Appendix D: Specialist reports

Plant Ecological and Fauna Habitat Assessment

of

SAMANCOR MIDDELBURG FERROCHROME TERRAIN

Prepared for:

Environmental Assurance (Pty) Ltd

March 2011

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1. Introduction:

Yggdrasil Scientific Services (YSS) and Galago Environmental were appointed to conduct a plant ecological, mammal, avifauna, reptile and amphibian survey on the Samancor Middelburg Ferrochrome terrain, a Portion of the farm Middelburg Town and Townlands 287 JS for the closure of the slimes dam.

2. Location of the study site:

The 350 hectares study site (2529CD) is located south-east and adjacent to Middelburg residential suburbs in the 2529CD quarter degree grid cell and elsewhere are surrounded by industrial sites and roads (Mandela Drive and N11). About half of the site is taken up by the ferrochrome processing plant. The other half is located to the south-west and is undeveloped.

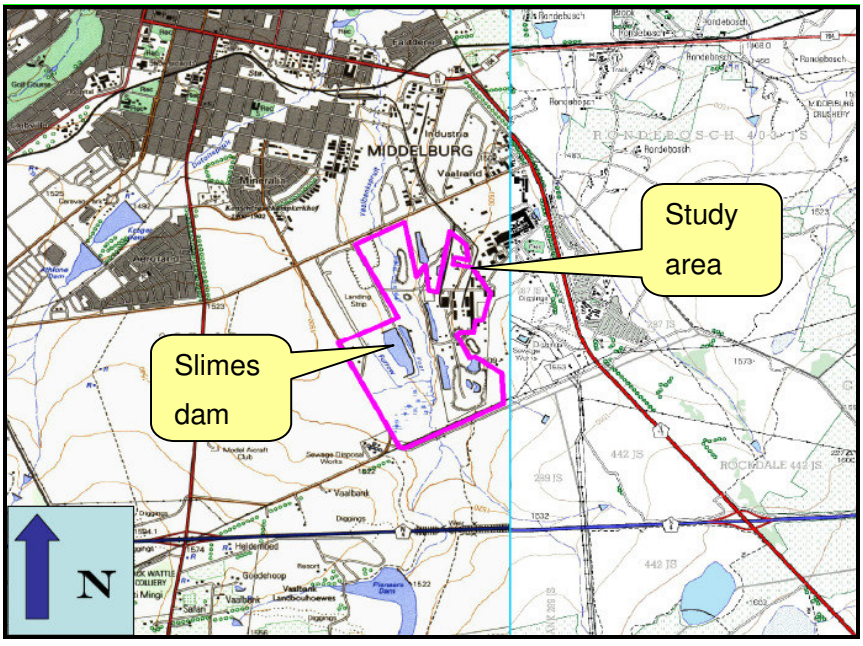

Figure 1: Locality map of the study area

3. Plant Ecological Assessment

Only two main plant communities were identified namely *Phragmites mauritianus - Kniphofia porphyrantha* wetland and the *Hyparrhenia hirta - Hypoxis hemerocallidea* grassland. In both of these plant communities disturbance was evident. Other areas associated with the industrial activities as well associated infrastructure i.e. roads, landing strips etc., were mapped as disturbed areas. Both of these plant communities were assigned a high species richness as they are seen as important to conserve plant biodiversity and also important to remain conserved to ensure that national as well as provincial conservation targets are met. See Appendix A for the Plant Ecological Report

4. Fauna assessment:

The **mammal** study found that the Vaalbank Spruit and its riparian zones are regarded as ecologically sensitive. The slimes dam area to the west of the Ferrochrome plant is not regarded as ecologically sensitive.

The closure program will have no effect on terrestrial mammals with territories / home ranges some distance away from the work. The rehabilitation process if done correctly with slopes that is sufficient for small mammals to navigate will in the end create a much-improved habitat, especially if landscaping and reseeding are implemented to accelerate floral and vertebrate repopulation. See Appendix A for the Mammal report.

The **avifauna study** found that the wetland habitat offers ideal breeding, roosting and/or foraging habitat for two Red Data avifaunal species, the African Grass-Owl and African Marsh-Harrier. African Grass-Owls was observed roosting within the *Imperata cylindrica* wetland grass and it is possible that they also will breed within the area during February to April. The African Marsh-Harrier was not observed on the study site but the wetland habitat will favour this species, at least for foraging purposes. An area of at least 200 meter from the edge of the wetland should be left undisturbed to act as a buffer zone for both the African Grass-owl and the African Marsh-owl. The rest of the grassland area could offer ideal foraging habitat for Lesser Kestrel. However they are only likely to forage over the area on occasion, since more suitable open grassland habitat can be

found surrounding the study site that will favour this species. The threat to this species is mainly focused on the northern Palaearctic range where this species breed.

It is important to realise that rehabilitated of the slimes dam area could result in disturbance to the red listed African Grass-Owls, either during the breeding season or during the non-breeding season when this species roost in the area. The area to be rehabilitated is situated to the south of the wetland area where the African Grass-Owls were found. It is therefore recommended that rehabilitation practices be implemented as far away from the wetland system as possible. Heavy vehicles that transport topsoil to the slimes dam should stay clear of the sensitive wetland area and use the shortest route over the wetland as possible. Noise by implements sloping the slimes dam or working in the area must be kept to a minimum. See Appendix B for the Avifauna report.

The **herpetological** study found that the study area has been severely disturbed since the 1960s. As this has created near lifeless areas with regards to amphibians and reptiles, with edge effects on the adjacent terrain, it is a commendable proposal to rehabilitate. At present the impression is that a reasonable list of amphibians and reptiles has been documented in the past from the relevant quarter degree grid cell, but little evidence exists that these species are still present. Population densities appear to be very low, which may be due to additional stresses, such as toxic effluent and air pollution in the vicinity of the industrial centre. Rehabilitation of the slimes dam with the proper slopes could improve the herpetofaunal biodiversity on the site, if vegetation species could attract insects and other small mammals that is a food source. See Appendix C for the herpetological report

5. Mitigation:

From a plant ecological perspective it is proposed that:

The slimes dam has already been rehabilitated and vegetation has re-established on the slimes dam. Increase in alien and invasive species should be monitored. During the original rehabilitation of the slimes dam there was numerous disturbance events. Disturbance events lead to the destruction of the internal competition between the originally occurring plant species. Because of the removal of these plant species a window of opportunity exist for alien and invasive species to enter the ecosystem and successfully establish themselves. The vegetation has re-established itself and natural competition between revegetated and/ indigenous and alien and invasive plants. However it is still recommended that the alien and invasive species should be controlled. Methods for the control of alien and invasive species include:

- Mechanical control methods. The removal of species by hand or with appropriate tools, instruments and machines
- Chemical control methods. The optimal use of herbicides to control target species.
- Biological control. This involves the intentional use of populations of natural enemies of the target alien or invasive species or other methods that adversely affect the biological integrity of the target species.
- Habitat management uses measures such as prescribed burning, grazing and other activities
- Integrated pest management (IPM). IPM involves a combination of methods above based on ecological research regular monitoring and careful co-ordination (WESSA – KZN, 2008).

It is also recommended that drainage lines the rehabilitated slimes dam are checked to ensure that they are free-draining of and institute corrective action if unnecessary impoundment or scouring is identified

From a faunal perspective mitigation proposed is that:

Mitigation proposed is that:

- At least 100 ha of wetland areas and a minimum terrestrial buffer of 200 m from the edge of a wetland/stream should be left undisturbed to act as suitable breeding and foraging habitat for African Grass-Owls and the African Marsh-Harriers.
- Proper veld management practises should be implemented with respect to grazing, burning and control of woody invasions.
- **No vehicles should be allowed to move in or across the wet areas or drainage lines and possibly get stuck.** This leaves visible scars and destroys habitat, and it is important to conserve areas where there are tall reeds or grass, or areas where there is short grass and mud.
- It is suggested that where work is to be done close to the drainage lines, these areas **be fenced off during construction,** to prevent heavy machines and trucks from trampling the plants, compacting the soil and dumping in the system.
- Alien and invasive plants must be removed from the wetland.

6. Environmental sensitivity:

6.1. Plant ecological perspective

On a national scale the study area fell within the Rand Highveld Grassland vegetation unit which poorly conserved currently since only 1% of this vegetation unit is conserved. This vegetation unit is also seen as endangered. The conservation target set for this vegetation unit is 24%.

On a provincial scale the study area fell within the following conservation categories no natural habitat remaining, least concern, important and necessary and highly significant conservation areas. Plant community one fell within the important and necessary conservation area whilst plant community two fell within the highly significant conservation areas. Plant community one contained a high species richness whilst plant community two contained a medium species richness. Currently there is not a lot of activity present within the plant communities. There are also no future plans for these

plant communities in terms of land use and therefore they can make a significant contribution towards meeting national and provincial conservation targets. Both of these plant communities were therefore assigned a high species richness as they are seen as important to conserve plant biodiversity and also important to remain conserved to ensure that national as well as provincial conservation targets are met.

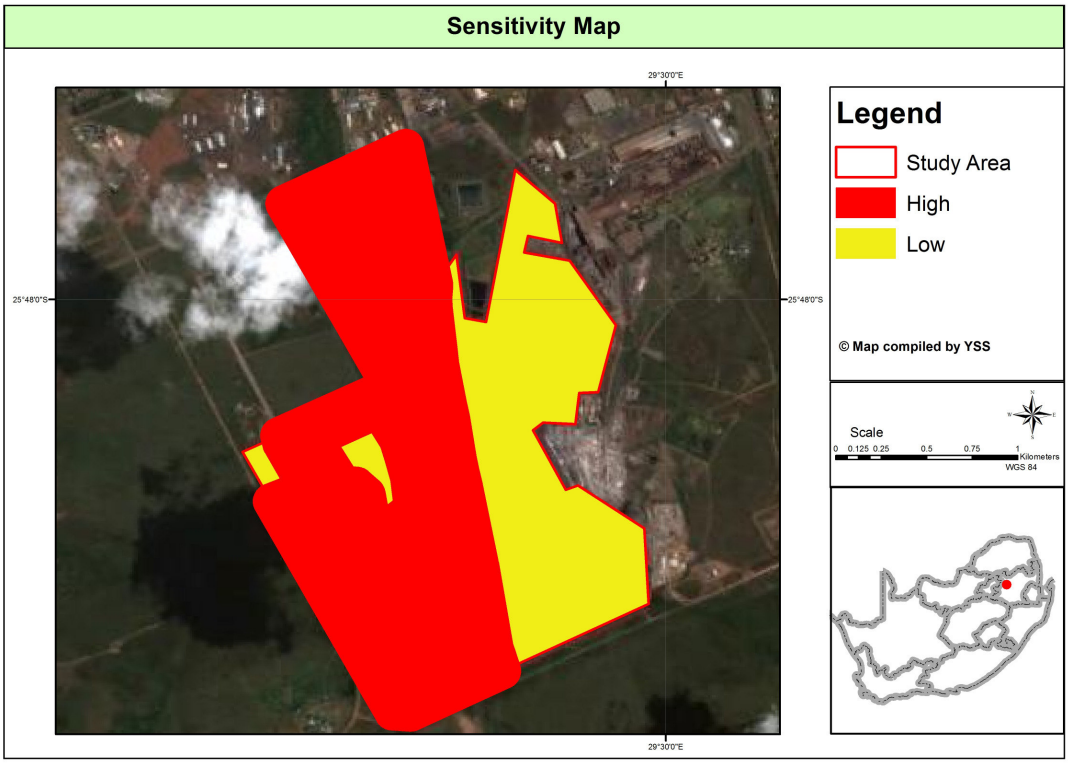

Figure 2: Plant ecological sensitivity map

6.2. Faunal perspective

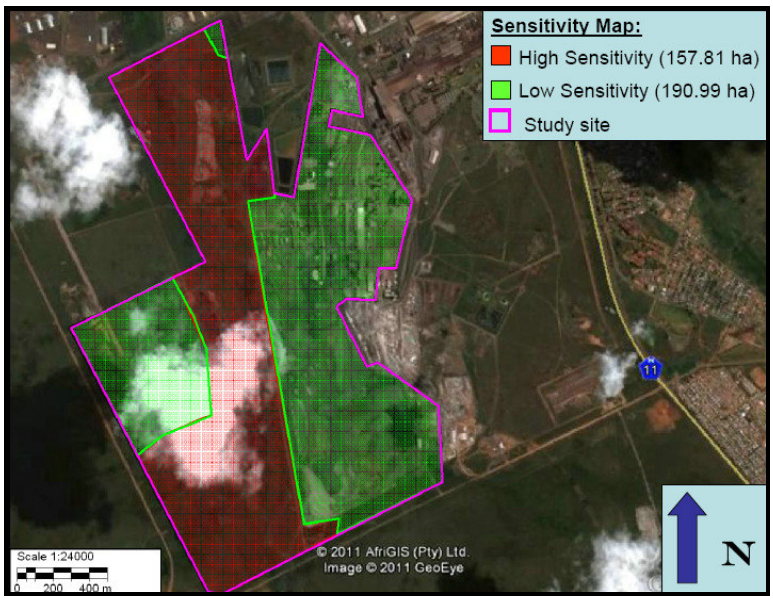

Figure 3: Combined fauna sensitivity map

Sensitivity mapping rules:

BIODIVERSITY ELEMENT	SENSITIVITY MAPPING RULE
Mammal and Herpetofauna habitat	Sensitive fauna habitat
Avifauna habitat	Sensitive avifauna habitat & 200m buffer for red listed birds

6. Conclusion:

The biodiversity study found that certain areas of the study site have a high sensitivity. Two main plant communities were identified during the site visit namely ***Phragmites mauritianus - Kniphofia porphyrantha*** wetland and ***Hyparrhenia hirta - Hypoxis hemerocallidea*** grassland. Large sections of the study area were disturbed. Both of the plant communities were assigned high because of species richness and or national and provincial conservation targets. Vegetation on the slimes dams have established. The re-established vegetation does include alien and invasive species. These species should be removed to ensure that natural succession continues on the closed slimes dams.

The wetland habitat offers ideal breeding, roosting and/or foraging habitat for two Red Data avifaunal species, the African Grass-Owl and African Marsh-Harrier as well as red listed mammals.

It is important to realise that closure of the slimes dam area could result in disturbance to the red listed African Grass-Owls, either during the breeding season or during the non-breeding season when this species roost in the area. The area to be rehabilitated is situated to the south of the wetland area where the African Grass-Owls were found. It is therefore recommended that rehabilitation practices be implemented as far away from the wetland system as possible. Heavy vehicles that transport topsoil to the slimes dam should stay clear of the sensitive wetland area and use the shortest route over the wetland as possible.

APPENDIX A: PLANT ECOLOGICAL REPORT

Plant Ecological Report

For the closure of the slimes dam
(Samancor)

Prepared for:
Environmental Assurance (Pty) Ltd

Date:
March 2012

Yggdrasil scientific services

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Declaration

I, Lorainmari den Boogert declare that -

- I act as the independent specialist;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of specialist

Yggdrasil Scientific Services (Pty) Ltd.

Name of company

15 March 2012

Date

Executive summary

This document reports on the findings made during the plant ecological study conducted on the 1St of December 2011 within the study area situated at Samancor.

The plant ecological study was conducted in order to determine the following:

- A literature review on the study area
- A floristic overview of the current vegetation on the study area
- Classifies the major vegetation units in the study area
- Identify all impacts as well as potential mitigation measures to minimise these impacts.
- Make recommendations pertaining to the conservation of any sensitive systems within the study area as well as recommendations specific to management during the different phases of the project.

The study area (Samancor Middelburg Ferrochrome) is situated approximately 2km southwest of Middelburg in the Mpumalanga Province. Sampling points were located on the Vaalankspruit.

Only two main plant communities were identified namely *Phragmites mauritianus - Kniphofia porphyrantha* wetland and the *Hyparrhenia hirta - Hypoxis hemerocallidea* grassland. In both of these plant communities disturbance was evident. Other areas associated with the industrial activities as well associated infrastructure i.e. roads, landing strips etc, were mapped as disturbed areas. Both of these plant communities were assigned a high species richness as they are seen as important to conserve plant biodiversity and also important to remain conserved to ensure that national as well as provincial conservation targets are met.

Two main plant communities were identified during the site visit namely ***Phragmites mauritianus - Kniphofia porphyrantha*** wetland and ***Hyparrhenia hirta - Hypoxis hemerocallidea*** grassland. Large sections of the study area were disturbed. Both of the plant communities were assigned high because of species richness and or national and provincial conservation targets. Vegetation on the slimes dams have established. The re-established vegetation does include alien and invasive species. These species should be removed to ensure that natural succession continues on the closed slimes dams.

For more recommendations, impacts and mitigation measures see full text..

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1 Introduction

An ecosystem is the interacting system that encompasses a biotic community and its non-living, physical environment. Vegetation, the primary producer in an ecosystem, is a logical choice of study because vegetation is:

- Immediately at hand for studying,
- Evident
- Familiar and easily identifiable if the elements (species) of the vegetation are known (Solomon *et al.* 2002).

Plant communities are defined as: "The collection of plant species growing together in a particular location that shows a definite association or affinity to each other" (Kent & Coker 2000). A plant community is unique in its floristic composition as well as the plant species abundances and associated habitat competition. Plant communities can occur in gradients as a result of continuity in environmental factor or they can be clear and easily identifiable unit. Vegetation is a readily observable expression of the ecology and relationships as well as a series of interactions between the biotic organisms and their abiotic environment and hence is a physical representation of an ecosystem. It is therefore of grave importance to determine the vegetation ecology of an area to assist before any conservation and land-use planning (Bredenkamp 2001, Bredenkamp & Brown 2001)

1.1 Project outline

This document reports on the findings made during the plant ecology study conducted on the 1st of December 2011 on the study area situated at Samancor. The slimes dam has already been rehabilitated and the studies are necessary to obtain a closure certificate.

The study was conducted by Yggdrasil Scientific Services (Pty) Ltd (from here on known as YSS), an independent ecological specialist company based in Pretoria, Gauteng, on behalf of Environmental Assurance (Pty) Ltd (from here on known as ENVASS). Lorainmari den Boogert (MSc. Plant Science) was responsible for the fieldwork, data interpretation as well as report writing.

1.2 Terms of reference

The plant ecological study was conducted in order to determine the following:

- A literature review on the study area
- A floristic overview of the current vegetation on the study area
- Classifies the major vegetation units in the study area
- Identify all impacts as well as potential mitigation measures to minimise these impacts.
- Make recommendations pertaining to the conservation of any sensitive systems within the study area as well as recommendations specific to management during the different phases of the project.

2 Project location

The study area is situated approximately 2km southwest of Middelburg in the Mpumalanga Province (Figure 1).

3 Description of the surrounding environment

3.1 The abiotic environment

3.1.1 *Climate and rainfall*

Climate data were obtained from the Agricultural Research Council – Institute for Soil, Climate and Water (ARC-ISCW) Climate Information System (www.arc.agri.za). The nearest reliable station with sufficient data (2001 to 2010) is that of Middelburg (30461) with altitude 1600mamsl and GPS coordinates 25.86352°S; 29.64211°E. The climate is typical of the Highveld, with warm summers (December to February) and cold winters (June to August). Rainfall typically occurs as thunderstorms of high intensity and short duration. All data are shown as mean ± standard error.

