# WETLAND DELINEATION :
# Portion 531 of the farm Elandsfontein 108 IR and the Remainder of Portion 2 of the farm Elandsfontein 90 IR.

Commissioned by

**ABLAND (Pty) LTD**


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# CONDITIONS RELATING TO THIS REPORT

**Declaration of interest**

Enviroguard Ecological Services cc has no vested interest in the property studied nor is it affiliated with any other person/body involved with the property and/or proposed development. Enviroguard Ecological Services cc is not a subsidiary, legally or financially of the proponent.

The study was undertaken by Prof. LR Brown & Mr CL Cook. They are registered as Professional Natural Scientists with the following details:

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| SPECIALIST | QUALIFICATION |
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| Mr C Cook | MSc Zoology (Aquatic Science)<br>BSc Hons Zoology<br>BSc Botany & Zoology<br>Wetland and Riparian Delineation *(DWAF Accredited Course)* |

**Indemnity**

Although Enviroguard Ecological Services cc exercises due care and diligence in rendering services and preparing documents, the client takes full responsibility for this report and its implementation in terms of the National Environmental Management Act of 1998, and exempt Enviroguard Ecological Services cc and its associates and their sub-contractors from any legal responsibility based on the timing of the assessment, the result and the duration thereof, which has an influence on the credibility and accuracy of this report. .Enviroguard Ecological Services cc accepts no liability, and the client, by receiving this document, indemnifies Enviroguard Ecological Services cc and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by Enviroguard Ecological Services cc and by the use of the information contained in this report.

**Background to the study**

A wetland delineation study was conducted on the study site to determine the presence and extent of wetland habitat for a proposed development of the area. The study area and its surroundings were mined for gold in the past, as is evident from the presence of several slimes dams (tailings dams) in and around the site. One of the slimes dams within the study area has been reclaimed in order to obtain remaining residual gold particles that were not originally mined, while other slime dams and sand dumps remain intact within the surrounding area.

Only one site visit was undertaken to the site on 25 January 2014. Only plants visible in the area and those that flowered at the time of the visit could be identified with high levels of confidence. The wetland was delineated according to DWAF guidelines and procedures.

**Terms of reference**

**Enviroguard Ecological Services cc** was requested to conduct a wetland delineation of the delineation of the wetland area present on the study site. This report includes the delineation and also provides an assessment on the ecological state of these areas.

# 1 INTRODUCTION

## 1.1 Wetland functions and values

The term “wetland” is a generic term for all the different kinds of habitats where the land is wet for some period of time each year, but not necessarily permanently wet. Wetlands are found where the landform (topography) or geology slows down or obstructs the movement of water through the catchment, or where the groundwater surfaces causing the soil layers in the area to be temporarily, seasonally or permanently wet. This provides an environment where particular plants (hydrophytes) that are adapted to wet conditions tend to grow in abundance. The plants in turn affect the soil and hydrology by further slowing down the movement of water (e.g. reed beds) or by producing organic matter that may accumulate in the soil.

Wetlands are important because of the functions and values that they provide which benefit mankind. These benefits can be either direct or indirect benefits (Table 1). Until very recently the benefits of wetlands to society were often not recognized, and many wetlands have been destroyed, or poorly managed. Wetland benefits refer to: "*those functions, products, attributes and services provided by the ecosystem that have values to humans in terms of worth, merit, quality or importance. These benefits may derive from outputs that can be consumed directly; indirect uses which arise from the functions or attributes occurring within the ecosystem; or possible future direct outputs or indirect uses*" (Howe et al., 1991 in Kotze et al., 2005).

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The functioning of a wetland is also affected by other factors, many of which result from the activities of people. These include "off-site" factors which take place in the surrounding catchment (e.g. a change in land cover from natural grassland to a gum tree plantation which would decrease the amount of water reaching the wetland) and "on-site" factors which take place at the wetland (e.g. fire, draining, damming, etc.).

**Table 1**. Direct and indirect wetland benefits (Kotze *et al.*, 2005).

| INDIRECT BENEFITS | DIRECT BENEFITS |
| --- | --- |
| **Hydrological Benefits** include:<br>➢ Water Purification<br>➢ Sustained stream flow<br>➢ Flood reduction<br>➢ Ground water recharge/discharge<br>➢ Erosion Control<br>**Biodiversity Conservation**- Integrity and irreplaceability<br>**Chemical Cycling** | ➢ Water Supply<br>➢ Provision of harvestable resources (reeds etc.)<br>➢ Socio-cultural significance<br>➢ Tourism and recreation<br>➢ Education and research |

Their flat and wide nature assists in reducing the velocity of the flow, because of reduced gravitation and spreading of the concentrated channel flow over a wider area. This causes sediment to settle down, thereby purifying the water from sediment, but also of other pollutants adsorbed to the sediments, e.g. bacteria and viruses. The flatness of the surface area also promotes contact between water and sediments because of the shallow nature of the water column, leading to high levels of sediment/soil-water exchanges. The shallow nature also promotes exposure of bacteria and viruses to solar radiation, which assists in the elimination of these from wetland waters (Seidel, 1970; Rogers, 1983 in Kotze et al., 1994).

The shallow oxygenated surface water promotes the occurrence of aerobic/anaerobic processes by maximising the aerobic/anaerobic interface where denitrification can occur (Hemond and Benoit, 1988; Hammer, 1992 in Kotze et al., 1994).

The flat and wide nature of palustrine floodplain-type wetlands is responsible for the greater retention time of these systems relative to the river or channel flow. One of the most important mechanisms for bacterial removal by wetlands is simply detention while natural die-back occurs. Pathogenic micro-organisms found in sewage effluent generally cannot survive for long periods of time outside the host organisms (Hemond and Benoit, 1988 in Kotze et al., 1994).

## 1.2 Types of wetlands

There are **many different types of wetlands;** and a number of classification systems have been developed to try to describe these different types. One system which has been developed for inland wetland systems is based on the hydrogeomorphic (HGM) characteristics of wetlands (Marneweck and Batchelor, 2002; Kotze et al., 2005) (Figure 1). This approach follows that used by the US Environmental Protection Agency, and this classification system has been included as part of a proposed wetland classification system for South African wetlands by Ewart-Smith et al (2006).

This **hydrogeomorphic classification** system classifies wetlands according to their form (*geomorph*- characteristics) and the way in which water moves in, through and out of the wetland system (*hydro*- characteristics). The classification system recognises 5 generic palustrine wetland types:

- Pans and depressions (incl. lakes);
- Seepage wetlands;
- Un-channelled valley bottoms;
- Channelled valley bottoms; and
- Floodplains.

Different wetlands perform different functions in the landscape.

