to adjacent valley bottoms through subsurface diffuse flow paths.**
Flats 	In areas with weakly developed drainage patterns and flat topography, rainfall may not drain off the landscape very quickly, if at all, due to the low relief. In such areas (commonly characterized by aeolian deposits or recent sea floor exposures) the wet season water table may rise close to, or above, the soil surface, creating extensive areas of shallow inundation or saturated soils. In these circumstances the seasonal or permanently high groundwater table creates the conditions for wetland formation.

3.4 Wetland Functionality, Status and Sensitivity

Wetland functionality is defined as a measure of the deviation of wetland structure and function from its natural reference condition. The natural reference condition is based on a theoretical undisturbed state extrapolated from an understanding of undisturbed regional vegetation and hydrological conditions. In the current assessment the hydrological, geomorphological and vegetation integrity was assessed for the wetland unit associated with the study site, to provide a Present Ecological Status (PES) score (Macfarlane *et al*, 2007) and an Environmental Importance and Sensitivity category (EIS) (DWAF, 1999). Broad impacts that affected wetlands on the study site are summarised in Table 3. These impacts are based on evidence observed during the field survey and land-use changes visible on aerial imagery.

The allocation of scores in these functional and integrity assessments are subjective and are thus vulnerable to the interpretation of the specialist. Collection of empirical data is precluded at this level of investigation due to project constraints including time and budget. Water quality values, species richness and abundance indices, surface and groundwater volumes, amongst others, should ideally be used rather than a subjective scoring system such as is presented here.

The functional assessment methodologies presented below take into consideration subjective recorded impacts to determine the scores attributed to each functional Hydrogeomorphic (HGM) wetland unit. The aspect of wetland functionality and integrity that is predominantly addressed includes hydrological and geomorphological function (mainly 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 wetlands found on the study site were assessed using WetEcoServices (Kotze et al 2005), WET-Health (Macfarlane et al, 2007)) and the Ecological Importance and Sensitivity (DWAF, 1999).

Table 3: The impacts associated with the various HGM units as used in the determination of the functionality, status and sensitivity of these units.

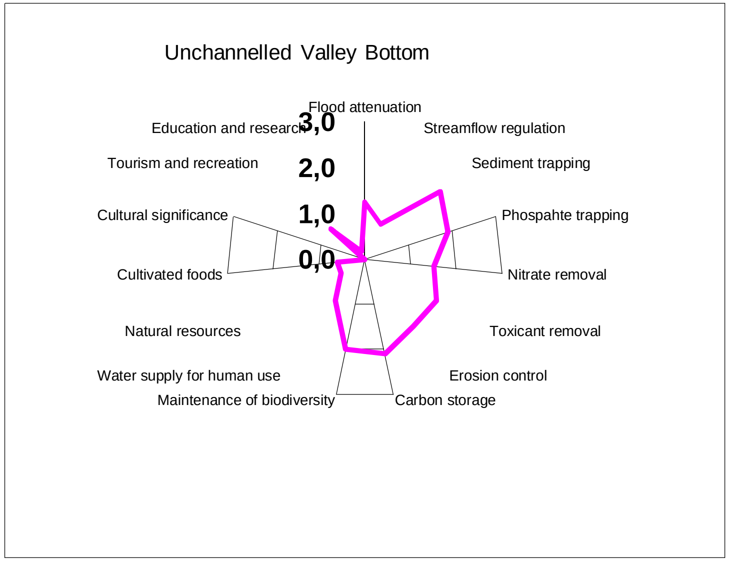
HGM Unit	Current & Potential Impacts	PES Score
Unchannelled Valley Bottom with Hillslope Seepage elements	The Unchannelled Valley Bottom flows from north east to south west and ultimately into the Aston Dam south west from the study site. The surrounding farmland is likely to increase the amount of sediment and nutrient and pesticide input into the wetland. At the time of the field survey no surface water was observed in the wetland. Although the survey took place before the onset of the rainy season, a decrease in surface water flow may be attributed to the increased water use from the surrounding farmland. However it is likely that during the rainy season water reaches the wetland and due to a decreased surface roughness may cause an increase in the amount of sediment and other foreign material input into the wetland. Although the vegetation was burnt during the site visit, various exotic plant species could be identified as well as the remnants of some wetland vegetation such as *Phragmites australis* and *Typha capensis.* Numerous large soil heaps were also found in the western corner of the wetland suggesting some disturbance in the soil profile. Potential impacts associated with future mining activities include; soil compaction, loss of water, pollution, change in the hydrology, geomorphology and vegetation composition of the area.	**C**
Pan Wetland	The Pan wetland shares similar impacts as the Unchannelled Valley Bottom and is likely hydrologically connected to the Unchannelled Valley Bottom. Any impacts on the Unchannelled Valley Bottom are thus likely to have an impact on the Pan Wetland as well.	**C**

