Wetland Delineation of the DeWittekrans Project, Hendrina, Mpumalanga Province

Study of Soil, Landform and Vegetation Indicators

For GCS (Pty) Ltd.

Prepared by Resource Management Services (REMS)

P.O. Box 2228 Highlands North 2037

South Africa

rems@global.co.za

website: www.remans.co.za

December 2008

Executive Summary

This wetland delineation was done for the Environmental Impact Assessment for several properties on Mpumalanga higheld, south east of Hendrina – collectively called the De Wittekrans project. The report identifies and delineates the wetland zones using soil-landform and vegetation indicators on the farms Tweefontein 203 IS (Portion 1); DeWittekrans 218 IS (Remainder, and Portions 1, 5, 10, 11); Groblershoop (Remainder); Groblershoek (Remainder); and Israel (Remainder, and Portion 3). The soil-landform survey was conducted according to standard methodology at a semi-detailed level. The following wetland zones were delineated: two separate seasonal zones comprising valley bottoms 327 ha in extent; and a temporary zone covering mainly footslopes 769 ha in extent. The site is 3755 ha in extent, hence the wetlands account for 29% of the area

The hydrophyllic vegetation was associated mainly with the seasonal and temporary wetland zones and permanent/ semi-permanent farm dams. There is a low abundance and frequency of hydrophyllic plants in all temporary wetland zones. The wetlands are of moderate importance to the ecosystem functioning of the Klein Olifants River, which supplies water to downstream users (agriculture, mining, urban areas and conservation) and therefore must be managed with long term sustainabilty of these enterprises. To ascertain the wetlands importance a resource economics study must be commissioned to the ascertain the monetry value of their ecosystem services and non-use values.

The soil-landform map shows the distribution and extent of the dominant soil components as well as the position (terrain unit and slope class) they occupy in the landscape. forms part of an undulating plain comprising convex hills with gently to strongly sloping gradients. Parent materials for the present-day soils were probably derived from sandstone and shale of the Vryheid Formation, dolerite and alluvium.

From bottomland to crest, the site is composed of valley bottoms of the Klein Olifants River tributaries consisting of level terraces, incised channels and steep banks (map unit VB1) and covered with deep, poorly drained, vertic, gleyed, calcareous clay of the Rensburg form. Secondary valley bottoms (map unit VB2), in turn, comprises deep, poorly drained, dark coloured, non-vertic, gleyed, heavy loam to clay of the Katspruit form. Associated with this soil but occurring mainly towards the outer edges of the valley bottoms as well as lower footslopes are members of the Westleigh form, i.e. deep, poorly to somewhat poorly drained, mottled, sandy loam to sandy clay loam becoming gleyed in the deep subsoil. Both these areas seem to be waterlogged for long periods during the year having several hydrophillic wetland species, with rusty streaking of the upper topsoil in places bear evidence of a water table fluctuating from the surface.

In this area, most of the footslopes (unit FA1) are composed of an array of somewhat poorly drained, moderately deep to deep soils with subsoil (below 20/30 cm soil depth) wetness prevailing for short to intermediate periods during and after rain events. They

belong *inter alia* to the Westleigh form (dark coloured, loamy medium/fine sand to sandy loam and sandy clay loam topsoil on mottled (plinthic), sandy loam to sandy clay loam subsoil and deep subsoil); Longlands form (dark coloured, loamy medium/fine sand to sandy loam topsoil on thick, bleached, loamy medium/fine sand to sandy loam E horizon overlying distinctly mottled, sandy loam to sandy clay loam deep subsoil; Kroonstad form (dark coloured, loamy medium/fine sand to sandy loam topsoil on bleached, loamy mediumfine sand to sandy loam E horizon overlying with an abrupt transition distinctly gleyed, sandy clay loam deep subsoil; and Wasbank form (dark coloured, loamy medium/fine sand to sandy loam topsoil on relatively thin, bleached, loamy medium/fine sand to sandy loam E horizon overlying with an abrupt transition hard plinthite.

Presenting the terrestrial area (midslope-crest terrain unit configuration), unit MA2 contains an association of moderately deep to deep, well-drained, red, apedal soils of the Hutton form; yellow-brown, apedal soils of the Clovelly form; moderately well-drained, yellow-brown, apedal overlying mottled deep subsoil layers of the Avalon form; and well-drained to moderately well-drained, yellow-brown, apedal overlying hard plinthite soils of the Glencoe form. All these soils do not exhibit top- or subsoil wetness, although the deep subsoil of the Avalon form normally displays hydromorphic conditions for short periods during the year after rain events. Unit MA3 represents the area underlain by dolerite on the farm Israel. The soils form an association of moderately deep, well-drained, dark red, sandy clay loam to clay loam and clay of the Hutton form (weakly structured soil overlying weathered dolerite), and Shortlands form (moderately developed, fine, sub-angular, blocky structured soil on weathered dolerite). Very shallow and shallow soils in complex association with rock outcrops some with steep gradients are features of units FA1, MA2, MA3 and MA4.

Due to human-induced impacts, such as gully erosion, overgrazing and the presence of the sand and tar roads, the wetland zones have been negatively affected to varying degrees. A buffer strip 50m from the wetland boundary is recommended to protect the wetland habitat from construction and mining activities. This is to maintain the water holding and filtering properties of the wetland soil and the surface roughness of the intact vegetation both of which annenuate floods, trap sediment and provide habitat for numerous plants and animal species. The Environmental Management Plan should be followed to prevent unncessary damage to the wetlands and associated ecosystems. This includes routine monitoring of water that leaves the mining works, for heavy minerals and pollutants. An environmental control officer is required on site, from the pre-construction phase to the post restoration phase.

Table of Contents

Definition of terms

Biome: Broadest division of a continent into natural units that share common ecological processes and species.

Facultative plants: Capable of adapting to different environmental conditions

Hydric soil: Has developed anaerobic conditions due to saturation, ponding or flooding during the growing season

Hydrophyllic: Strong affinity for water

Obligate plants: Capable of existing in only a particular environmental conditions

Palaeartic migrants: Birds that over winter in the northern hemisphere

Plinthite: A soil material that is rich in sesquioxides, poor in humus and is highly weathered, and commonly displays mottles and Fe/Mn nodules in a platy, polygonal or reticulate pattern

Ruderal species: Hardy plants, mainly annuals and biannuals that colonise open ground and disturbed areas

1. Introduction

Over 44% of the Grassland biome has been transformed by agriculture, forestry, mining and urbanization (Mucina and Rutherford 2006). The eastern highveld, which is within this biome contains many shallow coal reserves, its wetlands also serve as a source of two of the country's largest rivers the Olifants and the Vaal. Numerous permanent, seasonal and temporary wetlands feed these rivers which are vital for people, businesses and ecosystems downstream. Coal mining has and continues to have both direct and indirect impacts on water resources and agricultural sustainability through, pollution such as acid mine drainage and the silting of dams. Many areas in which open cast mining and some forms of underground mining have been undertaken are irreversibly transformed. It has proven exceeding complicated to restore agricultural production and few mining companies have shown a willingness to even attempt restoration of the pre-mining biological diversity. As a result, many of these ecosystems have been transformed into mounds of earth with patches of ruderal species with low carrying capacity.