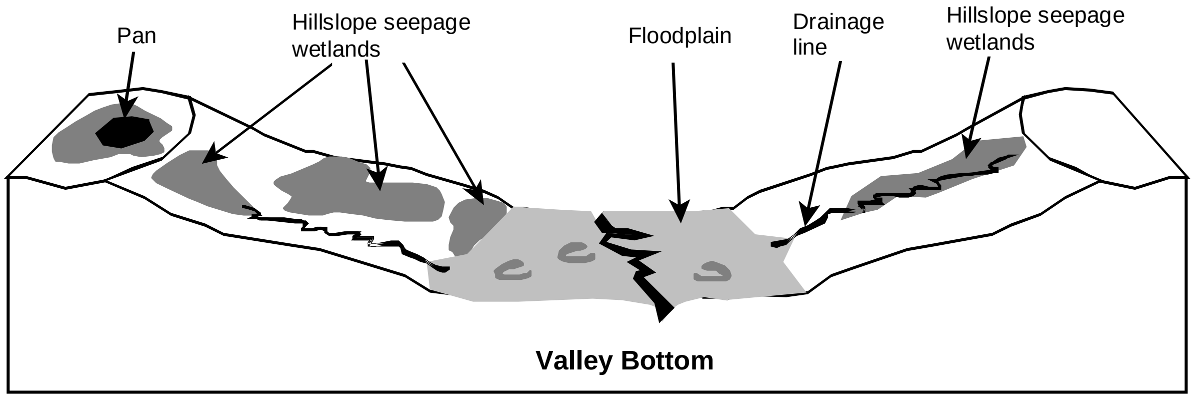



**Figure 1** This hydrogeomorphic (HGM) classification is an easy classification system for wetlands which can be applied at desktop level. Additionally it has strong **links to the hydrological functions**, since wetlands are grouped by hydrological characteristics; and it therefore provides insight into the likely functional importance (role in the landscape) that the wetland type is likely to play (Marnewick and Batchelor, 2002; Kotze et al., 2005).

## 1.3 Hydrological zones

As mentioned previously, because of the landscape in which wetlands usually occur, the hydrological regime is not constant throughout the entire wetland. Consider a typical floodplain wetland located within a valley bottom. Depressions could be present within this valley bottom wetland of which the soil surface is below the water table; they are therefore permanently saturated (wet even in the dry winter months). As one moves from these depressions towards the surrounding upland, the general trend will be to move along an incline from the valley bottom towards the foot slopes of the catchment. Flooding of the perimeter areas of the floodplain will therefore be dependent on the extent of flooding (volume of water per unit of time). During high runoff events, these areas will be flooded, and conversely, during low runoff events they will not be flooded. Consequently the period of flooding, which affects the development of reduced soil conditions, will also be shorter than for the lower lying areas. It can be concluded that within this wetland there exists a hydrological gradient ranging from permanent saturation at its deepest end, to periodic saturation at its shallowest end. At some point within this hydrological gradient the average period of saturation of the soil will be insufficient for this area to develop reduced soil conditions, and to therefore be classified as a wetland.

There are thus regions which range from those which remain permanently flooded and/or saturated for the entire year (permanently saturated) to those which are flooded and/or saturated for 5-11 months of the year (seasonally saturated), or saturated at or close to the soil surface for 1-5 months (temporarily saturated) in the year, but still long enough to develop reduced soil conditions. These areas of different duration of reduced soil conditions are referred to as hydrological zones. Depending on the hydrology, a wetland can possess all three hydrological zones (permanent, seasonal and temporary), any two of them, or only one.

The hydrological zones are recognised by the presence of redoximorphic features within the soil matrix, but are distinguished from one another by the relationships in which they occur. The redox concentrations (mottles: the red, yellow and black spots) are close to the soil surface in the seasonal and temporary wet zones of the wetland, while they are much deeper in the soil profile in the non-wetland area. These mottles are absent or far fewer in the permanent wet area due to these areas being mostly, void of oxygen (because of the relatively permanent presence of water) so that oxidation of the colourless $Fe^{2+}$ to $Fe^{3+}$ does not occur as readily as in the temporarily and seasonally wet soils.

***The significance of reduction and the resulting redox concentrations and redox depletions in defining a wetland is that it is only once the soil of a piece of land displays these redoximorphic features within the upper 500mm, that it is classified as being a wetland.***

In practice it is not easy to identify the subtype as the contribution of groundwater to wetlands is difficult to determine. However, it is important to recognize the existence of the different water transfer mechanisms as they affect various aspects of the wetland ecology (Table 2).

**Table 2**. The three landscape locations and their associated hydrological subtypes.

| Landscape location | Subtype based on water transfer Mechanism |
|---|---|
| Hillslope wetlands | Surface water-fed<br>Surface and groundwater-fed<br>Groundwater-fed |
| Valley bottom wetlands | Surface water-fed<br>Surface and groundwater-fed<br>Groundwater-fed |
| Depression wetlands | Surface water-fed<br>Surface and groundwater-fed<br>Groundwater-fed |

**Permanent Wet Zone**

Of any of the zones, the permanent wet areas have the greatest potential to decrease the velocity of flow due to the high friction value of the vegetation typically associated with this zone (also, due to the flat nature of palustrine type wetlands, they naturally decrease the velocity of flow, even in the absence of vegetation). Due to the permanent wet nature of the soils, it is mostly anaerobic. Although the wetland plants provide substantial surface area for the attachment of microbes, both above-ground and below-ground, due to the aerobic rhizosphere around roots, this process is not as significant in this zone as it is in the seasonal wet zone which is marked by dry (aerobic) and wet (anaerobic) cycles. Because of the longer prevalence of anaerobic conditions, water purification functions associated with organic matter are more efficient in the permanent wet zone than in the other zones. The prolonged anaerobic conditions of the permanent wet zone promoted flood attenuation and regulation more so than the seasonal wet zone due to conditions (anaerobic) promoting the aggregations of organic material.

**Seasonal Wet Zone**

Due to the seasonal nature of flooding, aerobic and anaerobic conditions are more favourable for performing water purification functions than in the permanent zone. The seasonal zone is therefore the most important location for water purifying processes dependant on an aerobic/anaerobic environment. Although the frictional value of the seasonal wet zone is not as high as that of the permanent wet zone, it is still sufficient in most cases, depending on the ratio of inflow and surface area, to decrease the velocity sufficiently enough for all water purifying processes to take place (due to the flat nature of palustrine type wetlands, they naturally decrease the velocity of flow, even in the absence of vegetation).

The seasonal wet zone is usually characterised by having a lower organic content than the permanent wet zone due to more oxygen, which promoted the decay of organic material. Processes associated with organic matter are therefore not as efficient in the seasonal wet zone as in the permanent wet zone, but still contribute significantly towards water purification through these processes. The contribution of organic soils in withholding water, thereby performing a flood attenuation and regulation function, is less so than in the case of the permanent wet zones where there is usually a thicker layer of organic material due to the anaerobic conditions which is more characteristic of the permanent wet zone than of the seasonal wet zone.

**Temporary Wet Zone**

The temporary wet zone is the transitional zone between the wetland and the surrounding dry land. Because of the limited surface area, the limited water volumes they receive, absence of significant aerobic/anaerobic conditions, limited organic material (due to relative short periods of anaerobic conditions) and average plant productivity, temporary wet areas do not contribute significantly to the hydrological functions, e.g. water purification, typically associated with palustrine floodplain type wetlands. Temporary wet areas are, however, more capable of performing hydrological functions than the surrounding dry land and could represent important sites for these functions where no other, or very little of the other, more capable hydrological units occur.