3.4.1 Provision of Goods and Services - WET-Ecoservices

Hydro-geomorphic units are per definition characterised by physical and hydrological features that allow them to perform specific ecosystem services. The degree of disturbance and modification of wetlands results in a decrease in the ability to which they are able to perform these ecosystem services.

A Wet-Ecoservice evaluation was done for the hydro-geomorphic types found on site to determine the services provided by the wetlands (Table 4 and 5).

Table 4: Results and brief discussion of the Ecosystem Services provided by the Unchannelled Valley Bottom Wetland with Hillslope Seepage elements



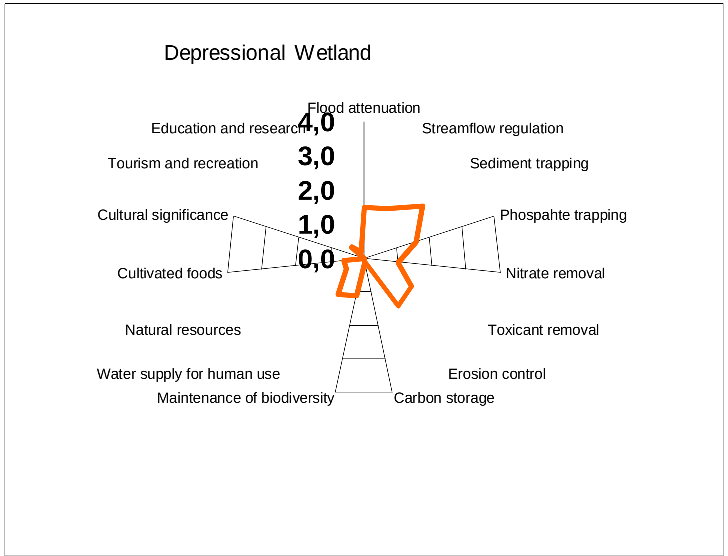
Function	Score	Significance.
Flood attenuation	1.2	Moderately Low
Stream flow regulation	0.8	Low
Sediment trapping	2.2	Moderately High
Phosphate trapping	1.9	Moderately Low
Nitrate removal	1.5	Moderately Low
Toxicant removal	1.8	Moderately Low
Erosion control	1.8	Moderately Low
Carbon storage	2.1	Moderately Low
Maintenance of biodiversity	2.0	Moderately Low
Water supply for human use	1.1	Moderately Low
Natural resources	0.6	Moderately Low
Cultivated foods	0.6	Low
Cultural significance	0.0	Low
Tourism and recreation	1.0	Moderately Low
Education and research	0.2	Low

The Unchannelled Valley Bottom scored low to moderately low for the majority of the functions. However the wetland scored moderately high for both sediment trapping and carbon storage. The high score for sediment trapping is due to the high number of sediment sources around the wetland. Carbon storage is due to the thick layer of organic material found in the centre of the wetland.

The value for Cultivated Foods is also low although ploughing and crop production occurs in the wetland. The reason for this is that the scoring system takes into consideration the use of the wetland for subsistence agriculture rather than commercial activities, which does not occur on the site.

It is important to note that the absence of an intact vegetation layer probably influenced the low scores obtained. A follow-up assessment should verify the values reflected in this study.

Table 5: Results and brief discussion of the Ecosystem Services provided by the Pan Wetland



Function	Score	Significance.
Flood attenuation	1.5	Moderately Low
Stream flow regulation	1.6	Moderately Low
Sediment trapping	2.3	Moderately High
Phosphate trapping	1.6	Moderately Low
Nitrate removal	1.0	Moderately Low
Toxicant removal	1.6	Moderately Low
Erosion control	1.7	Moderately Low
Carbon storage	0.1	Low
Maintenance of biodiversity	1.1	Low
Water supply for human use	1.3	Low
Natural resources	0.6	Moderately Low
Cultivated foods	0.6	Low
Cultural significance	0.0	Low
Tourism and recreation	0.5	Low
Education and research	0.2	Low

The Depression Wetland scored low to moderately low for the majority of the functions except for Sediment trapping which is due to the high number of sediment sources around the wetland. Cultural significance scored lowest due to the location of the wetland on a farm.