Wetlands are defined as: "lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water" Cowardin and Golet (1995). In order to be classified as a wetland the land contains, 1.) hydrophyllic plants for some part of the year, 2.) predominantly undrained hydric soils and 3.) has a substrate which is saturated or covered by shallow water at some time during the growing season. The ecological, social and economic attributes of wetlands make them the some of the most valuable and productive ecosystems on earth. Some of the most important uses of wetlands include: renewable water for household and industrial consumption; stabilising river catchments; the prevention of soil erosion and providing valuable habitat for fauna and flora.

1.1 Background and objectives

The DeWittekrans project is located on the farms Tweefontein 203 IS (Portion 1); DeWittekrans 218 IS (Remainder, and Portions 1, 5, 10, 11); Groblershoop (Remainder); Groblershoek (Remainder); and Israel (Remainder, and Portion 3), south east of Hendrina, Mpumalanga, mainly covers land within the Klein-Olifants River watershed. This river runs from south to north and comprises a distinct channel and associated terraces, and is joined by various secondary valley bottoms.

To comply with the Environmental Impact Assessment process, the delineation of wetlands would *inter alia* be requested by the authorities. In order to meet this requirement, wetland delineation has been undertaken to

1. Identify and classify the soil-landform resources and map them at a semi-detailed level; and

2. Delineate the wetland according to landform (terrain unit), soil and vegetation indicators.

In essence, the wetland delineation process is a land evaluation procedure where physical indicators of land (soil, terrain and vegetation) are utilised in terms of the requirements of wetland recognition. According to the Department of Water and Forestry (2005), the object of the delineation procedure is to identify the outer edge of the temporary zone. From this information it is then possible to comment on the location of the various mining activities and infrastructure and any related impacts on the wetland.

This survey utilises terrain units, soil types with their covariant soil wetness indicators, and hydrophyllic vegetation to differentiate between temporary, seasonal and permanent wetlands. Temporary wetlands are saturated for maximum of 3 months a year while, seasonal wetlands are saturated for a minimum of 3 months a year**.** During periods of low rain**,** permanent wetlands may dry out**,** however, these are then termed semi permanent (DWAF, 2005). All farm dams were deemed to be permanent bodies of water.

1.2. Hydrology

The De Wittekrans project is located within the quaternary subcatchment B12A (Appendix 1). This quaternary subcatchment is within the B1 sub-drainage region which is within the Main Olifants Catchment. The Upper Olifants Catchment has two main rivers, namely the Olifants River and one of its' major tributaries the Klein Olifants River. The Olifants River is approximately 17km north west of the site and the Klein Olifants River runs through the site (Appendix 1). This river flows into the Middelburg Dam, later joining the Olifants River, which flows into the Loskop dam. Thereafter the river flows through Mpumalanga and the central part of the Kruger National Park to Mozambique, finally discharging to the Indian Ocean. There are a number of issues identified by the Olifants River Forum that affect the Upper Olifants Catchment, these include:

1. The need for increased transfer of water into the Water Management Area for power generation.
2. Increased water quality problems, specifically related to mining activities.

In recognising these issues, the Cleanwater 2020 Initiative was created with the aim of determining the location, quantity and quality of excess mine water and recommending promising mine water management options for the short and the long-term.

The presence of pans is typical of the Mpumalanga highveld. Endorheic pans have been found in the areas surrounding the study site (such as Chrissies Meer). These pans have been found to be extremely valuable ecologically and in fact are considered among the most threatened aquatic habitats in South Africa (Cowan and van Riet, 1998). These pans have been found to support migratory birds as well as a large variety of floral and faunal species (Palmer *et al*, 2002).

1.3 Methodology

The study area, which is approximately 3755 ha in size, was selectively traversed and an auger used to examine soils at designated sites (to comply with semi-detailed survey intensity). Approximately 250 soil-landform observations were made. Orthophoto maps (scale 1:10 000) were used as field maps. The present land use practices, condition of the land surface, slope classes and relevant terrain unit features were also noted during the field investigation. The soils were identified, described and classified in accordance with the South African Taxonomic System (Soil Classification Working Group, 1991). The Soil Classification Working Group's (1991) subdivision of landform into terrain units was utilised. A map legend comprising soil and landform components was constructed and used during the fieldwork stage to compile a soil-landform map. The procedure for the identification and delineation of wetlands and riparian areas as described by the Department of Water and Forestry (2005) was followed. The soil-landform and wetland delineation map was formatted and reproduced by PEDOGIS, Pretoria who also supplied the size of each map unit.

The occurrence of obligate and facultative wetland plant species are important indicators of the water holding capacity of the soils. Obligate wetland species occur 99% of the time in permanent and seasonal zones only, while facultative species can also occur in temporary wetlands with a probability of 67-99% (Reed 1988). The boundary between fairly pristine wetlands is marked by a change in species composition from hydrophyllic to upland plants. Differentiating between terrestrial, temporary and seasonal wetlands zones requires the vegetation to be in good condition. Vegetation was analysed from transects, plants were recorded and identified on site. Those that were unknown were taken to the National Herbarium in Pretoria where they were identified. Nomenclature follows Germishuizen and Meyer (2003).

2. Soil – Landform of the DeWittekrans project

The land surface of the project area is characterised by an undulating plain comprising convex hills with gently to strongly sloping gradients and a local relief of 50 – 100 m. In turn, the hills are composed of crests, midslopes, footslopes and valley bottoms. Parent materials for the present-day soils were probably derived from sandstone and shale of the Vryheid Formation (majority of the area), and dolerite (on the farm Israel, Portion 3) (Geological Survey, 1986); as well as clayey alluvium in valley bottom sites.

It is widely accepted that the land surface of the Highveld is the result of the planation and dissection of various erosion cycles. The crests of the present-day landscape around Hendrina form part of an extensive surface, probably the result of the Early Tertiary or African erosion surface (Partridge and Maud, 1987). During subsequent dissection (by at least two major erosion cycles) the landscape of today evolved.

According to the Land Type Survey Staff (1985) the broad soil pattern of the majority of the project area belongs to the plinthic catena in which upland duplex and margalitic soils are rare. The upland soils are dystrophic and/or mesotrophic and red soils are widespread (land type Ba). Where the land is associated with dolerite, the soils display one or more of vertic, melanic and red structured diagnostic horizons (land type Ea).