## 2 OBJECTIVES OF THE STUDY

The objectives of the study are as follows:

- To delineate the wetland area present on the site.
- To assess the ecological status and ecosystem services of wetland on the site.

## 3 STUDY AREA

The study area is situated in Germiston between the N3 Eastern Bypass to the west and various industrial developments to the east (Figure 2). The site and its surrounding areas were mined for gold in the past, as is evident from the presence of several slimes dams (tailings dams) in and around the site. The study area itself used to contain slimes dams of which most have been reclaimed in order to obtain any remaining residual gold particles resulting in only remnants of old slimes dams still remaining. Other remnants of slimes dams are present in the upper local catchment of the watercourse that flows through the western boundary of the site (Figure 3).

The construction and operation of slimes dams in the past and their subsequent reclamation within the study area have completely transformed the natural habitat of the area and created a present day environment characterised by alien invasive species, weeds and a patchy distribution of secondary grassland vegetation elements.

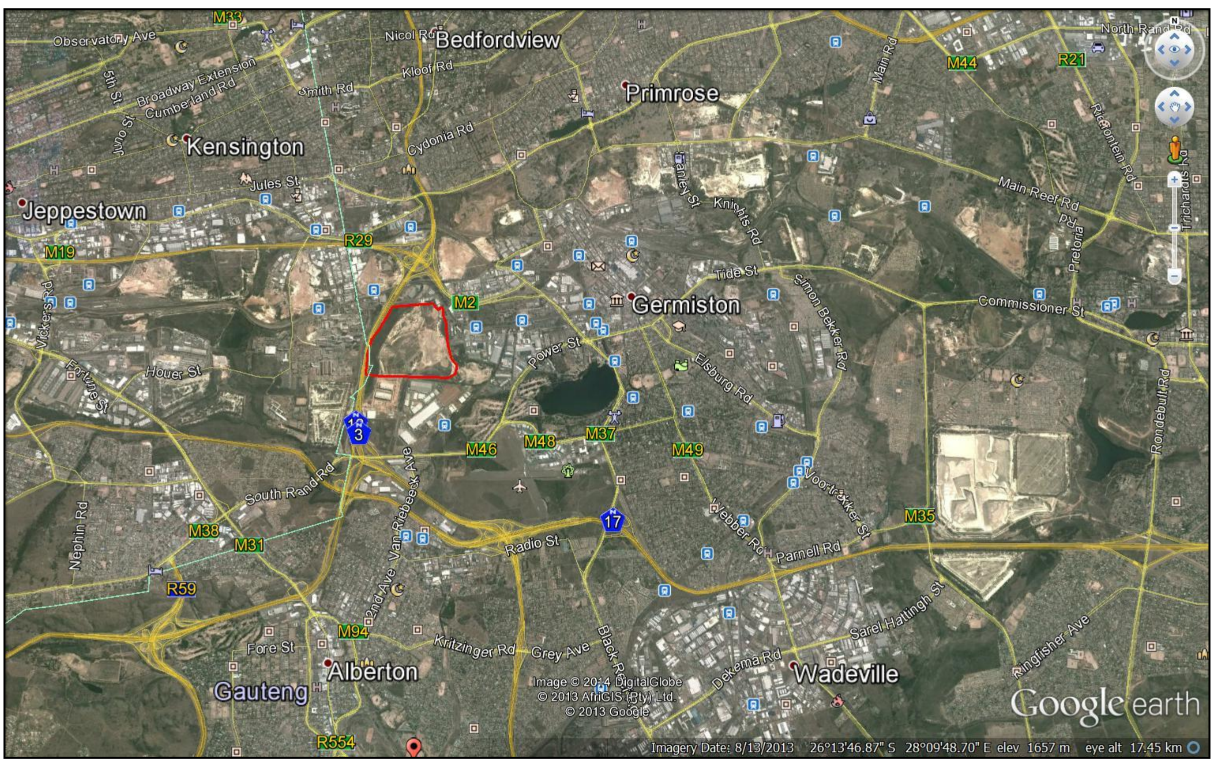



**Figure 2.** Locality map of the study site (in red) (Source: Google earth 2014).

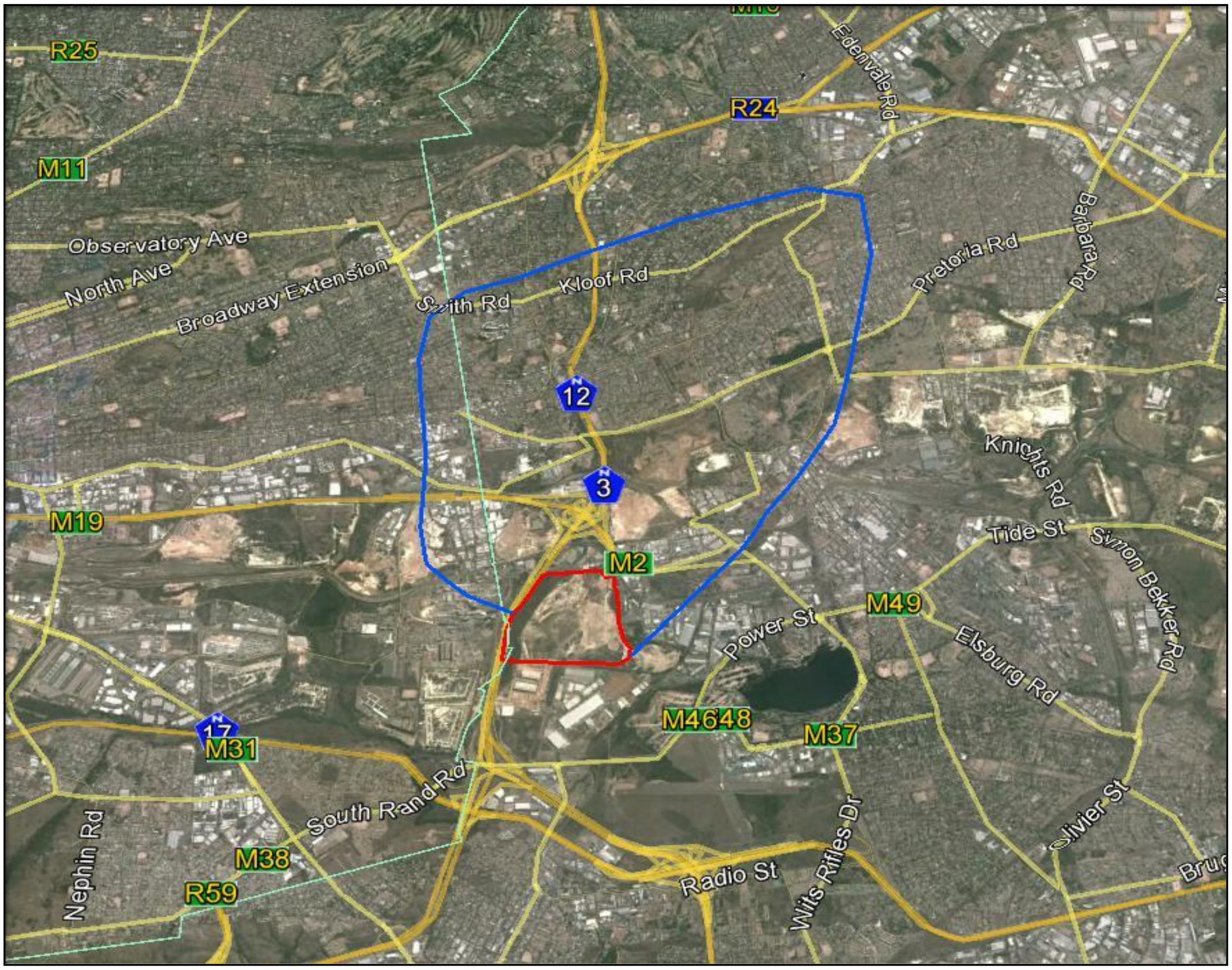



**Figure 3** Wetland catchment area (Source: Google earth 2014).

# 4. METHODS

## 4.1 Wetland delineation

In March 2008 GDARD (Formerly GDACE) released updated guidelines for the undertaking of biodiversity assessments. These guidelines contain a number of stipulations relating to the protection of wetlands and the undertaking of wetland assessments. The guidelines state that a wetland delineation procedure must identify the outer edge of the temporary zone of the wetland, which marks the boundary between the wetland and adjacent terrestrial areas and is that part of the wetland that remains flooded or saturated close to the soil surface for only a few weeks in the year, but long enough to develop anaerobic conditions and determine the nature of the plants growing in the soil.

The guidelines also state that locating the outer edge of the temporary zone must make use of four specific indicators including the terrain unit indicator, the soil form indicator, the soil wetness indicator and the vegetative indicator. In addition the wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive in a sensitivity map.

The guidelines stipulate buffers to be delineated around the boundary of a wetland; the wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive and a 30m buffer delineated around the edge of the wetland in which no development must be allowed to occur.

For the purposes of this investigation a wetland was defined according to the definition in the National Water Act (1998) 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 in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

Wetland delineation took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas" published by the department of Water Affairs and Forestry (DWAF, 2005). The method for identification and delineation uses four indicators to indicate/flag the presence of riparian areas and wetlands. These four indicators are:

- **Terrain Unit** (location in the landscape)
- **Soil form** (typical wetland soil forms)
- **Vegetation** (indicator species or hydrophytes) and
- **Soil wetness** (evidence of hydric conditions).

For delineation purposes only the wetland boundary is defined as the edge where the ***hydric indicators are encountered within the top 50cm or 500 mm of the surface***, but from a wetland management perspective consideration should extend beyond the boundaries to include the wetland catchment as a whole.