The value for Cultivated Foods is also low although ploughing and crop production occurs in the wetland. The reason for this is that the scoring system takes into consideration the use of the wetland for subsistence agriculture rather than commercial activities, which does not occur on the site.

It is important to note that the absence of an intact vegetation layer probably influenced the low scores obtained. A follow-up assessment should verify the values reflected in this study.

3.4.2 Present Ecological Status (PES) – WET-Health

The wetlands on site have been impacted by burning, ploughing and grazing (above the threshold that can be tolerated by primary grassland). This was observed by the lack of vegetation cover on the site and the evidence of ploughing and soil disturbance and has led to an increase in exotic vegetation as well as impacting on the hydrology and geomorphology of the wetlands. The hydrology of the area was further impacted by increased farming activities as well as a decrease in surface roughness due to loss of indigenous vegetation cover. Hydrophytic sedge and grass species function to retard and diffuse the flow of surface water whilst preventing soil particles from being swept away.

A summary of the three components of the WET-Health namely Hydrological; Geomorphological and Vegetation Health assessment for the wetlands found on site is presented in Table 6 and Table 7, with explanations of the scored listed in Table 8 and Table 9.

It is important to note that the absence of an intact vegetation layer probably influenced the low scores obtained. A follow-up assessment should verify the values reflected in this study.

Table 6: Summary of hydrology, geomorphology and vegetation heath assessment for the Unchannelled Valley Bottom Wetland with Hillslope Seepage elements.

Assessment	Hydrology module	Geomorphology module	Vegetation module
Assessment of impacts and Present State (Categories A-F)	C	C	D
Assessment of Trajectory of Change (Categories ↑↑, ↑ ,→, ↓, ↓↓)	→	↓	↓↓

Table 7: Summary of hydrology, geomorphology and vegetation heath assessment for the Depression.

Assessment	Hydrology module	Geomorphology module	Vegetation module
Assessment of impacts and Present State (Categories A-F)	C	C	C
Assessment of Trajectory of Change (Categories ↑↑, ↑ ,→, ↓, ↓↓)	→	→	↓↓

Table 8: Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*, 2007)

DESCRIPTION	PES SCORE
Unmodified, natural.	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	**C**

DESCRIPTION	PES SCORE
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	D
Seriously modified. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	F

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	(↓↓)

3.4.3 Ecological Importance and Sensitivity (EIS)

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; and
- Basic human needs including subsistence farming and water use.

The Ecological Importance and Sensitivity of each of the wetlands is represented in Table 10 and Table 11 below. Explanations of the scores are given in Table 12. **Again the absence of an intact vegetation layer probably influenced the low scores obtained. A follow-up assessment should verify the values reflected in this study.**

Table 10: EIS scores obtained for the Unchannelled Valley Bottom Wetland with Hilldlope Seepage elements (DWAF, 1999)

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	1.3	1.0
Hydro-functional importance	1.8	1.0
Direct human benefits	0.5	3.0
Overall score	**1.2**	

Table 11: EIS scores obtained for the Depression Pan (DWAF, 1999)

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	1.3	3.0
Hydro-functional importance	0.4	3.0
Direct human benefits	0.3	3.0
Overall score	**0.7**	

Table 12: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores (DWAF, 1999)

Ecological Importance and Sensitivity Categories	Rating
Very High Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers	>3 and <=4
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	>2 and <=3
Moderate **Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers**	**>1 and <=2**
Low/Marginal **Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers**	**>0 and <=1**

3.5 Buffer Zones

Local government policies require that protective wetland buffer zones be calculated from the outer edge of the temporary zone of a wetland and river buffer zones be calculated from the outer edge of the riparian zone (KZN DAEA, 2002; CoCT, 2008; GDACE, 2009). Although research is underway to provide further guidance on appropriate defensible buffer zones, there is no current standard other than the generic recommendation of 100m for rivers, and 50m for wetlands outside the urban edge was applied (GDARD, 2009). In the case of the wetland recorded on the study site, an understanding of the origin of water that results in the wetland conditions should form the basis of refining the generic 50m buffer zone suggested through an analysis of empirical data.

