WETLAND ASSESSMENT

A WETLAND DELINEATION AND ECOLOGICAL ASSESSMENT OF WETLANDS ASSOCIATED WITH THE KANGALA COAL PROJECT NEAR DELMAS, MPUMALANGA.

UNIVERSAL COAL (PTY) LTD

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EXECUTIVE SUMMARY

The aim and objectives of the study are to delineate, classify and map the wetlands associated with the proposed Kangala coal mine on portion 1 and R/E of portion 2 of the farm Wolvenfontein 244 IR, in the Delmas area, Mpumalanga Province. Additionally, an ecological functional assessment was also conducted to determine services provided for by the wetland units. The present integrity and ecological importance and sensitivity of the delineated wetland areas were also determined. The practical field procedure for the identification and delineation of wetlands and riparian areas according to the Department of Water Affairs and Forestry was adopted as the methodology for this survey. A Level II functional assessment was conducted to identify and categorise the importance of ecological services offered by the wetlands.

Four Hydro-geomorphic (HGM) types of natural wetland systems occur within the area assessed. Approximately 25% of the study area is comprised of wetland areas, the largest wetland unit being the hillslope seepage wetlands which comprise approximately three quarters of the total wetland area. The unchannelled valley bottom wetlands comprise approximately one third of all wetland areas and the hillslope seepage wetlands connected to the pans comprise approximately 10% of the total wetland area. The smallest wetland unit within the study area are the pans.

The enhancement of the quality of water was determined to be the most important ecological services provided for by all the assessed wetlands. The services associated with water quality enhancement are important to consider when taking into considering the surrounding land uses (agricultural practices) and the impacts to water quality as a result. The present state of the wetlands in the study area is therefore modified to some extent when compared with what would be expected for reference conditions. Wetland units in the study area which have been critically modified are a result of agricultural practices and informal roads. The unchannelled valley bottom wetland was determined to be largely natural. The highest ecological importance and sensitivity (EIS) scores are located with the unchannelled valley bottom wetlands. No rare or endangered species were identified for any of the wetland units. The EIS of the remaining wetland units was determined to vary from largely modified to critically modified with these systems providing little importance to the maintenance of ecological diversity and functioning on local and wider scales.

A conservation plan has been formulated for this study. Agriculture is largely responsible for the current impacts to all the wetland units in the study area. Impacts associated with the agricultural practices have affected the ecological state of the wetlands, but there has been no evidence of any of these impacts seriously affecting the underlying hydrology supporting the wetlands. A buffer zone has been described for selected wetland areas. It is suggested that no mining activities take place within the selected wetland areas and associated buffer areas. Additionally, it is recommended that any agricultural activities encroaching into the wetland units cease and these areas be rehabilitated to improve the integrity of these impacted areas as well as restore ecological functioning. A conservation plan aimed at improving the integrity of the wetland areas and the associated ecological functioning to improve water quality and biodiversity maintenance should

therefore be directed at managing the land use practices in the area and the direct use and conversion of the wetland resources.

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ACRONYMS

CV	-	CURRICULUM VITAE
DEAT	-	DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM
DWA	-	DIGBY WELLS AND ASSOCIATES
DWAF	-	DEPARTMENT OF WATER AFFAIRS
EIS	-	ECOLOGICAL IMPORTANCE AND SENSITIVITY
EMP	-	ENVIRONMENTAL MANAGEMENT PLAN
HGM	-	HYDRO-GEOMORPHIC
IWQMP	-	INTEGRATED WATER QUALITY MANAGEMENT PLAN
PES	-	PRESENT ECOLOGICAL STATE
SFI	-	SOIL FORM INDICATOR
SWI	-	SOIL WETNESS INDICATOR
TUI	-	TERRAIN UNIT INDICATOR
VI	-	VEGETATION INDICATOR
WMA	-	WATER MANAGEMENT AREA

1 INTRODUCTION

The general conservation status of freshwater ecosystems worldwide is poor and continues to decline at a rapid rate, with rivers and wetlands among the most threatened of all ecosystems (Vitousek *et al.*, 1997, Revenga *et al.*, 2000). According to Moyle and Williams (1990) and Jensen *et al.* (1993) this decline is a result of severe alteration caused by human activities. Due to the increase in the human population, there is an increase in the demand for water, which in turn results in an increase in pollution to freshwater ecosystems. The sectors which are responsible for this are the domestic, agricultural, recreational and industrial sectors as they all depend on fresh flowing water (Roux *et al.*, 1996). According to Jungwirth *et al.* (2000) and Muhar *et al.* (2000) aquatic ecosystems are heavily degraded on a global level by these human activities and impacts. As a result it is important for both conservation and management of freshwater systems to determine which basic processes, functions and structures make up the ecological integrity of these ecosystems. In spite of the fact that conservation of biological diversity has been the main aim of conservation biology, the phrase "biological integrity" has formed the cornerstone of all these programs. The ability of a biological system to function and maintain itself in the face of changes in environmental conditions is referred to as biological or biotic integrity (Angemeier and Karr, 1994).

South Africa has a diverse assortment of natural resources which does not include water (Ashton, 2007). One of the primary reasons for the scarcity of our water resources is that the excessive human population growth and development has resulted in unbalancing the availability of and state of water resources locally and on a global scale (Davies & Day, 1998). Water resources in South Africa are currently considered to be finite which suggests that in South Africa as a result of the excessive use of water resources will result in a water shortage that will progress into a water crisis unless the adequate management actions are taken to address this area of concern (Davies & Day, 1998). There have been some significant changes over the past few years to the priorities and approaches to management of water resources in South Africa (Ashton *et. al*, 2005). Culmination in the promulgation of the Water Services Act (WSA: Republic of South Africa, 1997) and the National Water Act (NWA: Republic of South Africa, 1998) may be attributed to the process of reform of the policy on water resources and water services (Ashton *et. al*, 2005).

According to the NWA, a water resource is not only considered to be the water that can be extracted from a system and utilized but the entire water cycle. This includes evaporation, precipitation and entire aquatic ecosystem including the physical or structural aquatic habitats, the water, the aquatic biota, and the physical, chemical and ecological processes that link water, habitats and biota. The entire ecosystem is acknowledged as a life support system by the NWA. According to van Wyk *et al.* (2006) the "resource" is defined to include a water course, surface water, estuary and aquifer, on the understanding that a water course includes rivers and springs, the channels in which the water flows regularly or intermittently, wetlands, lakes and dams into or from which water flows, and where relevant, the banks and bed or the system. Basic human needs, societal well-being and economic growth and development are supported by river ecosystem goods and services. A range of processes which support human well-being are included as ecosystem services such as the maintenance of water quality, waste disposal as well as those services relating to recreational and spiritual needs (van Wyk ***et al.,*** 2006). The Act requires that sufficient water is to be reserved to maintain as well as sustain the ecological functioning of the country's aquatic ecosystems which include rivers, wetlands, groundwater and estuarine systems. If the country's water resources continue to be abused and deteriorate, this will result in an unavoidable loss of key ecosystem services that support social and economic development (Postel and Richter, 2003; Driver et al., 2005; Dudgeon et al., 2006).

The diverse goods and services provided for by water resources are acknowledged by the NWA. This ingrains the democratic principles necessary to safeguard equity in access to these resources. The aim is that society should be able to use as well as protect an agreed upon suite of goods and services derived from the water resources. The water law provides for an integrated, adaptive process for water resource management. The optimal use of natural resources for sustainable economic activity is essential in developing countries (Howarth and Farber, 2002). Biodiversity is a vital component for maintaining ecological processes and thus in ensuring sustainability of the ecosystem goods and services which is vital for successful water resource management (MacKay ***et al.,*** 2004)

South Africa's National Biodiversity Strategy and Action Plan (DEAT, 2005) acknowledges that there is cause for significant concern due to the declining status of ecosystems, that degradation of ecosystems leads to a reduction in ecosystem services. This may result in a reduced capacity to generate clean water and a loss of food production due to land degradation. The overall framework for environmental governance in South Africa has been created by South Africa's Constitution (Act 108 of 1996) by establishing the right to an environment that is not harmful to health and well-being, by balancing the right to have the environment protected with rights to valid social and economic development and by allocating environmental functions to a wide range of government agencies in all spheres and requiring co-operation between government agencies and spheres of government (DEAT, 2005). National legislation has been promulgated to govern national competencies, one of which is water (National Water Act).

Wetlands are highly susceptible to the degradation of quality and a reduction in quantity as a result of anthropogenic resource use activities, (Mitsch and Gosselink, 1993; Brinson, 1993; Bernaldez et al., 1993, Diederichs and Ellery, 2001) land-surface-development (Gibbs, 2000) and landscape-management (Kotze and Breen, 1994; Whitlow, 1992) practices that alter their hydrological regime impacting these systems (Winter and Llamas, 1993). Historically wetlands have been perceived to be wastelands (Maltby, 1986) and this has resulted in the exploitation, alteration and in many cases the complete destruction of these valuable ecosystems, with an accompanying loss of associated ecosystem goods and services (Begg, 1986). It is now acknowledged that these ecosystems perform functions making them invaluable to the management of both water quantity and quality, and as a result wetlands are regarded as integral components of catchment systems (Jewitt and Kotze, 2000; Dickens et al., 2003).

This study includes a wetland assessment of wetland units associated with the study area. The aim of the study is to delineate and assess the health and functioning of the wetland units associated with the study area. The following tasks were identified in order to meet the project objectives:

- Conduct a desktop and field investigation of the wetlands within the study areas;
- Assess, classify, delineate and map the identified wetlands;
- Describe the general ecological functions of the wetlands;
- Determine the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the wetlands on site; and
- Provide a report with maps of wetlands, detailing all the information, including environmental impacts and mitigatory measures.

This report describes the approach adopted, the results of the approach as well as a discussion of the significance and relevance of the determined results. Additionally, management options have also been provided to protect and manage ecosystems and areas of ecological importance.

2 TERMS OF REFERENCE

Digby Wells & Associates (DWA) was appointed by Universal Coal (Pty) Ltd as environmental consultants to investigate the environmental aspects as required for the Environmental Impact Assessment (EIA) phase for the proposed Kangala mine on portion portion 1 and R/E of portion 2 of the farm Wolvenfontein 244 IR, in the Delmas area, Mpumalanga Province. Environmental considerations for this study included the assessments of the wetland areas associated with the study area. The NWA is important in that it provides a framework to protect water resources against over exploitation and to ensure that there is water for social and economic development, human needs and to meet the needs of the aquatic environment. The NWA recognises wetlands as a water resource and is protected under the Act. This study addresses the following regulations and regulatory procedures of the South African Department of Water Affairs and Forestry (DWAF) and the Department of Environmental Affairs and Tourism (DEAT):

- Section 19 of the National Water Act (Act 36 of 1998);
- Section 21 of the National Water Act (Act 36 of 1998);
- Section 21 of the Environment Conservation Act,(Act 73 of 1989);
- Section 24 of the Constitution – Environment (Act 108 of 1996); and
- Section 5 of the National Environmental Management Act (Act 107 of 1998).

This report presents the results obtained during a wetland survey conducted during August 2009. The report serves to present the findings of a wetland assessment of the wetland areas associated with the study area. Information generated from this survey would be used to delineate, classify and map the wetlands as well as determine ecological integrity of the wetland units. Additionally, potential impacts associated with the proposed Kangala mine will be identified and discussed.

3 STUDY AREA

The study area is located on portion 1 and R/E of portion 2 of the farm Wolvenfontein 244 IR, in the Delmas area, Mpumalanga Province. The site is located in the quaternary catchment, B20A, which is situated within the upper reaches of the Olifants Catchment Water Management Area (WMA 4). The study area is upstream and connected to the Bronkhorstspruit, a tributary of the Olifants River. The R42 transects the study area resulting in wetland units being assessed either side of the road. Pictures of the assessed wetland areas in relation to the study area are presented in **Appendix A**.

4 EXPERTISE OF THE SPECIALIST

A curriculum vitae (CV) and declaration of independence is attached in **Appendix B**.