**Terrain Unit Indicator:**

Identifies those parts of the landscape where wetlands are likely to occur: Pans are usually concentrated in areas with an average slope of less than one degree and are characterised by a lack of integrated drainage. Inundation is usually seasonal or ephemeral. This indicator cannot be used for mapping, but is useful for screening (e.g. desktop screening assessment of where development is proposed in or alongside a valley bottom wetland or river). 1:50 000 topographic maps were used to generate digital base maps onto which the boundaries of the wetland can be delineated using Arcview 9.2. The terrain unit indicator is used for indicating the likely presence of wetlands, but not for delineation purposes.

**Soil Form Indicator:**

Particular forms of soil are associated with wetlands and display hydromorphic characteristics, and their presence at a site indicates that permanent or periodic (temporary or seasonal) saturation of the soil near the surface occurs. Soils forms are also only indicators of possible wetland presence: i.e. on its own it is not sufficient information to rely on for wetland verification. The exceptions are the Katspruit, Champagne, Willowbrook and Rensburg soil forms which are mostly associated with permanent wetlands. No comprehensive soil survey has been undertaken for the site.

**Vegetation Indicator**

The presence of indicator plant species or hydrophytes can be used to denote the presence of wetlands. This indicator is very useful as verification of the boundaries in undisturbed sites. Soil condition is the primary criterion that signifies waterlogged conditions. These conditions manifest itself through plant communities that can tolerate hydromorphic soils. These plants are hydrophytes that are adapted to stresses imposed on plants through temporary or permanent waterlogged conditions.

**Soil wetness Indicator**

This indicator refers to the colour of soil component is often the most diagnostic indicator of hydromorphic soils. Iron is what gives soil its red-brown colour; the reddish colour originates from iron-oxide (rust) – iron and oxygen. Wetland soils can be permanently, seasonally or temporarily saturated. This normally results in anoxic (low oxygen) conditions in the saturated zone. Soil colour is markedly influenced by the oxidation statues of manganese and iron. Yellow, red and reddish brown soil form under well-oxidised conditions and greyish colours when aeration is poorer. Under anoxic conditions, iron becomes soluble and can be leached out of the soil. Where the soil is permanently wet; the iron can all be dissolved out of the soil; resulting in a greyish or blueish colour. This is termed gleying. Prolonged periods of water saturation producing gleysation, where grey and blue mottles are form and are a condition in which hydrophilic plants flourish. Soil that are gleyed or organic soils indicate permanently saturated zones. Where the soil is only saturated on a seasonal basis (at least 3 months per year); the gleying may not be extensive. Instead, due to alternating periods of iron being dissolved and then oxidised, a mottled appearance develops in the soil. Consequently it is possible to identify wetland areas on the basis of soil colour, while mottle hue and chroma initially increase and then decrease the more saturated the soils become (Table 3 & Figure 4).

**Table 3:** Relationship between degree of wetness (wetland zone) and vegetation (adapted from Kotze et al, 1994)

| **Degree of wetness** | | | |
|---|---|---|---|
| | **Temporary** | **Seasonal** | **Permanent / Semi-permanent** |
| **Soil Depth (0cm – 50cm)** | Few / no mottles<br>Non-sulphuric | Many mottles<br>Seldom sulphuric | Few / no mottles<br>Often sulphuric |
| **Vegetation** | Predominantly grass species | Predominantly sedges and grasses | Predominantly reeds and sedges |

By observing the evidence of these features, in the form of indicators, wetlands can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF 2005).