Where construction of access roads and the construction activities within the 1:100 year floodline or the wetland/riparian area (whichever is the greatest), as well as within wetlands and associated buffers is authorised by appropriate authorities and a Water Use License granted, the buffer areas should still be respected as an area where impacts must be kept to an absolute minimum. The buffer areas should be clearly marked during construction and workers must be informed that activities and traffic beyond the buffer zone must be limited to only that which is necessary. In addition, construction within 500m of a wetland area can also only take place once authorised by DWA.

Buffer zones have been shown to perform a wide range of functions and have therefore been widely proposed as a standard measure to protect water resources and their associated biodiversity. These include (i) maintaining basic hydrological processes; (ii) reducing impacts on water resources from upstream activities and adjoining landuses; (iii) providing habitat for various aspects of biodiversity. A brief description of each of the functions and associated services is outlined in Table 13 below.

Table 13: Generic functions of buffer zones relevant to the study site (adapted from Macfarlane*et al*, 2010)

Primary Role	Buffer Functions
Maintaining basic aquatic processes, services and values.	• Groundwater recharge: Seasonal flooding into wetland areas allows infiltration to the water table and replenishment of groundwater. This groundwater will often discharge during the dry season providing the base flow for streams, rivers, and wetlands. • Flood attenuation: Wetland vegetation increases the roughness of stream margins, slowing down flood-flows. This may therefore reduce flood damage in downstream areas. Vegetated buffers have therefore been promoted as providing cost-effective alternatives to highly engineered structures to reduce erosion and control flooding, particularly in urban settings.
Reducing impacts from upstream activities and adjoining land uses	• Storm water attenuation: Flooding into the buffer zone increases the area and reduces the velocity of storm flow. Roots, braches and leaves of plants provide direct resistance to water flowing through the buffer, decreasing its velocity and thereby reducing its erosion potential. More water is exchanged in this area with soil moisture and groundwater, rather than simply transferring out of the area via overland flow. • Sediment removal: Surface roughness provided by vegetation, or litter, reduces the velocity of overland flow, enhancing settling of particles. Buffer zones can

Primary Role	Buffer Functions
	therefore act as effective sediment traps, removing sediment from runoff water from adjoining lands thus reducing the sediment load of surface waters. • Removal of toxics: Buffer zones can remove toxic pollutants, such hydrocarbons that would otherwise affect the quality of water resources and thus their suitability for aquatic biota and for human use. • Nutrient removal: Wetland vegetation and vegetation in terrestrial buffer zones may significantly reduce the amount of nutrients (N & P), entering a water body reducing the potential for excessive outbreaks of microalgae that can have an adverse effect on both freshwater and estuarine environments. • Removal of pathogens: By slowing water contaminated with faecal material, buffer zones encourage deposition of pathogens, which soon die when exposed to the elements.

3.6 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 run-off, and therefore the hydrological regime of the site. In the absence of the specific development layout, general impacts and mitigation measures are provided. These should be refined to site specific mitigation measures that should be included in an Environmental Management Plan. A range of management measures are available to address threats posed to watercourses (Table 14). The mitigation measures proposed below are intended to prevent further degradation to wetland as a result of the construction and operation. It is important to note that this section aims to highlight areas of concern. It is important that any mitigation be implemented in the context of an Environmental Management Plan in order to ensure accountability and ultimately the success of the mitigation.

Table 14: **Impacts and suggested management procedures relevant to the proposed development (modified from Macfarlane *et al*, 2010)**

Threat / Impact	Source of the threat	Primary Management Procedure
Changing the quantity and fluctuation properties of the watercourse by for example stormwater input, or restricting water flow 1. Physical destruction of wetland by open cast mining 2. Alteration of catchment and hillslope seepage	*Construction:* • Mining within / around wetland, thereby altering, diverting or impeding flow • Sedimentation as a result of construction activities. • Vehicles driving in / through the wetland • Lack of adequate rehabilitation resulting in invasion by invasive plants	• No activities should take place in the watercourses and associated buffer zone. Any unavoidable activities within wetland areas is subjected to authorization by means of a water use license. • Construction must be restricted to the dryer winter months. • A temporary fence or demarcation must be erected around the works area to prevent access to the wetland. • Prevent pedestrian and vehicular access into the wetland and buffer areas. • Formalise access roads and make use of existing roads and tracks where feasible, rather than creating new routes through naturally vegetated areas.