5 AIMS AND OBJECTIVES

The aim of the assessment of the wetland units was to delineate the wetland areas as well as determine the integrity (health) and ecological significance of these units. In order to achieve this aim, the following objectives were addressed:

- To determine if any wetland units will be directly impacted upon by the proposed mining activities and associated infrastructure;
- To undertake an assessment of the impacts associated with various activities on the functionality of the wetland units; and
- To recommend measures that should be included in the Environmental Management Plan (EMP) to prevent as well as limit impacts to wetland areas.

6 METHODOLOGY

6.1 Wetland Delineation

Maps were generated from 1:50 000 topographic maps and satellite imagery, onto which the wetland boundaries were delineated. Each of the identified wetlands were classified according to their hydro-geomorphic (HGM) determinants based on modification of the system proposed by Brinson (1993), and modified for use by Marneweck and Batchelor (2002) and subsequently revised by Kotze *et al.* (2004).

A site visit was undertaken in September 2009 for orientation. In order to determine the boundaries of wetlands areas, the methodology described by DWAF (2005) was adopted. This included a desktop delineation by estimating wetland boundaries from satellite imagery, making use of topography, the presence of water and different vegetation structure as indicators. The wetland delineation procedure was started from the downstream part of the area to be delineated, utilising indicators such as the presence of water or obligate hydrophilic vegetation. A soil auger was used to examine the first 0.5m of the soil profile for the presence of soil wetness and/or soil form indicators (DWAF, 2005). In Accordance with Kotze and Marneweck (1999) soil augering was conducted to identify indicators of hydric conditions so as to verify whether or not the areas delineated as wetlands met the criteria for classification as wetlands.

6.1.1 Wetland Classification, Delineation and Mapping

In accordance with DWAF guidelines (2005) the wetland delineation procedure considers four attributes to determine the limitations of the wetland. These attributes are discussed according to the DWAF guidelines in further detail later on in this section. The four attributes are:

- Terrain Unit Indicator – helps to identify those parts of the landscape where wetlands are more likely to occur;
- Soil Form Indicator – identifies the soil forms, which are associated with prolonged and frequent saturation;
- Soil Wetness Indicator – identifies the morphological “signatures” developed in the soil profile as a result of prolonged and frequent saturation; and
- Vegetation Indicator – identifies hydrophilic vegetation associated with frequently saturated soils.

In accordance with the definition of a wetland in the NWA, vegetation is the primary indicator of a wetland, which must be present under normal circumstances. The soil wetness indicator, however, tends to be the most important in practices. The remaining three indicators are then used in a confirmatory role. The reason for this is that the response of vegetation to changes in the soil moisture regime or management are relatively quick and may be transformed, whereas the morphological indicators in the soil are significantly more permanent and will hold the indications of frequent and prolonged saturation long after a wetland has been drained (perhaps several centuries) (DWAF, 2005).

For the purpose of this study, wetlands are considered as those ecosystems defined by the NWA 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."

Terrain Unit Indicator

Terrain Unit Indicator (TUI) areas include depressions and channels where water would be most likely to accumulate. These areas are determined with the aid of topographical maps, aerial photographs and engineering and town planning diagrams (these are most often used as they offer the highest degree of detail needed to accurately delineate the various zones of the wetland) (DWAF, 2005).

Soil Form Indicator

Hydomorphic soils are taken into account for the Soil Form Indicator (SFI) which will display unique characteristics resulting from prolonged and repeated water saturation (DWAF, 2005). The continued saturation of the soils results in the soils becoming anaerobic and thus resulting in a change of the chemical characteristics of the soil. Iron and manganese are two soil components which are insoluble under aerobic conditions and become soluble when the soil becomes anaerobic and thus begin to leach out into the soil profile. Iron is one of the most abundant elements in soils and is responsible for the red and brown colours of many soils. Resulting from the prolonged anaerobic conditions, iron is dissolved out of the soil, and the soil matrix is left a greying, greenish or bluish colour, and is said to be "gleyed". Common in wetlands which are seasonally or temporarily saturated is a fluctuating water table, these results in alternation between aerobic and anaerobic conditions in the soil (DWAF, 2005). Iron will return to an insoluble state in aerobic conditions which will result in deposits in the form of patches or mottles within the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these insoluble iron compounds. Thus, soil that is gleyed and has many mottles may be interpreted as indicating a zone that is seasonally of temporarily saturated (DWAF, 2005).

Soil Wetness Indicator

In practice, the Soil Wetness Indictor (SWI) is used as the primary indicator (DWAF, 2005). Hydromorphic soils are often identified by the colours of various soil components. The frequency and duration of the soil saturation periods strongly influences the colours of these components.

Grey colours become more prominent in the soil matrix the higher the duration and frequency of saturation in a soil profile (DWAF, 2005). A feature of hydromorphic soils are coloured mottles which are usually absent in permanently saturated soils and are most prominent in seasonally saturated soils, and are less abundant in temporarily saturated soils (DWAF, 2005). In order for a soil horizon to qualify as having signs of wetness in the temporary, seasonal or permanent zones, a grey soil matrix and/or mottles must be present.

Vegetation Indicator

If vegetation was to be used as a primary indicator, undisturbed conditions and expert knowledge are required (DWAF, 2005). Due to this uncertainty, greater emphasis is often placed on the SWI to delineated wetland areas. In this assessment the SWI has been relied upon to delineated wetland areas in addition, the identification of indicator vegetation species and the use of plant community structures has been used to validate these boundaries. As one moves along the wetness gradient from the centre of the wetland to the edge, and into adjacent terrestrial areas plant communities undergo distinct changes in species composition. Valuable information for determining the wetland boundary and wetness zone is derived from the change in species composition. When using vegetation indicators for delineation, emphasis is placed on the group of species that dominate the plant community, rather than on individual indicator species (DWAF, 2005).

6.2 Wetland Functional Assessment

In accordance with the method described by Kotze *et al.* (2007) a Level II ecological functional assessment of the associated wetland areas was undertaken. This methodology provides for a scoring system to establish the services of the wetland ecosystem. The onsite wetlands were assessed utilizing the functional assessment technique, WET-EcoServices, developed by Kotze *et al,* (2007) to provide an indication of the benefits and services. These scores provide an indication of the ecological services offered by the different HGM units for this study.

6.3 Determining the Present Ecological Status (PES) and Ecological Importance and Sensitivity (EIS) of wetlands

A present ecological status and ecological importance and sensitivity analysis was conducted in order to establish a baseline integrity for the associated wetlands. For the purpose of this assessment, the scoring system applied in the procedure for the determination of Resource Directed Measures for wetland ecosystems (DWAF, 1999) was applied. The output scores from the indices are presented in the standard DWAF A - F ecological categories, and provide a score of the PES of the habitat integrity of the wetland system being examined. According to Kleynhans and Louw (2007) EcoClassification is the procedure to determine and categorise the ecological state of various biological and physical attributes compared to the reference state. The used categories were modified from Kleynhans (1996 and 1999). In order to ascribe the individual category scores used in the assessment, air photo analysis, an assessment of the key drivers as well as limited field sampling were used. The interpretation of scores for determining PES is presented in Table 1 and the categories used to determine the EIS is presented in Table 2.

Table 1: Interpretation of the ecological categories and descriptions (Kleynhans & Louw, 2007).

Category	Class	Ecological Description
A	**Natural**	Modifications to the natural abiotic template and the characteristics of the biota are undetectable. The characteristics of the resources are completely determined by unmodified natural regimes. Even potential anthropogenic induced changes to the abiotic characteristics and anthropogenic risks to the well being of biota are not measurable.
A/B, B, B/C	**Good**	Modifications to the natural abiotic template and the characteristics of the biota may vary from small to moderate. The characteristics of the resource are largely determined by natural regimes while anthropogenic resources tend to play a small to moderate role. There is a small risk that the resource base may be exceeded. Consequently, the risk to the well-being and survival of especially intolerant biota (depending on the nature of the disturbance) at a limited number of localities may be somewhat higher than expected under natural conditions. Temporarily and spatially this may result in somewhat lowered abundances and frequency of occurrence of intolerant and moderately intolerant species. However, even in the short, medium and long term the resilience and adaptability of biota are not compromised. The impacts of local and acute disturbances are to an extent mitigated by some refuge areas.
C, C/D, D	**Fair**	Modifications to the natural abiotic template and the characteristics of the biota may vary from moderate to large. The characteristics of the resource are partly determined by natural regimes but anthropogenic influences tend to play a major role. There is a moderate to large risk that the resource base may be exceeded. Consequently, the risk to the well-being and survival of especially intolerant biota (depending on the nature of the disturbance) at a significant number of localities may be higher that expected under natural conditions. Temporarily and spatially this may result in low abundances and frequency of occurrence of intolerant and moderately intolerant species, as well as a possible increase in the abundances and frequency of occurrence of tolerant species which may reach pest proportions. However, in the medium to long term the resilience and adaptability of biota are not compromised. The impacts of local and acute disturbances are to an extent mitigated by some refuge areas.
E, F	**Poor**	Modifications to the natural abiotic template and the characteristics of the biota may vary from large to competely dominant. The characteristics of the resource are almost completely determined by severe anthropogenic influences. There is a serisou to critical risk that the resource base may be exceeded. Consequently, the risk to the well-being and survival of all but the most tolerant biota (depending on the nature of the disturbance) at almost all localities is serious to critical. Temporarily and spatially this will result in the absence of intolerant and moderately intolerant species and very low abundances and frequency of occurence and can reach pest proportions. On all temporal and spatial scales the resilience and adaptability of biota are compromised. The impacts of local and acute disturbances are to an extent mitigated by some refuge areas.

Table 2: Ecological importance and sensitivity categories. Interpretation of median scores for biotic and habitat determinants (Kleynhans, 1999).

Class	Description	Score
A	Floodplains that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 AND <=4
B	Floodplains that are considered to be ecologically important and sensitive. The biodiversity of these floodplains 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
C	Floodplains that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 AND <=2
D	Floodplains that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. The play an insignificant role in moderating the quantity and quality of water of major rivers.	0 AND <=1

6.4 Ecological Description

According to Kleynhans and Louw (2007) the A to F scale represents a continuum, and that the boundaries between categories are notional, artificially-defined points along the continuum. As a result of this there may be uncertainty regarding which category a particular entity belongs to. This situation falls within the concept of a fuzzy boundary, where a particular entity may potentially have membership of both classes (Robertson *et al*. 2004). For practical purposes these situations are referred to as boundary categories and are denoted as A/B, B/C, C/D, and so on. An illustration of the distribution of the ecological categories on a continuum (Kleynhans & Louw, 2007) is presented in Figure 1.

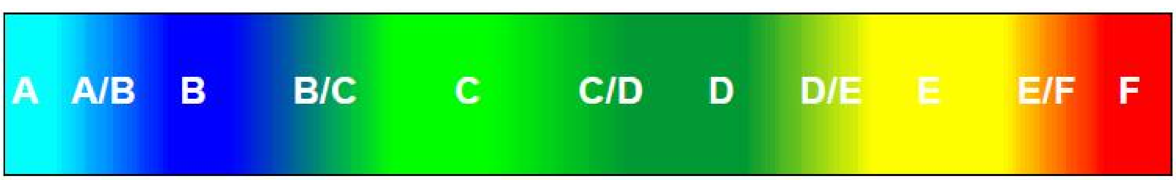


Figure 1: An illustration of the distribution of the ecological categories on a continuum

7 KNOWLEDGE GAPS

Due to the wetland assessment being conducted during the autumn months, a comprehensive ecological assessment could not be effectively conducted. This should be taken into consideration when interpreting the results. Finding from other specialist studies conducted during the summer season have been used to supplement this report which may contribute to an increase in the confidence of the findings.

8 FINDINGS

8.1 Wetland Delineation

The wetlands in the study area are linked to both perched groundwater and surface water. Four Hydro-geomorphic (HGM) types of natural wetland systems occur within the area assessed. These are:

- Pans;
- Hillslope seepage wetlands connected to a pan;
- Valley bottom wetland without a channel; and
- Hillslope seepage wetland connected to a watercourse.

The distribution of the various HGM types of wetland occurring in the study area are presented in **Appendix C**. Photographs of the various wetland units is presented in Figure 2. The area (ha) of the different wetland types assessed and the percentage in relation to the study area as well as a description based on their setting in the landscape and hydrologic components are given in Table 3 and Table 4 respectively.