3.1.1.1 Rainfall

The site experience strongly seasonal summer rainfall, with very dry winters. The mean annual precipitation is 710.30 ± 13.75 mm (Figure 3), with the vast majority of the rainfall occurring as thunderstorms in the warm summer months (Figure 2), relatively uniform across most of the surrounding area (Barnard, 1999, Mucina and Rutherford, 2006). Incidence of frost ranges from 10 to 35 days per annum (Mucina and Rutherford, 2006)

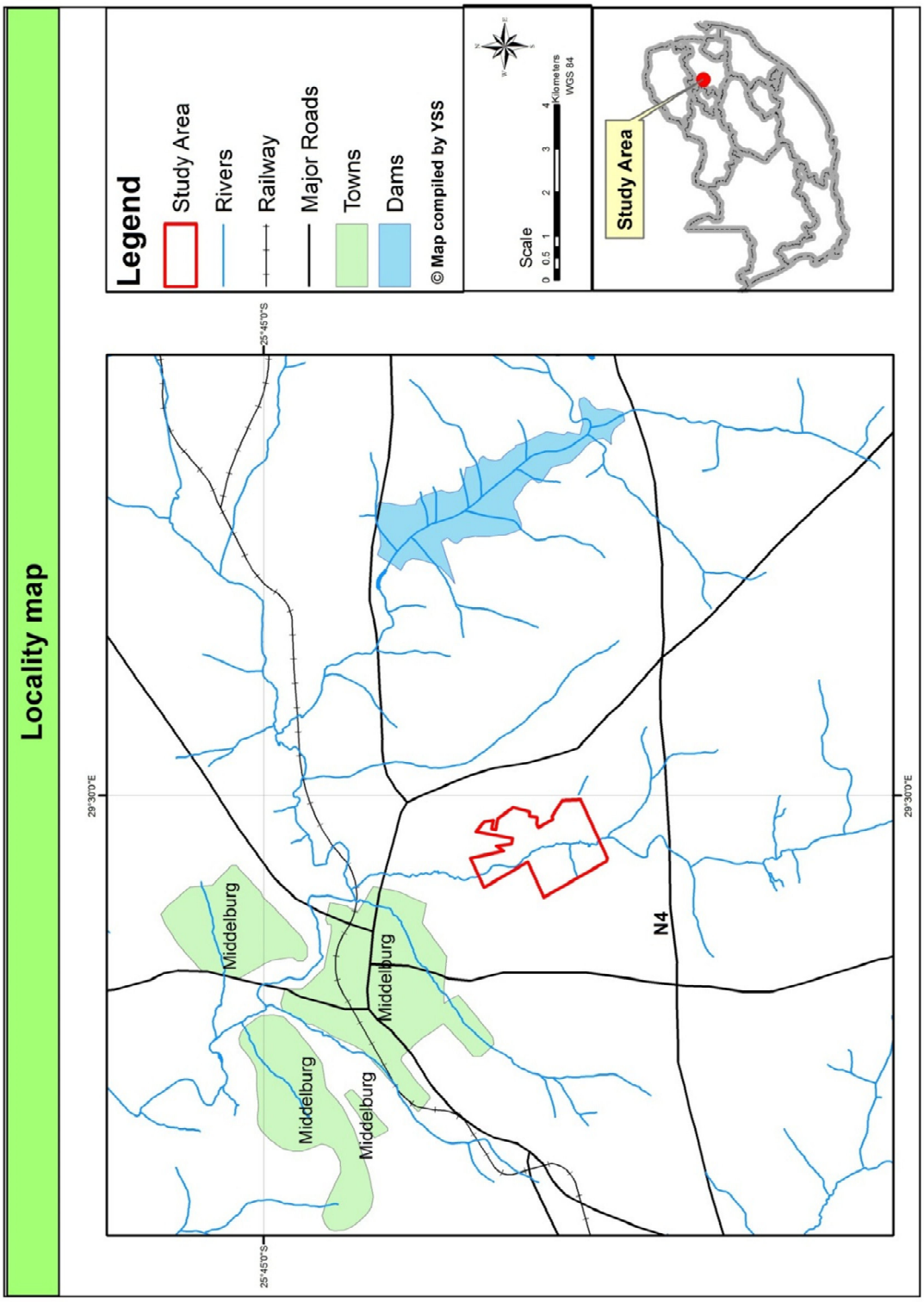

Figure 1. Location of the study area. The closest town is Middelburg. (approximately 2km away).

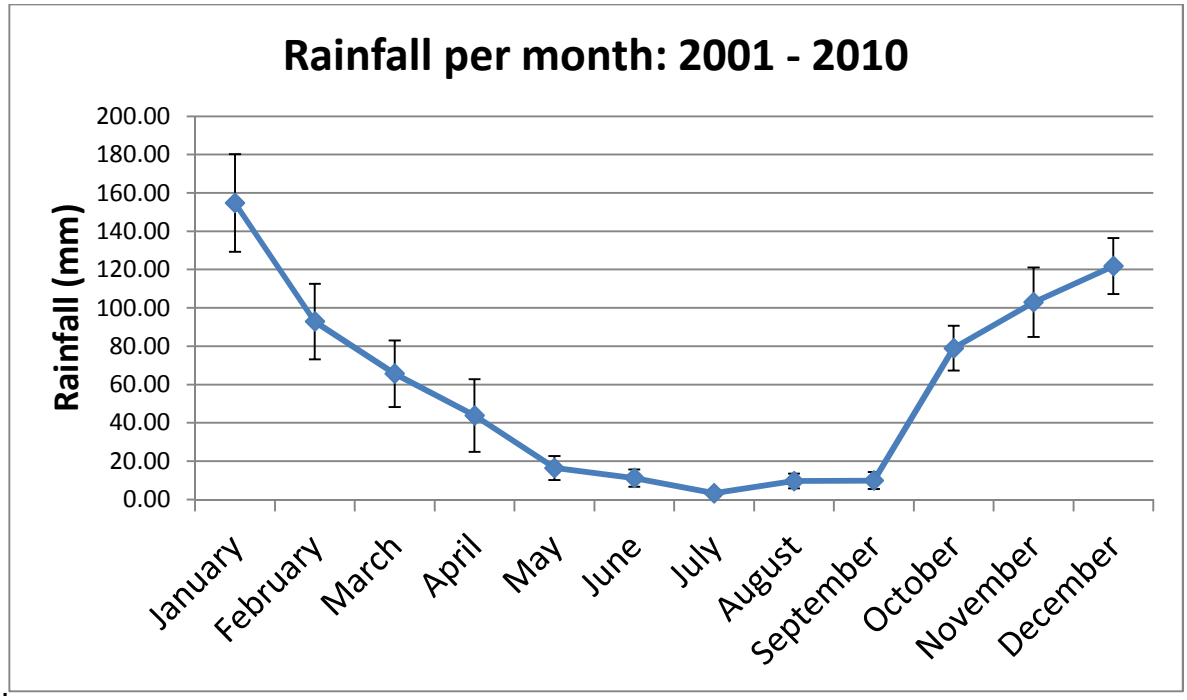

Figure 2. Mean monthly rainfall for Middelburg from 2001 to 2010.

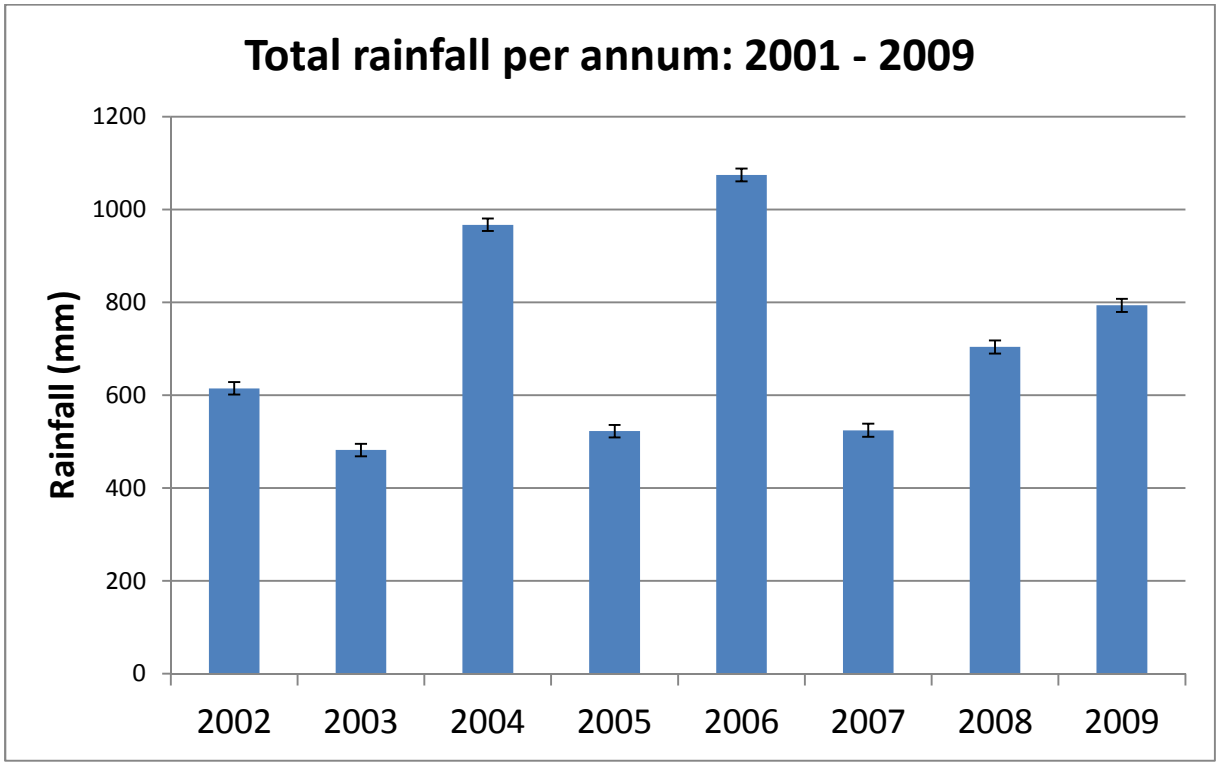

Figure 3. Mean annual rainfall for Middelburg from 2001 to 2010.

3.1.1.2 Temperature

The temperature recorded from the Middelburg station is summarized in Figure 4. Temperatures in the vicinity of the mine should approximate these temperatures. The mean maximum daily temperature exceeds 27°C between November and February, the hottest months, while the mean maximum daily temperature in the winter months (May to August) is just below 1°C.

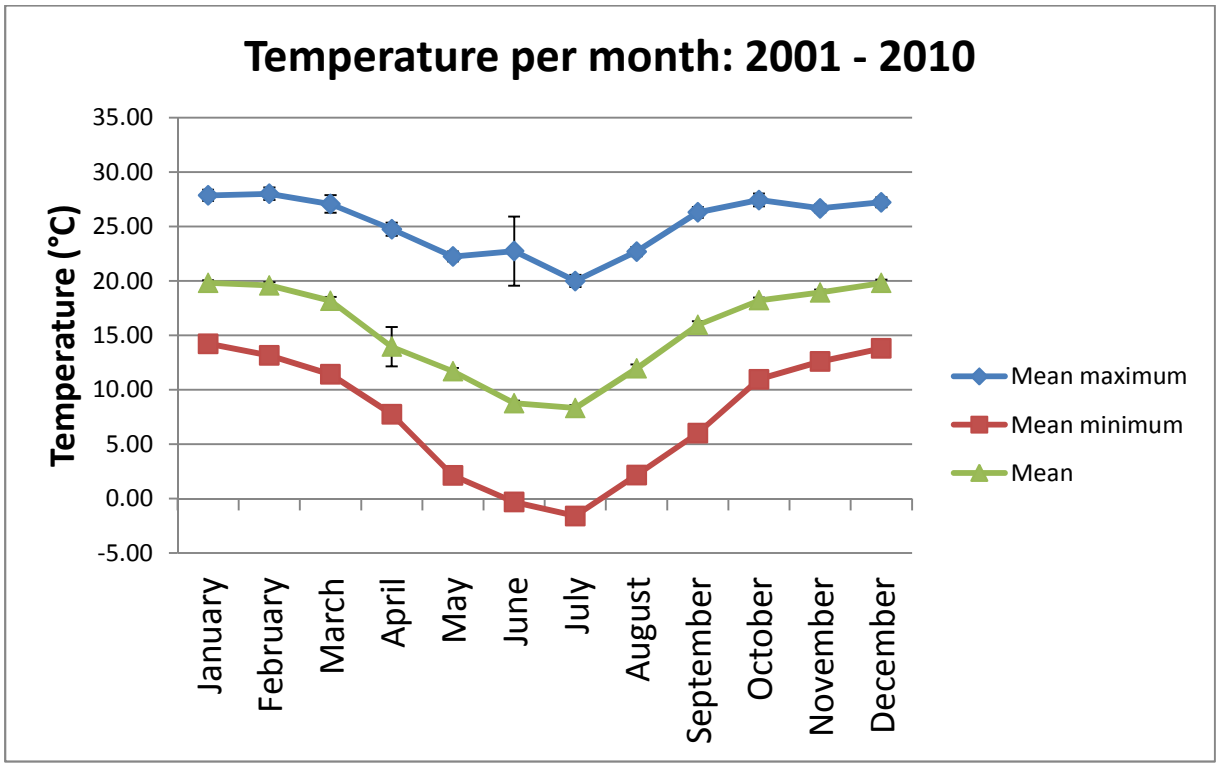

Figure 4. Mean maximum and minimum temperatures for Middelburg from 2001 to 2010.

3.1.1.3 Extreme weather conditions

The mine is situated in the Highveld zone which is characterized by occasional tornadoes and summer hailstorms. These hailstorms normally occur between mid-November and mid-April in the Witbank area. Thunderstorms occur frequently during summer and are usually accompanied by lightning, heavy rain, strong winds and occasional hail. Storms are localised and rainfall can vary considerable over short distances. An average of six hailstorms can be expected per annum. Frost occurs in the winter months, peaking with a mean occurrence of nine days in June. No definite pattern of draught could be determined from data.

3.1.2 *Topography and drainage*

Most of the study area is situated on valley bottom and hillslopes. The Vaalbankspruit runs through the study area (Figure 5). The Vaalbankspruit is a tributary of the Klein Olifants

River. The study area falls within the B12D quaternary catchment (Figure 5) which forms part of the Olifants River System.

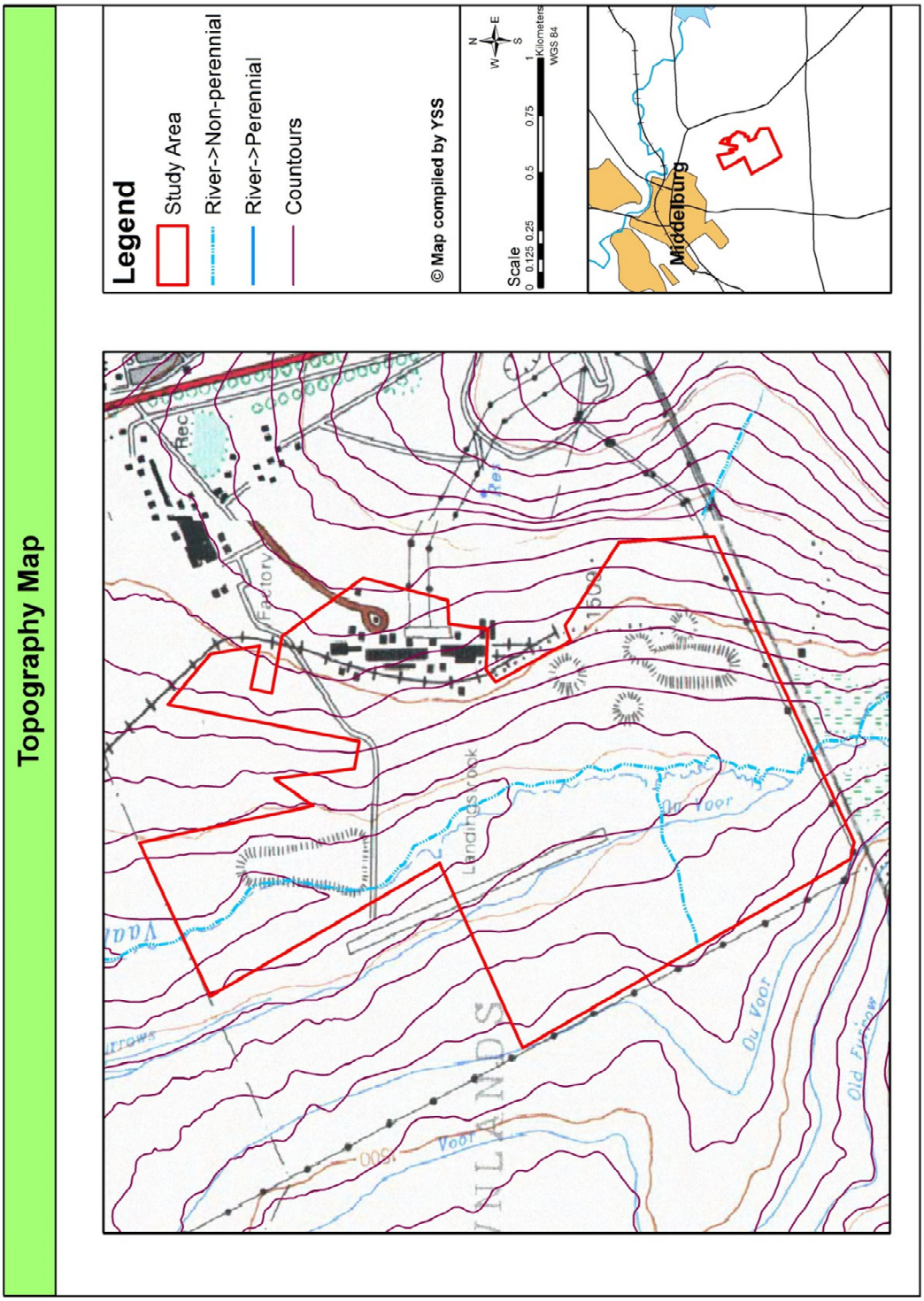

Figure 5. Topography and drainage patterns surrounding the sampling points. All sampling points were situated on the Vaalbankspruit.

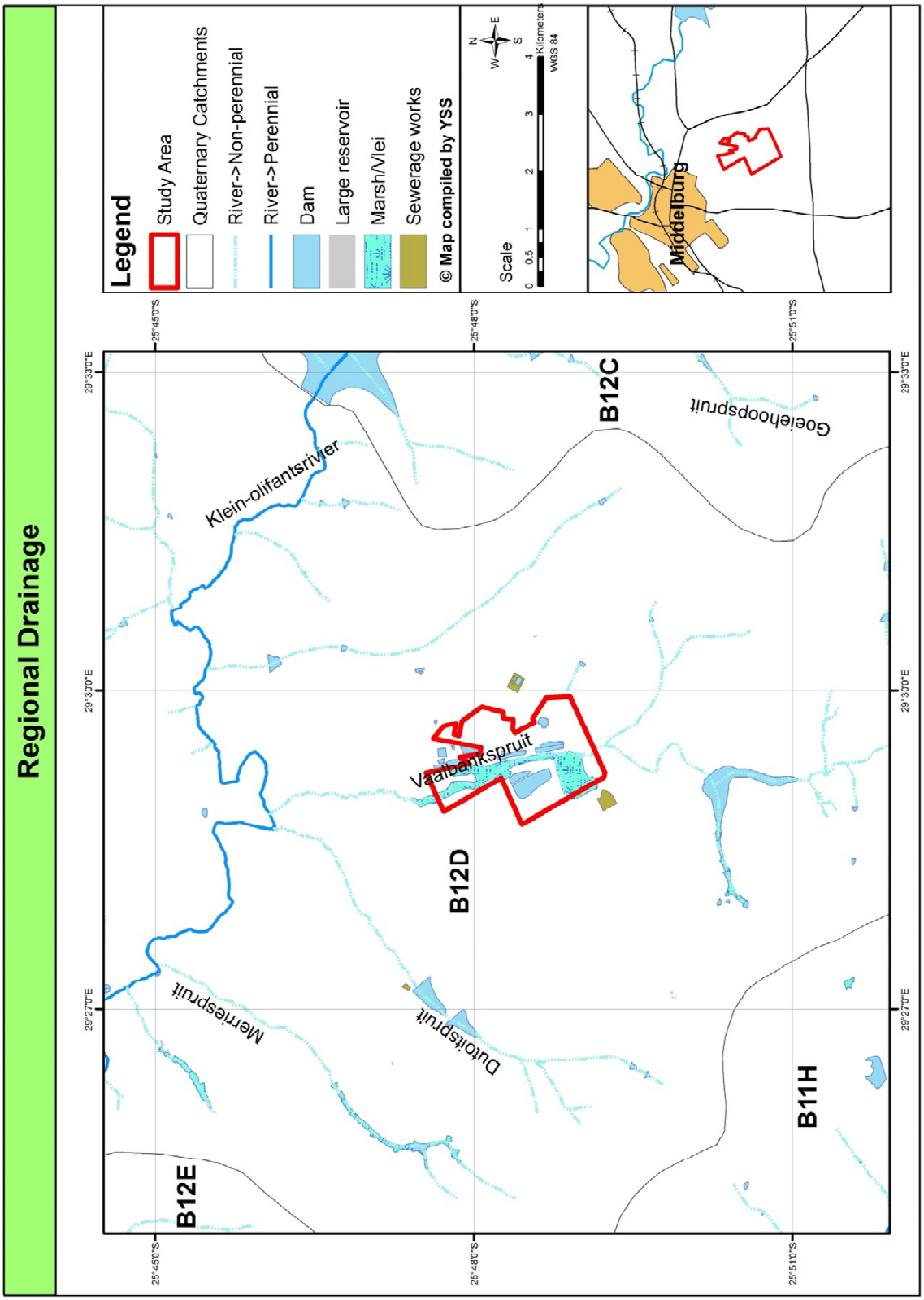

Figure 6. Regional drainage surrounding the study area

3.1.3 *Surrounding land use*

Land use surrounding the study area is best described as light industrial. Other surrounding land uses include:

- The Nasaret township
- Sewerage treatment plants,
- Farming and tourism.

3.2 Biotic environment

3.2.1 *Vegetation*

According to Acocks (1988) the natural veld-type which occurs in the project area can be described as 'Bankenveld vegetation' classified under the Grassland Biome. In terms of the new vegetation map constructed under the editorship of Mucina & Rutherford (2006) the study area falls within the Rand Highveld Grassland (Gm11). Other vegetation units in close proximity of the study area include the Eastern Highveld Grassland (Gm 12) and the Eastern Temperate freshwater (Figure 7).