2.1 Description of the landform

From bottomland to crest, the site is composed of valley bottoms (terrain unit 5) of the Olifants River tributaries consisting of level terraces with gradients of 0 - 2%, incised channels and steep banks (map unit VB1); gently to moderately sloping secondary valley bottoms with gradients of 3 - 8% (map unit VB2); gently to strongly sloping footslopes (terrain unit 4) with gradients of 3 - 15% (map unit FA1); and level to strongly sloping midslopes and crests (terrain units 3 and 1) with gradients of 1 - 15% (map units MA2 and MA3). A limited area of strongly sloping to steep midslopes with gradients of 8 - >30% has also been demarcated (map unit MA3). (See Table 3 for a description of the landform components and specific slope classes.) In places bank and gully erosion of unit VB1 as well as gully erosion of unit VB2 are features of the landscape.

2.2 Description of the soils

Individual profile descriptions are summarised in Table 1 while other selected properties and derived characteristics are given in Table 2. A generalised description is also shown in Table 3. Only dominant soil components are reflected in map units.

The terraces of the Olifants River (unit VB1; 298.3 ha in extent) are covered by deep, poorly drained, vertic clay with black topsoil overlying dark greyish, gleyed, calcareous subsoil of the **Rensburg form** (soil code Rg). Although the local soil water table has been lowered due to the incision of the river channel (therefore assuming the subsoil is presently displaying relic gleyed properties), the rusty streaking of the upper topsoil is proof of waterlogged conditions prevailing for long periods during the rainy season (Table 2).

The secondary valley bottoms (unit VB2; 28.6 ha in extent) comprise deep, poorly drained, heavy loam to clay with dark coloured, non-vertic topsoil overlying gleyed, non-vertic subsoil of the **Katspruit form** (Ka). Associated with this soil but occurring mainly towards the outer edges of the valley bottoms as well as lower footslopes are members of the **Westleigh form** (We), i.e. poorly to somewhat poorly drained, dark coloured, sandy loam to sandy clay loam topsoil overlying mottled, sandy clay loam to clay loam subsoil becoming gleyed in the deep subsoil. These areas seem to be waterlogged for long periods during the year – the rusty streaking of the upper topsoil bearing evidence of a water table fluctuating from the surface. Except for gully-eroded sites where the local soil water table has been disturbed, this water table seems to be functioning normally in undisturbed sites.

In this area, most of the footslopes (unit FA1; 769.2 ha in extent) are composed of an array of somewhat poorly drained, moderately deep to deep soils with subsoil (below 20/30 cm soil depth) wetness prevailing for short to intermediate periods during and after rain events (Table 2). They belong *inter alia* to the **Westleigh form** (We: dark coloured, loamy medium/fine sand to sandy loam and sandy clay loam topsoil on mottled (plinthic), sandy loam to sandy clay loam subsoil and deep subsoil); **Longlands form** (Lo: dark coloured, loamy medium/fine sand to sandy loam topsoil on thick, bleached, loamy medium/fine sand to sandy loam E horizon overlying distinctly mottled, sandy loam to sandy clay loam deep subsoil; **Kroonstad form** (Kd: dark coloured, loamy medium/fine sand to sandy loam topsoil on bleached, loamy mediumfine sand to sandy loam E horizon overlying with an abrupt transition distinctly gleyed, sandy clay loam deep subsoil; and **Wasbank form** (Wa: dark coloured, loamy medium/fine sand to sandy loam topsoil on relatively thin, bleached, loamy medium/fine sand to sandy loam E horizon overlying with an abrupt transition hard plinthite.

Presenting the terrestrial area (midslope-crest terrain unit configuration), unit MA2 (2 259.4 ha in extent) contains an association of moderately deep to deep, well-drained, red, apedal soils of the **Hutton form** (Hu: loamy medium/fine sand to sandy clay loam topsoil on sandy loam to sandy clay loam subsoil overlying weathered rock); moderately deep to deep, well-drained, yellow-brown, apedal soils of the **Clovelly form** (Cv: loamy medium/fine sand to sandy clay loam topsoil on sandy loam to sandy clay loam subsoil overlying weathered rock); moderately deep to deep, moderately well-drained soils of the **Avalon form** (Av: dark brownish, loamy medium/fine sand to sandy clay loam on yellow-brown, apedal, sandy loam to sandy clay loam subsoil overlying mottled, sandy loam to sandy clay loam deep subsoil); and moderately deep to deep, well-drained to moderately well-drained, apedal soils of the **Glencoe form** (Gc: dark brownish, loamy medium/fine sand to sandy clay loam on yellow-brown, apedal, sandy loam to sandy clay loam subsoil overlying hard plinthite). All these soils do not exhibit top- or subsoil wetness, although the deep subsoil of the Avalon form normally displays hydromorphic conditions for short periods during the year after rain events (Table 2).

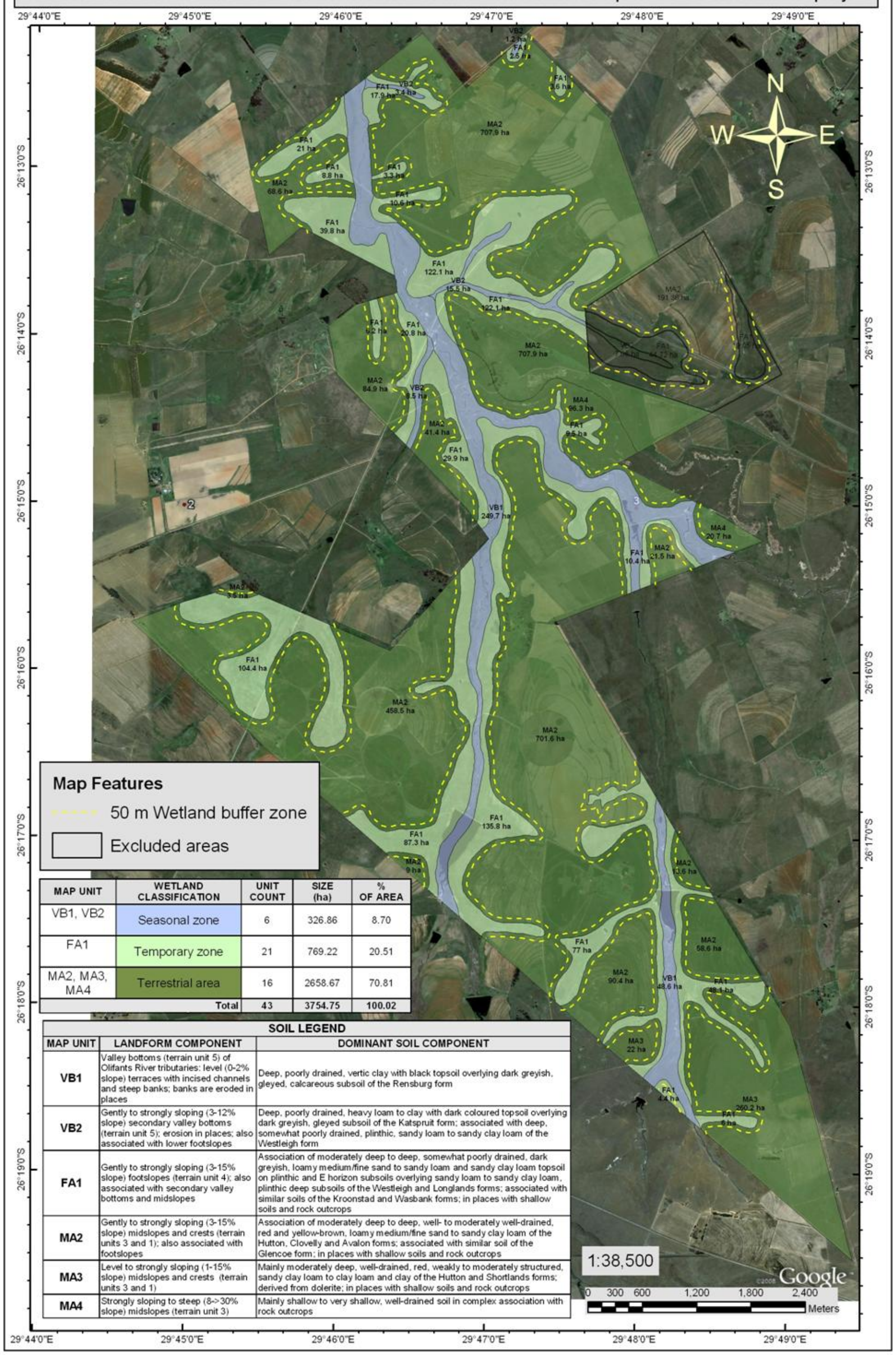
Also comprising a midslope and crest landscape, unit MA3 (282.2 ha in extent) represents the area underlain by dolerite on the farm Israel (Remainder, and Portion 3).