Table 3: Area of the different HGM wetland types within the study area.

Wetland type	Area of wetland assessed	
	Hectares (ha)	Percentage (%)
Pans	16.1	6.5
Hillslope seepage wetland connected to a pan	22.2	8.9
Hillslope seepage wetland connected to a watercourse	179.0	72.0
Unchannelled valley bottom wetland	31.3	12.6
Total	248.6	100.0

The total size of the study area is approximately 950 ha with approximately 25% (248.6 ha) of the study area being comprised of wetland areas. The hillslope seepage wetlands comprise approximately three quarters (179 ha) of the total wetland area. The unchannelled valley bottom wetlands comprise approximately one third (31.3 ha) of all wetland areas. The hillslope seepage wetlands connected to the pans comprise approximately 20 ha of the total wetland area. The smallest wetland unit within the study area are the pans comprising approximately 16 ha (6.5%).

Table 4: The definition of the different HGM wetland types occurring in the study area [based on the system first described by Brinson (1993) and modified for the Highveld by Marneweck and Batchelor (2002), and further developed by Kotze *et al.*(2004)].

Pans	**TOPOGRAPHIC SETTING**	**DESCRIPTION**	
	In depressions and basins, often at drainage divides on top of the hills	A basin shaped area with a closed elevation contour that allows for the non-permanent (seasonal or temporary) accumulation of surface water. An outlet is usually absent.	
	HYDROLOGIC COMPONENTS		
	Inputs	**Throughputs**	**Outputs**
	Runoff from the surrounding catchment area and lateral seepage from adjacent hillslope seepage wetlands.	None.	Evapo-transpiration and groundwater discharge from leakage.
Hillslope seepage wetlands connected to pans	**TOPOGRAPHIC SETTING**	**DESCRIPTION**	
	Along the slopes of pan basins	Occur adjacent to pans on the concave or convex slopes associated with the pan basin and are characterized by the colluvial (transported by gravity) movement of materials. Generally always associated with sandy soil forms.	
	HYDROLOGIC COMPONENTS		
	Inputs	**Throughputs**	**Outputs**
	Predominantly groundwater from perched aquifers and interflow.	Interflow and diffuse surface flow.	Variable but predominantly restricted to interflow and diffuse surface flow
Valley bottom wetlands without channels	**TOPOGRAPHIC SETTING**	**DESCRIPTION**	
	Occur in the shallow valleys that drain the slopes.	Valley bottom areas without a stream channel. Are gently or steep sloped and characterized by the alluvial transport and deposition of material by water.	
	HYDROLOGIC COMPONENTS		
	Inputs	**Throughputs**	**Outputs**
	Receive water inputs from adjacent slopes via runoff and interflow. May also receive inputs from a channelled system. Interflow may be from adjacent slopes, adjacent hillslope seepage wetlands if these are present, or may occur longitudinally along the valley bottom.	Surface flow and interflow.	Variable but predominantly stream flow.
Hillslope seepage wetlands connected to watercourses	**TOPOGRAPHIC SETTING**	**DESCRIPTION**	
	Hillslopes	Occur on concave or convex slopes immediately adjacent to, or at the head of watercourses including other wetlands. Characterized by the colluvial (transported by gravity) movement of materials. Generally always associated with sandy soil forms.	
	HYDROLOGIC COMPONENTS		
	Inputs	**Throughputs**	**Outputs**
	Predominantly groundwater from perched aquifers and interflow.	Interflow and diffuse surface flow.	Variable including interflow, diffuse surface flow and stream flow.

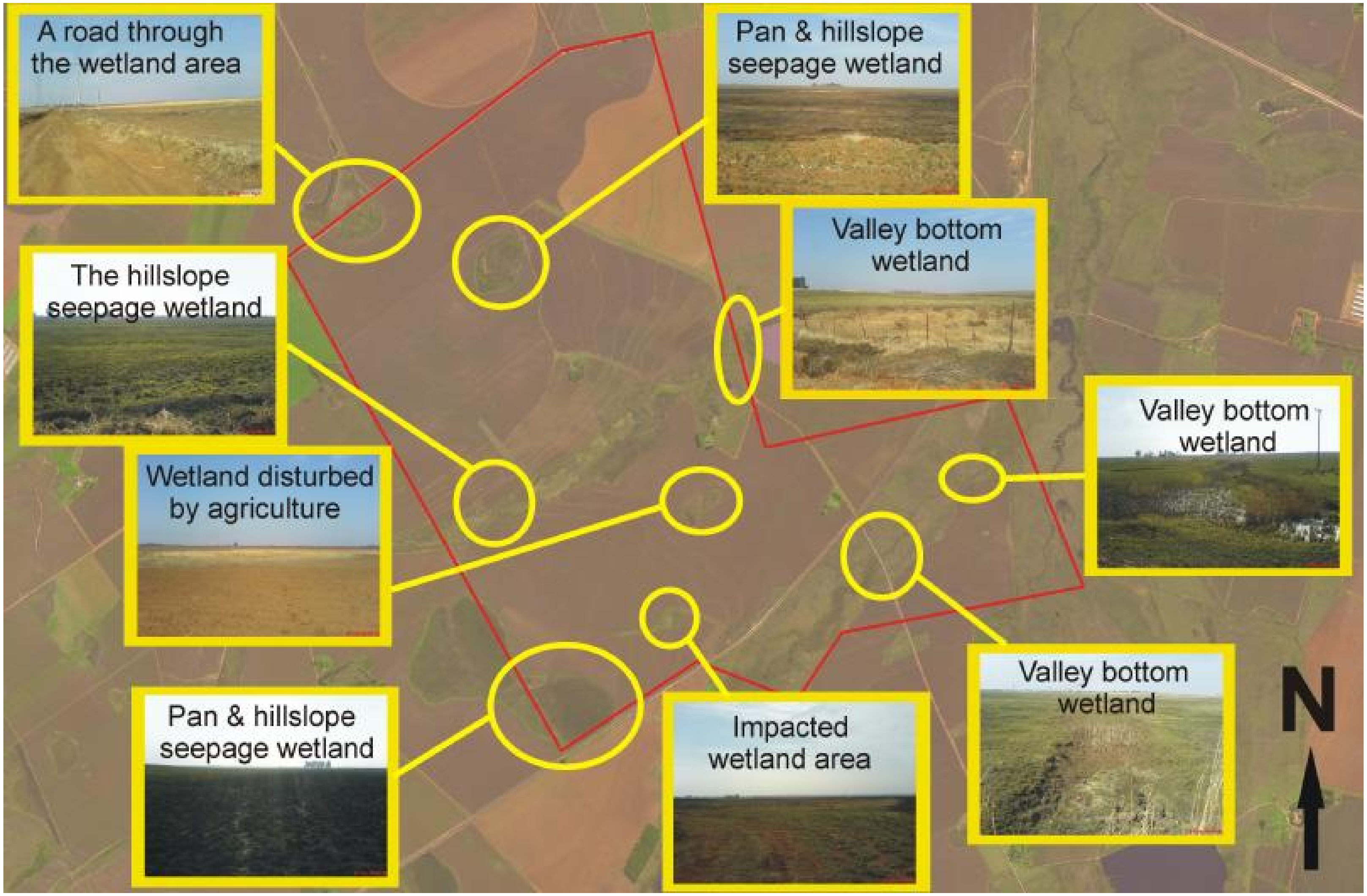


Figure 2: Photographs of the identified and delineated wetland units within the study area

8.1.1 Description of Wetland Types

8.1.1.1 Pans

Pans receive water both from surface and groundwater flows, which then accumulates in the depression owing to a generally impervious underlying layer which prevents the water draining away (Goudie and Thomas, 1985; Marshall and Harmse, 1992). According to Kotze *et al.* (2007) pans are usually isolated from streams and because of their position in the landscape the opportunity for attenuating flows is limited. Due to their inward draining nature, they do capture runoff and as a result they reduce the volume of surface water that would otherwise reach the stream during stormflow conditions. According to Goudie and Thomas (1985) and Marshall and Harmse (1992) pans are not considered locations for the trapping of sediment, as many pans originate from the removal of sediment by wind, thus creating what are referred to as deflation basins.

8.1.1.1 Hillslope seepage wetlands

According to Kotze *et al. (*2007) these wetlands are usually associated with groundwater discharges, although flows through them may be supplemented by surface water contributors. These wetlands are expected to contribute to some surface flow attenuation early in the season until the soils are saturated, after which their contribution to flood attenuation will be limited (WRP, 1993; McCartney, 2000 and McCartney *et al.,* 1998). The characteristic soil forms of the hillslope seepage wetlands which occur in the study area are sandy. It is common for these soils to remain saturated for periods during the summer months (wet season). Two HGM types of hillslope wetlands occur in the study area:

- Hillslope seepage wetlands connected to pans; and
- Hillslope seepage wetlands connected to a watercourse.

Hillslope seepage wetlands connected to pans are seepage systems situated on the slopes of pan basins which are connected to the pan and contribute to the hydrodynamics of the pan. Hillslope seepage wetlands connected to watercourses are wetland systems which are directly linked on the surface to watercourses. This type of system typically contributes to flow in the watercourses, even if this contribution is only on a seasonal basis.

8.1.1.2 Valley bottom wetlands without channels

This type of wetland resembles a floodplain in its location and gentle gradient, with potentially high levels of sediment deposition (Kotze *et al.,* 2007). Extensive areas of these wetlands remain saturated as stream channel input is spread diffusely across the wetland even at low flows (Kotze *et al.,* 2007). These wetlands also tend to have a high organic content. This is the dominant wetland type in both the study areas. Facultative wetland indicator plant species, comprising a mixture of grasses and sedges are evident as longitudinal bands within a relatively narrow zone along the valley bottoms. Facultative wetland plant species usually grow in wetlands (67-99% of occurrences) but occasionally are found in non-wetland areas. Lateral seep zones form part of the adjacent hillslope seepage wetlands, this is a characteristic for all the valley bottom wetlands. The primary drivers for these systems, owing to the shallow gradients along the valley bottoms are diffuse horizontal surface flow and interflow. There is generally a clear distinction in the transition in the vegetation structure between the mixed grass-sedge meadow zones that characterise these wetlands to the more intermittently wet grassland habitats associated with the adjacent hillslope seepage wetlands (Kotze *et al.,* 2007).

8.1.2 Functional Assessment of Wetlands

Extensive literature searches have revealed that very few practitioners have quantified the benefits of wetland functionality. In addition to this, it appears likely that the functions of the wetlands are variable depending on the characteristics of the wetlands and landscape. In spite of these limitations, some general discussion is possible based on generalised functions that the types of wetlands detected in the area may perform.

8.1.2.1 Pans

According to Kotze *et al.* (2007) the ability for attenuating floods is limited by the position of the pans in the landscape, which is generally isolated from stream channels. As a result of their inward draining nature, pans do catch runoff, and thus reduce the volume of water which would otherwise reach the stream system during stormflow conditions (Kotze *et al.,* 2007). According to Goudie and Thomas (1985) and Marshal and Harmse (1992) pans are not considered important locations for sediment trapping as many pans originate from the removal of sediment by wind, creating what is referred to as deflation basins.

Precipitation of minerals is carried out by temporary pans, including phosphate minerals due to the concentrating effects of evaporation (Kotze *et al.,* 2007). In addition to this, nitrogen cycling is likely to be important with some losses due to denitrification and volatilization in the case of high pH's. According to Allan *et al.* (1995) the pedology, geology and local climate influence the water quality in pans. These factors in turn also influence the response of these systems to nutrient inputs (Kotze *et al.,* 2007). According to Kotze *et al.* (2007) accumulated salts and nutrients in non-perennial pans can be transported out of the system by wind and be deposited on the surrounding slopes. That which is remaining may then dissolve again when water enters the system as the pan fills after rainfall events.