Threat / Impact	Source of the threat	Primary Management Procedure
processes by open cast mining		• Management of on-site water use and prevent stormwater or contaminated water directly entering the wetland. • Management of point discharges • Planning of construction site must include eventual rehabilitation / restoration of indigenous vegetative cover • Alien plant eradication and follow-up control activities prior to construction, to prevent spread into disturbed soils, as well as follow-up control during construction. • The amount of vegetation removed should be limited to the least amount possible. • Rehabilitation of damage/impacts that arise as a result of construction must be implemented immediately upon completion of construction
	Operational: • Vehicles driving in / through the wetland • Damage to vegetated areas • Lack of adequate rehabilitation resulting in invasion by invasive plants • Mining within wetland areas alter hydrology	• Operational activities should not take place within watercourses or buffer zones. Where unavoidable, the footprint needed must be kept to a minimum. This is subjected to authorization by means of a water use license. • Where possible, operations(that is authorised by a water use license) within the wetland must be restricted to the drier winter months • Operational activities should not impact on rehabilitated areas and be followed-up with rehabilitation where needed • Operational workers should respect and also maintain fences that are in place to prevent access into rehabilitated areas
	Closure: • Acid Mine Drainage (AMD) • Lack of rehabilitation • Flow or seepage of polluted water from old mining areas	• Shafts and boreholes must be sealed to reduce the possibility of fires. • Mine planning should endeavour to remove as much coal as possible. • Water quality of surrounding groundwater and watercourses should be monitored regularly to ascertain if flooding and extraction of the coal was sufficient to reduce AMD levels. • The wetland area must be adequately rehabilitated and monitored for at least 5 years
Changing the amount of sediment entering water resource and associated change in turbidity (increasing or decreasing the amount)	*Construction:* • Earthwork activities when constructing • Clearing of surface vegetation will expose the	• Construction in and around watercourses must be restricted to the dryer winter months. • A temporary fence or demarcation must be erected around the works area to prevent water runoff and

Threat / Impact	Source of the threat	Primary Management Procedure
	soils, which in rainy events would wash through the wetland, 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 wetland • Erosion (e.g. gully formation, bank collapse) *Operational:* • Vehicles impacting on surface vegetation	erosion of the disturbed or heaped soils into wetland areas. • Formalise access roads and make use of existing roads and tracks where feasible, rather than creating new routes through naturally vegetated areas. • Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area (DWAF, 2005). • A vegetation rehabilitation plan should be implemented. • 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 operation 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. • Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. • Runoff from the construction area must be managed to avoid erosion and pollution problems. • Implementation of best management practices • Source-directed controls • Maintain buffer zones to trap sediments • Active rehabilitation • No operational activities should take place within watercourses or buffer zones.
Alteration of water quality – toxic contaminants (including toxic metal ions (e.g. copper, lead, zinc) and hydrocarbons	*Construction:* • Runoff from road surfaces • Discharge of solvents, and other industrial chemicals • Spillage of coal	• 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 wetland or wetland buffer. • Control of waste discharges

Threat / Impact	Source of the threat	Primary Management Procedure
	Operational: • Discharge of solvents, and other industrial chemicals *Closure:* • Acid Mine Drainage (AMD) • Lack of rehabilitation • Flow or seepage of polluted water from old mining areas	• Maintenance of buffer zones to trap sediments with associated toxins • Ensure that no operational activities impact on the wetland or buffer area. This includes edge effects. • Control of waste discharges and do not allow dirty water from operational activities to enter the watercourse • Shafts and boreholes must be sealed to reduce the possibility of fires. • Mine planning should endeavour to remove as much coal as possible. • Water quality of surrounding groundwater and watercourses should be monitored regularly to ascertain if flooding and extraction of the coal was sufficient to reduce AMD levels.

4 CONCLUSION

Wetland delineations discussed in this report are based on a low confidence level due to site conditions encountered during the time of the assessment. Until follow-up site visits can be undertaken these wetland areas should be considered as preliminary delineations.

Two (2) wetland areas were recorded on Portion 26, and no wetland areas were found on Portions 46 or 47. However a manmade dam structure is located on Portion 46. Based on distinguishable wetland indicators, the wetlands found on Portion 26 is classified as an Unchannelled Valley Bottom Wetland with Hillslope seepage zones and a Pan Wetland (Figure 5). The Unchannelled Valley Bottom wetland flows from north east to south west and ultimately extend to Ashton Dam. Only a small portion of the pan wetland is located on the study site. The wetland areas were burnt during the site visit and vegetation could thus not be sampled, while adequate soil sampling was hampered by past cultivation of some of the wetland areas. Another pan wetland was recorded within 500m east of Portions 46 & 47.