The Rand Highveld Grassland lies within a highly variable landscape with extensive sloping plains and a series of ridges slightly elevated over undulating surrounding plains. The vegetation is species-rich, wiry, sour grassland alternating with low, sour shrubland on rocky outcrops and steeper slopes. It is rich in plant taxa (especially when in pristine condition) and constitutes sour grassland dominated by graminoid genera such as *Themeda*, *Heteropogon*, *Eragrostis* and *Elionurus*. The forb composition is equally diverse and well represented by members of the Asteraceae family, while the woody community forms a typical, albeit sparse, component of the ridges. It is poorly conserved and good examples are preserved in the Bronkhorstspruit Dam Nature Reserve. Large parts of this ecological type have been transformed by agriculture, forestation and urbanisation (Mucina & Rutherford 2006).

The Eastern Highveld Grassland area is dominated by Highveld grasses (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya*) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Acacia caffra, Celtis africana, Diospyros lycioides* subsp *lycioides, Parinari capensis, Protea caffra, P. welwitschii* and *Searcia magalismontanum*). The conservation status for the area is endangered and some 44% of the land has been transformed primarily by cultivation, plantations, mines, urbanisation and building of dams (Mucina & Rutherford 2006).

The freshwater wetlands in the surrounding area fall within the Eastern Temperate vegetation unit according to Mucina & Rutherford (2006) (Figure 7). The landscape can be described as flat or shallow depressions filled with (temporary) water bodies supporting zoned systems of aquatic and hygrophilous vegetation of temporarily flooded grasslands and ephemeral herblands. Some 15% of the Eastern Temperate wetlands have been transformed to cultivated land, urban areas or plantations. In some places intensive grazing and use of wetlands as drinking pools by cattle and sheep cause major damage to the wetland vegetation (Mucina & Rutherford 2006).

3.3 Mpumalanga biodiversity conservation plan

The Mpumalanga Biodiversity Conservation Plan (MBCP) maps the distribution of the province's known terrestrial ecosystems into five categories. These are ranked according to ecological and biodiversity importance and their contribution to meeting the quantitative targets set for each biodiversity feature (Ferrar & Lötter 2007). The categories are:

- *Protected areas* – already protected and managed for conservation
- *Irreplaceable areas* – protection crucial, no other options available to meet targets
- *Highly Significant areas* – protection needed, very limited choice for meeting targets
- *Important and Necessary areas* – protection needed, greater choice in meeting targets
- *Least concern* – areas of natural habitat that could be used to meet some conservation targets but not needed now, as long as other areas are not lost
- *No natural habitat remaining* – virtually natural habitat has been irreversibly lost as a result of cultivation, timber plantations, mining, urban development Ferrar & Lötter (2007).

The majority of the study area falls within the no natural habitat remaining category and the second largest portion of the study area is categorised as least concern. The study area does however contain some important and necessary and highly significant conservation areas. Highly Significant areas (50-99% irreplaceable) are described as areas where protection is needed and there is very limited choice for meeting targets according to Ferrar & Lötter (2007). Highly Significant areas need to be managed for the conservation of biodiversity.

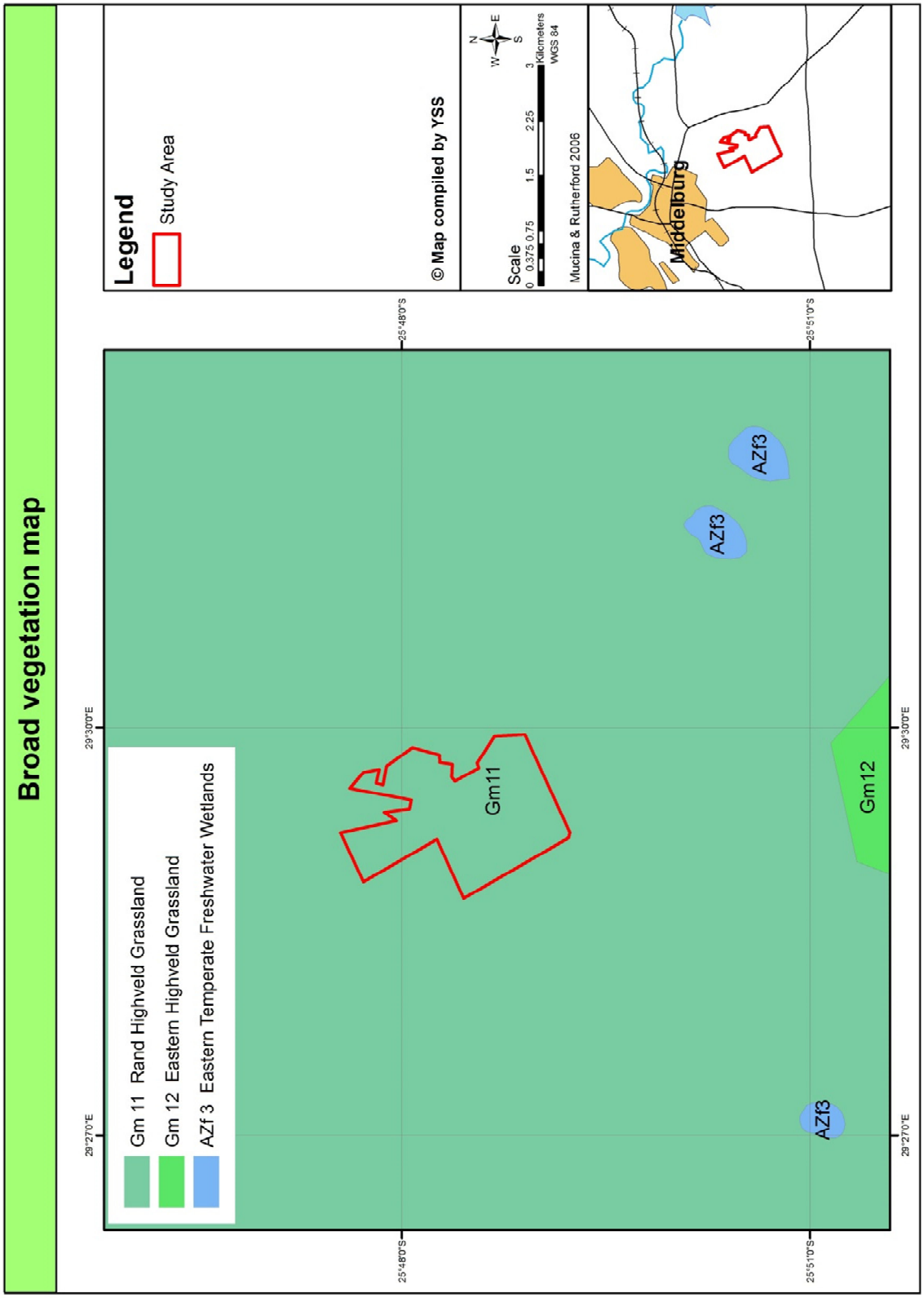

Figure 7. The study area falls within the Rand Highveld Grassland Gm11. Other vegetation units in close proximity to the study area are the Eastern Highveld Grassland (Gm12) and the Eastern Temperate Freshwater Wetlands (AZf3).

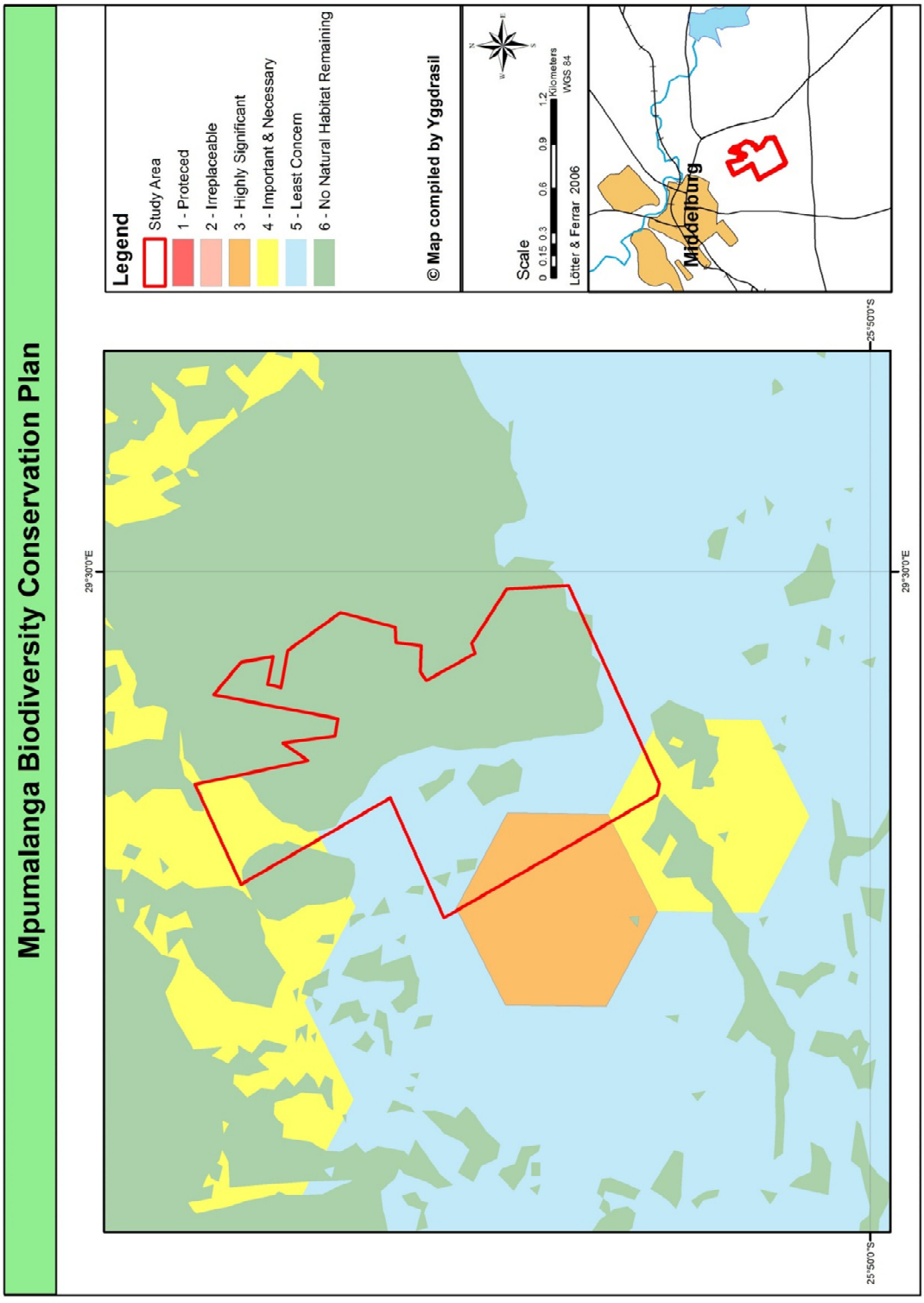

Figure 8. The study area falls within the Highly Significant, Important and Necessary, least concern and No Natural Habitat Remaining categories according to the terrestrial biodiversity categories based on the Mpumalanga Biodiversity Conservation Plan (Lötter and Ferrar 2006).

4 Methodology

The site was visited on the 1st and 2nd of December 2011 by Lorainmari le Grange (MSc Plant Science, UP).

Prior to the site visit the vegetation was delineated into homogenous units on a recent aerial photograph. At several sites within each homogeneous unit a description of the dominant and characteristic species was made. These descriptions were based on total floristic composition, following established vegetation survey techniques (Mueller-Dombois & Ellenberg 1974; Westhoff & Van der Maarel 1978). During the flora survey a species list was compiled. The term plant species refers to trees, shrubs, grasses and forbs. Comprehensive species lists were therefore derived for each plant community / ecosystem present on the site. These vegetation survey methods have been used as the basis of a national vegetation survey of South Africa (Mucina *et al.* 2000) and are considered to be an efficient method of describing vegetation and capturing species information. Notes were additionally made of any other features that might have an ecological influence.

The identified systems are not only described in terms of their plant species composition, but also evaluated in terms of the potential habitat for red data plant species.

A species list from POSA (http://posa.sanbi.org, November 2011, Grid reference: 2529CD&DC) containing the species that might occur in the area are listed in Annexure A. Red data species with updated threatened status according to the book Red list of South African Plants 2009 published by SANBI in *Strelitzia* 25 (Raimondo *et al.* 2009). These lists were then evaluated in terms of habitat available on the site, and also in terms of the present development and presence of man in the area.

Alien invasive species, according to the Conservation of Agricultural Resources Act (Act No.43 of 1983) as listed in Henderson (2001), are indicated. Medicinal plants are indicated according to Van Wyk, Van Oudtshoorn & Gericke (1997),

Plant species recorded in each plant community with an indication of the status of the species by using the following symbols:

A = Alien woody species

W = Weed

G = Planted in Garden (Garden Escape)

P = Protected trees species

D = Dominant

d = subdominant

M = Medicinal plant species p = Provincial protected species

RD = Red data listed plant

4.1 Assignment of species richness, conservation priority & sensitivity.

Species richness, conservation priority and sensitivity have all been quantified and or categorised to ensure that rationale behind the assignment of categories are clear. Four different categories of species richness have been identified namely low, medium, high and very high. Species richness was interpreted as the number of indigenous species recorded in the sample plots representing the plant community. Alien woody species and weeds were not included in the calculation of species richness. The categories were assigned as follows:

- A **low** level of species richness is allocated to communities which contain one to twenty four indigenous species.
- **Medium** level of species richness is allocated to communities which contain more than twenty five but less than forty indigenous species.
- **High** allocated to communities which contain more than forty but less than sixty indigenous species

Very high, is allocated only to communities which contain more than sixty indigenous species (Bredenkamp & Kemp 2010)

The following **conservation priority** categories were used for each plant community (Bredenkamp 2010):

- **High**: Ecologically sensitive and valuable land with high species richness and/or sensitive ecosystems that should be conserved and no development should be allowed.
- **Medium-high**: Land where smaller sections are disturbed but which is in general ecologically sensitive to development/disturbances.
- **Medium**: Land that should be conserved but on which low impact development could be considered under exceptional circumstances.
- **Medium-low**: Land of which small sections could be considered to conserve but where the area in general has little conservation value.

- **Low**: Land that has little conservation value and that could be considered for developed with little to no impact on the vegetation.

According to the GDARD (2009) minimum requirement only High and Low sensitivity must be indicated. No development will be allowed on High sensitive areas.

In terms of sensitivity the following criteria applies:

- **High**: High and Medium-High conservation priority categories mentioned above are considered to have a High sensitivity and development should not be supported.

- **Low:** Medium, Medium-Low and Low conservation priority categories mentioned above are considered to have a Low sensitivity and development may be supported. Portions of vegetation with a Medium conservation priority should be conserved.

Sensitivity mapping was done based on the conservation priority and sensitivity value. Areas with a high sensitive value were mapped with a 100 m buffer.

5 Results and discussion

5.1 Classification of the plant communities

Only two main plant communities were identified namely *Phragmites mauritianus - Kniphofia porphyrantha* wetland and the *Hyparrhenia hirta - Hypoxis hemerocallidea* grassland (Table 1). In both of these plant communities disturbance was evident. Other areas associated with the industrial activities as well associated infrastructure i.e. roads, landing strips etc., were mapped as disturbed areas. The plant communities as well as disturbed areas were mapped and each area was assigned both sensitivity as well as a conservation priority value as described in section 4.1 (Table 1,).

Table 1. Plant communities as well as their associated conservation priority and sensitivity value.

Plant communities	Conservation priority	Sensitivity
1. Phragmites mauritianus - Kniphofia porphyrantha	High	High
2. Hyparrhenia hirta - Hypoxis hemerocallidea	Medium-High	High

5.2 Description of the plant communities present

5.2.1 *Phragmites mauritianus - Kniphofia porphyrantha wetland*

Wetlands are defined by the South African National Water Act (Act No 36 of 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 soils”. All wetlands are protected by law (National Water Act 36 of 1998) because of their importance and their vulnerability to damaging impacts (Ferrar & Lötter 2007). Wetlands are important because they:

- Provide hydrological control which helps prevent soil erosion (attenuate floods, store and release water slowly);
- Recharge groundwater sources;
- Purify water by trapping many pollutants, including sediment, heavy metals and disease causing organisms;
- Are very productive since they supply nutrients and water in a stable environment for rapid plant growth and thus can be used as grazing areas if done on a sustainable basis; and
- Are one of the most biodiverse ecosystems, providing life support for a wide variety of species, some totally reliant on wetlands for their survival (Davies and Day 1998; DWAF 2005).

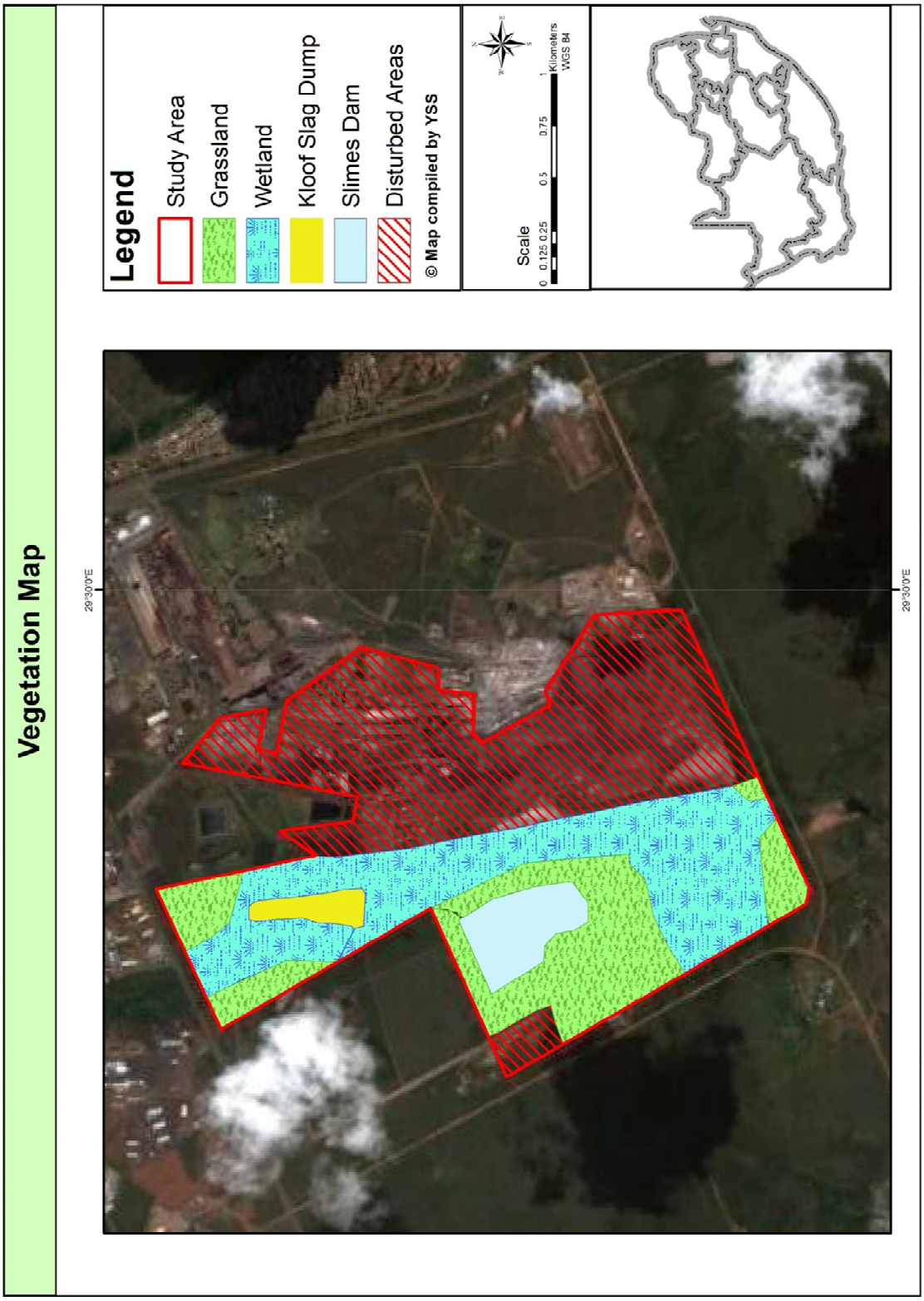

Figure 9. Vegetation map of the study area, indicating the presence of grassland, wetland and disturbed areas.