The soils form an association of moderately deep, well-drained, dark red, sandy clay loam to clay loam and clay of the **Hutton form** (Hu: weakly structured soil overlying weathered dolerite); and **Shortlands form** (Sd: moderately developed, fine, sub-angular, blocky structured soil on weathered dolerite).

Very shallow and shallow soils in complex association with rock outcrops some with steep gradients are features of units FA1, MA2, MA3 and MA4 (117 ha in extent).

The leaching status of the Hutton, Clovelly, Avalon and Glencoe soils of unit MA2 probably varies between dystrophic and mesostrophic, while it has been typified as mesotrophic for the Hutton and Shortlands soils of unit MA3 (according to data given by Land Type Survey Staff, 1985). In general, the upland sandy and light loamy soils are acid and exhibit low fertility levels; the loamy soils are acid with low to moderate fertility levels; whereas the valley bottom heavy loam and clayey soils are slightly acid to alkaline and have moderate fertility levels.

FIGURE 1: Semi-detailed soil-landform and wetland delineation map of the DeWittekrans project



MAP UNIT	WETLAND CLASSIFICATION	UNIT COUNT	SIZE (ha)	% OF AREA
VB1, VB2	Seasonal zone	6	326.86	8.70
FA1	Temporary zone	21	769.22	20.51
MA2, MA3, MA4	Terrestrial area	16	2658.67	70.81
	Total	43	3754.75	100.02

SOIL LEGEND

MAP UNIT	LANDFORM COMPONENT	DOMINANT SOIL COMPONENT
VB1	Valley bottoms (terrain unit 5) of Olifants River tributaries: level (0-2% slope) terraces with incised channels and steep banks; banks are eroded in places	Deep, poorly drained, vertic clay with black topsoil overlying dark greyish, gleyed, calcareous subsoil of the Rensburg form
VB2	Gently to strongly sloping (3-12% slope) secondary valley bottoms (terrain unit 5); erosion in places; also associated with lower footslopes	Deep, poorly drained, heavy loam to clay with dark coloured topsoil overlying dark greyish, gleyed subsoil of the Katspruit form; associated with deep, somewhat poorly drained, plinthic, sandy loam to sandy clay loam of the Westleigh form
FA1	Gently to strongly sloping (3-15% slope) footslopes (terrain unit 4); also associated with secondary valley bottoms and midslopes	Association of moderately deep to deep, somewhat poorly drained, dark greyish, loamy medium/fine sand to sandy loam and sandy clay loam topsoil on plinthic and E horizon subsoils overlying sandy loam to sandy clay loam, plinthic deep subsoils of the Westleigh and Longlands forms; associated with similar soils of the Kroonstad and Wasbank forms; in places with shallow soils and rock outcrops
MA2	Gently to strongly sloping (3-15% slope) midslopes and crests (terrain units 3 and 1); also associated with footslopes	Association of moderately deep to deep, well- to moderately well-drained, red and yellow-brown, loamy medium/fine sand to sandy clay loam of the Hutton, Clovelly and Avalon forms; associated with similar soil of the Glencoe form; in places with shallow soils and rock outcrops
MA3	Level to strongly sloping (1-15% slope) midslopes and crests (terrain units 3 and 1)	Mainly moderately deep, well-drained, red, weakly to moderately structured, sandy clay loam to clay loam and clay of the Hutton and Shortlands forms; derived from dolerite; in places with shallow soils and rock outcrops
MA4	Strongly sloping to steep (8->30% slope) midslopes (terrain unit 3)	Mainly shallow to very shallow, well-drained soil in complex association with rock outcrops