During the time of the study the vegetation was burnt, accurate functionality assessments could therefore not be conducted. The soil of the area was also disturbed by ploughing. It is suggested that a follow up study be undertaken during the summer after rains to refine the preliminary functional assessment presented in this report. Furthermore, it is important that seepage conditions be verified in terms of geohydrology and soil so as to ensure an accurate understanding of water movement on the study sites, and therefore appropriate mitigation measures and buffer zones.

An estimate of the Present Ecological State and Ecological Integrity and Sensitivity for preliminary wetlands discussed in this report are presented below:

Wetland Unit	Estimated PES Score	Description	EIS Score
Unchannelled Valley Bottom	C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	1.2 (Moderate)
Pan	C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	0.7 (Low/Marginal)

A minimum buffer of 50m from the edge of the confirmed wetland boundaries should be respected. These confirmed boundaries should take into account the geohydrology of the site and its relationship to a detailed understanding of the proposed activities.

Should interventions be planned within the wetland area or its buffer zone, they are subject to a water use license in terms of Section 21 (c) and (1) of the National Water Act in terms of its location within 500m of a wetland, as required by the DWA.

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Appendix A: Methodology

<u>WetEcoServices:</u>

WetEcoServicesKotzee*et al*, (2005) was adapted and used to assess the different benefit values of wetland 3. A Level 1 desktop assessment was performed to determine the wetland's functional benefits. Several characteristics were verified during the field survey to produce a comprehensive initial functional analysis. This technique is not ideally suited to determine the specific level of impact of a current or proposed development and is based more on qualitative data as opposed to quantitative data, which opens it up to subjective misuse (Kotzee*et al*, 2005).

<u>WET-Health</u>

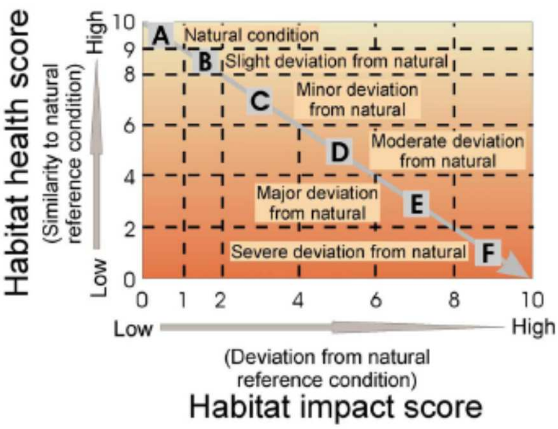
WET-Health is a tool designed to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function from its natural reference condition. This technique attempts to assess hydrological, geomorphological and vegetation health and is suitable for the functional assessment of floodplain, channelled and unchannelled valley bottom, seepage wetlands and pans. It is a modular approach that uses:

- An impact-based approach for those activities that do not produce clearly visible responses in wetland structure and function. The impact of irrigation or afforestation in the catchment, for example, produces invisible impacts on water inputs. This is the main approach used in the hydrological assessment.
- An indicator-based approach for activities that produce clearly visible responses in wetland structure and function such as the presence of gullies or alien species. This approach is mainly used in the assessment of geomorphological and vegetation health.

Each of these modules follows a broadly similar approach that examines extent, intensity and magnitude of impact. This is translated into a health score. The approach is as follows:

- The extent of impact is measured as the proportion of a wetland and/or its catchment that is affected by an activity. Extent is expressed as a percentage.
- The intensity of impact is estimated by evaluating the degree of alteration that results from a given activity.
- The magnitude of impact for individual activities is the area-weighted product of extent and intensity.
- The magnitude of individual activities is combined in a structured and transparent way to calculate the overall impact of all activities that affect hydrology, geomorphology or vegetation.
- The overall magnitude of impact is then translated into an estimate of wetland health for hydrology, geomorphology or vegetation.

Wetland health is placed into the following health categories that are compatible with the standard DWAF A-F ecological categories.