8.1.2.2 Hillslope Seepage wetlands

According to Kotze ***at al.*** (2007) it is recognizable that evapotranspiration in the wetland may result in a considerable reduction in the volume of water which would otherwise potentially reach the stream system. The wetlands offer a service in that they accumulate organic matter and fine sediments in the wetland soils, these results in the wetland slowing down the sub-surface movement of water down the slope. This “plugging effect” thus increases the storage capacity of the slope above the wetland, and prolongs the contribution of water to the stream system during low flow periods (Kotze ***et al.,*** 2007). According to Rogers, Rogers and Buzer (1985), Gren (1995), Ewel (1997) and Postel and Carpenter (1997) these wetlands remove excess nutrients and inorganic pollutants produced by agriculture, industry and domestic waste. These wetland types have a relatively high removal potential for nitrogen in particular. There is an increase in erosion potential as the gradient of the slope increases and as a result hillslope seepage wetlands tend to be very important from an erosion control point of view, provided that the vegetation remains intact (Kotze ***et al.,*** 2007).

8.1.2.3 Valley bottom wetlands without channels

Similarly to valley bottom wetlands with channels, valley bottom wetlands without channels also offer a service in the enhancement to the quality of water. This is with respect to the removal of toxicants and nitrates. This removal is higher than in valley bottom wetlands with channels owing to the greater contact of the wetland with runoff waters, particularly if there is a significant groundwater contribution to the wetland (Kotze ***et al.,*** 2007). According to Cronk and Siobhan Fennessy (2001) and Keddy (2002) the phosphate retention levels may be lower because a certain amount of phosphate may be re-mobilized under prolonged anaerobic conditions. These wetlands provide an additional service in trapping and the retention in the wetland itself of sediment carried by runoff waters. Finally, these wetland provide flood attenuation through the spreading out and the slowing down of floodwater in the wetland, thereby reducing the severity of floods downstream.. This depositional environment is created by the surface roughness caused by the vegetation. The depositional environment is enhanced through the presence of dams. These wetlands provide valuable grazing ground during winter periods and early spring as a result of extended periods of wetness.

8.1.3 WET-EcoServices Functional Assessment of on Site Wetlands

The general features of the wetland unit were assessed in terms of functioning and the overall importance of the hydro-geomorphic unit was then determined at a landscape level. The level of functioning supplied by the hydro-geomorphic unit for various ecological services is presented in Table 5. The results from the “WET-EcoServices” tool for the respective wetland units are presented below in Figure 3, Figure 4, Figure 5 and Figure 6.

Table 5: A listing and scoring of ecological services offered by each of the HGM units.

Ecological Services	Overall Score			
	Pans	Hillslope seepage wetlands connected to pans	Hillslope seepage wetlands connected to a watercourse	Unchannelled valley bottom wetlands
Flood attenuation	1.0	1.3	2.5	3.2
Streamflow regulation	0.8	0.9	2.2	3.3
Sediment trapping	1.7	1.3	2.6	3.1
Phospahte trapping	2.4	2.2	2.8	3.0
Nitrate removal	2.6	2.3	2.9	2.9
Toxicant removal	2.4	2.2	2.8	3.1
Erosion control	0.9	1.8	2.7	2.6
Carbon storage	1.8	1.7	2.2	2.7
Maintenance of biodiversity	2.6	2.0	2.5	2.8
Water supply for human use	1.2	0.7	2.2	2.4
Natural resources	1.0	1.1	1.2	2.2
Cultivated foods	0.2	1.5	0.6	0.8
Cultural significance	1.3	0.6	0.7	1.1
Tourism and recreation	0.7	0.6	1.1	0.8
Education and research	0.5	0.4	1.0	1.2

Note: The importance of EcoServices supplied by the wetland systems are scored according to the following:

- < 0.5 Low
- 0.5 – 1.5 Moderately Low
- 1.5 – 2.5 Intermediate
- 2.5 – 3.5 Moderately High
- >3.5 High

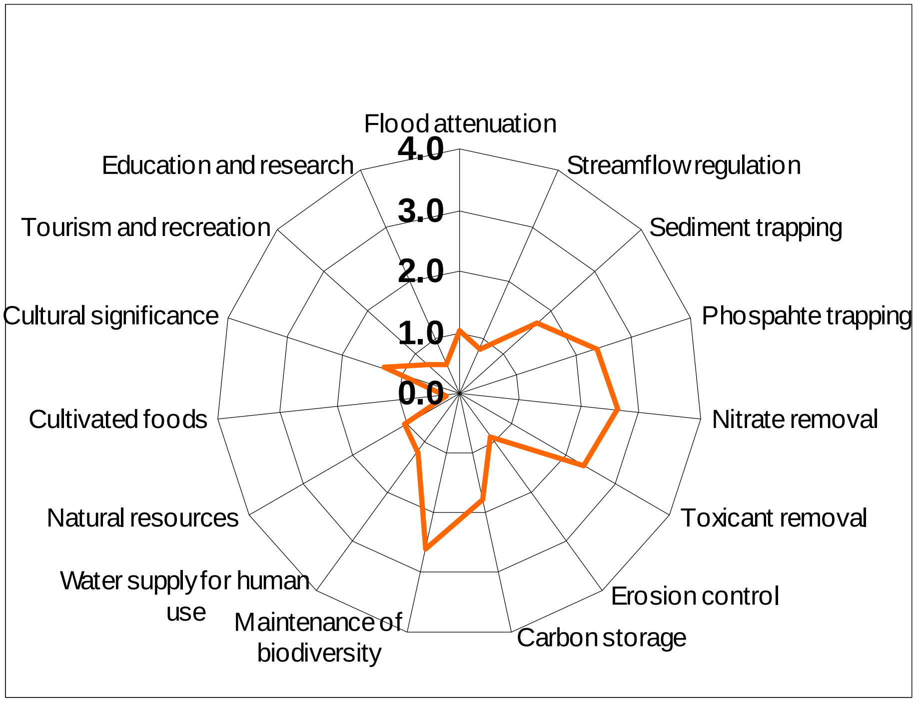


Figure 3: Radial plots indicating the functions performed by the pans.

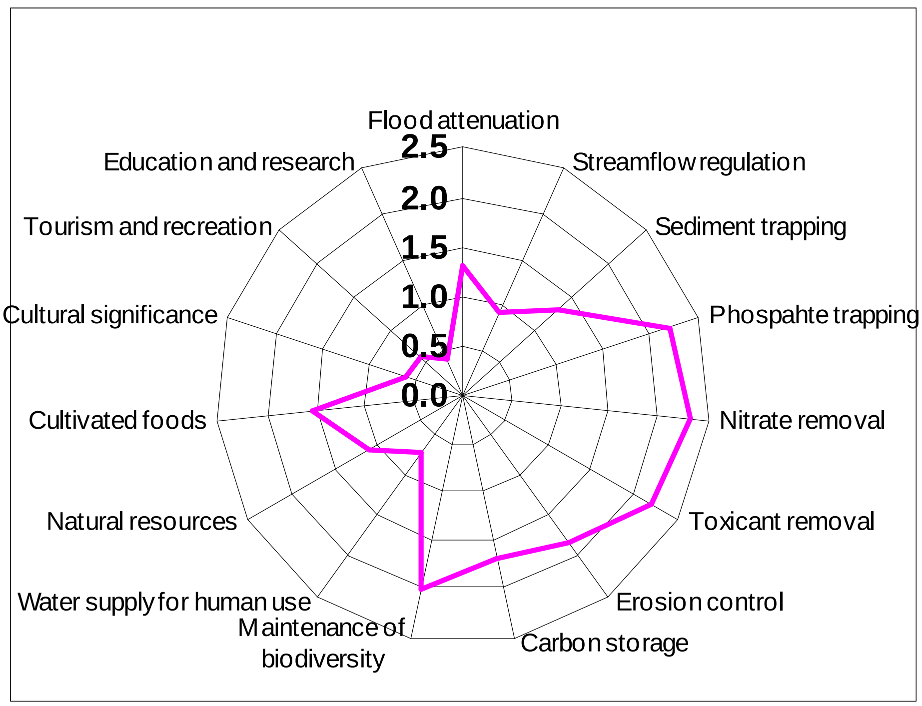


Figure 4: Radial plots indicating the functions performed by the hillslope seepage wetlands connected to the pans.

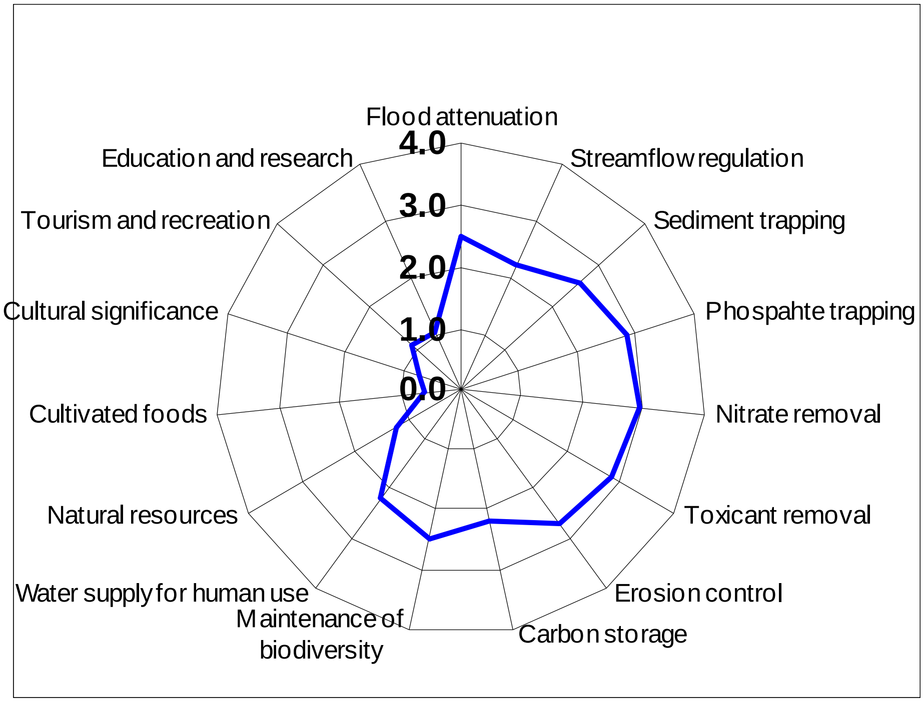


Figure 5: Radial plots indicating the functions performed by the hillslope seepage wetlands connected to the watercourses.