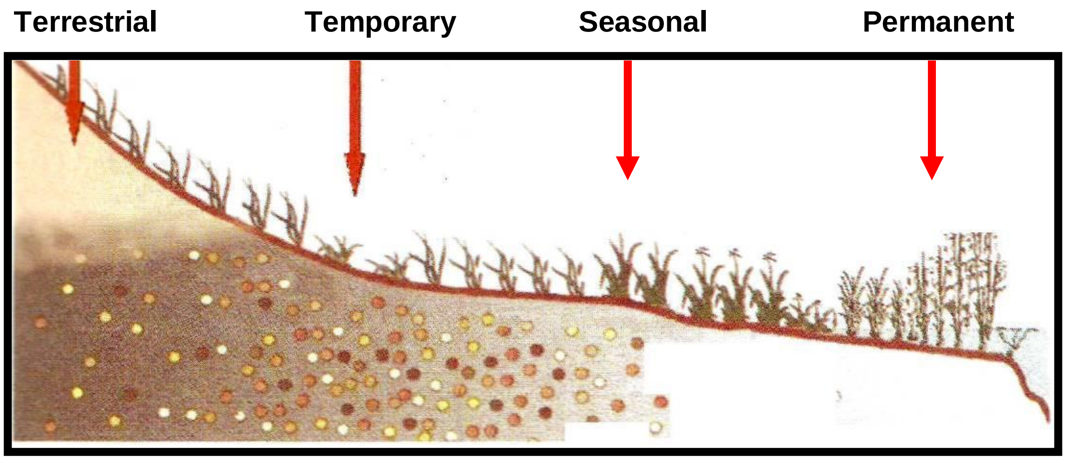



**Figure 4.** Cross section through a valley bottom wetland indicating how soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the permanent wet hydrological zone to the temporarily wet hydrological zone and eventually into the non-wetland or terrestrial zone (Department of Water Affairs and Forestry, 2003 as adapted by Kotze, 1996)

**Field survey**

The site is disturbed to different degrees, which include permanent and reversible damage to the wetland area within the site. Historic impacts include the disturbance, pollution and removal of large portions of the soil profile due to the construction and operation of the slimes dams, while more recent impacts include the hydrological-based reclamation of the onsite slimes dam. The result has been bare surface areas with little to no vegetation cover or topsoil in many areas. As a result the identification of typical wetland indicators in the form of hydrophytes and hydromorphic soils were restricted on the site.

A Dutch soil auger was used to extract the cores to a depth of 50cm. All soil samples were evaluated in hand for soil composition, colour, number, size and chroma of mottles as well as wetness, after which they were discarded. The location of each soil core was marked using a hand held Garmin Colorado 300 GPS. Field verification was limited to the presence of hydric soils on the site as well as presence of hygrophytic and hydrophilic vegetation.

Soil auger samples were taken in transects that were laid parallel to each other in the study area. Soil samples were taken along transects radiating away from the visibly 'wettest' parts of the area at regular intervals. Soil auger samples were restricted to the immediate site.

## 4.2 Wetland assessment

### 4.2.1 Present Ecological Status

The **Present Ecological State** (PES) refers to the current state or condition of a watercourse in terms of all its characteristics and reflects the change to the watercourse from its reference condition. The results from such an assessment are compared to the standard DWAF A-F ecological categories (Table 4) from where the PES/Habitat integrity of the wetland can be determined. The values give an indication of the alterations that have occurred in the wetland system.

**Table 4:** Present Ecological Status Categories of Wetlands (adapted from Kleynhans, 1996 & 1999)

| Ecological category | Score | Description |
|---|---|---|
| A | 90-100% | Unmodified, natural. |
| B | 80-90% | Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged |
| C | 60-80% | Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. |
| D | 40-60% | Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred |
| E | 20-40% | Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive |
| F | 0-20% | Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible. |

### 4.2.2 Ecological Importance and Sensitivity

The **Ecological Importance and Sensitivity** (EIS) of a watercourse is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales, and both abiotic and biotic components of the system are taken into consideration. Sensitivity refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred. The ecological importance and sensitivity categories are indicated in Table 5.

**Table 5:** Ecological Importance & Sensitivity Categories of Wetlands

| EIS Categories | Description |
|---|---|
| Low/marginal | Not ecologically important and sensitive at any scale. Biodiversity ubiquitous and not sensitive to flow and habitat modifications (Wetlands: play an insignificant role in moderating water quality & quantity) |
| Moderate | Ecologically important & sensitive on provincial/local scale. Biodiversity not usually sensitive to flow & habitat modifications. (Wetlands: play a small role in moderating water quantity & quality) |
| High | Ecologically important & sensitive and important. Biodiversity may be sensitive to flow & habitat modifications. (Wetlands: Play a role in moderating water quantity & quality) |
| Very high | Ecologically important & sensitive on a national (or even international) level. Biodiversity usually very sensitive to flow & habitat modifications. (Wetlands: play a major role in moderating water quantity & quality) |

### 4.2.3 Wetland ecoservices

*WET-EcoServices* (Kotze *et al.* 2004) was used to assess the goods and services that the floodplain provides. This tool provides guidelines for scoring the importance of different ecosystem services delivered by a wetland. The different services are then assessed based on existing knowledge and/or field assessment data. Each of fifteen different categories are assessed based on various characteristics (e.g. size of the wetland, pattern of flow through the wetland, social value and uses, etc.) that are relevant to the particular benefit.

# 5. RESULTS.

## 5.1 Wetland delineation

The wetland habitat on the property occurs along the lower lying portion on the western boundary of the site. It is associated with a tributary of the Natalspruit and can be classified in terms of its hydro-geomorphic characteristics, as a **channelled valley bottom** wetland that receives both surface and subsurface water input (Figure 5). Similar to other valley bottom wetlands, the delineated wetland displays a gradient of wetness across its width. Facultative hydrophytes and terrestrial species dominate the drier wetland portions, while obligated hydrophytes occur in the wetter areas.

The vegetation of the central wet to moist portion of the valley bottom wetland (permanently wet area) is dominated by a homogeneous stand of the obligate hydrophyte *Phragmites australis* (Common Reed) (see photo above). *Phragmites australis* is the dominant wetland plant species inside the study area, as well as downstream of the study area where it forms similar large stands. It commonly forms extensive stands in moist and permanently wet (standing water of up to 1 m deep) areas and can spread at a rate of 4-5 meters per year. The plant is known to form dense stands with little place for other plant species to also establish.