FIGURE 2: Vegetation community map of the De Wittekrans project

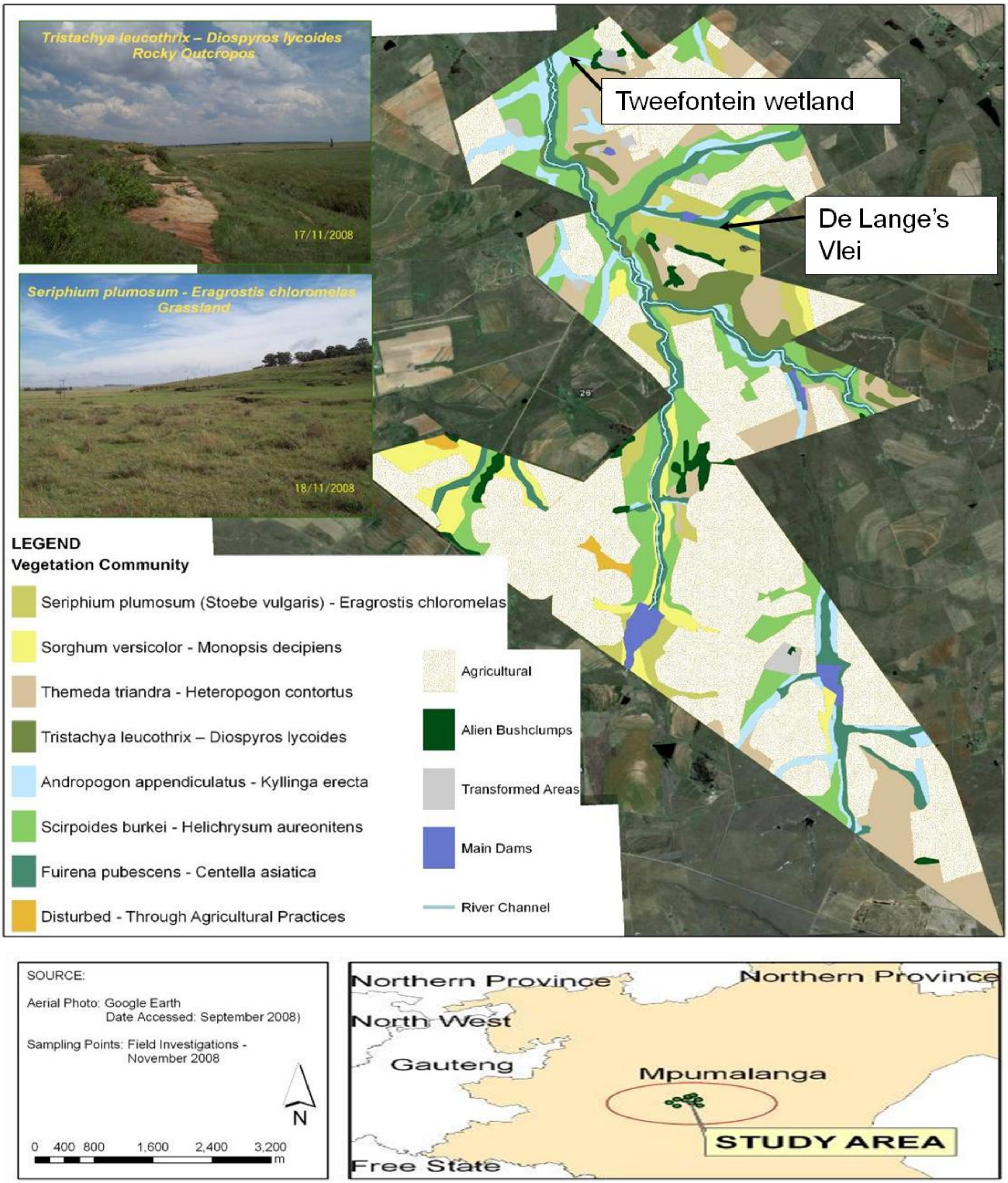


Table 1: Description of the dominant soils of DeWittekrans project

SOIL CODE/ MAP SYMBOL	SOIL FORM AND FAMILY	BRIEF PROFILE DESCRIPTION
Rg / VB1	Rensburg 2000 clay	*Vertic A horizon*: 30-50 cm thick, black, strong coarse blocky, very firm, clay (clay content >45%); gradually overlying *G horizon*: >50 cm thick, dark grey brown, strong coarse blocky, very firm, medium hard lime nodules, clay (clay content >45%)
Ka / VB2	Katspruit 1000 heavy loam to clay	*Orthic A horizon*: 30-40 cm thick, very dark grey brown, weak/moderate medium sub-angular blocky, firm to very firm, clay loam to clay (clay content 30-45%); gradually overlying *G horizon*: >50 cm thick, grey brown, moderate medium/coarse blocky, firm to very firm, clay (clay content >40%)
We / VB2	Westleigh 1000 sandy loam to sandy clay loam	*Orthic A horizon*: 20-30 cm thick, very dark grey brown, massive to weak medium blocky, firm, sandy loam to sandy clay loam (clay content 15-30%); gradually overlying *Soft plinthic B horizon*: >50 cm thick, dark grey brown, weak medium blocky, firm, mottled black, brown and orange many clear, sandy clay loam to clay loam (clay content >20%); becoming gleyed with depth
We / FA1	Westleigh 1000 loamy medium/fine sand to sandy loam and sandy clay loam	*Orthic A horizon*: 20-30 cm thick, dark grey brown, massive, friable, sandy loam (clay content 8-25%); gradually overlying *Soft plinthic B horizon*: >30 cm thick, dark grey brown to light yellow brown, massive to weak medium blocky, friable to firm, mottled black, yellow-brown and orange many clear, sandy loam to sandy clay loam (clay content 12-30%); abruptly overlying *C horizon*: weathered, Fe-rich rock or hard plinthite
Lo / FA1	Longlands 1000 loamy medium/fine sand to sandy loam	*Orthic A horizon*: 20-30 cm thick, dark grey brown, massive, friable, loamy medium/fine sand to sandy loam (clay content 8-20%); gradually overlying *E horizon*: 20-60 cm thick, greyish, massive, friable, loamy medium/fine sand to sandy loam (clay content 6-20%); clearly overlying *Soft plinthic B horizon*: 10-30 cm thick; light yellow brown, massive, friable to firm, sandy loam to sandy clay loam (clay content 15-25%) with many, clear, large yellow mottles
Kd / FA1	Kroonstad 1000 loamy medium/fine sand to sandy loam	*Orthic A horizon*: 20-30 cm thick, dark grey brown, massive, friable, loamy medium/fine sand to sandy loam (clay content 8-20%); gradually overlying *E horizon*: 20-50 cm thick, greyish, massive, friable, loamy medium/fine sand to sandy loam (clay content 6-20%); clearly overlying *G horizon*: 10-30 cm thick; grey, massive, firm, sandy clay loam (clay content 25-35%) with many, clear, large yellow mottles