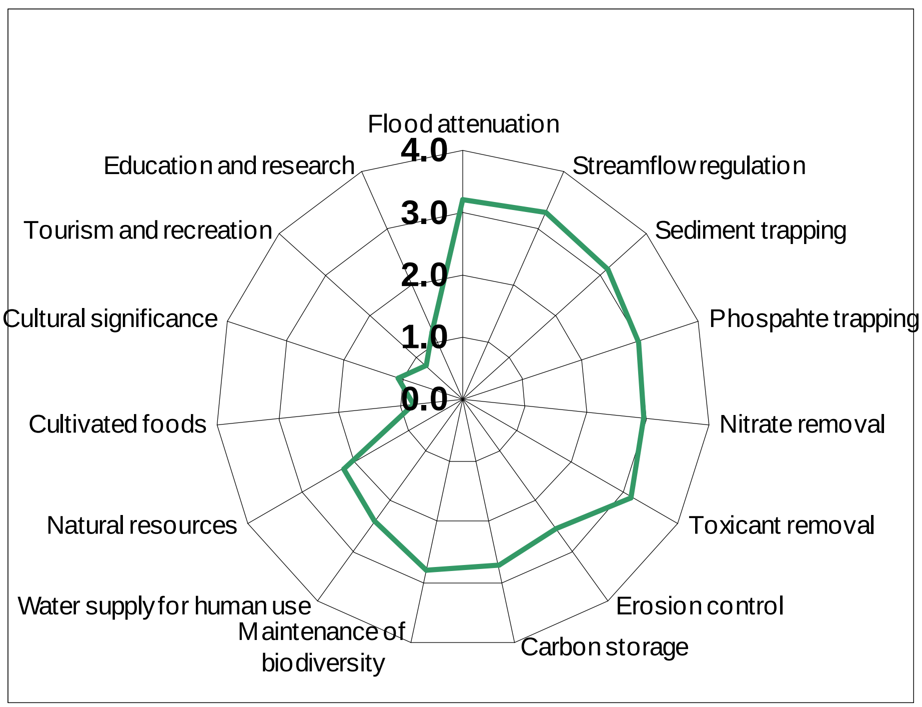
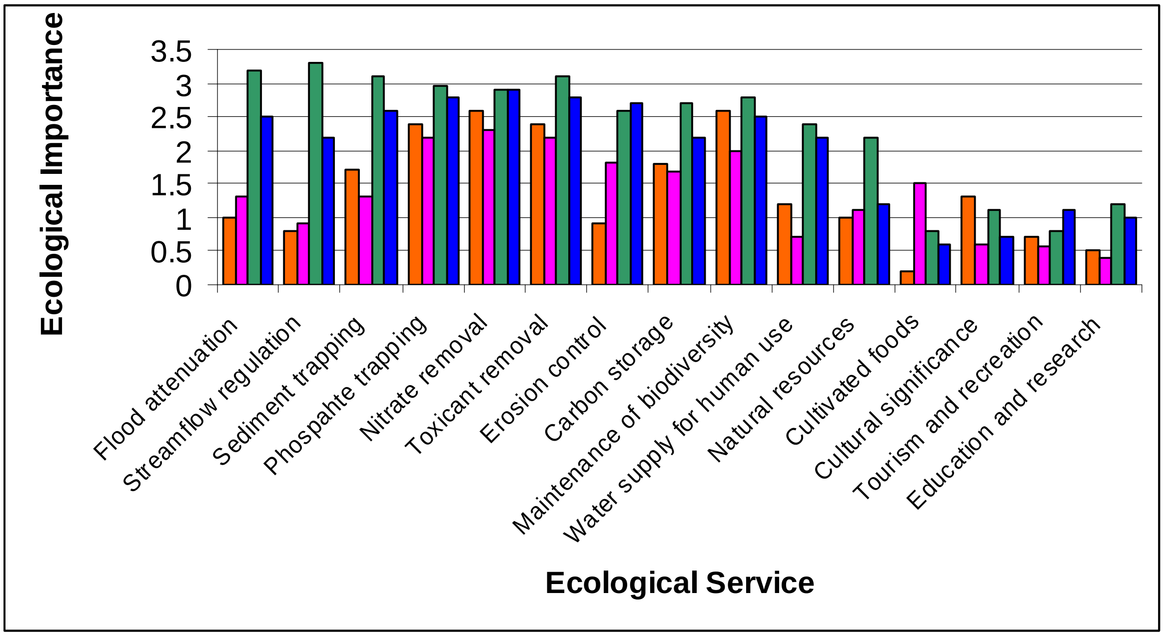


Figure 6: Radial plots indicating the functions performed by the unchannelled valley bottom wetlands.

The most important ecological services provided for by all the assessed wetland units are associated with water quality enhancement. These services consist of sediment and phosphate trapping as well as nitrate and toxicant removal. These services in particular were determined to be of intermediate importance for the pans and the associated hillslope seepage wetlands. The exception is that nitrate removal and the maintenance of biodiversity were determined to be of moderately high ecological importance for the pan. The similar services associated with water quality enhancement were determined to be of moderately high ecological importance for the unchannelled valley bottom wetland and associated hillslope seepage wetlands. The unchannelled valley bottom wetland had the most ecological services assigned a moderately high importance and this is to be expected due to the diffuse nature of the system. This will provide important services such as flood attenuation, streamflow regulation, sediment trapping and erosion control. The services associated with water quality enhancement are important to consider when taking into consideration the surrounding land uses (agricultural practices) and the impacts to water quality as a result. Agricultural fields are encroaching into the various wetland units increasing the potential for erosion, loss of habitat and impacts to biodiversity. The unchannelled valley bottom wetland provides a variety of ecological services which should be protected to maintain these services. The lower scores for the remaining wetland units associated with water quality enhancement services may be as a result of agricultural practices impacting on these systems and reducing the ability of these systems to provide effective services.

The importance of the various ecological services offered for each wetland unit is presented in Figure 77. This provides an indication of the importance of the wetland units to provide valuable ecological services both for the immediate and downstream areas. Figure 7 indicates the high ecological importance of water quality enhancement services for all the units.



Note: – Pan

– Hillslope seepage wetland connected to the pan

– Unchannelled valley bottom wetland

– Hillslope seepage wetland connected to the watercourse

Figure 7: A summarised comparison of ecological services offer for each wetland unit and the importance of each service.

8.1.4 The Present Ecological Status

All of the wetlands within the study area have been modified to some extent. The wetlands within the study area were determined to be largely natural or critically modified. The classified PES areas for the study area are presented in **Appendix D**. The percentage relating to the PES is as follows (ratings from section 6.3):

- 12.7% are largely natural (with a PES of B);
- 82.9% are moderately modified (with a PES of C);
- 0.4% are largely modified (with a PES of D); and
- 4.0% are critically modified (with a PES of E).

The present state of the wetlands in the study area is, therefore, modified to some extent when compared with what would be expected for reference conditions. Wetland units which have been critically modified are a result of agricultural practices and informal roads causing a loss of seepage area for these units. Additional impacts to the wetland units resulting from agricultural practices include increased sediment loads, water quality modifications, indigenous vegetation removal and invasive plant encroachment. There are a series of dams and culverts upstream and downstream of the study area, as well as within the site boundary itself. These dams and culverts impact on the units by altering flow dynamics and permanently inundate areas. The unchannelled valley bottom wetland was determined to be largely natural due to the limited direct impacts to the system as well as the ability of the system to provide habitat, food and water for biodiversity as well as the importance of the system to enhance water quality.

8.1.5 Ecological Importance and Sensitivity

The highest ecological importance and sensitivity scores (rated as C) are located with the unchannelled valley bottom wetlands (ratings from section 6.3). These have the highest EIS scores predominantly as a result of their functioning to retain as well as enhance water quality and maintain biodiversity for the area, as well as support adjacent wetland areas through interflow seepage. No rare or endangered species were identified for any wetland unit. Due to the nature of the current land uses and the encroachment of agricultural activities on the wetland units, the impact on biodiversity would be considerable as a result of habitat loss, human disturbances and competition for food in a reduced area. The EIS of the remaining wetland units was determined to vary from largely modified (D) to critically modified (E) with these systems providing little importance to the maintenance of ecological diversity and functioning on local and wider scales. These systems would also have a largely reduced ability to resist disturbance and provide capability to recover from disturbance once it has occurred. The classified EIS areas for the study area are presented in **Appendix E**. The percentage relating to the EIS is as follows:

- 72.3% are moderately modified (with a EIS of C);
- 24.9% are largely modified (with a EIS of D); and
- 2.8% are critically modified (with a EIS of E).

9 DISCUSSION

The outcome of this assessment discusses recommendations to conserve selected delineated wetlands in this study area. Agricultural practices are largely responsible for the current impacts to all the wetland units in the study area. Some of the identified impacts as a result of the agricultural practices include deterioration of water quality, increased erosion and, sedimentation potential, indigenous vegetation removal and exotic plant encroachment.

Taking into consideration the nature of surrounding land uses, the ability of the wetland units to enhance water quality is important and is considered when formulating the conservation plan. The integrity (health) of all the wetland units was modified to some degree and these modifications are as a result of the current land use. In spite of this, the health of the unchannelled valley bottom wetland was determined to be largely natural when considering the provision of ecological services such as water quality enhancement and biodiversity maintenance.

The majority of wetland units within the study area would provide little importance to the maintenance of ecological diversity and functioning on local and wider scales. These systems would also have a largely reduced ability to resist disturbance and provide capability to recover from disturbance once it has occurred. While it is evident from the study that the impacts associated with the agricultural practices have affected the ecological state of the wetlands, there has been no evidence of any of these impacts seriously affecting the underlying hydrology (key driver) supporting the wetlands.

As a result of the current ecological state as well as the ecological services provided for by the wetlands, a buffer zone has been described for selected wetland areas. The buffer zone takes into consideration the health of the system and the importance of ecological services provided for by the various wetland units. Wetland units which have been critically modified such as the pan and hillslope seepage wetlands on the northern project area boundary have not been assigned a buffer area and it is suggested that these areas be lost to mining in order to conserve healthier wetland units elsewhere. In addition to this, moderately modified and largely natural wetland units have been allocated a 100m buffer zone which must be adhered to in order to preserve these systems. This buffer zone will adequately allow for the conservation of the wetland area and ensure the continuation of ecological functioning of the systems. The buffer zone for the selected wetland areas is presented in **Appendix F.**

The development of any conservation plan should contain clearly defined objectives. The development of the recommendations for the plan assumes that the maintenance of water quantity and quality suitable for aquatic and terrestrial biodiversity and human uses within the wetlands in the study area is one of the primary objectives. As a result of identified ecological services provided for by the wetlands, conservation of the selected wetland area is important. It is suggested that no mining activities take place within the selected wetland areas and associated buffer areas. Additionally, it is recommended that any agricultural activities and other land uses encroaching into the wetland units cease and these areas be rehabilitated to improve the integrity of these impacted areas as well as restore ecological functioning. This will also provide compensation for the recommended wetland areas which may be lost to proposed mining activities.

A conservation plan aimed at improving the integrity of the wetland areas and the associated ecological functioning to improve water quality and biodiversity maintenance should therefore be directed at managing the land use practices in the area and the direct use and conversion of the wetland resources. As a result of downstream users dependant on the water resource, namely agriculture, livestock, humans and fauna and flora, the development of a conservation plan is therefore crucial to ensure minimal impact to the quality and quantity of available water reporting downstream of the study area. Key components to consider for such a plan are:

- Adhere to the allocated 100m buffer zone;
- Agricultural fields within the delineated wetland areas and associated buffer zone to be rehabilitated;

- Access roads within wetland areas to be rehabilitated;
- Mining vehicles to only make use of existing roads; and
- No diverting or pumping of water to take place from the wetland units.

It is also recommended that infrastructure be placed beyond the buffer zone associated with the pan in the northern portion of the study area. This will ensure that these wetland units will not be impacted on. Should the area between the pan in the northern section and valley bottom wetlands be mined, it can be concluded that there will be a loss of sub-surface interflow from the pan to the valley bottom wetlands and this water will then decant into the mining area. Thus in order to ensure that there is no loss of interflow to the valley bottom wetlands, no mining should take place between the pan and valley bottom wetland.

10 CONCLUSION

Four different types of wetland units were identified within the study area. The health of the units varied from largely natural to critically modified. Additionally, the EIS of these wetlands units varied from moderately modified to critically modified. No sensitive or Red Data species were recorded for any wetland unit. Impacts to the wetland units are as a result of the agricultural practices on the periphery of the wetlands, resulting in water quality impairment, loss of habitat, increased sediment loads, erosion and loss of biodiversity.

A 100m buffer zone was described for selected wetland units and it is strongly recommended that no activities take place within these zones. Additionally, wetland units which were determined to be critically modified are recommended to be lost to the proposed mining operation, this will allow for healthier units to be preserved. Where agriculture has impacted on wetland units selected to be conserved, it is recommended that the disturbed areas be rehabilitated to compensate for the wetland areas recommended to be lost to mining. The ability and importance of the wetland units to be conserved to not only provide water but to also enhance water quality is ecologically important and must be protected.

11 DESCRIPTION OF POTENTIAL IMPACTS

The impacts associated with the various activities for each phase of the mining operation will be addressed in this section. Impacts will be discussed with reference to the duration, extent, severity, likelihood and significance. The activities that will result in the impacts have been discussed. Further detail on the activities can be found in the EIA report.

11.1 Construction phase

Activity 2: *Transport of construction material*

This activity will be associated with increased traffic of heavy duty transport and operating vehicles. It is likely that the increase in vehicle use will cause further damage (deterioration) to the informal roads which will result in further exposure of non-vegetated areas increasing the potential for erosion and sedimentation during rainfall periods. The increase in vehicle numbers will also increase the potential of spillages and leaks from operating vehicles into the wetland systems which would impact on water quality. This activity is considered to be short in duration as well as local in extent with impacts being transported downstream away from the site by the wetlands. The severity of the impact was determined to be minor.