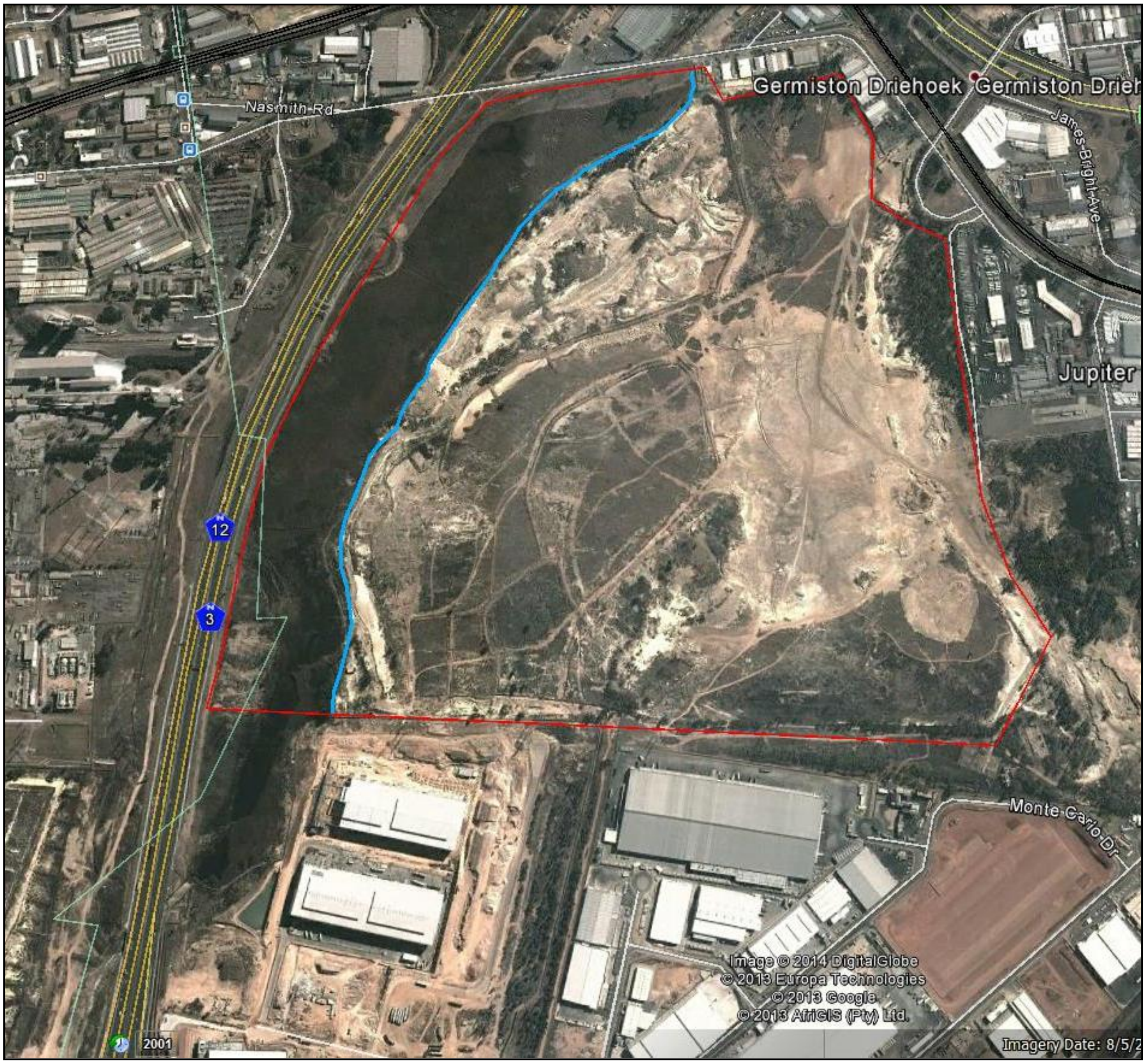



**Figure 5** Wetland present on site (Blue line = edge of the wetland) (Source: Google earth 2014).

The dominance of *Phragmites australis* on the site is not only due to the wetness of the wetland area, but is also likely to be the result of its above average tolerance of pollutants that are commonly prevalent in the water and sediment of wetlands that occur immediately downstream of slimes dams. It is a halophyte that can tolerate alkaline habitats and alkaline water.

The category 1 declared alien invasive grass *Cortaderia selloana* is also present within the moist sections of the wetland.

The edge of the wetland has been permanently destroyed by the dumping of slime for many years and the current slimes reclamation process. This has resulted in large open bare patches where the bedrock has been exposed (see photo right).

**Bare open bedrock**

Large sections along the edge of the wetland have been dug out and embankments built where sand and sludge from the slimes reclamation process have been washed into the wetland area (see photo right). Some pioneer grass and forb species have become established on these embankments. In other areas the sand / sludge have been washed into the wetland itself where it negatively affects the wetland ecosystem.

**Sludge washed onto wetland edge**

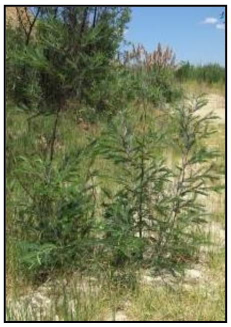
A more than 5m high embankment was created along the southern edge of the wetland (see photo right). There is however some sand sludge present in this section of the wetland too.

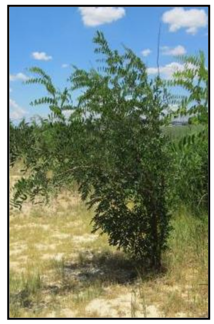
**Tall embankment along wetland edge**

The edge and adjacent areas of the wetland remains largely bare, however in some cases isolated patches of *Cynodon dactylon* (Couch Grass), *Nidorella hottentotica* and *Conyza podocephala* are present. The largest part of the area adjacent to the wetland edge, where no sludge is present, is dominated by open to dense stands homogeneous stands of *Cortaderia selloana* (Pampas Grass) (see photo below right). Although *Cortaderia selloana* can grow inside wetlands, these

large stands occur outside the wetland where the once wetland soils have been largely removed by mining activities. This alien invader species is able to grow in highly polluted soil and has therefore been used with some success to rehabilitate and prevent the erosion of tailing surfaces. The prevalence of the species across the footprint of the reclaimed tailings dam therefore gives some indication of the likely pollution status of the remaining sediment.

A large number of declared alien invasive species are also present along the edge of the wetland and pose a huge risk to the larger environment. These species include *Acacia mearnsii, Tamarix chinensis, Eucalyptus camaldulensis, Robinia pseudoacacia, Campuloclinium macrocephalum, Cirsium vulgare* and the alien invasive grass *Pennisetum clandestinum.*



On the north-eastern edge of the wetland a stand of *Euclayptus camaldulensis* trees occur that was most probably planted to assist in the drying of the wetland and slimes dams present at that time. These trees range in height with some up to an estimated 15-18 m tall.

The areas bordering onto the wetland comprises a mixture of excavated land, small slimes/water dams and small areas where the terrestrial vegetation have recovered though still in an early secondary successional stage.

## 5.2 Site hydrology

The drainage on the site broadly mimics the topography, which entails that the overland drainage would flow from the higher parts of the site on the eastern section down towards the wetland on the western boundary of the site. There are many areas where erosion has taken place mainly as a result of the slimes reclamation processes. This has also resulted in further drying of the surrounding areas due to more water runoff and less water retention of the soil.

## 5.3 Wetland assessment

### 5.3.1 Present ecological status (PES)

Table 6 (Kleynhans 1999). It should however be noted that if a score of less than 2 is attributed to any impact, the lowest rating is used to attribute PES class and not the mean.

**Table 6:** PES classes (from Kleynhans 1999) indicating the interpretation of the mean scores to rate the PES category.

| WITHIN GENERALLY ACCEPTABLE RANGE | | |
|---|---|---|
| **Category** | **Score** | **Description** |
| A | >4 | Unmodified, or approximates natural condition and/or represents a natural condition due to successful rehabilitation process/program(s) which has occurred and/or are in the process of occurring. |
| B | >3 and 4 | Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged |
| C | >2 and 3 | Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged. |
| D | 2 | Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred. |
| **OUTSIDE GENERAL ACCEPTABLE RANGE** | | |
| E | >0 and 2 | Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive |
| F | 0 | Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat |

The results from the PES analysis indicate the **channelled valley bottom** wetland to be in **PES class E** (Table 7) indicating that it is seriously modified with losses of natural habitats and ecosystem functions. This can be ascribed to the effect of the polluted water from the slimes reclamation processes on the wetland, the destruction of the natural vegetation and the introduction of alien vegetation along the edge and the rest of the study wetland area.