Appendix B: Survey data

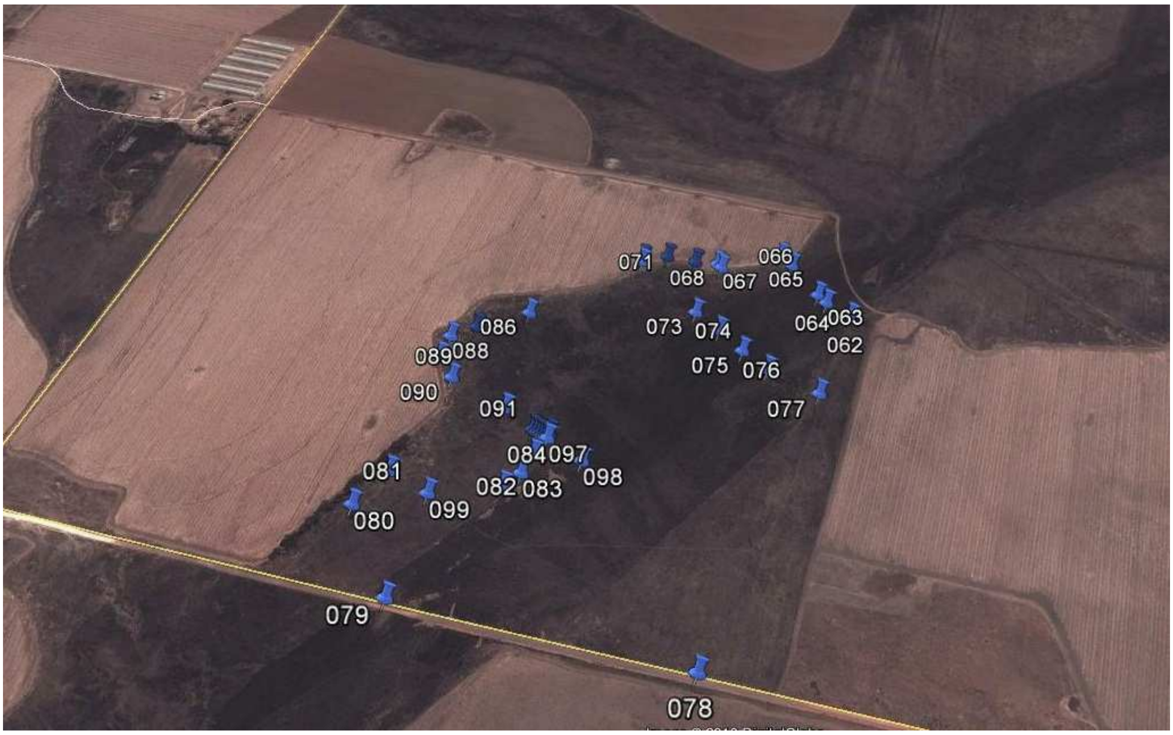


Figure 9: Map indicating location of sample points.

Table 18: Descriptions of soil and plant species recorded in the wetland areas

Point	Coordinates	Notes and important plant species
62	**26°13'36.18"S and 28°33'56.69"E**	• Entire area burnt • Sandy grey topsoil • Hard Clay 50cm
63	**26°13'35.07"S and 28°33'55.19"E**	• No vegetation • Slight mottling 20cm • Sandy topsoil • Clay subsoil
64	**26°13'34.45"S and 28°33'54.66"E**	• Remnants of *Phragmites australis*
65	**26°13'32.00"S and 28°33'53.02"E**	• Vegetation burnt • Damp clay soil • Slight mottling • Root oxidation • Clear line between vegetation types (Reeds and grass)
66	**26°13'31.17"S and 28°33'52.33"E**	• Clear line between vegetation types (Reeds and grass) • No mottling • Brown red topsoil • Loam soil at 30cm
67	**26°13'32.17"S and 28°33'48.30"E**	• Small patch of dead semi woody vegetation (Exotic) • *Tagetesminuta*
68	**26°13'31.90"S and 28°33'48.02"E**	• Ploughed fields • Soil Disturbed