Wa / FA1	Wasbank 1000 loamy medium/fine sand to sandy loam	*Orthic A horizon*: 20-30 cm thick, dark grey brown, massive, friable, loamy medium/fine sand to sandy loam (clay content 8-20%); gradually overlying *E horizon*: 20-30 cm thick, greyish, massive, friable, loamy medium/fine sand to sandy loam (clay content 6-20%); abruptly overlying *Hard plinthic B horizon*: hard ferricrete
Hu / MA2	Hutton 1100 /2100 loamy medium/fine sand to sandy loam and sandy clay loam	*Orthic A horizon*: 20-30 cm thick, dark reddish brown, massive, friable, loamy medium/fine sand to sandy loam and sandy clay loam (clay content 8-25%); gradually overlying *Red apedal B horizon*: >30 cm thick, dark reddish brown, massive, friable, loamy medium/fine sand to sandy loam and sandy clay loam (clay content 10-30%); clearly overlying *C horizon*: weathered rock or Fe-rich nodular layer
Cv / MA2	Clovelly 1100 /2100 loamy medium/fine sand to sandy loam and sandy clay loam	*Orthic A horizon*: 20-30 cm thick, dark brown to dark grey brown, massive, friable, loamy medium/fine sand to sandy loam and sandy clay loam (clay content 8-25%); gradually overlying *Yellow-brown apedal B horizon*: >30 cm thick, yellow-brown to strong brown, massive, friable, loamy medium/fine sand to sandy loam and sandy clay loam (clay content 10-30%); clearly overlying *C horizon*: weathered, Fe-rich rock
Av / MA2	Avalon 1100 /2100 loamy medium/fine sand to sandy loam and sandy clay loam	*Orthic A horizon*: 20-30 cm thick, dark brown to dark grey brown, massive, friable, loamy medium/fine sand to sandy loam and sandy clay loam (clay content 8-25%); gradually overlying *Yellow-brown apedal B horizon*: 30-60 cm thick, yellow-brown to strong brown, massive, friable, friable, loamy medium/fine sand to sandy loam and sandy clay loam (clay content 10-30%); gradually overlying *Soft plinthic B horizon*: >30 cm thick, light yellow brown, massive, friable to firm, sandy loam to sandy clay loam with many faint blackish, yellowish, orange mottles
Gc / MA2	Glencoe 1100 /2100 loamy medium/fine sand to sandy loam and sandy clay loam	*Orthic A horizon*: 20-30 cm thick, dark brown to dark grey brown, massive, friable, loamy medium/fine sand to sandy loam and sandy clay loam (clay content 8-25%); gradually overlying *Yellow-brown apedal B horizon*: 30-60 cm thick, yellow-brown to strong brown, massive, friable, friable, loamy medium/fine sand to sandy loam and sandy clay loam (clay content 10-30%); abruptly overlying *Hard plinthic B horizon*: hard ferricrete
Hu / MA3	Hutton 2100 sandy clay loam to clay loam	*Orthic A horizon*: 20-30 cm thick, dark reddish brown, weak blocky, friable to firm, sandy clay loam to clay loam (clay content 25-35%); gradually overlying *Red apedal B horizon*: >20 cm thick, dark red, weak blocky, friable to firm, sandy clay loam to clay loam (clay content 30-40%); clearly overlying *C horizon*: weathered dolerite

Sd / MA3	Shortlands sandy clay loam to clay loam	*Orthic A horizon*: 20-30 cm thick, dark reddish brown, weak to moderate blocky, friable to firm, sandy clay loam to clay loam (clay content 30-40%); gradually overlying *Red structured B horizon*: >20 cm thick, dark red, moderate fine sub-angular blocky, friable to firm, clay loam to clay (clay content 35-45%); clearly overlying *C horizon*: weathered dolerite

Photograph 1: Top of the Tweefontein Wetland, the trees and saplings in the baground are *Populis alba* (a category 2 invasive alien plant)

Table 2: Selected properties and inferred characteristics of the dominant soils

SOIL PROPERTIES	Rensburg	Katspruit	Westleigh (VB2)	Westleigh (FA1)	Longlands Kroonstad Wasbank (FA1)	Hutton Clovelly Glencoe (MA2)	Avalon (MA2)	Hutton Shortlands (MA3)
Water seepage capacity of deep subsoil/ underlying rock	Slow	Slow	Slow	Moderate-Slow	Moderate-Slow	Rapid-Moderate	Moderate	Rapid-Moderate
Soil wetness indicator		From surface: waterlogged for long to intermediate periods during year	From surface: waterlogged for long to intermediate periods during year	Subsoil: during and after rain events for short to intermediate periods during year	Subsoil: during and after rain events for short to intermediate periods during year	None	Deep subsoil: after rain events for short periods during year	None
pH class (topsoil)	7.5-8.2	6.5-7.5	6.5-7.5	5.5-6.5	5.5-6.5	5.5-6.5	5.5-6.5	6.0-7.0
Natural erosion hazard - water	Moderate	Moderate	Moderate	Moderate	Moderate	Low; Moderate if sandy	Low; Moderate if sandy	Low
Swell-shrink potential of soil	High-Very high	Moderate-Low	Low-Moderate	Low	Low	Low	Low	Low-Moderate
Compaction potential	Moderate	Low	Low	Low	Low	High-Moderate	Moderate	Moderate
Stability of soil	Low	Moderate	Moderate	Moderate	Moderate-Low	High-Moderate	Moderate-High	High-Moderate
Adsorption capacity of pollutants	Moderate-Low	Moderate-Low	Moderate-Low	Low	Low	High-Moderate	Moderate	Moderate
Dust potential	Very low	Very low	Very low	Low	Low	High-Moderate	Moderate	Moderate

2.3 Soil-landform map

The distribution of the soil-landform resources is given on the semi-detailed soil-landform map (Figure 1). The map legend, contained in Table 3, indicates the dominant soil component as well as the terrain unit and slope class. The sizes of the map units are given in Figure 1 and summarised in Table 4.

Table 3: Map legend of the soil-landform resources of DeWittekrans project

MAP UNIT	LANDFORM COMPONENT	DOMINANT SOIL COMPONENT
VB1	Valley bottoms (terrain unit 5) of Olifants River tributaries: level (0-2% slope) terraces with incised channels and steep banks; banks are eroded in places	Deep, poorly drained, vertic clay with black topsoil overlying dark greyish, gleyed, calcareous subsoil of the Rensburg form
VB2	Gently to strongly sloping (3-12% slope) secondary valley bottoms (terrain unit 5); erosion in places; also associated with lower footslopes	Deep, poorly drained, heavy loam to clay with dark coloured topsoil overlying dark greyish, gleyed subsoil of the Katspruit form; associated with deep, somewhat poorly drained, plinthic, sandy loam to sandy clay loam of the Westleigh form
FA1	Gently to strongly sloping (3-15% slope) footslopes (terrain unit 4); also associated with secondary valley bottoms and midslopes	Association of moderately deep to deep, somewhat poorly drained, dark greyish, loamy medium/fine sand to sandy loam and sandy clay loam topsoil on plinthic and E horizon subsoils overlying sandy loam to sandy clay loam, plinthic deep subsoils of the Westleigh and Longlands forms; associated with similar soils of the Kroonstad and Wasbank forms; in places with shallow soils and rock outcrops
MA2	Gently to strongly sloping (3-15% slope) midslopes and crests (terrain units 3 and 1); also associated with footslopes	Association of moderately deep to deep, well- to moderately well-drained, red and yellow-brown, loamy medium/fine sand to sandy clay loam of the Hutton, Clovelly and Avalon forms; associated with similar soil of the Glencoe form; in places with shallow soils and rock outcrops
MA3	Level to strongly sloping (1-15% slope) midslopes and crests (terrain units 3 and 1)	Mainly moderately deep, well-drained, red, weakly to moderately structured, sandy clay loam to clay loam and clay of the Hutton and Shortlands forms; derived from dolerite; in places with shallow soils and rock outcrops
MA4	Strongly sloping to steep (8->30% slope) midslopes (terrain unit 3)	Mainly shallow to very shallow, well-drained soil in complex association with rock outcrops

Table 4: Hydrophyllic plant species, related vegetation community and landform component(s) of the site.