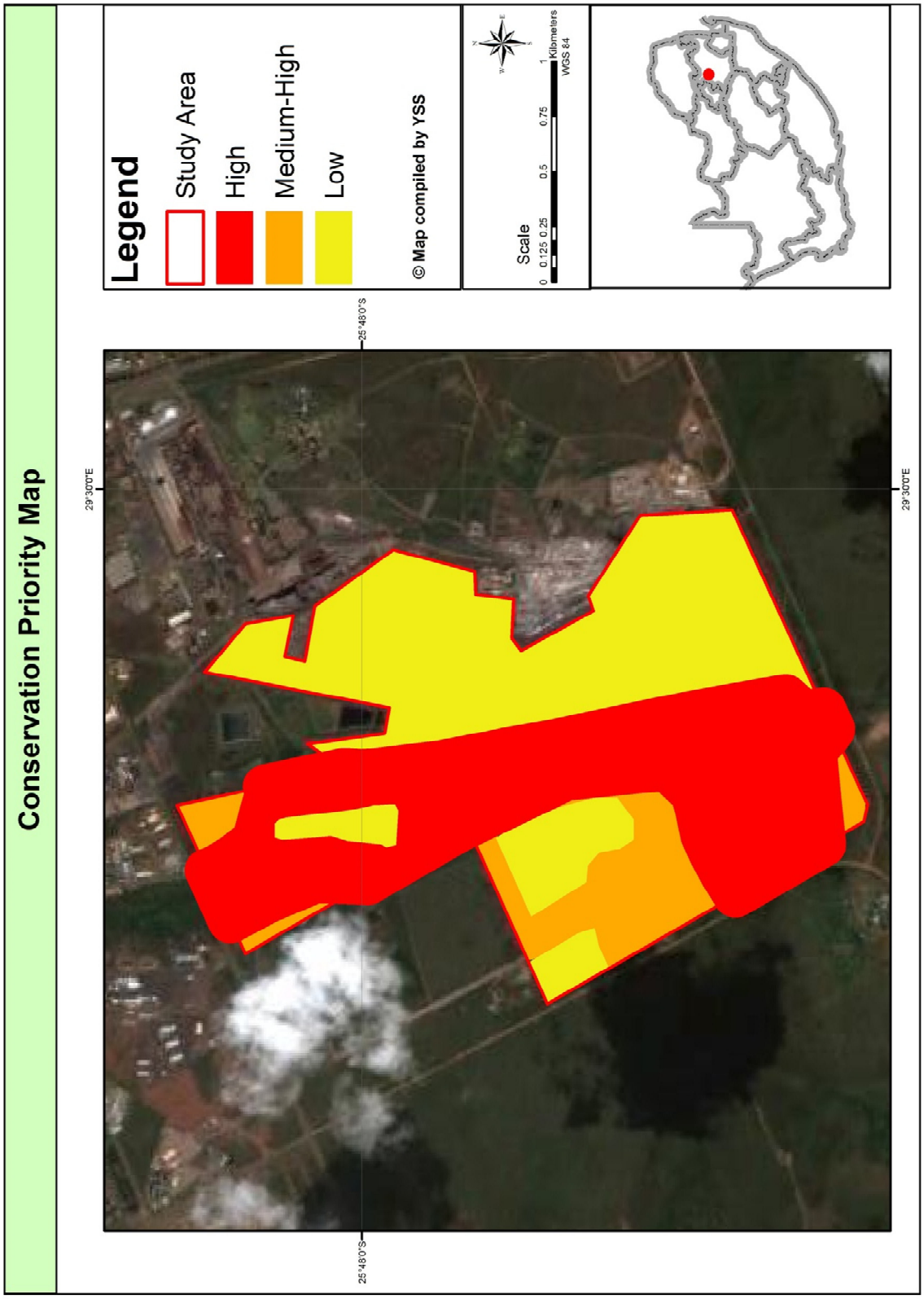

Figure 10.Map indicating the conservation priority of the plant communities present within the study area,

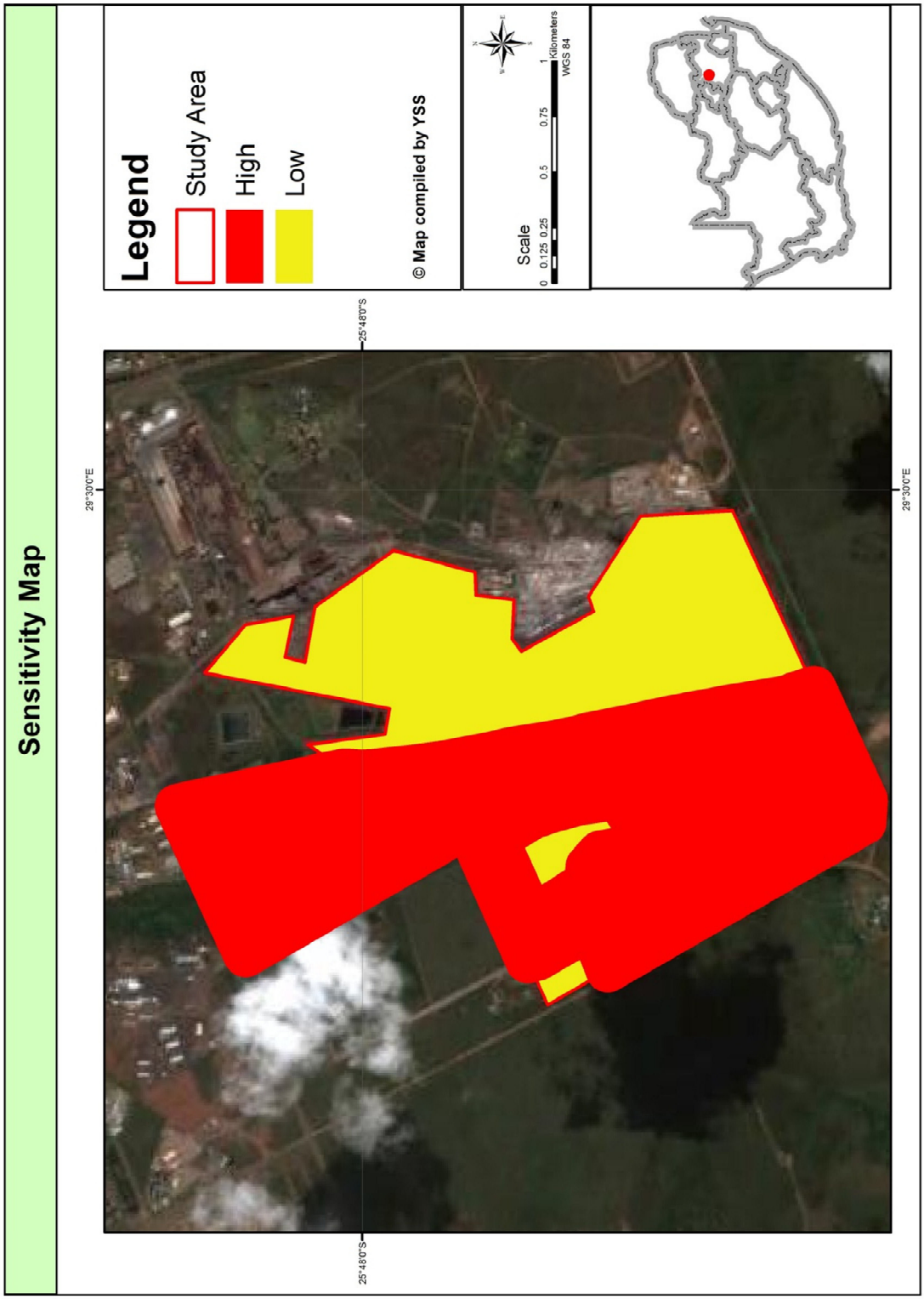

Figure 11. Map indicating the sensitivity of the plant communities present in the study area. All plant communities with a high sensitivity were mapped with a 100m buffer.

Wetlands are, however, some of the most threatened habitats in world today (DWAF 2005). In some catchments in South Africa, studies have revealed that over 50% of the wetlands have already been destroyed. Mining and pollution are two of the many culprits which alter the water flow and water quality, which kill or damage wetlands. Continued wetland destruction will result in less pure water, less reliable water supplies, increased severe flooding, lower agricultural productivity, and more endangered species (DWAF 2005).

This plant community was present along the Vaalbankspruit (channelled valley bottom) as well as a drainage line (hillslope seepage wetland), within the study area (Figure 9). The dominant species in the plant community was *Phragmites mauritianus*, and subdominant species were *Agrostis lachnantha* and *Imperata cylindrica.* The grass layer was the dominant layer in this plant community. The diagnostic species of this plant community was *Kniphofia porphyrantha.* This plant community contained 52 plant species in total seven of which were alien/invasive species. The plant community also contained a tree layer. The plant community contained a high species richness with 45 indigenous plant species (Table 2, Table 3, Figure 12). Parts of this plant community have recently been burnt. The plant community had a high species richness and was assigned a high conservation priority because of the valuable ecosystem services a wetland provides (Figure 10). The plant community was also assigned a high sensitivity (Figure 11). Although the plant community was mapped, no formal wetland delineation was conducted and mapping was based solely on aerial photography and vegetation observed during the site visit. The complete wetland areas on the site can't be determined by looking at the vegetation only, even if according to the National Water Act's definition of a wetland is vegetation the primary indicator. A complete detailed soil survey needs to be conducted on the site to determine the extent of the wetlands. Soil wetness indicators (hydromorphic soils) tend to be the key factor in delineating the wetlands (DWAF 2005).

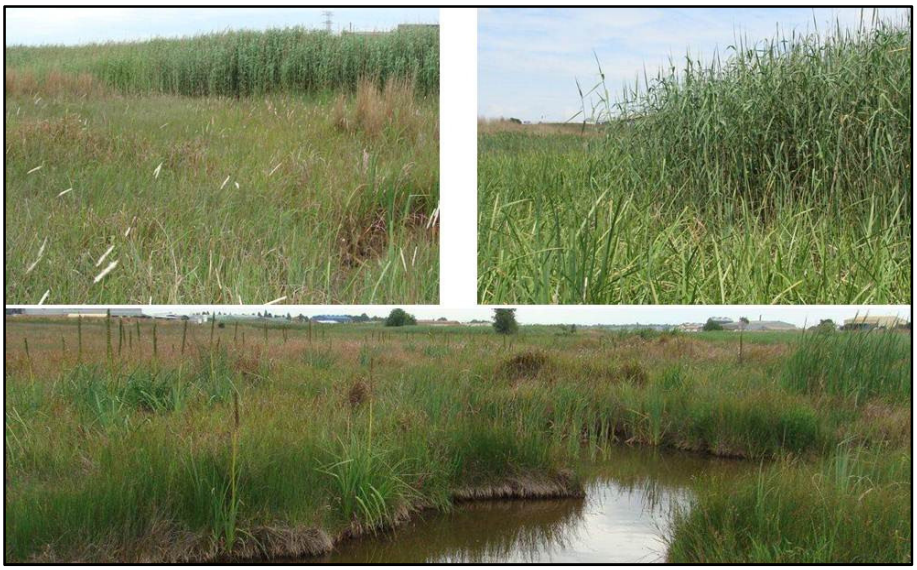

Figure 12. Images representative of the wetland plant community present in the study area

Table 2. Floristic list noted in plant community one

Trees

Species Name	Status
Celtis africana	
Combretum erythrophyllum	
Morus species	A
Salix species	A

Grasses

Species Name	Status
Agrostis lachnantha	d
Cynodon dactylon	
Digitaria eriantha	
Hyparrhenia hirta	
Imperata cylindrica	d
Leersia hexandra	
Panicum coloratum	
Pennisetum clandestinum	
Phragmites mauritianus	D
Themeda triandra	
Setaria pallide-fusca	

Forbs and Shrubs

Species Name	Status
Albuca species	
Barleria pretoriensis	
Berkheya radula	W
Bidens bipinnata	W
Carex austro-africana	
Chironia palustris	
Chlorophytum cooperi	
Cirsium vulgare	
Commelina africana	
Cyperus denudatus	
Euphorbia striata	
Fuirena pachyrrhiza	
Gazania krebsiana	
Gomphocarpus fruticosus	
Gunnera perpensa	
Juncus effusus	
Juncus exsertus	
Kniphofia porphyrantha	d
Kyllinga erecta	
Ledebouria cooperi	M
Monopsis decipiens	
Nidorella anomala	
Oenothera rosea	
Pelargonium luridum	
Physalis viscosa	
Pseudognaphalium luteo-album	

Ranunculus multifidus	
Scabiosa columbaria	
Senecio achilleifolius	
Senecio venosus	
Sonchus wilmsii	W
Tagetes minuta	W
Typha capensis	
Verbena bonariensis	W
Wahlenbergia undulata	
Zantedeschia aethiopica	
Zornia linearis	

Table 3. Description of the vegetation structure of plant community one

1. Phragmites mauritianus - Kniphofia porphyrantha wetland			
Status	Wetland		
Soil	Clay	**Rockiness**	
Conservation priority:	High	**Sensitivity:**	High
Agricultural potential:	Not evaluated	**Need for rehabilitation**	High
Dominant spp.	*Phragmites mauritianus*		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
Trees	4	3
Shrubs		
Grass	2.5	54
Forbs	0.5-0.1	27

5.2.2 *Hyparrhenia hirta - Hypoxis hemerocallidea grassland*

The plant community borders with the *Phragmites mauritianus - Kniphofia porphyrantha* wetland community (Figure 9). Parts of the plant community have recently been burnt. *Hyparrhenia hirta* is the dominant species of this plant community (Table 4 & Figure 13). *Hyparrhenia hirta* is a grass which indicates that anthropogenic disturbance had occurred in the area. This is plagioclimax grassland and will persist for approximately 20 to 30 years (O' Connor & Bredenkamp 1997). Subdominant species included *Themeda triandra*, *Imperata cylindrica* and *Fuirena pachyrrhiza*. The diagnostic species of the plant community was *Hypoxis hemerocallidea* (Table 4). The dominant layer of this plant community was the grasslayer (Table 5). During the site visit 37 plant species were recorded four of which were alien/invasive species. The plant community has a medium level of species richness. It does contain four medicinal plant species one of which, *Hypoxis hemerocallidea* is a listed declining species (Raimondo *et al.* 2009). The plant community has been assigned a medium to high conservation priority and subsequently a high sensitivity (Figure 10, Figure 11).

Figure 13. images of plant community two *Hyparrhenia hirta - Hypoxis hemerocallidea* grassland. a) subdominant *Themeda triandra* in the foreground, b) Dominance of *Hyparrhenia hirta* evident in the plant community.

Table 4. Floristic list noted in plant community two

Grasses

Species Name	Status
Brachiaria serrata	
Cynodon dactylon	
Elionurus muticus	
Eragrostis capensis	
Eragrostis curvula	
Heteropogon contortus	
Hyparrhenia hirta	D
Imperata cylindrica	d
Setaria pallide-fusca	
Themeda triandra	d

Forbs and Shrubs

Species Name	Status
Berkheya radula	
Boophane disticha	M
Chironia palustris	
Cirsium vulgare	
Elephantorrhiza elephantina	
Eucomis autumnalis	M
Euphorbia striata	
Fuirena pachyrrhiza	d
Hermannia transvaalensis	
Hypoxis hemerocallidea	M, RD
Hypoxis rigidula	M
Ipomoea ommaneyi	
Ipomoea transvaalensis	
Nidorella anomala	
Oenothera rosea	

Peucedanum magalismontanum	
Physalis viscosa	
Polygala hottentotta	
Pseudognaphalium luteo-album	
Psiadia punctulata	
Scabiosa columbaria	
Schkuhria pinnata	W
Sonchus wilmsii	W
Sphenostylis angustifolia	
Tagetes minuta	W
Verbena brasiliensis	W
Vernonia oligocephala	

Table 5. Description of the vegetation structure of plant community two

2. Hyparrhenia hirta - Hypoxis hemerocallidea grassland			
Status	Anthropogenic grassland		
Soil	Clay -Loam	**Rockiness**	Low
Conservation priority:	High	**Sensitivity:**	High
Agricultural potential:	Not evaluated	**Need for rehabilitation**	Moderate
Dominant spp.	*Paspalum dilatatum, Cyperus esculentus, Paspalum urvillei*		

Vegetation structure		
Layer	**Height (m)**	**Cover (%)**
Trees	10	9
Shrubs	1.3	3
Grass	0.7	23
Forbs	0.5-0.1	47

5.3 Conservation priority and sensitivity in comparison with national and provincial targets set

On a national scale the study area fell within the Rand Highveld Grassland vegetation unit which poorly conserved currently since only 1% of this vegetation unit is conserved. This vegetation unit is also seen as endangered. The conservation target set for this vegetation unit is 24% (Mucina & Rutherford 2006).

On a provincial scale the study area fell within the following conservation categories no natural habitat remaining, least concern, important and necessary and highly significant conservation areas. Plant community one fell within the important and necessary conservation area whilst plant community two fell within the highly significant conservation areas ((Ferrar & Lötter 2007). Plant community one contained a high species richness whilst plant community two contained a medium species richness. Currently there is not a lot of activity present within the plant communists. There are also no future plans for these plant communities in terms of land use and therefore they can make a significant contribution

towards meeting national and provincial conservation targets. Both of these plant communities were therefore assigned a high species richness as they are seen as important to conserve plant biodiversity and also important to remain conserved to ensure that national as well as provincial conservation targets are met.

6 Potential impacts and mitigation measures

The slimes dam has already been rehabilitated and vegetation has re-established on the slimes dam. Increase in alien and invasive species should be monitored. During the original rehabilitation of the slimes dam there was numerous disturbance events. Disturbance events lead to the destruction of the internal competition between the originally occurring plant species. Because of the removal of these plant species a window of opportunity exist for alien and invasive species to enter the ecosystem and successfully establish themselves. The vegetation has re-established itself and natural competition between revegetated and/ indigenous and alien and invasive plants. However it is still recommended that the alien and invasive species should be controlled.

Methods for the control of alien and invasive species include:

- Mechanical control methods. The removal of species by hand or with appropriate tools, instruments and machines
- Chemical control methods. The optimal use of herbicides to control target species.
- Biological control. This involves the intentional use of populations of natural enemies of the target alien or invasive species or other methods that adversely affect the biological integrity of the target species.
- Habitat management uses measures such as prescribed burning, grazing and other activities
- Integrated pest management (IPM). IPM involves a combination of methods above based on ecological research regular monitoring and careful co-ordination (WESSA – KZN, 2008).

It is also recommended that drainage lines the rehabilitated slimes dam are checked to ensure that they are free-draining of and institute corrective action if unnecessary impoundment or scouring is identified

7 Recommendations

It is recommended that all of the alien and invasive species be eradicated which are currently present on the slimes dam.

8 Assumptions and limitations

8.1 Assumptions

All mitigation measures contained in this plant ecological report will be considered.

8.2 Limitations

It is acknowledged that the knowledge of the vegetation specialist could be limited and there could be gaps in the information provided in this vegetation assessment report.

In order to obtain a comprehensive understanding of the dynamics of the vegetative communities in the project area, ecological assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints such long-term studies were not feasible and only one sampling trip was conducted in summer.

9 Conclusions

Two main plant communities were identified during the site visit namely ***Phragmites mauritianus - Kniphofia porphyrantha*** wetland and ***Hyparrhenia hirta - Hypoxis hemerocallidea*** grassland. Large sections of the study area were disturbed. Both of the plant communities were assigned high because of species richness and or national and provincial conservation targets. Vegetation on the slimes dams have established. The re-established vegetation does include alien and invasive species. These species should be removed to ensure that natural succession continues on the closed slimes dams.

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11 Annexure A. POSA Plant Species List (2529CD & 2529DC).