Activity 3: *Storage of fuel, lubricant and explosives*

The storage of fuel, lubricant and explosives will be required for the life of mine. Incorrect, inadequate or negligent storage of these materials may result in the potential pollution of surface water resources due to pollutant and toxicant spillages and leaks which may impact negatively the water quality and ecological functioning of the systems. This activity is considered to be medium in duration as it will be required for the life of mine. The impact will be local in extent with impacts being transported downstream away from the site by the wetlands. The severity of the impact was determined to have moderate effects.

Activity 4: *Site clearing and topsoil removal*

The clearing and removal of topsoil will result in the removal of vegetated areas causing open areas to become exposed. This will increase the potential load of sedimentation of the water resources due to erosion of the exposed areas and topsoil stockpiles during periods of high rainfall. These exposed areas will also become eroded as a result of high winds moving across the areas. The removal of the topsoil and vegetation reduces the potential for recharge of shallow aquifers that feed hillslope wetlands, which in turn reduces the flow in water resources. This activity is considered to be medium in duration as it will be required for the construction and operating phases of the mine. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to be severe.

Activity 5: Construction of surface infrastructure

The area designated for surface infrastructure will no longer allow for seepage of surface water into underground aquifers due to the hardening of surfaces. The reduction in the seepage potential of the catchment will result in a decrease in surface water quantity reporting to the downstream system. The reduction in water quantity will in turn result in a loss of wetland areas due to these areas being "starved" of water, as well as wetland areas being reduced and ecological functioning inhibited. Hardening of surfaces will increase the velocity of runoff which will increase the potential for erosion of exposed open areas. This activity is considered to be short in duration as well as local in extent with impacts being transported downstream away from the site by the wetlands. The severity of the impact was determined to be minor.

Activity 6: Establishment of initial boxcut and access ramps

The establishment of the mining area by means of an initial boxcut will dewater surrounding aquifers. There will be a reduction on surface water quantity due to reduction in catchments size. Some wetlands within the study area are linked to perched aquifers which provide a water source through lateral seepage and interflow. The potential loss of these aquifers will in turn result in a loss of certain wetland areas. This activity is considered to be medium in duration as it will be required for the life of mine. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to be very severe.

Activity 7: Temporary waste and sewerage handling and treatment

The temporary storage of waste and sewerage as well as the handling and treatment may potentially impact on the quality of water through spillages and leaks in the event of this activity not being conducted correctly or with negligence. This activity will be ongoing throughout the life of mine and spillages and leaks of waste and sewerage will also impact on ecological functioning of wetland units affecting not only water quality enhancement services but also biodiversity maintenance of the systems. This activity is considered to be medium in duration as it will be required for the life of mine. The extent will be local with impacts being transported downstream away from the site by the wetlands. The severity of the impact was determined to have moderate effects.

11.2 Operational phase

Activity 9: Storage of fuel, lubricant and explosives

Similarly to what was described for Activity 3, the storage of fuel, lubricant and explosives will be required for the life of mine. Incorrect, inadequate or negligent storage of these materials may result in the potential pollution of surface water resources due to pollutant and toxicant spillages and leaks which may impact negatively the water quality and ecological functioning of the systems. This activity is considered to be medium in duration as it will be required for the life of mine. The impact will be local in extent with impacts being transported downstream away from the site by the wetlands. The severity of the impact was determined to have moderate effects.

Activity 10: *Topsoil and overburden removal and stockpiling*

Similarly to Activity 4, the removal of topsoil and overburden as well as stockpiling will increase the potential load of sedimentation of the water resources due to erosion of the stockpiles during periods of high rainfall. These stockpiles will also become eroded as a result of rain and high winds moving across the areas. The increased sediment load of wetland areas inhibits these systems to provide ecological services such as water quality enhancement. The removal of the topsoil and vegetation reduces the potential for recharge of shallow aquifers that feed hillslope wetlands, which in turn reduces the flow in water resources. This activity is considered to be medium in duration as it will be required for the construction and operational phases. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to be severe.

Activity 12: *Coal removal*

The removal of coal will result in both soil and coal dust being created which will increase the potential of excessive siltation of the wetland areas. This will impact on the quality of water available in the wetland units as well as inhibit the ability of the wetland units to provide key ecological services. There will be a reduction on surface water quantity due to reduction in catchments size. This activity is considered to be medium in duration as it will be required for the operational phase. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to be very severe.

Activity 13: *Vehicular activity on haul roads*

The vehicular activity will result in the creation of soil as well as coal dust which will increase the potential of excessive siltation of the wetland areas. Natural dust will be created from use of the haul road and coal dust will be created during transport by haul trucks. This will impact on the quality of water available in the wetland units as well as inhibit the ability of the wetland units to provide key ecological services. This activity is considered to be medium in duration as it will be required for the operational phase. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to be minor.

Activity 14: *Water use around site*

The use of water to mitigate mining related impacts as well as for mine operation may result in underground aquifers and/or opencast areas being pumped to make water available for use. In the event of an aquifer being pumped, this may decrease the lateral seepage potential of the area resulting in a reduction of wetland size and potentially wetland loss. Additionally, the use of dirty water from opencast areas may impact on the quality of water within the wetland systems if the dirty water is exposed to these systems. This in turn will inhibit the ability of these wetland units to provide beneficial ecological services. This activity is considered to be medium in duration as it will be required for the operational and decommissioning phases. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to have moderate effects.

Activity 15: *Screening and washing*

Ineffective management and poor maintenance of the screening and washing plant and process may result in leaks as well as spillages from this infrastructure. The dirty water from the screening and washing process which makes its way to the wetland areas will impact on the quality of water of the systems which will have a greater impact on downstream water users. This activity is considered to be medium in duration as it will be required for the operational phase. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to have moderate effects.

Activity 16: *Discard dump*

Seepage from the discard dump into the underground aquifers may impact on the quality of water of these aquifers which in turn provide seepage to wetland areas. In spite of this seepage process providing some water quality enhancement ability, the seepage of impacted water quality from the discard dump may impact on wetland functioning as the quality of the impacted water may not be completely restored by the seepage process. This activity is considered to be medium in duration as it will be required for the operational phase. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to have moderate effects.

Activity 17: *Pollution control dams*

Ineffective management and poor maintenance of the pollution control dams may result in leaks as well as spillages from this infrastructure. The dirty water which makes its way to the wetland areas will impact on the quality of water of the systems which will have a greater impact on downstream water users. This activity is considered to be medium in duration as it will be required for the operational phase. The impact will be local in extent with impacts likely to occur further downstream away from the site. The severity of the impact was determined to have moderate effects.

Activity 18: *Waste and sewerage generation and disposal*

Similarly to Activity 7, generation of waste and sewerage as well as the disposal may potentially impact on the quality of water through spillages and leaks in the event of this activity not being conducted correctly or with negligence. This activity will be ongoing throughout the life of mine and spillages and leaks of waste and sewerage will also impact on ecological functioning of wetland units affecting not only water quality enhancement services but also biodiversity maintenance of the systems. This activity is considered to be medium in duration as it will be required for the life of mine. The extent will be local with impacts being transported downstream away from the site by the wetlands. The severity of the impact was determined to have moderate effects.

Activity 19: *Concurrent replacement of overburden and topsoil and revegetation*

This may be considered to be a positive impact if implemented properly. The replacement of overburden and topsoil throughout the construction phase may result in the reduction of the catchment size being limited so that the footprint of the disturbed area is kept to a minimum. This will also allow for the seepage areas to be restored to maintain sub-surface flow dynamics and restore ecological functioning. Sedimentation of the water resources due to erosion of the rehabilitated areas will be limited through the revegetation of the area. This activity will assist by limiting the reduction in recharge of shallow aquifers that feed hillslope wetlands. This activity is considered to be medium in duration as it will be required for the operational phase as well as the decommissioning phase. The extent will be local with effects being noted further downstream away from the site. The severity of the impact was determined to be positive and severe.

11.3 Decommissioning phase

Activity 21: *Demolition of infrastructure no longer required*

The demolition and removal of infrastructure may result in impacts to water quality through spillages and leaks. These spillages and leaks may be considered for infrastructure such as sewerage and waste facilities, toxicant, pollutant and fuel storage infrastructure and general vehicle use. In the event that this infrastructure is not demolished properly and with caution, resulting spillages and leaks would impact on water quality and functioning of wetland units. The demolition of infrastructure may require vehicles making use of non-designated areas such as wetlands which will modify the health and functioning of these impacted systems. This activity is considered to be short in duration as well as local in extent with impacts being transported downstream away from the site by the wetlands. The severity of the impact was determined to be minor.

Activity 22: *Final replacement of overburden and topsoil and revegetation*

Similarly to Activity 19, this may be considered to be a positive impact if implemented properly. The replacement of overburden and topsoil throughout the life of mine as well as the final replacement during the decommissioning phase may result in the restoration of the catchment size prior to being impacted on. This will restore the lost seepage areas and maintain sub-surface flow dynamics and restore ecological functioning. Sedimentation of the water resources due to erosion of the rehabilitated areas will be limited through the revegetation of the area. This activity is considered to be medium in duration as it will be required for the decommissioning phase. The extent will be local with effects being noted further downstream away from the site. The severity of the impact was determined to be positive and severe.

12 CUMULATIVE IMPACTS

The wetland groupings of endorheic pans, seepage and floodplain wetlands were identified as the three main functional wetland groupings in the Mpumalanga Province (DWAF, 2002). The endorheic pans occur predominantly in the wetter highveld region, mainly grassland biome, with the main concentration in the Lake Chrissies area. According to DWAF (2002) a total of 4 628 endorheic pans occur in Mpumalanga of which 2043 are determined to be perennial and 2585 non-perennial pans. The majority of perennial pans are still intact (89.34%) with 10.66% being transformed. The non-perennial pans are more heavily transformed with 31.13% being transformed and 68.84% still intact (DWAF, 2002).

Floodplain wetlands are generally characterized by a broad, generally flat landform, which is generally dominated by alluvial processes, these wetlands can also occur adjacent to a well-defined river channel (DWAF, 2002). It was determined that the majority of floodplain wetlands in Mpumalanga are untransformed (87.29%) and 12.71% are transformed (DWAF, 2002). Seepage wetlands occur predominantly on a noticeable slope and include those areas on sloping valley bottoms and are commonly called seeps or sponges. According to DWAF (2002) the land use impact in Mpumalanga, affects 22.08% of the seepage wetlands and 77.92% are untransformed.

Cultivated lands have a 6.96% impact on floodplain wetlands and a further 12.37% impact on seepage wetlands in the Mpumalanga Province (DWAF, 2002). Drainage of floodplain and seepage wetlands as a result of agriculture has dramatic impacts on their hydrological value and this drainage can be described as the main threat to the integrity of wetlands (DWAF, 2002). Cultivated lands is also a major threat to endorheic pans in Mpumalanga due to fields in crop farming regions often surrounding or encroaching directly onto the periphery of pans, or even impinge into the actual basins of smaller non-perennial pans (DWAF, 2002). More than 70% of the pans in Mpumalanga are affected by farming practices (Allen, Seaman & Kaletja 1995).

Mining has a 0.58% impact on floodplain wetlands and a further 0.69% impact on seepage wetlands in the Mpumalanga Province (DWAF, 2002).

The dominant land use in the immediate and surrounding area is agricultural activity. The surrounding cultivated lands as well as livestock farming have impacted considerably on the associated wetlands. The significance of this impact was determined to be 48/100 (moderately low). The current land use does not impact on the underlying hydrology of the wetland areas and as a result of this, the cumulative loss of wetlands resulting from the proposed and future mining activities would be considerably higher. The significance of this cumulative impact was determined to be 67/100 (moderately high).

13 DECRIBED MITIGATION MEASURES

The objectives described for the recommended mitigation and/or management measures for each identified impact associated with each activity are presented below in Table 6. Table 6 lists the relevant activities for each phase of the mining operation and provides information pertaining to the legal requirements, recommended actions plans, timing, responsible person and significance after mitigation.

Table 6: Information pertaining to the recommended mitigation measures for the identified impacts associated with each activity.