**Table 7:** PES calculation for the channelled to un-channelled valley bottom area

| Criteria and attributes | Relevance | Score | Confidence |
|---|---|---|---|
| **Hydrological** | | | |
| Flow modification | Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland. | 2 | 4 |
| Permanent Inundation | Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota. | 2 | 4 |
| **Water Quality** | | | |
| Water Quality Modification | From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland | 1 | 4 |
| Sediment load modification | Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats. | 2 | 4 |
| **Hydraulic/Geomorphic** | | | |
| Canalisation | Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage. | 3 | 4 |
| Topographic Alteration | Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or changes wetland habitat directly or through changes in inundation patterns. | 1 | 4 |
| **Biota** | | | |
| Terrestrial Encroachment | Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions. | 2 | 5 |
| Indigenous Vegetation Removal | Direct destruction of habitat through any human activities affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion. | 1 | 5 |
| Invasive plant encroachment | Affect habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading). | 1 | 5 |
| Alien fauna | Presence of alien fauna affecting faunal community structure. | 2 | 4 |
| Overutilisation of biota | Overgrazing, Over-fishing, etc | 4 | 4 |
| **Mean** | | **1.91** | **4.3** |
| **Class** | | **E** | |

### 5.3.2 Ecological Importance and Sensitivity (EIS)

The EIS and functions were calculated using the new draft DWA guidelines and model, as developed by M. Rountree, but not yet published. Information was used form the SIBIS and VEGMAP products. A mean score between 0 and 4 is obtained, with 0 as the lowest and 4 as the highest score. No classification of the scores is given.

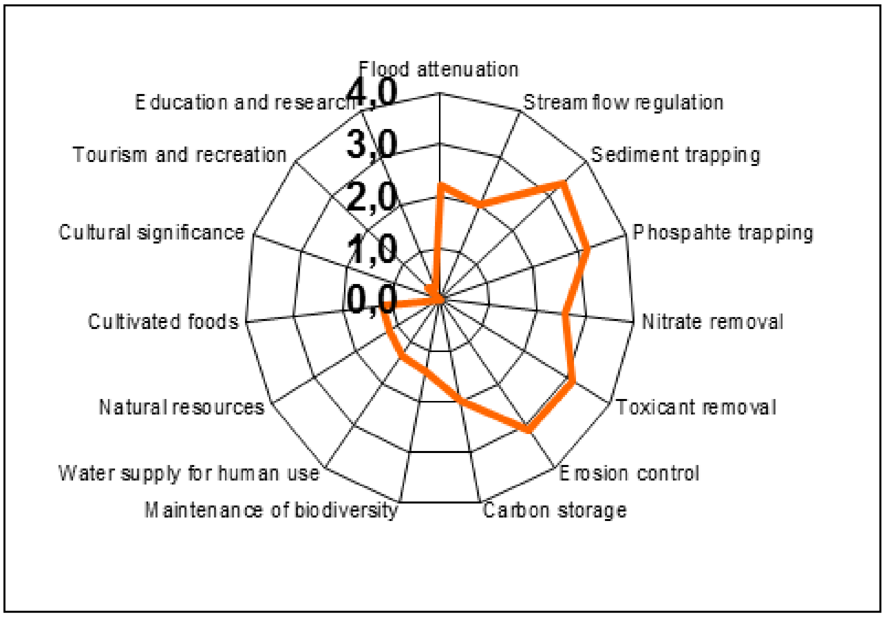
The **channelled wetland area** has an Ecological Importance and Sensitivity (EIS) score of 0.99 (Table 8). This is a value between 0 and 4, with 0 being very low and 4 very high. The wetland therefore has a low EIS score. It is not regarded as being ecologically important or sensitive with a low biodiversity though it plays a role in moderating water quality and quantity

**Table 8** EIS calculation of the channelled to un-channeled wetland

| ECOLOGICAL IMPORTANCE AND SENSITIVITY | Score (0-4) | *Confidence (1-5)* | Motivation |
|---|---|---|---|
| **Biodiversity support** | **0.66** | ***4*** | |
| *Presence of Red Data species* | **0.00** | *4.00* | No known red data or protected species observed on site. |
| *Populations of unique species* | **0.00** | *4.00* | No unique plant or animal populations were observed. |
| *Migration/breeding/feeding sites* | **2.00** | *4.00* | Though a few bird species were observed, few nests were present.. |
| **Landscape scale** | **1.00** | ***4.80*** | |
| *Protection status of the wetland* | **1.00** | *5.00* | The wetland and surrounding area has been exposed to slimes dams, mining and various industrial developments surrounding the area. |
| *Protection status of the vegetation type* | **1.00** | *5.00* | The wetland is not located in an endangered vegetation type. Although dominated by *Phragmites* it is very homogeneous as a result of the polluted state of the water. The vegetation surrounding the wetland is mostly pioneer and alien invasive species with few indigenous species present. |
| *Regional context of the ecological integrity* | **1.00** | *5.00* | The wetland is in PES class E due to the large scale degradation of the surrounding areas as well as the wetland area itself. |
| *Size and rarity of the wetland type/s present* | **1.00** | *4.00* | The wetland is not particularly rare and has no vulnerable ecosystem present. |
| *Diversity of habitat types* | **1.00** | *5.00* | The wetland has a low species diversity as well as habitat diversity. The wetland is dominated by a homogeneous stand of *Phragmites* australis |

| Sensitivity of the wetland | 1.33 | *3.33* | |
|---|---|---|---|
| *Sensitivity to changes in floods* | 2.00 | *3.00* | The area is totally surrounded by various developments. High rainfall events will cause water in channel to flow into the wetland. The large reed bed should however be able to retain such water. The sediment washed into the wetland could however have a negative influence on the wetland's ability to retain water. |
| *Sensitivity to changes in low flows/dry season* | 1.00 | *3.00* | Minimally impacted by the surrounding developments. |
| *Sensitivity to changes in water quality* | 1.00 | *4.00* | The wetland receives water of various qualities due to water the surrounding industries as well as the slimes dam polluted water. |
| **ECOLOGICAL IMPORTANCE & SENSITIVITY** | **0.99** | ***4.0*** | |

### 5.3.3 Wetland ecoservices




WET-EcoServices (Kotze *et al.* 2004) was used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision-making. Overall the **wetland** has a low-moderate ecosystem services (spider diagram right). It has a low species richness and biodiversity due to the destruction of the natural vegetation and resultant loss of habitat for insects and amphibians. However, the wetland plays a role in terms of sediment trapping, toxicant and phosphate removal, and erosion control.