Family	Species	Threat status	Growth forms
ACANTHACEAE	*Blepharis innocua C.B.Clarke*	LC	Herb
ACANTHACEAE	*Chaetacanthus costatus Nees*	LC	Dwarf shrub, herb
ACANTHACEAE	*Dicliptera minor C.B.Clarke subsp. minor*	LC	Herb
ACANTHACEAE	*Justicia anagalloides (Nees) T.Anderson*	LC	Herb
ACANTHACEAE	*Ruttya ovata Harv.*	LC	Shrub
ACANTHACEAE	*Crabbea hirsuta Harv.*	LC	Herb
ACAROSPORACEAE	*Acarospora intrusa H.Magn.*		Lichen
ACAROSPORACEAE	*Acarospora laevigata H.Magn.*		Lichen
ACAROSPORACEAE	*Acarospora tenuis H.Magn.*		Lichen
AGYRIACEAE	*Trapeliopsis parilis Brusse*		Lichen
ALLIACEAE	*Tulbaghia acutiloba Harv.*	LC	Herb
AMARANTHACEAE	*Alternanthera pungens Kunth*	NE	Herb
AMARYLLIDACEAE	*Crinum bulbispermum (Burm.f.) Milne-Redh. & Schweick.*	Declining	Geophyte, hydrophyte
AMARYLLIDACEAE	*Crinum graminicola I.Verd.*	LC	Geophyte
AMARYLLIDACEAE	*Crinum macowanii Baker*	Declining	Geophyte
AMARYLLIDACEAE	*Nerine rehmannii (Baker) L.Bolus*	LC	Geophyte
AMARYLLIDACEAE	*Crinum graminicola I.Verd.*	LC	Geophyte
AMARYLLIDACEAE	*Nerine angustifolia (Baker) Baker*	LC	Geophyte
AMARYLLIDACEAE	*Nerine rehmannii (Baker) L.Bolus*	LC	Geophyte
ANACARDIACEAE	*Searsia dentata (Thunb.) F.A.Barkley*	LC	Shrub, tree
ANACARDIACEAE	*Searsia gerrardii (Harv. ex Engl.) Moffett*	LC	Shrub
ANACARDIACEAE	*Searsia magalismontana (Sond.) Moffett subsp. magalismontana*	LC	Dwarf shrub
ANACARDIACEAE	*Searsia montana (Diels) Moffett*	LC	Shrub, tree
ANACARDIACEAE	*Searsia pyroides (Burch.) Moffett var. pyroides*	LC	
ANACARDIACEAE	*Searsia gerrardii (Harv. ex Engl.) Moffett*	LC	Shrub
ANACARDIACEAE	*Searsia montana (Diels) Moffett*	LC	Shrub, tree

ANTHERICACEAE	*Chlorophytum fasciculatum (Baker) Kativu*	LC	Herb
ANTHERICACEAE	*Chlorophytum transvaalense (Baker) Kativu*	LC	Herb
APIACEAE	*Afrosciadium magalismontanum (Sond.) P.J.D.Winter*	LC	Herb
APIACEAE	*Alepidea peduncularis A.Rich.*	DDT	Herb
APIACEAE	*Centella asiatica (L.) Urb.*	LC	Climber, herb
APIACEAE	*Conium chaerophylloides (Thunb.) Sond.*	LC	Herb
APIACEAE	*Cyclospermum leptophyllum (Pers.) Sprague ex Britton & P.Wilson*	NE	Herb
APIACEAE	*Foeniculum vulgare Mill. var. vulgare*	NE	Herb
APOCYNACEAE	*Asclepias albens (E.Mey.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias brevipes (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias eminens (Harv.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias fallax (Schltr.) Schltr.*	LC	Herb
APOCYNACEAE	*Asclepias gibba (E.Mey.) Schltr. var. gibba*	LC	Herb
APOCYNACEAE	*Brachystelma circinatum E.Mey.*	LC	Geophyte, succulent
APOCYNACEAE	*Brachystelma nanum (Schltr.) N.E.Br.*	LC	Geophyte, succulent
APOCYNACEAE	*Brachystelma rubellum (E.Mey.) Peckover*	LC	Geophyte, succulent
APOCYNACEAE	*Cordylogyne globosa E.Mey.*	LC	Geophyte, succulent
APOCYNACEAE	*Cryptolepis cryptolepidioides (Schltr.) Bullock*	LC	Climber, shrub
APOCYNACEAE	*Duvalia polita N.E.Br.*	LC	Succulent
APOCYNACEAE	*Gomphocarpus rivularis Schltr.*	LC	Herb, shrub
APOCYNACEAE	*Gomphocarpus tomentosus Burch. subsp. tomentosus*	LC	Herb, shrub
APOCYNACEAE	*Huernia kirkii N.E.Br.*	LC	Succulent
APOCYNACEAE	*Huernia loeseneriana Schltr.*	LC	Succulent
APOCYNACEAE	*Huernia stapelioides Schltr.*	LC	Succulent
APOCYNACEAE	*Pachycarpus asperifolius Meisn.*	LC	Herb, succulent
APOCYNACEAE	*Pachycarpus suaveolens (Schltr.) Nicholas & Goyder*	VU	Herb, succulent
APOCYNACEAE	*Parapodium costatum E.Mey.*	LC	Herb, succulent
APOCYNACEAE	*Raphionacme galpinii Schltr.*	LC	Geophyte, herb, succulent

APOCYNACEAE	*Stapelia gettliffei R.Pott*	LC	Succulent
APOCYNACEAE	*Tavaresia barklyi (Dyer) N.E.Br.*	LC	Succulent
APOCYNACEAE	*Xysmalobium asperum N.E.Br.*	LC	Herb, succulent
APOCYNACEAE	*Gomphocarpus rivularis Schltr.*	LC	Herb, shrub
APOCYNACEAE	*Huernia loeseneriana Schltr.*	LC	Succulent
APOCYNACEAE	*Pachycarpus schinzianus (Schltr.) N.E.Br.*	LC	Herb, succulent
APOCYNACEAE	*Raphionacme galpinii Schltr.*	LC	Geophyte, herb, succulent
AQUIFOLIACEAE	*Ilex mitis (L.) Radlk. var. mitis*	Declining	Shrub, tree
ARACEAE	*Stylochaeton natalensis Schott*	LC	Herb
ARACEAE	*Zantedeschia albomaculata (Hook.) Baill. subsp. macrocarpa (Engl.) Letty*	LC	Geophyte, herb
ARCHIDIACEAE	*Archidium ohioense Schimp. ex Müll.Hal.*		Bryophyte
ASPARAGACEAE	*Asparagus flavicaulis (Oberm.) Fellingham & N.L.Mey. subsp. flavicaulis*	LC	Shrub
ASPARAGACEAE	*Asparagus virgatus Baker*	LC	Shrub
ASPHODELACEAE	*Aloe aculeata Pole-Evans*	LC	Herb, succulent
ASPHODELACEAE	*Aloe verecunda Pole-Evans*	LC	Herb, succulent
ASPHODELACEAE	*Aloe zebrina Baker*	LC	Herb, succulent
ASPHODELACEAE	*Chortolirion angolense (Baker) A.Berger*	LC	Geophyte, succulent
ASPHODELACEAE	*Kniphofia ensifolia Baker subsp. ensifolia*	LC	Herb
ASPHODELACEAE	*Kniphofia porphyrantha Baker*	LC	Herb
ASPHODELACEAE	*Trachyandra asperata Kunth var. carolinensis Oberm.*	LC	Geophyte, succulent
ASPHODELACEAE	*Trachyandra reflexipilosa (Kuntze) Oberm.*	LC	Geophyte, succulent
ASPHODELACEAE	*Trachyandra saltii (Baker) Oberm. var. saltii*	LC	Geophyte, succulent
ASPHODELACEAE	*Bulbine abyssinica A.Rich.*	LC	Geophyte, herb, succulent
ASPLENIACEAE	*Asplenium aethiopicum (Burm.f.) Bech.*	LC	Epiphyte, geophyte, herb, lithophyte
ASTERACEAE	*Aspilia mossambicensis (Oliv.) Wild*	LC	Herb
ASTERACEAE	*Aster harveyanus Kuntze*	LC	Herb
ASTERACEAE	*Aster peglerae Bolus*	LC	Herb
ASTERACEAE	*Berkheya speciosa (DC.) O.Hoffm. subsp. lanceolata Roessler*	LC	Herb

ASTERACEAE	*Blumea dregeanoides Sch.Bip. ex A.Rich.*	LC	Herb
ASTERACEAE	*Brachylaena rotundata S.Moore*	LC	Shrub, tree
ASTERACEAE	*Callilepis laureola DC.*	LC	Herb
ASTERACEAE	*Callilepis leptophylla Harv.*	Declining	Herb
ASTERACEAE	*Chrysocoma ciliata L.*	LC	Shrub
ASTERACEAE	*Conyza canadensis (L.) Cronquist*	NE	Herb
ASTERACEAE	*Conyza podocephala DC.*	LC	Herb
ASTERACEAE	*Cotula anthemoides L.*	LC	Herb
ASTERACEAE	*Denekia capensis Thunb.*	LC	Herb
ASTERACEAE	*Dicoma anomala Sond. subsp. gerrardii (Harv. ex F.C.Wilson) S.Ortíz & Rodr.Oubiña*	LC	Herb
ASTERACEAE	*Felicia muricata (Thunb.) Nees subsp. muricata*	LC	Shrub
ASTERACEAE	*Gamochaeta coarctata (Willd.) Kerguélen*	NE	Herb
ASTERACEAE	*Gazania krebsiana Less. subsp. serrulata (DC.) Roessler*	LC	Herb
ASTERACEAE	*Geigeria ornativa O.Hoffm. subsp. ornativa*	LC	Herb
ASTERACEAE	*Gerbera ambigua (Cass.) Sch.Bip.*	LC	Herb
ASTERACEAE	*Gerbera jamesonii Bolus ex Adlam*	LC	Herb
ASTERACEAE	*Gerbera natalensis Sch.Bip.*	LC	Herb
ASTERACEAE	*Gerbera piloselloides (L.) Cass.*	LC	Herb
ASTERACEAE	*Gnaphalium filagopsis Hilliard & B.L.Burtt*	LC	Herb
ASTERACEAE	*Haplocarpha scaposa Harv.*	LC	Herb
ASTERACEAE	*Helichrysum acutatum DC.*	LC	Herb
ASTERACEAE	*Helichrysum argyrolepis MacOwan*	LC	Dwarf shrub
ASTERACEAE	*Helichrysum aureonitens Sch.Bip.*	LC	Herb
ASTERACEAE	*Helichrysum caespititium (DC.) Harv.*	LC	Herb
ASTERACEAE	*Helichrysum chionosphaerum DC.*	LC	Herb
ASTERACEAE	*Helichrysum difficile Hilliard*	LC	Herb
ASTERACEAE	*Helichrysum lepidissimum S.Moore*	LC	Herb, shrub
ASTERACEAE	*Helichrysum mixtum (Kuntze) Moeser var. mixtum*	LC	Herb

ASTERACEAE	*Helichrysum nudifolium (L.) Less. var. nudifolium*	LC	Herb
ASTERACEAE	*Helichrysum rugulosum Less.*	LC	Herb
ASTERACEAE	*Helichrysum setosum Harv.*	LC	Herb, shrub
ASTERACEAE	*Helichrysum subluteum Burtt Davy*	LC	Herb
ASTERACEAE	*Hilliardiella hirsuta (DC.) H.Rob.*		Herb
ASTERACEAE	*Hypochaeris radicata L.*	NE	Herb
ASTERACEAE	*Lactuca inermis Forssk.*	LC	Herb
ASTERACEAE	*Lopholaena segmentata (Oliv.) S.Moore*	LC	Herb, succulent
ASTERACEAE	*Macledium zeyheri (Sond.) S.Ortíz subsp. zeyheri*	LC	Herb
ASTERACEAE	*Nidorella anomala Steetz*	LC	Herb
ASTERACEAE	*Nidorella hottentotica DC.*	LC	Herb
ASTERACEAE	*Nolletia rarifolia (Turcz.) Steetz*	LC	Suffrutex
ASTERACEAE	*Senecio glanduloso-pilosus Volkens & Muschl.*	LC	Herb
ASTERACEAE	*Senecio harveianus MacOwan*	LC	Dwarf shrub, herb
ASTERACEAE	*Senecio inornatus DC.*	LC	Herb
ASTERACEAE	*Senecio laevigatus Thunb. var. laevigatus*	LC	Herb
ASTERACEAE	*Senecio latifolius DC.*	LC	Herb
ASTERACEAE	*Senecio venosus Harv.*	LC	Herb
ASTERACEAE	*Seriphium plumosum L.*	NE	Shrub
ASTERACEAE	*Sonchus nanus Sond. ex Harv.*	LC	Herb
ASTERACEAE	*Vernonia galpinii Klatt*	LC	Herb
ASTERACEAE	*Zinnia peruviana (L.) L.*	NE	Herb
ASTERACEAE	*Berkheya zeyheri Oliv. & Hiern subsp. zeyheri*	LC	Herb
ASTERACEAE	*Dicoma anomala Sond. subsp. gerrardii (Harv. ex F.C.Wilson) S.Ortíz & Rodr.Oubiña*	LC	Herb
ASTERACEAE	*Helichrysum acutatum DC.*	LC	Herb
ASTERACEAE	*Helichrysum aureonitens Sch.Bip.*	LC	Herb
ASTERACEAE	*Helichrysum callicomum Harv.*	LC	Herb
ASTERACEAE	*Helichrysum mixtum (Kuntze) Moeser var. mixtum*	LC	Herb

ASTERACEAE	*Helichrysum oreophilum Klatt*	LC	Herb
ASTERACEAE	*Helichrysum stenopterum DC.*	LC	Herb
ASTERACEAE	*Senecio polyodon DC. var. polyodon*	LC	Herb
AYTONIACEAE	*Asterella wilmsii (Steph.) S.W.Arnell*		Bryophyte
BLECHNACEAE	*Blechnum australe L. subsp. australe*	LC	Geophyte, herb, lithophyte
BORAGINACEAE	*Cynoglossum lanceolatum Forssk.*	LC	Herb
BORAGINACEAE	*Trichodesma physaloides (Fenzl) A.DC.*	LC	Herb
BRASSICACEAE	*Heliophila rigidiuscula Sond.*	LC	Herb
BRASSICACEAE	*Lepidium bonariense L.*	NE	Herb
BRASSICACEAE	*Lepidium transvaalense Marais*	LC	Herb
BRYACEAE	*Bryum argenteum Hedw.*		Bryophyte
BRYACEAE	*Bryum pycnophyllum (Dixon) Mohamed*		Bryophyte, epiphyte
BRYACEAE	*Bryum argenteum Hedw.*		Bryophyte
BUDDLEJACEAE	*Nuxia congesta R.Br. ex Fresen.*	LC	Shrub, tree
BUDDLEJACEAE	*Gomphostigma virgatum (L.f.) Baill.*	LC	Dwarf shrub, herb, shrub
CAMPANULACEAE	*Wahlenbergia krebsii Cham. subsp. krebsii*	LC	Herb
CAPPARACEAE	*Boscia foetida Schinz subsp. rehmanniana (Pestal.) Toelken*	LC	Tree
CAPPARACEAE	*Cadaba aphylla (Thunb.) Wild*	LC	Shrub, tree
CAPPARACEAE	*Cleome maculata (Sond.) Szyszyl.*	LC	Herb
CAPPARACEAE	*Cleome monophylla L.*	LC	Herb
CARYOPHYLLACEAE	*Dianthus mooiensis F.N.Williams subsp. mooiensis var. mooiensis*	NE	Herb
CARYOPHYLLACEAE	*Pollichia campestris Aiton*	LC	Herb
CARYOPHYLLACEAE	*Silene undulata Aiton*	LC	Herb
CARYOPHYLLACEAE	*Pollichia campestris Aiton*	LC	Herb
CARYOPHYLLACEAE	*Spergularia media (L.) C.Presl*	NE	Herb
CELASTRACEAE	*Maytenus undata (Thunb.) Blakelock*	LC	Shrub, tree
CHENOPODIACEAE	*Chenopodium schraderianum Roem. & Schult.*	NE	Herb
CHENOPODIACEAE	*Chenopodium glaucum L.*	NE	Herb

COMBRETACEAE	*Combretum apiculatum Sond. subsp. apiculatum*	LC	Shrub, tree
COMBRETACEAE	*Combretum moggii Exell*	LC	Shrub, tree
COMMELINACEAE	*Commelina africana L. var. lancispatha C.B.Clarke*	LC	Herb
COMMELINACEAE	*Commelina livingstonii C.B.Clarke*	LC	Herb
COMMELINACEAE	*Cyanotis lapidosa E.Phillips*	LC	Herb, succulent
COMMELINACEAE	*Commelina subulata Roth*	LC	Helophyte, herb
CONVOLVULACEAE	*Convolvulus thunbergii Roem. & Schult.*	LC	Herb
CONVOLVULACEAE	*Ipomoea bathycolpos Hallier f.*	LC	Herb
CONVOLVULACEAE	*Merremia verecunda Rendle*	LC	Herb
CONVOLVULACEAE	*Xenostegia tridentata (L.) D.F.Austin & Staples subsp. angustifolia (Jacq.) Lejoly & Lisowski*	LC	Herb
CONVOLVULACEAE	*Ipomoea bolusiana Schinz*	LC	Dwarf shrub, herb, succulent
CONVOLVULACEAE	*Ipomoea crassipes Hook. var. crassipes*	LC	Herb, succulent
CRASSULACEAE	*Cotyledon orbiculata L. var. oblonga (Haw.) DC.*	LC	Dwarf shrub, succulent
CRASSULACEAE	*Crassula lanceolata (Eckl. & Zeyh.) Endl. ex Walp. subsp. transvaalensis (Kuntze) Toelken*	LC	Herb, succulent
CUCURBITACEAE	*Citrullus lanatus (Thunb.) Matsum. & Nakai*	LC	Climber, herb, succulent
CUCURBITACEAE	*Cucumis zeyheri Sond.*	LC	Herb
CUCURBITACEAE	*Cucumis hirsutus Sond.*	LC	Herb, succulent
CUCURBITACEAE	*Cucumis zeyheri Sond.*	LC	Herb
CYPERACEAE	*Ascolepis capensis (Kunth) Ridl.*	LC	Cyperoid, herb
CYPERACEAE	*Bulbostylis humilis (Kunth) C.B.Clarke*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus congestus Vahl*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus denudatus L.f. var. denudatus*	LC	Cyperoid, emergent hydrophyte, helophyte, herb
CYPERACEAE	*Cyperus longus L. var. longus*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus margaritaceus Vahl var. margaritaceus*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus marginatus Thunb.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Cyperus obtusiflorus Vahl var. flavissimus (Schrad.) Boeck.*	LC	Cyperoid, herb, mesophyte

CYPERACEAE	*Cyperus obtusiflorus Vahl var. obtusiflorus*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus rupestris Kunth var. rupestris*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus semitrifidus Schrad.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus sphaerospermus Schrad.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus tenax Boeck.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Eleocharis atropurpurea (Retz.) C.Presl*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Eleocharis dregeana Steud.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Fuirena coerulescens Steud.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Kyllinga alata Nees*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Kyllinga alba Nees*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Kyllinga erecta Schumach. var. erecta*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Lipocarpha rehmannii (Ridl.) Goetgh.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Mariscus uitenhagensis Steud.*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Pycreus macranthus (Boeck.) C.B.Clarke*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Pycreus nitidus (Lam.) J.Raynal*	LC	Cyperoid, helophyte, herb, sudd hydrophyte
CYPERACEAE	*Schoenoplectus decipiens (Nees) J.Raynal*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Scirpoides burkei (C.B.Clarke) Goetgh., Muasya & D.A.Simpson*	LC	Cyperoid, herb, mesophyte
CYPERACEAE	*Cyperus difformis L.*	LC	Cyperoid, helophyte, herb, mesophyte
CYPERACEAE	*Cyperus esculentus L. var. esculentus*	LC	Cyperoid, geophyte, herb, mesophyte
CYPERACEAE	*Cyperus marginatus Thunb.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Fuirena coerulescens Steud.*	LC	Cyperoid, helophyte, herb
CYPERACEAE	*Schoenoplectus tabernaemontani (C.C.Gmel.) Palla*	NE	Cyperoid, emergent hydrophyte, helophyte, herb
DICRANACEAE	*Campylopus robillardei Besch.*		Bryophyte
DICRANACEAE	*Campylopus perpusillus Mitt.*		Bryophyte
DIPSACACEAE	*Scabiosa columbaria L.*	LC	Herb
EBENACEAE	*Diospyros lycioides Desf. subsp. lycioides*	LC	Shrub
ERICACEAE	*Erica drakensbergensis Guthrie & Bolus*	LC	Shrub

ERICACEAE	*Erica drakensbergensis Guthrie & Bolus*	LC	Shrub
ERIOCAULACEAE	*Syngonanthus wahlbergii (Wikstr. ex Körn.) Ruhland var. wahlbergii*	LC	Herb, hydrophyte, tenagophyte
ERIOSPERMACEAE	*Eriospermum cooperi Baker var. cooperi*	LC	Geophyte
ERIOSPERMACEAE	*Eriospermum flagelliforme (Baker) J.C.Manning*	LC	Geophyte
ERIOSPERMACEAE	*Eriospermum mackenii (Hook.f.) Baker subsp. galpinii (Schinz) P.L.Perry*	NE	Geophyte
ERIOSPERMACEAE	*Eriospermum flagelliforme (Baker) J.C.Manning*	LC	Geophyte
ERIOSPERMACEAE	*Eriospermum porphyrovalve Baker*	LC	Geophyte
EUPHORBIACEAE	*Acalypha angustata Sond.*	LC	Dwarf shrub, herb
EUPHORBIACEAE	*Euphorbia gueinzii Boiss. var. albovillosa (Pax) N.E.Br.*	LC	Dwarf shrub, succulent
EUPHORBIACEAE	*Jatropha hirsuta Hochst. var. oblongifolia Prain*	LC	Dwarf shrub, herb, succulent
EUPHORBIACEAE	*Jatropha zeyheri Sond.*	LC	Dwarf shrub, herb, succulent
EUPHORBIACEAE	*Monadenium lugardiae N.E.Br.*	LC	Shrub, succulent
EXORMOTHECACEAE	*Exormotheca holstii Steph.*		Bryophyte
EXORMOTHECACEAE	*Exormotheca pustulosa Mitt.*		Bryophyte
FABACEAE	*Acacia caffra (Thunb.) Willd.*	LC	Shrub, tree
FABACEAE	*Acacia sieberiana DC. var. woodii (Burtt Davy) Keay & Brenan*	LC	Tree
FABACEAE	*Aeschynomene rehmannii Schinz var. leptobotrya (Harms ex Baker f.) J.B.Gillett*	LC	Dwarf shrub, shrub
FABACEAE	*Argyrolobium pauciflorum Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Argyrolobium tuberosum Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Dolichos falciformis E.Mey.*	LC	Herb
FABACEAE	*Dolichos trilobus L. subsp. transvaalicus Verdc.*	LC	Climber, herb
FABACEAE	*Elephantorrhiza elephantina (Burch.) Skeels*	LC	Dwarf shrub, shrub, suffrutex
FABACEAE	*Elephantorrhiza obliqua Burtt Davy var. glabra E.Phillips*	LC	Dwarf shrub
FABACEAE	*Eriosema burkei Benth. ex Harv. var. burkei*	LC	Herb
FABACEAE	*Eriosema cordatum E.Mey.*	LC	Herb
FABACEAE	*Eriosema gunniae C.H.Stirt.*	LC	Herb
FABACEAE	*Eriosema kraussianum Meisn.*	LC	Herb
FABACEAE	*Eriosema salignum E.Mey.*	LC	Herb
FABACEAE	*Eriosema squarrosum (Thunb.) Walp.*	LC	Herb