Activity	Objectives	Mitigation/Management measure	Frequency of mitigation	Legal Requirements	Recommended Action Plans	Timing of implementation	Responsible Person	Significance after Mitigation
CONSTRUCTION PHASE								
Transport of construction material (Activity 2)	Limit the footprint of the disturbed areas	Make use of existing roads and/or areas and roads designated for the mining operation	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Construction, operational and decommissioning phases.	Environmental Co-ordinator	Minor
	Avoid impacts to water quality through spillages and leaks	Proper maintenance of operating vehicles and regular vehicle inspections.	Weekly	National Water Act (Act 36 of 1998),		Construction, operational and decommissioning phases.	Environmental Co-ordinator	Minor
	Limit the erosion and sediment load reporting to wetlands	Remove lose earth from the road sides. Provide adequate draining to reduce velocity of runoff to limit the erosion potential.	Monthly	National Water Act (Act 36 of 1998),	Rehabilitation	Construction, operational and decommissioning phases.	Environmental Co-ordinator	Minor
Storage of fuel, lubricant and explosives (Activity 3)	Avoid impacts to water quality through spillages and leaks	The storage of materials and substances will be housed in suitable facilities. Management of these facilities will be ongoing and this will include regular inspections to detect faults/issues.	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Construction, operational and decommissioning phases.	Environmental Co-ordinator	Minor
Site clearing and topsoil removal (Activity 4)	Limit erosion of exposed areas and stockpiles as well as sediment load reporting to wetlands	Keep the footprint of the disturbed area to the minimum and designated areas only. Vegetate and wet stockpiles to limit erosion. Berms created	Daily	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Construction and operational phases	Environmental Co-ordinator	Moderate alteration

		below the piles to trap particles and runoff from the stockpile						
	Limit reduction in the re-charge of aquifers	Removal of vegetation during stripping and dump operation will be minimised to reduce the risk of the aquifers being drained and not properly recharged.	Daily	National Water Act (Act 36 of 1998),	Rehabilitation	Construction and operational phases	Environmental Co-ordinator	Moderate alteration
Construction of surface infrastructure (Activity 5)	Limit the reduction in catchment size	The planned reduction in catchment size will be managed to ensure that there will not be a dramatic reduction in catchment size.	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation	Construction and operational phases	Environmental Co-ordinator	Minor
	Limit the erosion potential of the site	Make use of permeable materials for pavements and walk-ways. Introduce a storm water management programme and create flower beds below the street level.	Monthly	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Construction and operational phases	Environmental Co-ordinator	Minor
Establishment of initial boxcut and access ramps (Activity 6)	All construction activities will be planned and managed to ensure that there will not be a dramatic reduction in catchment size and water reporting to the wetland.	Opencast establishment will dewater the surrounding aquifers and the impacts will be unavoidable, because of this mitigation will not be possible.	Daily	National Water Act (Act 36 of 1998),	Rehabilitation	Construction phase	Environmental Co-ordinator	Very significant
Temporary waste and sewerage handling and treatment (Activity 7)	Avoid impacts to water quality and wetland functioning through spillages and leakages.	A waste water management system will be introduced on site to ensure that potential pollution of the water resource will be minimised	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Construction, operational and decommissioning phases.	Environmental Co-ordinator	Minor

OPERATIONAL PHASE								
Storage of fuel, lubricant and explosives (Activity 9)	Avoid impacts to water quality through spillages and leaks	The storage of materials and substances will be housed in suitable facilities. Management of these facilities will be ongoing and this will include regular inspections to detect faults/issues.	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Construction, operational and decommissioning phases.	Environmental Co-ordinator	Minor
Site clearing and topsoil removal (Activity 10)	Limit erosion of exposed areas and stockpiles as well as sediment load reporting to wetlands	Keep the footprint of the disturbed area to the minimum and designated areas only. Vegetate and wet stockpiles to limit erosion. Berms created below the piles to trap particles and runoff from the stockpile	Daily	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Construction and operational phases	Environmental Co-ordinator	Moderate alteration
	Limit reduction in the re-charge of aquifers	Removal of vegetation during stripping and dump operation will be minimised to reduce the risk of the aquifers being drained and not properly recharged.	Daily	National Water Act (Act 36 of 1998),	Rehabilitation	Construction and operational phases	Environmental Co-ordinator	Moderate alteration
Coal removal (Activity 12)	All removal activities will be planned and managed to ensure that there will not be a dramatic reduction in catchment size and water reporting to the wetland.	The continuous removal of coal will dewater the surrounding aquifers and the impacts will be unavoidable, because of this mitigation will not be possible.	Daily	National Water Act (Act 36 of 1998),	Rehabilitation	Operational phase	Environmental Co-ordinator	Very significant
	Prevent siltation of the wetland units from coal and natural dust	Wetting of exposed and operating areas to suppress dust creation.	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Operational phase	Environmental Co-ordinator	Minor

Vehicular activity on haul roads (Activity 13)	Prevent siltation of the wetland units from coal and natural dust from the haul road and from the use of trucks	Wetting of the haul road to suppress dust creation as well as cover haul trucks to prevent dust emissions during transport.	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and closure plan	Operational phase	Environmental Co-ordinator	Minor
Water use around site (Activity 14)	Limit the use of water from aquifers	A water management plan will be implemented to prioritise the recycling of water and use of rain (storage) water.	Weekly	National Water Act (Act 36 of 1998),		Operational phase	Environmental Co-ordinator	Minor
	Avoid impacts to water quality from dirty water.	A dirty water management system will be introduced on site to ensure that potential pollution of the water resource will be minimised	Weekly	National Water Act (Act 36 of 1998),	Water monitoring plan	Operational phase	Environmental Co-ordinator	Minor
Screening and washing (Activity 15)	Avoid impacts to water quality from spillages and leakages.	Continuous maintenance and inspection of the infrastructure as part of the water management programme.	Weekly	National Water Act (Act 36 of 1998),	Water monitoring plan	Operational phase	Environmental Co-ordinator	Minor
Discard dumps (Activity 16	Avoid impacts to water quality of aquifers	Placement of perforated pipes and cut-off trenches to capture and drain dirty water.	Monthly	National Water Act (Act 36 of 1998),	Water monitoring plan	Operational phase	Environmental Co-ordinator	Minor
Pollution control dams (Activity 17)	Avoid impacts to water quality from spillages and leakages.	Continuous maintenance and inspection of the infrastructure as part of the water management programme.	Weekly	National Water Act (Act 36 of 1998),	Water monitoring plan	Operational phase	Environmental Co-ordinator	Minor
Waste and sewerage generation and disposal (Activity 18)	Avoid impacts to water quality and wetland functioning through spillages and leakages.	A waste water management system will be introduced on site to ensure that potential pollution of the water resource will be minimised	Weekly	National Water Act (Act 36 of 1998),	Water monitoring plan	Construction, operational and decommissioning phases.	Environmental Co-ordinator	Minor

Concurrent replacement of overburden and topsoil and revegetation (Activity 19)	Restore the size of the impacted/disturbed catchment area	The footprint of the area disturbed by the mining operation will have topsoil and overburden replaced to restore the total catchment area.	Daily	National Water Act (Act 36 of 1998),	Rehabilitation to represent original contours and topography as per the Rehabilitation and Closure Plan	Operational phase	Environmental Co-ordinator	Serious (Positive)
	Restoration of sub-surface flow dynamics	The soil profile will be replaced to represent the original make-up and structure.	Daily	National Water Act (Act 36 of 1998),	Rehabilitation and Closure Plan	Operational phase	Environmental Co-ordinator	Serious (Positive)
	Limit the erosion potential of exposed areas.	Exposed areas will be re-vegetated	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and Closure Plan	Operational phase	Environmental Co-ordinator	Serious (Positive)
	Restore the re-charge potential of aquifers	Re-vegetated areas will form seepage areas which will help to re-charge aquifers.	Weekly	National Water Act (Act 36 of 1998),	Restore of wetland areas and low gradient rehabilitation to create seepage units.	Operational phase	Environmental Co-ordinator	Serious (Positive)
DECOMMISSIONING PHASE								
Demolition of infrastructure no longer required (Activity 21)	Avoid impacts to water quality from spillages and leaks	The correct and careful handling of the infrastructure housing pollutants and toxicants to prevent spillages and leaks	Daily	National Water Act (Act 36 of 1998),	Rehabilitation and Closure Plan	Decommissioning phase	Environmental Co-ordinator	Minor
	Impacts to wetlands from vehicle use.	Vehicles to make use of existing roads and designated areas. Avoid wetland and natural habitat areas.	Daily	National Water Act (Act 36 of 1998),	Rehabilitation and Closure Plan	Decommissioning phase	Environmental Co-ordinator	Minor
Final replacement of overburden and topsoil and	Restore the size of the impacted/disturbed catchment area	The footprint of the area disturbed by the mining operation will have topsoil and overburden replaced	Daily	National Water Act (Act 36 of 1998),	Rehabilitation and Closure Plan	Decommissioning phase	Environmental Co-ordinator	Serious (Positive)

		to restore the total catchment area.						
	Restoration of sub-surface flow dynamics	The soil profile will be replaced to represent the original make-up and structure.	Daily	National Water Act (Act 36 of 1998),	Rehabilitation and Closure Plan	Decommissioning phase	Environmental Co-ordinator	Serious (Positive)
revegetation (Activity 22)	Limit the erosion potential of exposed areas.	Exposed areas will be re-vegetated	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and Closure Plan	Decommissioning phase	Environmental Co-ordinator	Serious (Positive)
	Restore the re-charge potential of aquifers	Re-vegetated areas will form seepage areas which will help to re-charge aquifers.	Weekly	National Water Act (Act 36 of 1998),	Rehabilitation and Closure Plan.	Decommissioning phase	Environmental Co-ordinator	Serious (Positive)

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Appendix A: Photographs of the assessed wetland units in relation to the study area

View across the hillslope seepage wetlands into the valley bottom wetlands.

A view of a dam used for agricultural purposes

A view into the pan, dense with vegetation and surrounded by agricultural fields.

Vegetation associated with the pan burnt from fires, the pan basin still evident.

The channel within the valley bottom with new vegetation beginning to grow

A road and power line transecting the pan on the northern boundary.

Appendix B: Curriculum Vitae (CV) and declaration of independence

Environmental Solutions Provider
Co. Reg. No. 1999/05985/07

Digby Wells & Associates (Pty) Ltd
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359 Pretoria Ave
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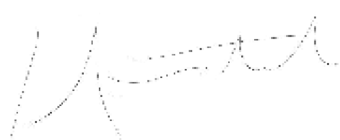
SPECIALIST DECLARATION OF INDEPENDENCE

I, Andrew Husted , declare that I –

- Act as the independent specialist for the undertaking of a specialist section for the proposed project Wetland Assessment – Kangala Project, Universal Coal (Pty) Ltd ;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the Environmental Impact Assessment Regulations, 2006;
- Do no have nor will have a vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any information that have 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 Environmental Impact Assessment Regulations, 2006;

Andrew Husted

Name of specialist



Signature of the specalist

Digby Wells & Associates

Name of company

7 September 2009

Date

ANDREW HUSTED

Mr Andrew Husted
Aquatic Ecologist
Digby Wells & Associates

EDUCATION

2006 - 2007:	BSc Masters in Aquatic Health – University of Johannesburg (UJ)
2005 – 2006:	BSc Hons. Zoology – Aquatic Health – Rand Afrikaans University (RAU)
2005 – 2003:	BSc Natural Science – Zoology & Botany (RAU)

EMPLOYMENT

January 2006 – June 2007: Econ@UJ, as an aquatic ecologist
August 2007 – present: Digby Wells and Associates, as an aquatic ecologist:

EXPERIENCE

Before joining DWA I was employed by Econ@UJ, a consortium based at the University of Johannesburg specializing in aquatic ecology as a researcher and project manager. I was involved in a number of projects at all levels. Through this I gained a wealth of experience in terms of aquatic assessments, project management and co-ordination and report writing. I was also responsible for the management of other master degree studies, ensuring work was completed correctly and the deliverables were met as well as written articles were correct and accurate.