# 6. DISCUSSION

The study area falls within the Quaternary Catchment C22B and contains a single stream that drains through the site in its north-western corner. The Quaternary Catchment has been subdivided into a local catchment of 890.71 ha, which incorporates the total drainage area for the unnamed stream as it exists in the study area (Figure 3). All identified wetland habitats within the study area are associated with this particular stream, which forms a tributary of the Natalspruit, one of the most polluted perennial rivers in Gauteng. The stream originates 3.67 km upstream of the study area just north of the Geldenhuis interchange and joins several other tributaries before it flows into the Natalspruit, approximately 9.13 km downstream of the study area. The local catchment is characterised by a highly urbanised area with several slimes dams that drain into a single stream, which has been highly transformed in terms of its hydrology and biodiversity.

The areas around the wetland on the study site have been highly disturbed by the reclamation process, with the result that little topsoil and organic material remain. Sedimentation has been taking place inside the *Phragmites australis* wetland due to the higher frictional surface of the vegetation and the gentle slope of the wetland compared to the rest of the study area. Consequently, topsoil with signs of wetness and organic material are present in the *Phragmites australis* wetland.

The vegetation is homogeneous comprising a large stand of *Phragmites australis* with a few other species present in the wetland. The areas around the wetland have been transformed with sludge from the slimes dam that has been washed into the wetland. The biodiversity and species composition of the total area is low with a **low-moderate ecosystem functioning**. The degradation that has taken place is of such a scale that the damage is considered to be irreversible. The few remaining functions of the wetland ecosystem have been severely compromised, however, it still performs important wetland-related functions such as erosion control, sedimentation, filtration and the support of various bird and insect species.

The main threats to wetland functioning on the site relate to the loss of habitat due to the slimes dam reclamation process and other anthropogenic factors. This entails that the original hydrological functioning of the wetland has effectively been lost, as well as any hydrological linkage that may have previously existed between the valley bottom wetland on the site and the areas outside the site.

Based on the PES, EIS and ecosystem services scores the wetland has a **low sensitivity**, **ecological functioning and diversity**. It must however, still be emphasized that the total wetland is considered as having a moderate ecosystem value mainly due to its erosion control, sedimentation and filtration functions/services.

The alien plant species pose a huge threat not only to the wetland area of the site, but also to the larger wetland system to which this wetland has some linkage. These species not only displaces the indigenous species, but also use more water and lowers the ecosystem functioning and conservation value of the total ecosystem.

# 7. CONCLUSION

The ecological significance of the wetland should be viewed in the context of the overall **level of functionality of the wetland, which is thought to be low**, and in the context of the hydrological 'isolation' of the wetland, which has resulted from significant historical modification and thus transformation of the ecosystem. The overall environmental significance of the wetland would thus be higher if a higher level of functionality was displayed or if it was less disturbed or transformed.

However, the remaining ecological functionality of the wetland would be lost if the wetland were to be destroyed. It must also be remembered that wetlands are protected under the National Water Act, and that the Act does not discriminate between degraded and non-degraded wetlands in terms of their importance. It is therefore recommended that a 30m buffer zone (Figure 6) is placed around the wetland. Construction activities should be restricted to the areas outside the buffer zone. As the majority of vegetation on the site has been totally transformed as well as cleared no negative impact is expected on the vegetation or functioning of the wetland.

All alien invasive vegetation along the wetland must be removed and eradicated from the property.

The proposed infrastructure should be constructed within the transformed or secondary succession areas. It is imperative that adequate stormwater management measures are implemented around the infrastructure and access roads.

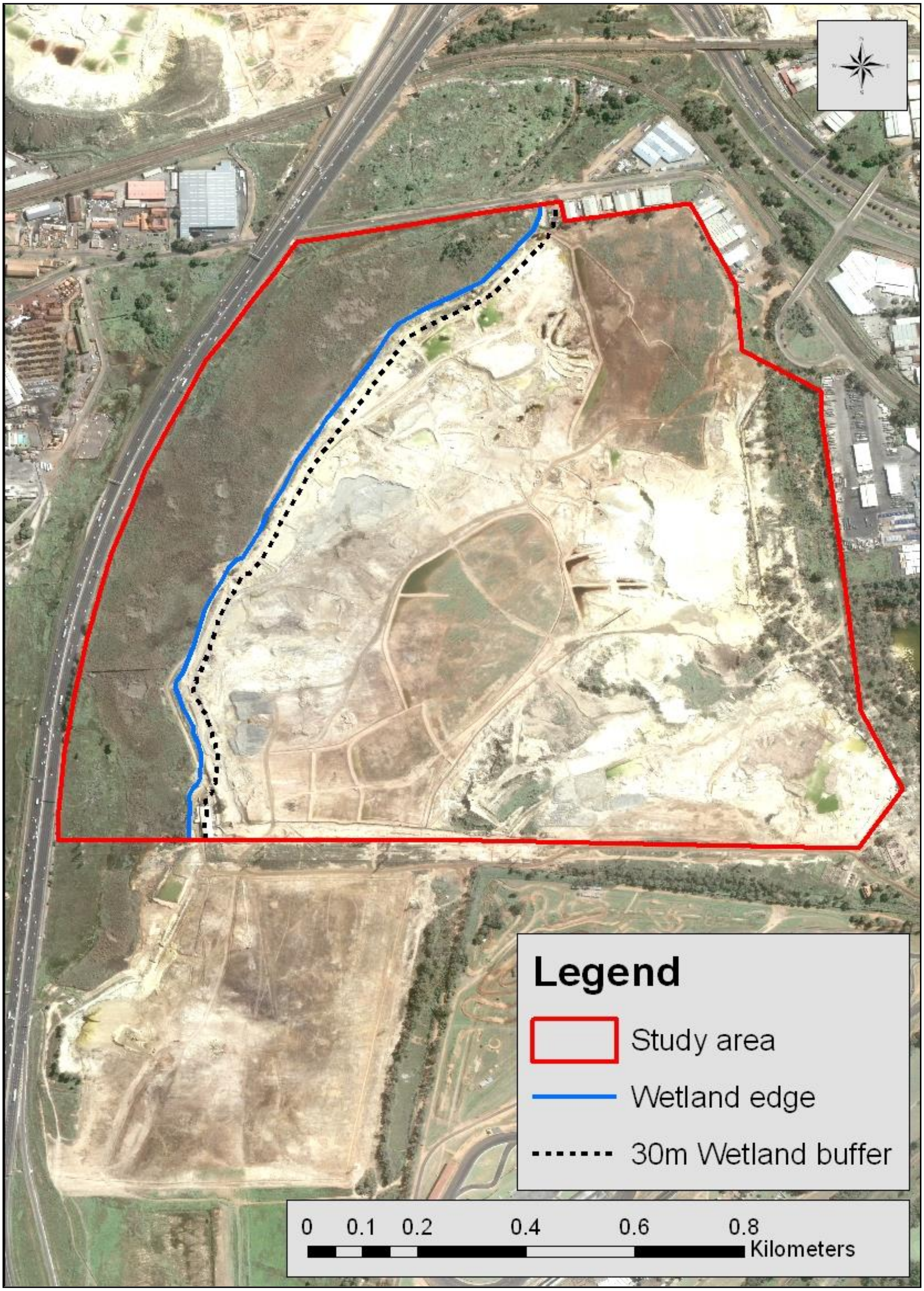



**Figure 6.** Wetland with 30m buffer zone

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