FABACEAE	*Erythrina zeyheri Harv.*	LC	Dwarf shrub, shrub, succulent
FABACEAE	*Indigastrum burkeanum (Benth. ex Harv.) Schrire*	LC	Herb
FABACEAE	*Indigofera atrata N.E.Br.*	LC	Herb
FABACEAE	*Indigofera confusa Prain & Baker f.*	LC	Herb
FABACEAE	*Indigofera daleoides Benth. ex Harv. var. daleoides*	LC	Herb
FABACEAE	*Indigofera egens N.E.Br.*	LC	Shrub
FABACEAE	*Indigofera frondosa N.E.Br.*	LC	Shrub
FABACEAE	*Indigofera hedyantha Eckl. & Zeyh.*	LC	Herb
FABACEAE	*Indigofera hilaris Eckl. & Zeyh. var. hilaris*	LC	Herb
FABACEAE	*Indigofera melanadenia Benth. ex Harv.*	LC	Herb, shrub
FABACEAE	*Indigofera obscura N.E.Br.*	LC	Herb
FABACEAE	*Indigofera oxalidea Welw. ex Baker*	LC	Herb
FABACEAE	*Indigofera oxytropis Benth. ex Harv.*	LC	Herb
FABACEAE	*Indigofera sordida Benth. ex Harv.*	LC	Herb
FABACEAE	*Lotononis calycina (E.Mey.) Benth.*	LC	Herb
FABACEAE	*Lotononis eriantha Benth.*	LC	Herb
FABACEAE	*Lotononis foliosa Bolus*	LC	Herb
FABACEAE	*Lotononis listii Polhill*	LC	Creeper, herb
FABACEAE	*Lotononis solitudinis Dummer*	LC	Herb
FABACEAE	*Lotus discolor E.Mey. subsp. discolor*	LC	Herb
FABACEAE	*Pearsonia aristata (Schinz) Dummer*	LC	Herb
FABACEAE	*Pearsonia cajanifolia (Harv.) Polhill subsp. cajanifolia*	LC	Herb, shrub
FABACEAE	*Pearsonia grandifolia (Bolus) Polhill subsp. latibracteolata (Dummer) Polhill*	LC	Herb
FABACEAE	*Pearsonia sessilifolia (Harv.) Dummer subsp. sessilifolia*	LC	Dwarf shrub, herb
FABACEAE	*Psoralea pinnata L. var. pinnata*	LC	Shrub, tree
FABACEAE	*Rhynchosia crassifolia Benth. ex Harv.*	LC	Climber, herb
FABACEAE	*Rhynchosia monophylla Schltr.*	LC	Herb
FABACEAE	*Rhynchosia nervosa Benth. ex Harv. var. nervosa*	LC	Herb
FABACEAE	*Sphenostylis angustifolia Sond.*	LC	Dwarf shrub, herb

FABACEAE	*Tephrosia macropoda (E.Mey.) Harv. var. macropoda*	LC	Herb
FABACEAE	*Tephrosia multijuga R.G.N.Young*	LC	Dwarf shrub, herb, shrub
FABACEAE	*Tephrosia retusa Burtt Davy*	LC	Herb
FABACEAE	*Tephrosia semiglabra Sond.*	LC	Herb
FABACEAE	*Trifolium dubium Sibth.*	NE	Herb
FABACEAE	*Vigna vexillata (L.) A.Rich. var. vexillata*	LC	Climber, herb
FABACEAE	*Zornia capensis Pers. subsp. capensis*	LC	Herb
FABACEAE	*Zornia linearis E.Mey.*	LC	Herb
FABACEAE	*Zornia milneana Mohlenbr.*	LC	Herb
FABACEAE	*Chamaecrista biensis (Steyaert) Lock*	LC	Herb
FABACEAE	*Crotalaria distans Benth. subsp. distans*	LC	Herb
FABACEAE	*Crotalaria lanceolata E.Mey. subsp. lanceolata*	LC	Herb
FABACEAE	*Elephantorrhiza elephantina (Burch.) Skeels*	LC	Dwarf shrub, shrub, suffrutex
FABACEAE	*Eriosema salignum E.Mey.*	LC	Herb
FABACEAE	*Lotononis foliosa Bolus*	LC	Herb
FABACEAE	*Neorautanenia ficifolia (Benth. ex Harv.) C.A.Sm.*	LC	Climber, herb, succulent
FABACEAE	*Neorautanenia mitis (A.Rich.) Verdc.*		Dwarf shrub, herb, succulent
FABACEAE	*Rhynchosia monophylla Schltr.*	LC	Herb
FABACEAE	*Rhynchosia nervosa Benth. ex Harv. var. nervosa*	LC	Herb
FOSSOMBRONIACEAE	*Fossombronia pusilla (L.) Dumort.*		Bryophyte
GENTIANACEAE	*Chironia purpurascens (E.Mey.) Benth. & Hook.f. subsp. humilis (Gilg) I.Verd.*	LC	Herb
GENTIANACEAE	*Sebaea grandis (E.Mey.) Steud.*	LC	Herb
GENTIANACEAE	*Sebaea leiostyla Gilg*	LC	Herb
GERANIACEAE	*Monsonia angustifolia E.Mey. ex A.Rich.*	LC	Herb
GERANIACEAE	*Pelargonium luridum (Andrews) Sweet*	LC	Geophyte, succulent
GERANIACEAE	*Pelargonium abrotanifolium (L.f.) Jacq.*	LC	Dwarf shrub, shrub
GERANIACEAE	*Pelargonium luridum (Andrews) Sweet*	LC	Geophyte, succulent
GREYIACEAE	*Greyia radlkoferi Szyszyl.*	LC	Shrub, tree
HYACINTHACEAE	*Dipcadi marlothii Engl.*	LC	Geophyte

HYACINTHACEAE	*Eucomis autumnalis (Mill.) Chitt. subsp. clavata (Baker) Reyneke*	NE	Geophyte
HYACINTHACEAE	*Ledebouria cooperi (Hook.f.) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria floribunda (Baker) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria luteola Jessop*	LC	Geophyte
HYACINTHACEAE	*Ledebouria revoluta (L.f.) Jessop*	LC	Geophyte
HYACINTHACEAE	*Ornithogalum flexuosum (Thunb.) U.& D.Müll.-Doblies*	LC	Geophyte
HYACINTHACEAE	*Ornithogalum tenuifolium F.Delaroche subsp. tenuifolium*	LC	Geophyte
HYACINTHACEAE	*Schizocarphus nervosus (Burch.) Van der Merwe*	LC	Geophyte
HYACINTHACEAE	*Albuca shawii Baker*	LC	Geophyte
HYACINTHACEAE	*Ornithogalum flexuosum (Thunb.) U.& D.Müll.-Doblies*	LC	Geophyte
HYDROCHARITACEAE	*Lagarosiphon major (Ridl.) Moss ex Wager*	LC	Herb, hydrophyte
HYDROCHARITACEAE	*Lagarosiphon muscoides Harv.*	LC	Herb, hydrophyte
HYPERICACEAE	*Hypericum lalandii Choisy*	LC	Herb
HYPOXIDACEAE	*Hypoxis acuminata Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis filiformis Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis hemerocallidea Fisch., C.A.Mey. & Avé-Lall.*	Declining	Geophyte
HYPOXIDACEAE	*Hypoxis iridifolia Baker*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis neliana Schinz*	LC	Geophyte
HYPOXIDACEAE	*Hypoxis rigidula Baker var. rigidula*	LC	Geophyte, herb
IRIDACEAE	*Babiana bainesii Baker*	LC	Geophyte, herb
IRIDACEAE	*Dierama mossii (N.E.Br.) Hilliard*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus crassifolius Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus elliotii Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus longicollis Baker subsp. platypetalus (Baker) Goldblatt & J.C.Manning*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus permeabilis D.Delaroche subsp. edulis (Burch. ex Ker Gawl.) Oberm.*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus vinosomaculatus Kies*	LC	Geophyte, herb
IRIDACEAE	*Hesperantha coccinea (Backh. & Harv.) Goldblatt & J.C.Manning*	LC	Geophyte, herb
IRIDACEAE	*Lapeirousia sandersonii Baker*	LC	Geophyte, herb
IRIDACEAE	*Moraea spathulata (L.f.) Klatt*	LC	Geophyte, herb

IRIDACEAE	*Tritonia cooperi (Baker) Klatt subsp. cooperi*	LC	Geophyte, herb
IRIDACEAE	*Tritonia nelsonii Baker*	LC	Geophyte, herb
IRIDACEAE	*Crocosmia paniculata (Klatt) Goldblatt*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus crassifolius Baker*	LC	Geophyte, herb
IRIDACEAE	*Gladiolus woodii Baker*	LC	Geophyte, herb
JUNCACEAE	*Juncus effusus L.*	LC	Helophyte, herb
JUNCACEAE	*Juncus oxycarpus E.Mey. ex Kunth*	LC	Helophyte, herb
LAMIACEAE	*Acrotome hispida Benth.*	LC	Herb
LAMIACEAE	*Ocimum obovatum E.Mey. ex Benth. subsp. obovatum var. obovatum*	LC	Herb
LAMIACEAE	*Pycnostachys reticulata (E.Mey.) Benth.*	LC	Herb
LAMIACEAE	*Rotheca hirsuta (Hochst.) R.Fern.*	LC	Herb
LAMIACEAE	*Salvia runcinata L.f.*	LC	Herb
LAMIACEAE	*Scutellaria racemosa Pers.*	NE	Herb
LAMIACEAE	*Stachys natalensis Hochst. var. galpinii (Briq.) Codd*	LC	Herb
LAMIACEAE	*Stachys natalensis Hochst. var. natalensis*	LC	Herb
LAMIACEAE	*Syncolostemon pretoriae (Gürke) D.F.Otieno*	LC	Herb
LAMIACEAE	*Tetradenia brevispicata (N.E.Br.) Codd*	LC	Shrub, succulent, tree
LECANORACEAE	*Carbonea latypizodes (Nyl.) Knoph & Rambold*		Lichen
LECANORACEAE	*Lecanora oreinoides (Körb.) Hertel & Rambold*		Lichen
LECANORACEAE	*Lecidella viridans (Flot.) Körb.*		Lichen
LECIDEACEAE	*Lecidea angolensis Müll.Arg.*		Lichen
LENTIBULARIACEAE	*Utricularia livida E.Mey.*	LC	Carnivore, herb
LENTIBULARIACEAE	*Utricularia stellaris L.f.*	LC	Carnivore, herb, pleustophyte
LINACEAE	*Linum thunbergii Eckl. & Zeyh.*	LC	Herb
LOBELIACEAE	*Lobelia erinus L.*	LC	Herb
LOBELIACEAE	*Monopsis decipiens (Sond.) Thulin*	LC	Herb
LOBELIACEAE	*Monopsis decipiens (Sond.) Thulin*	LC	Herb
LOPHIOCARPACEAE	*Lophiocarpus tenuissimus Hook.f.*	LC	Herb
LYCOPODIACEAE	*Lycopodiella sarcocaulon (A.Braun & Welw. ex Kuhn) Pic.Serm.*	LC	Geophyte, herb

LYTHRACEAE	*Nesaea sagittifolia (Sond.) Koehne var. sagittifolia*	LC	Dwarf shrub
LYTHRACEAE	*Rotala filiformis (Bellardi) Hiern*	LC	Herb, hydrophyte
MALPIGHIACEAE	*Sphedamnocarpus pruriens (A.Juss.) Szyszyl. subsp. galphimiifolius (A.Juss.) P.D.de Villiers & D.J.Botha*	LC	Climber, shrub
MALPIGHIACEAE	*Sphedamnocarpus pruriens (A.Juss.) Szyszyl. subsp. pruriens*	LC	Climber, shrub
MALPIGHIACEAE	*Triaspis hypericoides (DC.) Burch. subsp. nelsonii (Oliv.) Immelman*	LC	Climber, shrub
MALVACEAE	*Corchorus asplenifolius Burch.*	LC	Herb
MALVACEAE	*Corchorus trilocularis L.*	NE	Herb
MALVACEAE	*Grewia flava DC.*	LC	Shrub
MALVACEAE	*Grewia monticola Sond.*	LC	Shrub, tree
MALVACEAE	*Grewia vernicosa Schinz*	LC	Dwarf shrub, shrub
MALVACEAE	*Hermannia parvula Burtt Davy*	LC	Dwarf shrub
MALVACEAE	*Hermannia tomentosa (Turcz.) Schinz ex Engl.*	LC	Herb
MALVACEAE	*Hermannia transvaalensis Schinz*	LC	Herb
MALVACEAE	*Hibiscus aethiopicus L. var. ovatus Harv.*	LC	Herb
MALVACEAE	*Hibiscus pusillus Thunb.*	LC	Herb
MALVACEAE	*Sida chrysantha Ulbr.*	LC	Dwarf shrub
MALVACEAE	*Triumfetta sonderi Ficalho & Hiern*	LC	Dwarf shrub
MALVACEAE	*Melhania acuminata Mast. var. acuminata*	LC	Dwarf shrub
MALVACEAE	*Melhania prostrata DC.*	LC	Dwarf shrub
MALVACEAE	*Melhania randii Baker f.*	LC	Dwarf shrub
MESEMBRYANTHEMACEAE	*Ebracteola wilmaniae (L.Bolus) Glen*	LC	Succulent
MICAREACEAE	*Micarea endoviolascens Coppins*		Lichen
MOLLUGINACEAE	*Psammotropha myriantha Sond.*	LC	Herb
MORACEAE	*Ficus abutilifolia (Miq.) Miq.*	LC	Shrub, tree
MORACEAE	*Ficus glumosa Delile*	LC	Succulent, tree
MORACEAE	*Ficus salicifolia Vahl*	LC	Tree
MYROTHAMNACEAE	*Myrothamnus flabellifolius Welw.*	DDT	Dwarf shrub, shrub
OCHNACEAE	*Ochna inermis (Forssk.) Schweinf.*	LC	Shrub, tree

OCHNACEAE	*Ochna pulchra Hook.f.*	LC	Shrub, tree
OLEACEAE	*Jasminum multipartitum Hochst.*	LC	Climber, dwarf shrub
OLEACEAE	*Jasminum stenolobum Rolfe*	LC	Climber, dwarf shrub, shrub
OLEACEAE	*Menodora africana Hook.*	LC	Dwarf shrub, herb
ONAGRACEAE	*Epilobium salignum Hausskn.*	LC	Herb
ONAGRACEAE	*Epilobium tetragonum L. subsp. tetragonum*	LC	Herb
ONAGRACEAE	*Ludwigia palustris (L.) Elliott*	NE	Herb, hydrophyte
ONAGRACEAE	*Oenothera rosea L'Hér. ex Aiton*	NE	Herb
ONAGRACEAE	*Epilobium tetragonum L. subsp. tetragonum*	LC	Herb
ORCHIDACEAE	*Bonatea antennifera Rolfe*	LC	
ORCHIDACEAE	*Brachycorythis ovata Lindl. subsp. ovata*	LC	Geophyte, herb
ORCHIDACEAE	*Brachycorythis tenuior Rchb.f.*	LC	Geophyte, herb
ORCHIDACEAE	*Disa baurii Bolus*	LC	Geophyte, herb
ORCHIDACEAE	*Disa saxicola Schltr.*	LC	Geophyte, herb, lithophyte
ORCHIDACEAE	*Habenaria epipactidea Rchb.f.*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria falcicornis (Burch. ex Lindl.) Bolus subsp. caffra (Schltr.) J.C.Manning*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria filicornis Lindl.*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria galpinii Bolus*	LC	Geophyte, herb
ORCHIDACEAE	*Habenaria tridens Lindl.*	LC	Geophyte, herb
ORCHIDACEAE	*Satyrium cristatum Sond. var. cristatum*	LC	Geophyte, herb
ORCHIDACEAE	*Satyrium hallackii Bolus subsp. ocellatum (Bolus) A.V.Hall*	LC	Geophyte, herb
OROBANCHACEAE	*Alectra vogelii Benth.*	LC	Herb, parasite
OROBANCHACEAE	*Buchnera ciliolata Engl.*	LC	Herb, parasite
OROBANCHACEAE	*Buchnera longespicata Schinz*	LC	Herb, parasite
OROBANCHACEAE	*Buchnera simplex (Thunb.) Druce*	LC	Herb, parasite
OROBANCHACEAE	*Cycnium tubulosum (L.f.) Engl. subsp. tubulosum*	LC	Herb
OROBANCHACEAE	*Graderia subintegra Mast.*	LC	Herb, parasite, suffrutex
OROBANCHACEAE	*Sopubia cana Harv. var. cana*	LC	Herb, parasite
OXALIDACEAE	*Oxalis obliquifolia Steud. ex A.Rich.*	LC	Geophyte

PALLAVICINIACEAE	*Symphyogyna brasiliensis Nees & Mont.*		Bryophyte
PAPAVERACEAE	*Papaver aculeatum Thunb.*	LC	Herb
PARMELIACEAE	*Karoowia adligans (Brusse) Hale*		Lichen
PARMELIACEAE	*Neofuscelia verisidiosa (Essl.) Essl.*		Lichen
PARMELIACEAE	*Xanthoparmelia tasmanica (Hook. & Taylor) Hale*		Lichen
PARMELIACEAE	*Xanthoparmelia tinctina (Maheu & A.Gillet) Hale*		Lichen
PASSIFLORACEAE	*Adenia digitata (Harv.) Engl.*	LC	Climber, dwarf shrub, shrub, succulent
PHYLLANTHACEAE	*Phyllanthus incurvus Thunb.*	LC	Dwarf shrub, herb
PHYSCIACEAE	*Buellia olivacea Müll.Arg.*		Lichen
PHYSCIACEAE	*Buellia xantholepsis (Stizenb.) Müll.Arg.*		Lichen
POACEAE	*Agrostis eriantha Hack. var. eriantha*	LC	Graminoid
POACEAE	*Alloteropsis semialata (R.Br.) Hitchc. subsp. eckloniana (Nees) Gibbs Russ.*	LC	Graminoid
POACEAE	*Andropogon huillensis Rendle*	LC	Graminoid
POACEAE	*Aristida aequiglumis Hack.*	LC	Graminoid
POACEAE	*Aristida congesta Roem. & Schult. subsp. congesta*	LC	Graminoid
POACEAE	*Aristida junciformis Trin. & Rupr. subsp. junciformis*	LC	Graminoid
POACEAE	*Bewsia biflora (Hack.) Gooss.*	LC	Graminoid
POACEAE	*Brachiaria serrata (Thunb.) Stapf*	LC	Graminoid
POACEAE	*Ctenium concinnum Nees*	LC	Graminoid
POACEAE	*Cynodon dactylon (L.) Pers.*	LC	Graminoid
POACEAE	*Digitaria eriantha Steud.*	LC	Graminoid
POACEAE	*Digitaria ternata (A.Rich.) Stapf*	LC	Graminoid
POACEAE	*Digitaria tricholaenoides Stapf*	LC	Graminoid
POACEAE	*Elionurus muticus (Spreng.) Kunth*	LC	Graminoid
POACEAE	*Eragrostis capensis (Thunb.) Trin.*	LC	Graminoid
POACEAE	*Eragrostis curvula (Schrad.) Nees*	LC	Graminoid
POACEAE	*Eragrostis gummiflua Nees*	LC	Graminoid
POACEAE	*Eragrostis plana Nees*	LC	Graminoid