SPECIES	WETLAND TYPE	VEGETATION COMMUNITY	LANDFORM COMPONENT
Phragmites australis	Permanent/ semi permanent	Aquatic	Dam
Typha capensis	Permanent/ semi permanent	Aquatic	Dam
Elocharis palustris	Permanent/ seasonal	*F. pubescens - C. asiatica*	Valley bottom/ secondary valley bottom
Juncus acatissimus	Permanent/ seasonal	*F. pubescens - C. asiatica*	Secondary valley bottom
Juncus oxycarpus	Permanent/ seasonal	*F. pubescens - C. asiatica*	Secondary valley bottom
Leersia hexandra	Permanent/ seasonal	*F. pubescens - C. asiatica*	Valley bottom/ secondary valley bottom
Agrostis bergiana var. laeviuscula	Seasonal	*A. appendiculatus - K.erecta*	Secondary valley bottom
Agrostis lachnantha var. lachnantha	Seasonal	*A. appendiculatus - K.erecta*	Secondary valley bottom
Holcus lanatus	Seasonal	*A. appendiculatus - K.erecta*	Secondary valley bottom
Isolepis setacea	Seasonal	*A. appendiculatus - K.erecta*	Secondary valley bottom
Kyllinga erecta	Seasonal	*A. appendiculatus - K.erecta*	Valley bottom
Limosella maior	Seasonal	*A. appendiculatus - K. erecta* & *F. pubescens - C. asiatica*	Secondary valley bottom
Schoenoplectus decipiens	Seasonal	*A. appendiculatus - K. erecta* & *F. pubescens - C. asiatica*	Valley bottom
Andropogon appendiculatus	Seasonal/ temporary	*A. appendiculatus - K. erecta*	Valley bottom/ secondary valley bottom
Cyperus obtusiflorus	Seasonal/ temporary	*F. pubescens - C. asiatica*	Secondary valley bottom
Cyperus	Seasonal/	*F. pubescens - C. asiatica*	Footslope

rigidifolius	temporary		
Festuca scabra	Seasonal/ temporary	*F. pubescens - C. asiatica*	Valley bottom/ secondary valley bottom
Fuirena pubescens	Seasonal/ temporary	*F. pubescens - C. asiatica* *S. versicolor - M. decipiens*	Secondary valley bottom/ footslopes
Helitrichon turgidulum	Seasonal/ temporary	*F. pubescens - C. asiatica*	Valley bottom/ secondary valley bottom
Kyllinga erecta	Seasonal/ temporary	*A. appendiculatus - K.erecta*	Valley bottom
Limosella maior	Seasonal	*A. appendiculatus - K. erecta* & *F. pubescens - C. asiatica*	Secondary valley bottom
Stiburus conrathi	Seasonal/ temporary	*F. pubescens - C. asiatica*	Secondary valley bottom/ footslopes
Cyperus psuedovestitus	Temporary	*F. pubescens - C. asiatica*	Footslope
Imperata cylindrica	Temporary	*F. pubescens - C. asiatica*	Valley bottom/ secondary valley bottom
Pycreus macranthus	Temporary	*A. appendiculatus - K. erecta*	Secondary valley bottom/ footslopes
Schoenoplectus corymbosus	Temporary	*S. versicolor - M. decipiens*	Secondary valley bottom/ footslopes

Table 5: Evaluation of various ecosystem services contained within each wetland landform and its importance in the Klein Olifants river catchment (Table categorization adapted from Kotze et al 2007)

MAP UNIT	LANDFORM COMPONENT	PRESENT ECOLOGICAL STATE	SIZE (ha)	Ecosystem services				
				FLOOD ATTEN-UATION ****	STREAM-FLOW REGULATION **	SEDIMENT TRAPPING ****	BIODIVERSITY MAINTENANCE **	PROVISION OF HARVESTABLE RESOURCES **
VB1	Valley bottom - channelled with terraces	**C** Overgrazing, gully erosion, roads and dams	298.3	3	4	2	3	1
VB2	Valley bottom – channelled and unchannelled	**C** Overgrazing, gully erosion, roads and dams	28.6	3	3	3	4	1
FA1	Footslope	**B** Overgrazing and roads	769.0	3	3	3	4	2

Size is seldom important	*	Size is usually very important	***
Size is usually moderately important	**	Size is always very important	****

<u>Key to the Importance of the wetland components in the catchment</u>

5 Very important
4 Important
3 Moderate importance
2 Little importance
1 Marginal importance

Key to the Present Ecological Status categories (PES) (from Kleyhans 1999)

A	Unmodified or approximates natural conditions
B	Largely natural with a few modifications
C	Moderately modified, with some loss of natural habitats
D	Largely modified, a large loss of natural habitats and basic ecosystem functions
E	Seriously modified, extensive loss of habitats and ecosystem functions
F	Critically modified, the modifications have resulted in almost complete loss of habitat

2.4 Description of the hydrophyllic vegetation

Vegetation is an important component to delineate transitions between wetland zone(s) and terrestrial areas. Certain plants, only occur under specific adaphic conditions and are therefore, useful in distinguishing between different soils hydrological regimes. Obligate and faciultative species (Table 4) were used to delineate the wetland boundaries and describe its ecological state. This site has a high frequency and abundance of generalist terrestrial plants growing in the temporary and seasonal wetland zones and very few specialist wetland plant species this is mainly due to the absence of permanent wetlands on the site (Figure 1 and Table 5).

A. Seasonal wetlands

These wetlands account for 8.7% of the total area of the site, occur on the valley bottoms and some secondary valley bottoms. Plants from the *Fuirena pubescens – Centella asiatica* community are on either side of the non-perenial Klein Olifants River (Figure 2), in which the species composition changes along the gradient from south (upstream) to north (downstream). Furthest south *Elocharis palustris*, *Juncus acatissimus* and *J. oxycarpus* (obligate species) occur only in seasonal seeps. Whereas these species only occur around the farm dams upstream. *Limosella maior* (a herb and facultative species) is also found around the small farm dams and seasonal seeps and wetlands downstream. The grass *Helitrichon turgidulum* (a facultative species) is only found in the grasslands and seeps downstream. The semi permanent pools in the river (judged to be semi-permanent) contain the obligate species, *Phragmites australis* (a reed) and *Typha capensis* (a bulrush), in which weavers built their nests. The facultative graminoids *Cyperus obtusiflorus*, *Festuca scabra* and *Leersia hexandra* were only found in the upstream grassland communities. Whilst downstream *Agrostis bergiana var. laeviuscula* and *Agrostis lachnantha var. lachnantha* both obligate species were found in the *Andropogon appendiculatus – Kyllinga erecta* community. The grass *Andropogon appendiculatus* a facultative species was found throughout this wetland zone within the former vegetation community.

B. Temporary wetlands

These are the largest wetlands in the area accounting for 20.5 % of the sites surface area. The graminoids *Cyperus pseudovestitus, C. rigidifolius* and *Stiburus conrathi* only occur in the downstream *Fuirena pubescens – Centella asiatica* community. Whilst *Pycreus macranthus* only occurs within the *A. appendiculatus- K. erecta* grasslands. These graminoids are all a facultative species. Variation between the upstream and downstream vegetation indicate that the turn-over of species diversity within the gradient (beta diversity) shows evidence of the areas previous higher levels of biodiversity (before modern agricultural practices).