Point	Coordinates	Notes and important plant species
69	**26°13'31.72"S and 28°33'46.56"E**	• Clear line between vegetation types
70	**26°13'31.29"S and 28°33'44.67"E**	• Dark hard clay soils • *Imperata cylindrica*
71	**26°13'31.74"S and 28°33'43.00"E**	• Remnants of *P. Australis* and *Typha capensis* • Root oxidation within 50cm • Damp soil at 65cm • 80cm Clear mottling
72	**26°13'31.40"S and 28°33'43.01"E**	• Ploughed land • Sandy soil first 50cm • Mottling at 80cm • Clay at 60cm • Rocky layer at 55cm
73	**26°13'35.84"S and 28°33'46.67"E**	• Clear line between vegetation types (Reeds and grass)
74	**26°13'37.25"S and 28°33'48.20"E**	• Soft sandy soil • Clay soils under sandy • Remnants of *P. australis* • Red sheen on soil surface suggesting iron precipitation during wet season.or rather groundwater discharge??
75	**26°13'38.81"S and 28°33'49.68"E**	• Dry small stream • Thick organic layer • Red sheen
76	**26°13'40.22"S and 28°33'51.24"E**	• Clear line between vegetation types (Reeds and grass) •
77	**26°13'41.99"S and 28°33'54.40"E**	• *I. cylidrica*
78	**26°13'58.89"S and 28°33'47.28"E**	• Road construction • Rocky soil
79	**26°13'54.84"S and 28°33'30.25"E**	• Bridge • *T. capensis* • *P. australis*
80	**26°13'49.40"S and 28°33'27.32"E**	• Eucalyptus trees
81	**26°13'47.27"S and 28°33'29.06"E**	• *Arundodonax* • Slight mottling at 50cm • Sandy soil
82	**26°13'48.15"S and 28°33'35.75"E**	• Clear line between vegetation types (Reeds and grass) • Organic layer • Dark clay soil • Slight root oxdation
83	**26°13'47.32"S and 28°33'36.71"E**	• Clear line between vegetation types (Reeds and grass)
84	**26°13'46.10"S and 28°33'37.30"E**	• Clear line between vegetation types (Reeds and grass)

Point	Coordinates	Notes and important plant species
85	**26°13'44.71"S and 28°33'38.09"E**	• Clear line between vegetation types (Reeds and grass) •
86	**26°13'35.98"S and 28°33'35.92"E**	• Remnants of *Berkeyasp* • Red sheen • *Verbena bonariensis* • *Slight mottling*
87	**26°13'37.13"S and 28°33'32.68"E**	• Small dry channel • Red sheen
88	**26°13'37.87"S and 28°33'31.15"E**	• *A. donax*patch • Uneven terrain. • Lareg heaps
89	**26°13'39.36"S and 28°33'30.70"E**	• Ploughed field • Soil red
90	**26°13'40.90"S and 28°33'31.68"E**	• Abandoned house structure
91	**26°13'43.00"S and 28°33'35.25"E**	• Hard clay soil
92	**26°13'44.44"S and 28°33'37.07"E**	• Remnants of grass area • Clay soils
93	**26°13'44.65"S and 28°33'37.30"E**	• Remnants of grass area • Clay soils
94	**26°13'44.73"S and 28°33'37.51"E**	• Remnants of grass area • Clay soils
95	**26°13'44.88"S and 28°33'37.69"E**	• Remnants of grass area • Clay soils
96	**26°13'44.97"S and 28°33'37.86"E**	• Remnants of grass area • Clay soils
97	**26°13'45.04"S and 28°33'38.01"E**	• Remnants of grass area • Clay soils
98	**26°13'46.56"S and 28°33'40.19"E**	• Soft sponge like organic material
99	**26°13'48.65"S and 28°33'31.49"E**	• *Berkeya*remnants • Clay soil at 30cm • Sligh root oxidation

Appendix C: Glossary of Terms

Anaerobic	not having molecular oxygen (O_2) present
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
Gley	soil material that has developed under anaerobic conditions as a result of prolonged saturation with water. Grey and sometimes blue or green colours predominate but mottles (yellow, red, brown and black) may be present and indicate localised areas of better aeration
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)
Mottles	soils with variegated colour patters are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles
Seepage	A type of wetland occurring on slopes, usually characterised by diffuse (i.e. unchannelled, and often subsurface) flows
Perched water table	the upper limit of a zone of saturation in soil, separated by a relatively impermeable unsaturated zone from the main body of groundwater
Permanently wet soil	soil which is flooded or waterlogged to the soil surface throughout the year, in most years
Sedges	Grass-like plants belonging to the family Cyperaceae, sometimes referred to as nutgrasses. Papyrus is a member of this family.
Soil horizons	layers of soil that have fairly uniform characteristics and have developed through pedogenic processes; they are bound by air, hard rock or other horizons (i.e. soil material that has different characteristics).
Soil profile	the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991)
Soil saturation	the soil is considered saturated if the water table or capillary fringe reaches the soil surface

Temporarily wet soil	The soil close to the soil surface (i.e. within 50 cm) is wet for periods > 2 weeks during the wet season in most years. However, it is seldom flooded or saturated at the surface for longer than a month.
Temporary zone of wetness	the outer zone of a wetland characterised by saturation within 50cm of the soil surface for less than three months in a year
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