POACEAE	*Eragrostis procumbens Nees*	LC	Graminoid
POACEAE	*Eragrostis racemosa (Thunb.) Steud.*	LC	Graminoid
POACEAE	*Eragrostis sclerantha Nees subsp. sclerantha*	LC	Graminoid
POACEAE	*Hyparrhenia dregeana (Nees) Stapf ex Stent*	LC	Graminoid
POACEAE	*Hyparrhenia hirta (L.) Stapf*	LC	Graminoid
POACEAE	*Hyparrhenia newtonii (Hack.) Stapf var. newtonii*	LC	Graminoid
POACEAE	*Imperata cylindrica (L.) Raeusch.*	LC	Graminoid
POACEAE	*Ischaemum fasciculatum Brongn.*	LC	Graminoid
POACEAE	*Lophacme digitata Stapf*	LC	Graminoid
POACEAE	*Loudetia simplex (Nees) C.E.Hubb.*	LC	Graminoid
POACEAE	*Melinis repens (Willd.) Zizka subsp. repens*	LC	Graminoid
POACEAE	*Microchloa caffra Nees*	LC	Graminoid
POACEAE	*Monocymbium ceresiiforme (Nees) Stapf*	LC	Graminoid
POACEAE	*Panicum natalense Hochst.*	LC	Graminoid
POACEAE	*Perotis patens Gand.*	LC	Graminoid
POACEAE	*Pogonarthria squarrosa (Roem. & Schult.) Pilg.*	LC	Graminoid
POACEAE	*Schizachyrium sanguineum (Retz.) Alston*	LC	Graminoid
POACEAE	*Schizachyrium ursulus Stapf*	LC	Graminoid
POACEAE	*Setaria lindenbergiana (Nees) Stapf*	LC	Graminoid
POACEAE	*Setaria nigrirostris (Nees) T.Durand & Schinz*	LC	Graminoid
POACEAE	*Sporobolus natalensis (Steud.) T.Durand & Schinz*	LC	Graminoid
POACEAE	*Stiburus alopecuroides (Hack.) Stapf*	LC	Graminoid
POACEAE	*Themeda triandra Forssk.*	LC	Graminoid
POACEAE	*Trachypogon spicatus (L.f.) Kuntze*	LC	Graminoid
POACEAE	*Tripogon minimus (A.Rich.) Steud.*	LC	Graminoid
POACEAE	*Tristachya leucothrix Trin. ex Nees*	LC	Graminoid
POACEAE	*Tristachya rehmannii Hack.*	LC	Graminoid
POACEAE	*Urochloa panicoides P.Beauv.*	NE	Graminoid
POACEAE	*Agrostis lachnantha Nees var. lachnantha*	LC	Graminoid

POACEAE	*Alloteropsis semialata (R.Br.) Hitchc. subsp. eckloniana (Nees) Gibbs Russ.*	LC	Graminoid
POACEAE	*Alloteropsis semialata (R.Br.) Hitchc. subsp. semialata*	LC	Graminoid
POACEAE	*Andropogon eucomus Nees*	LC	Graminoid
POACEAE	*Andropogon huillensis Rendle*	LC	Graminoid
POACEAE	*Calamagrostis epigejos (L.) Roth var. capensis Stapf*	LC	Graminoid
POACEAE	*Ctenium concinnum Nees*	LC	Graminoid
POACEAE	*Digitaria tricholaenoides Stapf*	LC	Graminoid
POACEAE	*Elionurus muticus (Spreng.) Kunth*	LC	Graminoid
POACEAE	*Eragrostis chloromelas Steud.*	LC	Graminoid
POACEAE	*Eragrostis curvula (Schrad.) Nees*	LC	Graminoid
POACEAE	*Eragrostis gummiflua Nees*	LC	Graminoid
POACEAE	*Eragrostis obtusa Munro ex Ficalho & Hiern*	LC	Graminoid
POACEAE	*Hemarthria altissima (Poir.) Stapf & C.E.Hubb.*	LC	Graminoid
POACEAE	*Heteropogon contortus (L.) Roem. & Schult.*	LC	Graminoid
POACEAE	*Hyparrhenia dregeana (Nees) Stapf ex Stent*	LC	Graminoid
POACEAE	*Panicum repentellum Napper*	LC	Graminoid
POACEAE	*Setaria incrassata (Hochst.) Hack.*	LC	Graminoid
POACEAE	*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. sericea (Stapf) Clayton*	LC	Graminoid
POACEAE	*Setaria sphacelata (Schumach.) Stapf & C.E.Hubb. ex M.B.Moss var. torta (Stapf) Clayton*	LC	Graminoid
POACEAE	*Sporobolus stapfianus Gand.*	LC	Graminoid
POACEAE	*Stiburus alopecuroides (Hack.) Stapf*	LC	Graminoid
POACEAE	*Stiburus conrathii Hack.*	LC	Graminoid
POACEAE	*Trachypogon spicatus (L.f.) Kuntze*	LC	Graminoid
POACEAE	*Urelytrum agropyroides (Hack.) Hack.*	LC	Graminoid
POLYGALACEAE	*Polygala africana Chodat*	LC	Herb
POLYGALACEAE	*Polygala gracilenta Burtt Davy*	LC	Herb
POLYGALACEAE	*Polygala hottentotta C.Presl*	LC	Dwarf shrub, herb
POLYGALACEAE	*Polygala houtboshiana Chodat*	LC	Herb

POLYGALACEAE	*Polygala spicata Chodat*	LC	Herb
POLYGALACEAE	*Polygala virgata Thunb. var. decora (Sond.) Harv.*	LC	Dwarf shrub, shrub
POLYGALACEAE	*Polygala virgata Thunb. var. virgata*	LC	Dwarf shrub, shrub
POLYGALACEAE	*Polygala leendertziae Burtt Davy*	LC	Dwarf shrub, herb
POLYGALACEAE	*Polygala sphenoptera Fresen. var. sphenoptera*	LC	Dwarf shrub, herb
POLYGONACEAE	*Persicaria attenuata (R.Br.) Soják subsp. africana K.L.Wilson*	LC	Helophyte, herb, hydrophyte
POLYGONACEAE	*Persicaria lapathifolia (L.) Gray*	NE	Helophyte, herb, hydrophyte
POLYGONACEAE	*Rumex lanceolatus Thunb.*	LC	Herb
POLYGONACEAE	*Rumex woodii N.E.Br.*	LC	Herb
POLYGONACEAE	*Persicaria attenuata (R.Br.) Soják subsp. africana K.L.Wilson*	LC	Helophyte, herb, hydrophyte
POLYGONACEAE	*Persicaria decipiens (R.Br.) K.L.Wilson*	LC	Helophyte, herb
PORTULACACEAE	*Anacampseros subnuda Poelln. subsp. lubbersii (Bleck) Gerbaulet*	VU	Herb, succulent
PORTULACACEAE	*Portulaca quadrifida L.*	LC	Herb, succulent
PORTULACACEAE	*Portulaca rhodesiana R.A.Dyer & E.A.Bruce*	LC	Herb, succulent
POTAMOGETONACEAE	*Potamogeton nodosus Poir.*	NE	
POTTIACEAE	*Trichostomum brachydontium Bruch*		Bryophyte
PROTEACEAE	*Faurea saligna Harv.*	LC	Tree
PROTEACEAE	*Protea roupelliae Meisn. subsp. roupelliae*	LC	Tree
PROTEACEAE	*Protea welwitschii Engl.*	LC	Dwarf shrub, shrub
RANUNCULACEAE	*Clematis brachiata Thunb.*	LC	Climber
RANUNCULACEAE	*Ranunculus multifidus Forssk.*	NE	Herb
RHAMNACEAE	*Helinus integrifolius (Lam.) Kuntze*	LC	Climber, shrub
RICCIACEAE	*Riccia volkii S.W.Arnell*		Bryophyte
RICCIACEAE	*Riccia okahandjana S.W.Arnell*		Bryophyte
ROSACEAE	*Alchemilla woodii Kuntze*	LC	Herb
RUBIACEAE	*Galium capense Thunb. subsp. capense*	LC	Herb
RUBIACEAE	*Oldenlandia herbacea (L.) Roxb. var. herbacea*	LC	Herb
RUBIACEAE	*Pavetta zeyheri Sond. subsp. middelburgensis (Bremek.) P.P.J.Herman*	Rare	Dwarf shrub
RUBIACEAE	*Pavetta zeyheri Sond. subsp. zeyheri*	LC	Shrub, tree

RUBIACEAE	*Pentanisia angustifolia (Hochst.) Hochst.*	LC	Herb
RUBIACEAE	*Psydrax livida (Hiern) Bridson*	LC	Shrub, tree
RUBIACEAE	*Pygmaeothamnus chamaedendrum (Kuntze) Robyns var. chamaedendrum*	LC	Dwarf shrub
RUBIACEAE	*Pygmaeothamnus zeyheri (Sond.) Robyns var. zeyheri*	LC	Dwarf shrub
RUBIACEAE	*Richardia scabra L.*	NE	Herb
RUBIACEAE	*Tricalysia lanceolata (Sond.) Burtt Davy*	LC	Shrub, tree
RUBIACEAE	*Vangueria infausta Burch. subsp. infausta*	LC	Tree
RUBIACEAE	*Richardia humistrata (Cham. & Schltdl.) Steud.*	NE	Herb
RUTACEAE	*Thamnosma africana Engl.*	LC	Dwarf shrub, shrub
SANTALACEAE	*Thesium exile N.E.Br.*	LC	Herb, parasite
SANTALACEAE	*Thesium junceum Bernh. var. junceum*	LC	Herb, parasite, shrub
SANTALACEAE	*Thesium pallidum A.DC.*	LC	Herb, parasite, shrub
SANTALACEAE	*Thesium hystrix A.W.Hill*	LC	Dwarf shrub, parasite, shrub
SAPOTACEAE	*Mimusops zeyheri Sond.*	LC	Shrub, tree
SCROPHULARIACEAE	*Diclis rotundifolia (Hiern) Hilliard & B.L.Burtt*	LC	Herb
SCROPHULARIACEAE	*Jamesbrittenia aurantiaca (Burch.) Hilliard*	LC	Herb
SCROPHULARIACEAE	*Lindernia parviflora (Roxb.) Haines*	LC	Herb
SCROPHULARIACEAE	*Manulea rhodantha Hilliard subsp. aurantiaca Hilliard*	LC	Herb
SCROPHULARIACEAE	*Mimulus gracilis R.Br.*	LC	Helophyte, herb, hydrophyte
SCROPHULARIACEAE	*Nemesia fruticans (Thunb.) Benth.*	LC	Dwarf shrub, suffrutex
SCROPHULARIACEAE	*Zaluzianskya katharinae Hiern*	LC	Dwarf shrub, herb
SCROPHULARIACEAE	*Limosella longiflora Kuntze*	LC	Herb, hydrophyte
SELAGINELLACEAE	*Selaginella dregei (C.Presl) Hieron.*	LC	Geophyte, herb, lithophyte
SELAGINELLACEAE	*Selaginella mittenii Baker*	LC	Geophyte, herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes hirta Sw. var. hirta*	LC	Geophyte, herb, lithophyte
SINOPTERIDACEAE	*Cheilanthes multifida (Sw.) Sw. subsp. lacerata N.C.Anthony & Schelpe*		Herb
SINOPTERIDACEAE	*Pellaea calomelanos (Sw.) Link var. calomelanos*	LC	Geophyte, herb, lithophyte
SOLANACEAE	*Physalis viscosa L.*	NE	Herb
SOLANACEAE	*Solanum capense L.*	LC	Dwarf shrub, shrub

SOLANACEAE	*Solanum lichtensteinii Willd.*	LC	Dwarf shrub, shrub
STRYCHNACEAE	*Strychnos pungens Soler.*	LC	Shrub, tree
TARGIONIACEAE	*Targionia hypophylla L.*		Bryophyte
THELOTREMATACEAE	*Diploschistes caesioplumbeus (Nyl.) Vain.*		Lichen
THELYPTERIDACEAE	*Thelypteris confluens (Thunb.) C.V.Morton*	LC	Geophyte, herb, hydrophyte
THYMELAEACEAE	*Gnidia capitata L.f.*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia gymnostachya (C.A.Mey.) Gilg*	LC	Dwarf shrub
THYMELAEACEAE	*Gnidia kraussiana Meisn. var. kraussiana*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia microcephala Meisn.*	LC	Dwarf shrub, shrub
THYMELAEACEAE	*Gnidia sericocephala (Meisn.) Gilg ex Engl.*	LC	Dwarf shrub, shrub
URTICACEAE	*Pouzolzia mixta Solms var. mixta*	LC	Shrub, succulent, tree
VERBENACEAE	*Chascanum hederaceum (Sond.) Moldenke var. hederaceum*	LC	Herb
VERBENACEAE	*Chascanum incisum (H.Pearson) Moldenke*	LC	Herb
VERBENACEAE	*Lippia wilmsii H.Pearson*	LC	Shrub
VERBENACEAE	*Verbena aristigera S.Moore*	NE	Herb
VERBENACEAE	*Verbena brasiliensis Vell.*	NE	Herb
VITACEAE	*Cyphostemma simulans (C.A.Sm.) Wild & R.B.Drumm.*	LC	Climber, succulent
XYRIDACEAE	*Xyris capensis Thunb.*	LC	Helophyte, herb, hydrophyte
XYRIDACEAE	*Xyris congensis Büttner*	LC	Helophyte, herb, hydrophyte
ZAMIACEAE	*Encephalartos lanatus Stapf & Burtt Davy*	VU	Shrub, tree
ZAMIACEAE	*Encephalartos middelburgensis Vorster, Robbertse & S.van der Westh.*	CR	Shrub, tree

APPENDIX B: MAMMAL REPORT

GALAGO ENVIRONMENTAL

Fauna and Flora Specialists

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Mammal Habitat Assessment

of

SAMANCOR MIDDELBURG FERROCHROME TERRAIN

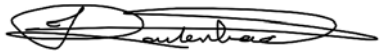
March 2012

Report author: I.L. Rautenbach Pr.Sci.Nat., Ph.D, T.H.E.D.

Declaration of Independence:

I, Ignatius Lourens Rautenbach (421201 5012 00 5) declare that I:

- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate the opportunity to also learn through the processes of constructive criticism and debate, I reserve the right to form and hold my own opinions and therefore will not willingly submit to the interests of other parties or change my statements to appease them
- abide by the Code of Ethics of the S.A. Council for Natural Scientific Professions
- act as an independent specialist consultant in the field of zoology
- am subcontracted as specialist consultant by Galago Environmental CC for the project "Mammal Diversity and Habitat Scan of Samancor Middelburg Ferrochrome Terrain" described in this report
- have no financial interest in the proposed development other than remuneration for work performed
- have or will not have any vested or conflicting interests in the proposed development
- undertake to disclose to the Galago Environmental CC and its client as well as the competent authority any material information that have or may have the potential to influence the decision of the competent authority required in terms of the Environmental Impact Assessment Regulations 2006
- My intellectual property in this report will only be transferred to the client (the party/ company that commissioned the work) on full payment of the contract fee. Upon transfer of the intellectual property, I recognise that written consent of the client will be required for release of any part of this report to third parties.



Dr. I.L. Rautenbach

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1. INTRODUCTION

Galago Environmental CC. was appointed to undertake a mammal habitat survey of the undeveloped portion of the Samancor Middelburg Ferrochrome terrain and especially the slimes dam area which is scheduled for rehabilitation. The focus of this report is to predict mammal species richness on the study site and the short and long term consequences of rehabilitation of the slimes dam. The site is located on a Portion of the farm Middelburg Town and Townlands 287 JS.

This report focuses on the reigning status of threatened and sensitive mammals likely to occur on the study site. Special attention was paid to the qualitative and quantitative habitat conditions for Red Data species deemed present on the site, and mitigation measures to ameliorate the effect of the development that is suggested. The secondary objective of the investigation was to gauge which mammals might still reside on the site and compile a complete list of mammal diversity of the study area.

2. SCOPE AND OBJECTIVES OF THE STUDY

- To qualitatively and quantitatively assess the significance of the mammal habitat components and current general conservation status of the property;
- Comments on ecological sensitive areas;
- Comments on connectivity with natural vegetation and habitats on adjacent sites;
- To provide a list of mammals which occur or might occur, and to identify species of conservation importance;
- To highlight potential impacts of the proposed development on the mammals of the study site, and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

3. STUDY AREA

The 350 hectares study site (2529CD) is located south-east and adjacent to Middelburg residential suburbs in the 2529CD quarter degree grid cell and elsewhere are surrounded by industrial sites and roads (Mandela Drive and N11). About half of the site is taken up by the ferrochrome processing plant. The other half is located to the south-west and is undeveloped.

The focus of this study is the slimes dame that is situated to the west of the ferrochrome plant.

The Samancor Middelburg Ferrochrome management plans to rehabilitate the slimes dam mentioned above.

The site falls in the Bankenveld veld type (Acocks, 1953). Low and Rebelo (1996) assign this area to their Moist Sandy Highveld Grassland. More recently Mucina and Rutherford (2006) defined the area as falling in their Rand Highveld Grassland. The topography of the general area is undulating plains typical of the Highveld Grasslands of the interior.

There are no natural or manmade structures that could serve as daytime roosts for cave-dwelling bats. However, the stream and its riparian zones are certain to support invertebrates, some of which will rise during summer sunsets and serve as rich feeding patches for bats commuting from their nearby roosts.

The 500 meters zone of adjoining properties are either industrial in nature, or consist of busy roads with agricultural land beyond.

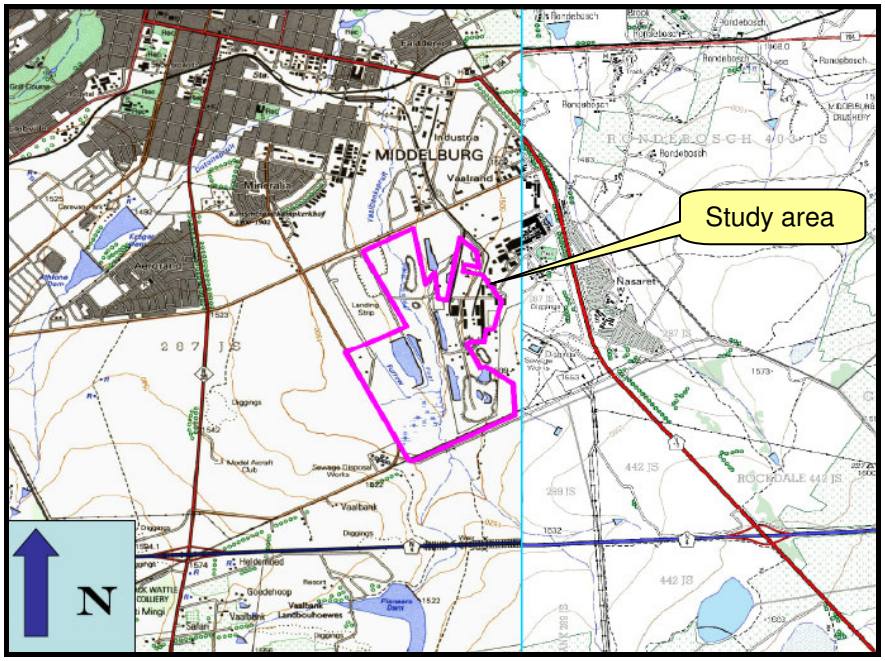

Figure 1: Locality map of the study area

5. METHODS

A site visit was conducted on 1 December 2011. During this visit the observed and derived presence of mammals associated with the recognized habitat types of the study site, were recorded. This was done with due regard to the well recorded global distributions of Southern African mammals, coupled to the qualitative and quantitative nature of recognized habitats.

The 500 meters of adjoining properties was scanned for important fauna habitats.

5.1 Field Surveys

During the site visit mammals were identified by visual sightings through random transect walks. No trapping or mist netting was conducted, as the terms of reference did not require such intensive work. In addition, mammals were also identified by means of spoor, droppings, burrows or roosting sites. Locals were interviewed to confirm occurrences or absences of species.

Three criteria were used to gauge the probability of occurrence of mammals on the study site. These include known distribution range, habitat preference and the qualitative and quantitative presence of suitable habitat.

5.2 Desktop Surveys

As the majority of mammals are secretive, nocturnal, hibernators and/or seasonal, distributional ranges and the presence of suitable habitats were used to deduce the

presence or absence of these species based on authoritative tomes, scientific literature, field guides, atlases and databases. This can be done irrespective of season. During the field work phase of the project, this derived list of occurrences is audited.

The probability of occurrences of **mammal** species was based on their respective geographical distributional ranges and the suitability of on-site habitat. In other words, *high* probability (√**)** would be applicable to a species with a distributional range overlying the study site as well as the presence of prime habitat occurring on the study site. Another consideration for inclusion in this category is the inclination of a species to be common, i.e. normally occurring at high population densities.

Medium probability (*) pertains to a mammal species with its distributional range peripherally overlapping the study site, or required habitat on the site being sub-optimal. The size of the site as it relates to its likelihood to sustain a viable breeding population, as well as its geographical isolation is also taken into consideration. Species categorised as *medium* normally do not occur at high population numbers, but cannot be deemed as rare.

A *low* probability (?) of occurrence will mean that the species' distributional range is peripheral to the study site and habitat is sub-optimal. Furthermore, some mammals categorised as *low* are generally deemed rare.

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5.3 Specific Requirements

During the visit the site was surveyed and assessed for the potential occurrence of Red Data and/or wetland-associated species such as:
Juliana's golden mole (*Neamblosomus juliana*), Highveld golden mole (*Amblysomus septentrionalis*), Rough-haired golden mole (*Chrysospalax villosus*), African marsh rat (*Dasymys incomtus*), Angoni vlei rat (*Otomys angoniensis*), Vlei rat (*Otomys irroratus*), White-tailed rat (*Mystromys albicaudatus*), a nember of shrews such as the Forest shrew (*Myosorex varius*), Southern African hedgehog *(Atelerix frontalis), a number of bats such as the* Short-eared trident bat (*Cloeotis percivali*), African clawless otter (*Aonyx capensis*), Spotted-necked otter (*Lutra maculicollis*), Marsh mongoose (*Atilax paludinosus*), Brown hyena (*Parahyaena brunnea*), etc.