C. Specific wetlands

The Tweefontein wetland has infestations of the invasive tree *Populis abla* (Figure 2 & Photograph 1) in the secondary valley bottom. These inhibit a portion of the subsurface and undeground flow of water from reaching the Klein Olifants River.

De Lange's Vlei has seen intense grazing pressure the vlei has been trampled excessively and the stream is eroding with several head-cuts migrating upstream. A scour hole has formed downstream of each of these headcuts with sediment being deposited at the junction of the stream and the Klein Olifants River. The vegetation along the lower reaches is indicative of poor veld management practices most of the palatable grasses have been replaced by nonpalatable species including shrubs in the *Seriphium plumosum – Eragrostis chloromelas* community (Figure 2). A pair of Great Snipe (*Gallinago media* palaeartic migrating birds that were seen in this wetland. Their habitat is specific to wetlands they are classified as near threatened on the endangered species list and are seldom seen in the Grassland Biome.

2.5 Riparian zone

The riparian zone occurs on the outer border of the *F. pubescens – C. asiatica* community (Figure 2) on the Klein Olifants River and all its tributaries, except for the most eastern one where a version of the *A. appendiculatus – K. erecta* community is located (Figure 2). Management of this zone is covered by management interventions of the wetlands (see Section 3.3).

<u>3. Conclusion and Recommendations</u>

With the aid of a semi-detailed survey of the soil, landform resources and vegetation of the De Wittekrans Site were identified, classified, mapped and evaluated. At this level of intensity a moderate-high level of confidence in the results are implied.

3.1 Wetland delineation

Based on the terrain unit and soil indicators as well as vegetation as described above, the map units of the project area may be classified according to the temporary and seasonal wetland zones as shown in Figure 1. The seasonal zones account for 8.7% of the entire area 326.9 ha, the temporary zones add up to 20.5% which is 769 ha. The total wetland area is 1095.9 ha this excludes the area for the wetland buffer.

3.2 Condition of the wetlands and their ecosystem services

In the project area, map units VB1, VB2 (seasonal wetland zone) and FA1 (temporary zone) had been affected moderately by human impact due to overgrazing causing *inter alia* gully erosion, as well as constructing of roads and dams (Table 4). All these wetlands have a moderate importance on sediment trapping, streamflow regulation and flood attenuation within the catchment. The FA1 wetland unit is in the most natural with few modifications on the Present Ecological Status (PES) scale. Habitat degredation is mainly due to overgrazing, The roads probably inhibited subsurface flow of water through footslope soils. The present ecological conditions reflect the current and past grazing pressure and fire regime history of the area. The FA1 zone has most of the wetlands biodiversity and has a higher conservation importance, this is due to its size.

3.3 Recommendations for ecological management

- An appropriate buffer strip of 50m (Figure 1) to protect the wetland habitats is highly recommended to prevent encroachment of infrastructure and machines into the wetland and riparian zones. The wetland zones should be clearly demarcated during the planning, design, construction and operational phases of the mine.

- The establishment of buildings within the adjacent catchments of the wetlands should be kept to a minimum. Proper storm water run-off facilities must be constructed to allow water to enter the wetland without eroding a channel and depositing silt.

- As a regulatory requirement: all facilities that store or process wastes must be kept a distance of 150 m from the wetland.

- Stream protection and stabilization measures are suggested to halt erosion in De Lange's Vlei.

- The valley bottom and associated footslopes contains a species of significant biodiversity importance. It should be zoned as off limits to any activity other than research and or conservation management.

- The buffer zone requirements should be written into the EMP and all its supporting documentation, to ensure that all construction and operational activities take place outside of this buffer zone. As the riparian area falls within the boundary of the wetland there is no need for additional management measures other than to maintain good relations with the landusers upstream. Importantly to ensure that their farm dam walls continue to withstand sudden downpours and flashflooding.

- Routine monitoring of all the water leaving the mine works must be carried out throughout the life of the mine until the end of the post closure phase. The levels of pH, iron, manganese and aluminium must be recorded. This monitoring forms the basis of routine environmental audits which are a statutory requirement, and shall assist in designing and planning the revegetation of the site.

- An environmental control officer must be present on site during the excavation, blasting and construction phases of the mine. He or she is also to supervise the machinery and insure that the contractors comply with Environmental Management Plan.

- A resource economics study should be commissioned to the ascertain the monetry value of wetland's ecosystem services and non-use values (including asthetic properties).

4. References

Cowan G.I. and van Riet, W. 1998. A directory of South African wetlands. Department of Environmental Affairs and Tourism: Pretoria

Cowardin L.M and Golet F.C, 1995. US Fish and Wildlife Service 1979 wetland classification : A review. Vegetatio 118:139-152

DWAF, Department Water Affairs and Forestry. 2005. A practical field procedure for identification and delineation of wetlands and riparian areas. Pretoria.

Geological Survey. 1986. 1:250 000 Geological Series 2630 Mbabane. Govt. Printer, Pretoria.

Germishuizen G. and Meyer N. L. 2003. Plants of Southern Africa. Strelitizia 14

Kleynhans C.J. 1999. A procedure for the determination of the ecological reserve for the purposes of the national water balance model for South African River. Institute of Water Quality Studies, Department of Water Affairs & Forestry, Pretoria

Kotze D.C, Marneweck G.C, Batchelor A.L, Lindley D.S, and Collins N. B, 2007, WET – EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands (in Prep)

Land Type Survey Staff. 1985. Land types of the maps 2628 East Rand, 2630 Mbabane. Mem. agric. nat. Resour. S. Afr. No.5. Pretoria.

Mucina L. and Rutherford M.C. 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute. Pretoria.

Palmer, R.W., Turpie, J., Marnewick, G.C. and Batchelor, A.L. (2002). Ecological and economic evaluation of wetlands in the upper Olifants River Catchment, South Africa. WRC Report No. 1162/1/02

Partridge T.C. & Maud R.R., 1987. Geomorphic evolution of southern Africa since the Mezozoic. *S.Afr.* J. Geol. 90, 179-208.

Reed D P B, 1988. National list of plant species that occur in wetlands: national summary. U.S. Fish and Wildlife Service, Washington, DC. Report No. 88

REMS, 2008. Baseline Study of Fauna and Flora of the Northern section of Ferreira’s, Portion 19 of Witbank 262 IT Mpumalanga Province, report for GCS (Pty) Ltd, Rivonia.

Soil Classification Working Group, 1991. Soil classification. A taxonomic system for South Africa. Mem. Agric. Aat. Resour. S. Afr. No. 15. Dept. Agric. Dev., Pretoria.

Appendix 1:Quaternary catchments around the De Wittekrans Project showing the Klein Olifants River