Special areas of interest include:

- **Aquatic ecosystem integrity, importance and sensitivity:**
  - Fish survey
    - Fish Assemblage Integrity Index (FAII) or if required the Fish Response Assessment Index (FRAI).
    - Fish Health Index (FHI)
    - Biodiversity report highlighting IUCN listed species.
  - Invertebrate survey
    - South African Scoring System Verison 5 index and if required the Macro Invertebrate Response Assessment Index (MIRAI).
    - Biodiversity report highlighting IUCN listed species.
  - Riparian and wetland vegetation survey

Application of the Vegetation Response Assessment Index (modification from RVI).

Rapid assessment of the ecological state of Wetland ecosystems.

Biodiversity report highlighting IUCN listed species.

- Habitat surveys
  - Index of Habitat Integrity (IHI)
  - Integrated Habitat Assessment System (IHAS)
  - Habitat Quality Index (HQI)
- Water quality assessment
  - Oxygen content and saturation, conductivity, pH and temperature (in situ).
  - General nutrient, salinity and toxic components of the samples.

- **Wetland Delineation:**

  Wetland & Riparian Delineation Training - DWAF
  - Terrain Unit Indicator – helps to identify those parts of the landscape where wetlands are more likely to occur
  - Soil Form Indicator – identifies the soil forms, which are associated with prolonged and frequent saturation
  - Soil Wetness Indicator – identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation
  - Vegetation Indicator – identifies hydrophilic vegetation associated with frequently saturated soils

  - Present Ecological State (PES) of wetlands
  - Ecological Importance and Sensitivity (EIS) of wetlands
  - Ecological services provided by wetlands (Wet-Ecoservices)

- **Estuarine Ecological State, Importance and Sensitivity Assessments:**
  - Estuarine Fish Condition Index

PAST PROJECTS

- Coal of Africa, Mpumulanga: GVM – Aquatic Assessment, Wetland Delineation

- Exxaro, Mpumulanga: Arnot Conveyor – Wetland Delineation & Aquatic Biomonitoring
- Kevin Ridge, Gauteng: GDACE – Basic Assessment
- Randgold, Ivory Coast: Tongon – Aquatic Assessment, River Diversion
- Merafe Resources, Mpumulanga: Schoongezicht – Wetland Delineation
- Xstrata, Mpumulanga: Butterfly Pit – Aquatic Assessment, River Diversion
- Xtrata, Mpumulanga: Spitzkop - Wetland Delineation & Aquatic Assessment

Appendix A: Distribution and extent of wetland types in the study area.

Plan 1

Universal Coal Kangala Coal Mine

Wetland Delineation

Legend

Non-perennial Stream

Perennial Stream

Project Area

Wetland

Hillslope Seepage Wetland (Pan)

Hillslope Seepage Wetland (Watercourse)

Pan

Valley Bottom Wetland (Without Channel)

DWA

Tel: +27 11 789 9495

Projection: Transverse Mercator
Datum: Hartebeesthoek 1994
Central Meridian: 29°E

Ref #: glo.UNI605.200909.015
Revision Number: 1
Date: 04/09/2009

N

0 0.25 0.5 1

Kilometres

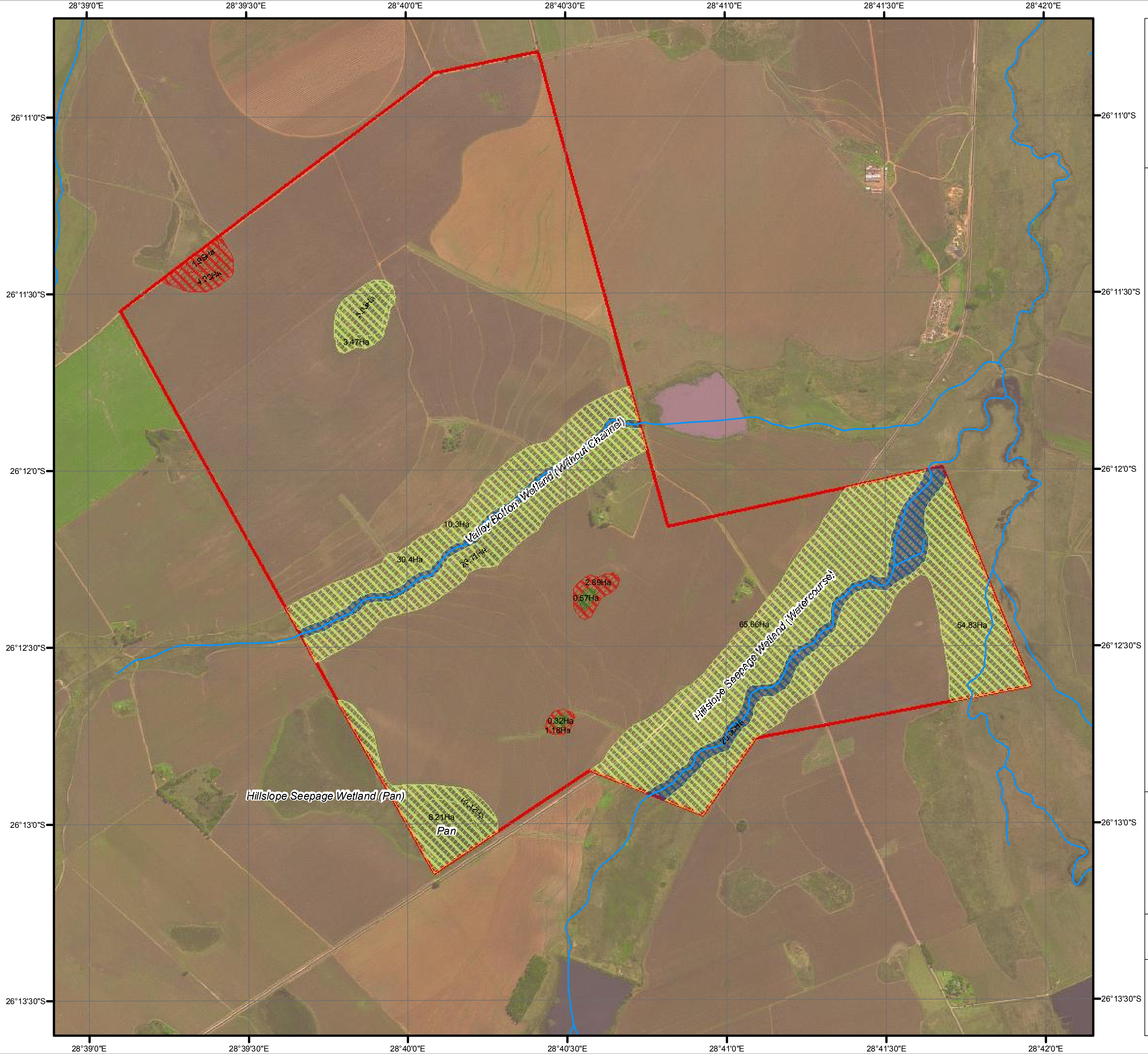
1:20,000

Appendix A: The Present Ecological State (PES) of wetlands in the study area

Plan 2

Universal Coal Kangala Coal Mine

Present Ecological State



Legend

- Non-perennial Stream
- Perennial Stream
- Project Area

Wetlands

- PES B
- PES C
- PES D
- PES E

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Date: 04/09/2009

N

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Kilometres

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Appendix E: The Ecological Importance and Sensitivity (EIS) of wetlands in the study area

Plan 3

Universal Coal Kangala Coal Mine

Ecological Importance & Sensitivity

Legend

Non-perennial Stream

Perennial Stream

Project Area

Wetlands

EIS C

EIS D

EIS E

DWA

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Projection: Transverse Mercator
Datum: Hartebeesthoek 1994
Central Meridian: 29°E

Ref #: glo.UNI605.200909.017
Revision Number: 1
Date: 04/09/2009

N

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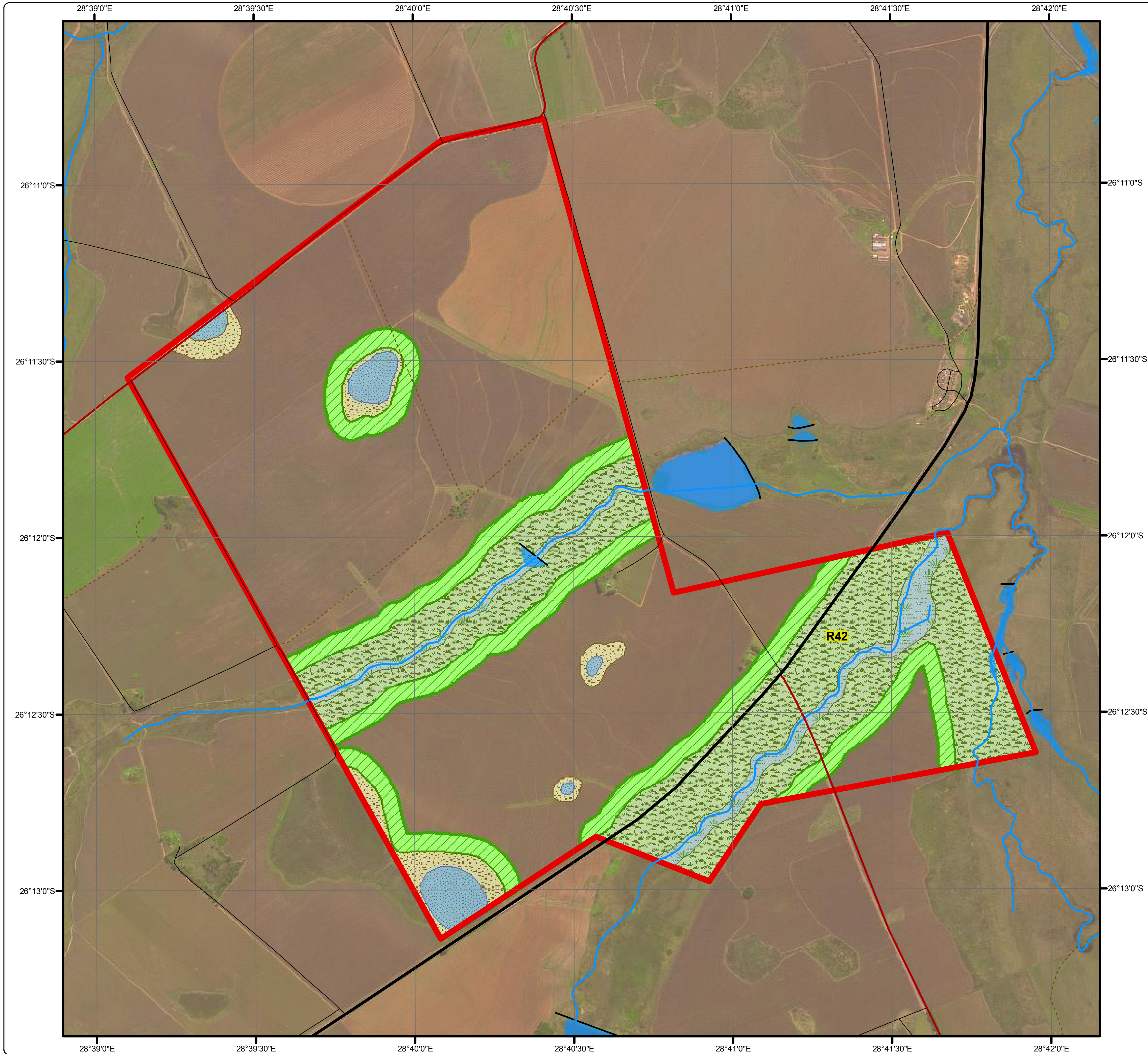
Kilometres

1:20,000

Appendix A: The described buffer zone for selected wetland areas



Plan 2

Universal Coal Kangala Coal Mine

Wetlands

Legend

- Project Area
- Arterial / National Route
- Main Road
- Minor Road
- Track
- Non-Perennial Stream
- Perennial Stream
- Dam Wall
- Dam / Lake

Wetland

- Hillslope Seepage Wetland (Pan)
- Hillslope Seepage Wetland (Watercourse)
- Pan
- Valley Bottom Wetland (Without Channel)
- 100m Buffer of Wetland

Universal Coal Development 1 (Pty) Ltd

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Datum: Hartebeesthoek 1994
Central Meridian: 29°E

Ref #: glo.UNI605.200909.012
Revision Number: 2
Date: 08/10/2009

N

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Kilometres
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