6. RESULTS

Acocks (1988), Mucina and Rutherford (2006), Low & Rebelo (1996), Knobel and Bredenkamp (2006), SANBI & DEAT (2009) discuss the peculiar natural plant associations of the study area in broad terms. It should be noted that botanical geographers have made immense strides in defining plant associations (particularly assemblages denoted as veld types), whereas this cannot be said of zoologists. The reason is that vertebrate distributions are not very dependent on the minutiae of plant associations. Rautenbach (1978 & 1982) found that mammal assemblages can at best be correlated with botanically defined biomes, such as those by Low and Rebelo (1996 & 1998), and latterly by Mucina and Rutherford (2006) as well Knobel and Bredenkamp (2006). Hence, although the former's work has been superseded by the work of the latter two, the definitions of biomes are similar and both remain valid for mammals and are therefore recognized as a reasonable determinant of mammal distribution.

The local occurrences of mammals are, on the other hand, closely dependent on broadly defined habitat types, in particular terrestrial, arboreal (tree-living), rupiculous (rock-dwelling) and wetland-associated vegetation cover. It is thus possible to

deduce the presence or absence of mammal species by evaluating the habitat types within the context of global distribution ranges. Sight records and information from residents or knowledgeable locals audit such deductions.

Mammal Habitat Assessment

From a mammal habitat perspective, two of the four major habitats are present on the site, i.e. terrestrial and water / wetland. The site lacks indigenous trees (arboreal habitat) and rocky ridges (rupiculous habitat).

The terrestrial habitat is in a poor ecological state of repair. However, it is well fenced and fairly large (ca. 150+ ha), allowing for the occurrence of small antelopes (duiker, steenbok, reedbuck), warthogs and bushpigs. It is furthermore not grazed by domestic stock.

The wetland and the overgrown riparian zone have verdant *Phragmites* reed beds and moisture-adapted grasses and sedges. This habitat is permanent and aseasonal and thus supports a plethora of mammals year-round, presumably at relative high population numbers. It is amazing that the reed beds sprouted and grow on the old slag dumps.

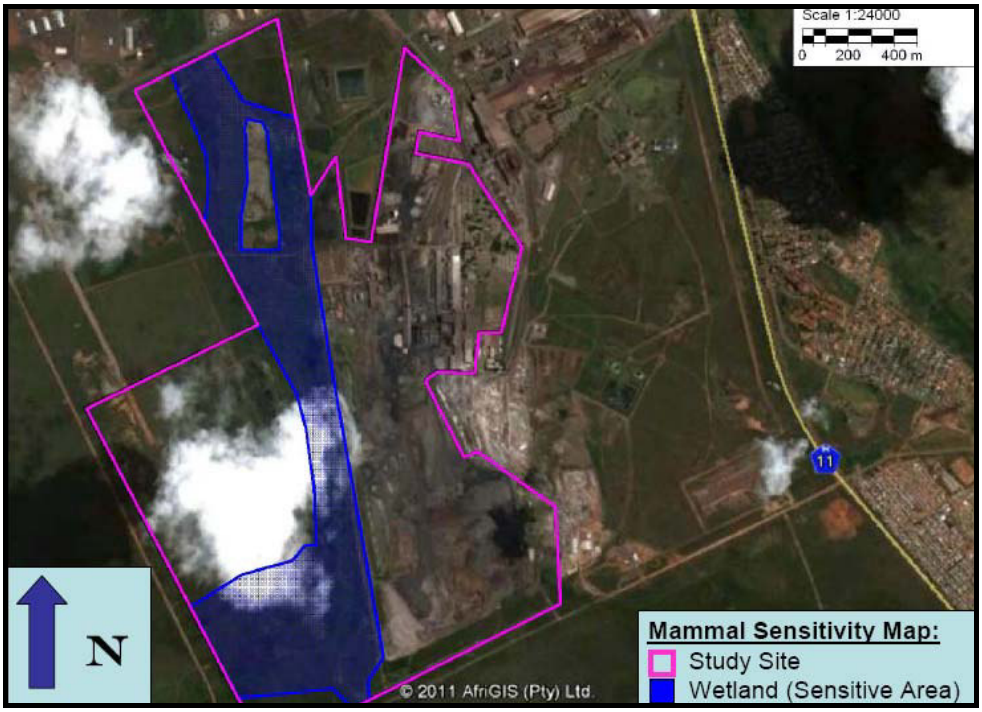

Figure 2: Map showing the sensitive wetland habitat on site

Expected and Observed Mammal Species Richness

Large mammals have long since been displaced to initially benefit agriculture and latterly industry. Some medium-sized mammals have by now also been displaced viz. aardvark, black-backed jackal and primates.

Of the 39 mammal species expected to occur on the study site (Table 1), 12 were confirmed through direct observations and the testimony of the Samancor environmental officer during the site visit (Table 2). It should be noted that potential occurrences is interpreted as to be possible over a period of time as result of expansion and contractions of population densities and ranges which stimulate migration.

Table 1 lists the mammals which were observed or deduced to occupy the site, or to be occasional visitors. All feral mammal species expected to occur on the study site (e.g. house mice, house rats, dogs and cats) were omitted from the assessment since these species normally associate with human settlements.

Most of the species of the resident diversity (Table 2) are common and widespread. Due to the nature of a slimes dam, very little mammal diversity occurred on the slimes dam that is proposed to be rehabilitated. Since the slimes dam is now mostly dry, some typical terrestrial mammals will benefit from the ample cover and nourishment along the banks of the slimes dam, depending on the vegetation cover, such as multimammate mice, four-striped grass mice and bushpigs.

All the listed bats are more than likely to feed on insect swarms rising over the water and wetlands on the study site during summer sunsets.

Low mammal diversity is due to low habitat diversity, past exterminations, partial isolation of the site size and a poor quality of conservation

Threatened and Red Listed Mammal Species

The hedgehog is a docile creature with a passive defence mechanism. It is predated upon by humans for a variety of reasons ranging from their cute disposition as pet to assumed medicinal values. If left to their own devices, this small insectivore has survived for millennia in natural conditions. Considering the strict access control to the site, it can be assumed to be present.

The 'Near Threatened' rodent and four 'Data deficient' shrews are flagged as Red Listed as a precaution, since qualitative and quantitative field data are lacking to allow an accurate assessment of their conservation status.

The spotted-necked otter appears to be more common than assumed, but as result of its close reliance of open water and wetlands offering ample aquatic prey items, they are deemed as 'Near Threatened'. Their continued presence is guaranteed on the site given access control and eventually management practices.

No other Red Data or sensitive species are deemed present on the site, either since the site is too disturbed, falls outside the distributional ranges of some species, or does not offer suitable habitat(s).

Table 1: The mammals which were observed or deduced to occupy the site
(Systematics and taxonomy as proposed by Bronner et.al [2003] and Skinner and Chimimba [2005])

	SCIENTIFIC NAME	ENGLISH NAME
√	*Lepus saxatilis*	Scrub hare
√	*Cryptomys hottentotus*	African mole rat
√	*Hystrix africaeaustralis*	Cape porcupine
*	*Thryonomys swinderianus*	Greater cane rat
?	*Pedetes capensis*	Springhare
√	*Rhabdomys pumilio*	Four-striped grass mouse
NT?	*Dasymys incomtus*	African marsh rat
*	*Mus minutoides*	Pygmy mouse
*	*Mastomys natalensis*	Natal multimammate mouse
*	*Mastomys coucha*	Southern multimammate mouse
*	*Aethomys ineptus*	Tete veld rat
√	*Otomys angoniensis*	Angoni vlei rat
√	*Otomys irroratus*	Vlei rat

	SCIENTIFIC NAME	ENGLISH NAME
*	*Gerbilliscus brantsii*	Highveld gerbil
?	*Dendromus melanotis*	Grey pygmy climbing mouse
?	*Dendromus mesomelas*	Brants' climbing mouse
?	*Dendromus mystacalis*	Chestnut climbing mouse
DD*	*Myosorex varius*	Forest shrew
DD*	*Suncus lixus*	Greater dwarf shrew
DD*	*Crocidura cyanea*	Reddish-grey musk shrew
DD*	*Crocidura hirta*	Lesser red musk shrew
NT?	*Atelerix frontalis*	Southern African hedgehog
*	*Tadarida aegyptiaca*	Egyptian free-tailed bat
*	*Neoromicia capensis*	Cape serotine bat
*	*Scotophilus dinganii*	African yellow house bat
*	*Scotophilus viridis*	Greenish yellow house bat
√	*Civettictis civetta*	African civet
?	*Genetta tigrina*	SA large-spotted genet
*	*Cynictis penicillata*	Yellow mongoose
√	*Galerella sanguinea*	Slender mongoose
√	*Atilax paludinosus*	Marsh mongoose
√	*Aonyx capensis*	African clawless otter
NT?	*Lutra maculicollis*	Spotted-necked otter
?	*Ictonyx striatus*	Striped polecat
√	*Potamochoerus larvatus*	Bushpig
√	*Phacochoerus africanus*	Common warthog
√	*Sylvicapra grimmia*	Common duiker
√	*Redunca arundinum*	Southern reedbuck
?	*Raphicerus campestris*	Steenbok

√ Definitely there or have a *high* probability to occur;
***** *Medium* probability to occur based on ecological and distributional parameters;
? *Low* probability to occur based on ecological and distributional parameters.

Red Data species rankings as defined in Friedmann and Daly's S.A. Red Data Book / IUCN (World Conservation Union) (2004) are indicated in the first column: CR= Critically Endangered, En = Endangered, Vu = Vulnerable, LR/cd = Lower risk conservation dependent, LR/nt = Lower Risk near threatened, DD = Data Deficient. All other species are deemed of Least Concern.

Table 2: Mammal species positively confirmed from the study site, observed indicators and habitat.

SCIENTIFIC NAME	ENGLISH NAME	OBSERVATION INDICATOR	HABITAT
L. saxatilis	Scrub hare	Faecal pellets	Short grass
C. hottentotus	African mole rat	Tunnel systems	Universal
H. africaeaustralis	Cape porcupine	Quills	Universal
O. angoniensis	Angoni vlei rat	Grass stem gnawings	Wetlands
O. irroratus	Vlei rat	Grass stem gnawings	Wetlands
G. sanguinea	Slender mongoose	Sight record	Good cover
A. paludinosus	Marsh mongoose	Tracts	Wetlands
A. capensis	Clawless otter	Tracts & faeces	Water bodies
P. larvatus	Bushpig	Reported	Near water
P. africanus	Common warthog	Reported	Plains
S. grimmia	Common duiker	Faecal pellets	Unversal
R. arundinum	Southern reedbuck	Reported	Riparian zones

The presence of the species listed in Table 2 was predictable. Given adequate habitat and sufficient territorial space, they were proven as robust species who can maintain a presence except for vigorous persecution.

Scrub hares and rodent moles are particularly common and widespread. They more than often co-exist with human activities in semi-urban situations and in the case of rodent moles even in suburban gardens.

Vlei rats are deemed sensitive given their dependence on their preferred habitat of rank hydrophilic vegetation, where they find adequate cover and sustenance.

Slender and marsh mongooses have reticent habits and therefore often succeed to persevere in rural and peri-urban situations, given sustainable prey.

The clawless otter is in fact more common and widespread than suspected, and it would appear that perennial streams and dams with adequate riparian cover and prey items often support populations of these aquatic carnivores.

Duiker and steenbok are also robust little herbivores capable to withstand low-key civilization pressures.

Bushpig, warthog and reedbuck were reported by the environmental officer of the Samancor facility. It is unknown whether these species were re-introduced or whether they immigrated.

7. FINDINGS AND POTENTIAL IMPLICATIONS

The slimes dam area to the west of the Ferrochrome plant is not regarded as ecologically sensitive, only the wetland system is sensitive. It is laudable that Samancor Middelburg Ferrochrome management plans to rehabilitate this slimes dam.

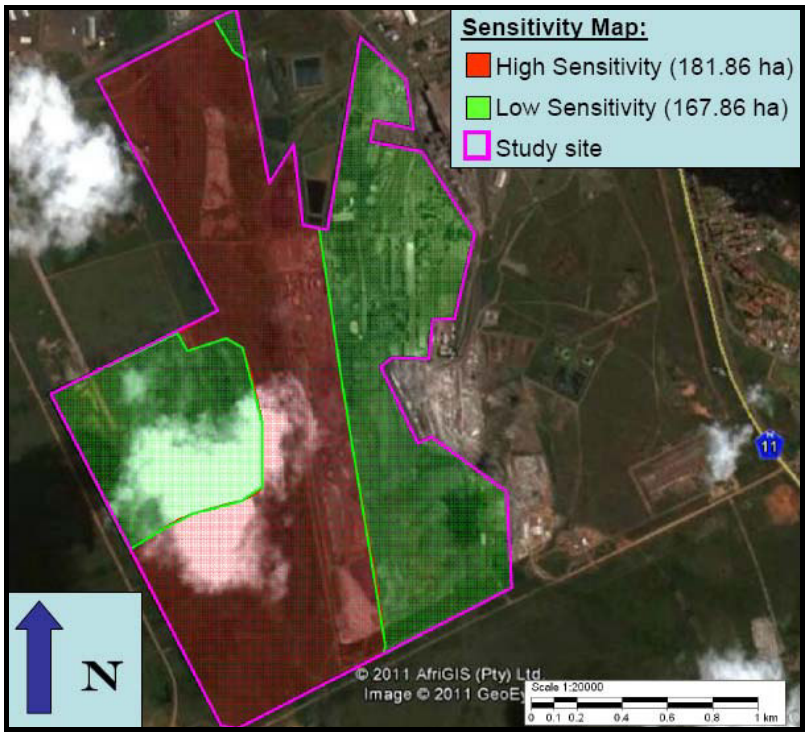

Figure 3: Mammal sensitivity map

The planned rehabilitation program will have no effect on terrestrial mammals with territories / home ranges some distance away from the work. The rehabilitation process if done correctly with slopes that is sufficient for small mammals to navigate will in the end create a much-improved habitat, especially if landscaping and reseeding are implemented to accelerate floral and vertebrate repopulation.

8. LIMITATIONS, ASSUMPTIONS AND GAPS IN INFORMATION

The assessment of mammal richness presented here is deemed sufficiently accurate. The contents of Table 1 are based on a desk top survey, on-site observations, testimony by the Samancor environmental officer, qualitative and quantitative assessments of habitats, and past experience of collecting surveys in the vicinity.

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are to some extent made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage. Galago Environmental can thus not accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. This report should therefore be viewed and acted upon with these limitations in mind.

9. RECOMMENDED MITIGATION MEASURES

Mitigation measures proposed for the rehabilitation of the slimes dam is that:

- Sloping of the slimes dam must be in line with practices that will ensure proper movement of fauna up and down the slope.
- Sloping must be done in such a manner to encourage vegetation establishment and reduce potential for erosion.

10. CONCLUSIONS

From a mammal perspective there are no compelling reasons why the rehabilitation can not be executed.

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APPENDIX C: AVIFAUNA REPORT

GALAGO ENVIRONMENTAL

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Avifaunal Habitat Assessment

of

SAMANCOR MIDDELBURG FERROCHROME TERRAIN

MARCH 2012

Report author: Mr. R.F. Geyser
Report verified/reviewed by: Dr. A.C. Kemp (Ph.D., Pr.Sci. Nat. (Zoology & Ecology))

VERIFICATION STATEMENT

Mr R. Geyser is not registered as a Professional Natural Scientist with the S.A. Council for Natural Scientific Professions. This communication serves to verify that the bird report compiled by Mr R.F. Geyser has been prepared under my supervision, and I have verified the contents thereof.

Declaration of Independence: I, Alan Charles Kemp (4405075033081), declare that I:

- am committed to biodiversity conservation but concomitantly recognize the need for economic development. Whereas I appreciate the opportunity to also learn through the processes of constructive criticism and debate, I reserve the right to form and hold my own opinions and therefore will not willingly submit to the interests of other parties or change my statements to appease them
- abide by the Code of Ethics of the S.A. Council for Natural Scientific Professions
- act as an independent specialist consultant in the field of zoology
- am subcontracted as specialist consultant by Galago Environmental CC for the proposed rehabilitation of the Samancor Ferrrochrome terrain described in this report
- have no financial interest in the proposed development other than remuneration for work performed
- neither have nor will have any vested or conflicting interests in the proposed development
- undertake to disclose to Galago Environmental CC and its client, and the competent authority, any material information that has or may have the potential to influence decisions by the competent authority as required in terms of the Environmental Impact Assessment Regulations 2006

Dr. A.C. Kemp

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1. INTRODUCTION

Galago Environmental CC. was appointed to undertake an avifaunal habitat survey for the proposed rehabilitation of a slimes dam (which is scheduled for rehabilitation) on the premises of the Samancor Ferrochrome terrain on a Portion of Middelburg Town and Townlands 287 JS (hereafter referred to as the study site).

The primary objective was to determine the presence of Red Data avifaunal species and to identify suitable habitat for these species. Direct observations and published data apart, qualitative and quantitative habitat assessments were used to derive the presence / absence of Red Data avifaunal species. A list of avifaunal species likely to be affected by the new development is compiled.

2. SCOPE AND OBJECTIVES OF THE STUDY

- To qualitatively and quantitatively assess the significance of the avifaunal habitat components, and current general conservation status of the property;
- To comment on ecologically sensitive areas;
- To comment on connectivity with natural vegetation and habitats on adjacent sites;
- To provide a list of avifauna that occur or that are likely to occur, and to identify species of conservation importance;
- To highlight potential impacts of the proposed development on the avifauna of the study site, and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

3. STUDY AREA

3.1 Locality

The study site, 350 ha in extent (excluding the 500 m extended study area), is situated within the 2529CD quarter degree grid cell (q.d.g.c.) and 2545_2925 pentad (SABAP2 protocol) just south of Middelburg within the Mpumalanga Province. The site is situated at an altitude of about 1 500 to just below 1480 metres above sea level (m.a.s.l.) and slopes downwards to the centre of the study site.

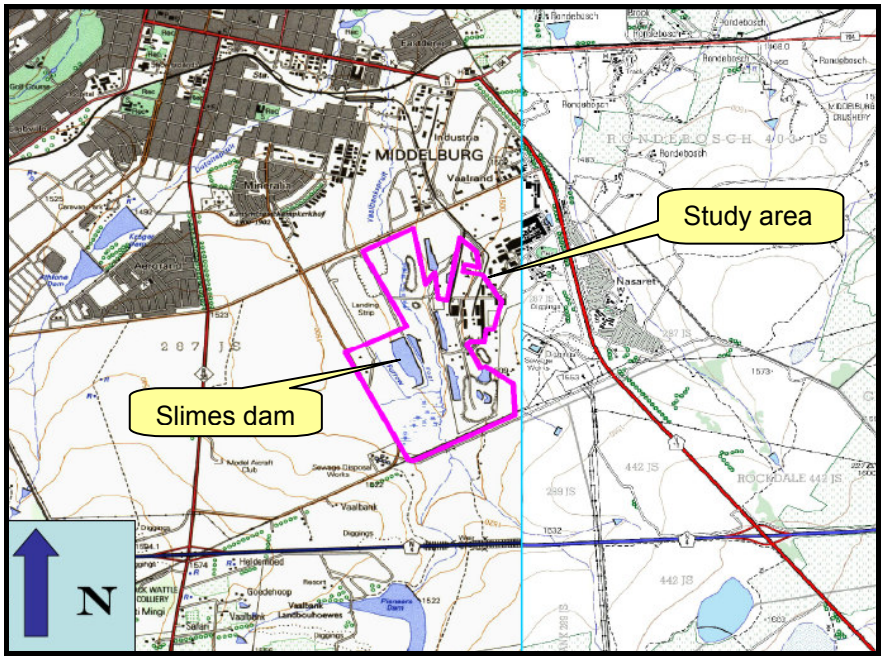

Figure 1: Locality map of the study area

3.2 Land Use

The largest portion of the study site consists of a disturbed industrial area on the eastern portion of the study site, the central wetland area of the Vaalbankspruit and western mainly disturbed grassland with the slimes dam area.

The study site is situated within the Mesic Highveld Grassland Bioregion of the Grassland Biome and more specifically within the Rand Highveld Grassland vegetation type according to Mucina and Rutherford (2006).

4. METHODS

A site visit was conducted on 1 December 2011 to record the presence of bird species associated with the habitat systems on the study site and to identify possible sensitive areas. During this visit the observed and derived presence of avifaunal species associated with the recognized habitat types of the study site, were recorded. This was done with due regard to the well recorded global distributions of Southern African avifauna, coupled to the qualitative and quantitative nature of recognized habitats.

4.1 Field Surveys

Birds were identified visually, using 10X42 Bushnell Legend binoculars and by call, and where necessary were verified from Sasol Birds of Southern Africa (Sinclair *et al*., 2011) and Southern African Bird Sounds (Gibbon, 1991).

The 500 m of adjoining properties was scanned for important animal species and avifaunal habitats.

During the site visit, birds were identified by visual sightings or aural records along random transect walks. No trapping or mist netting was conducted, since the terms of reference did not require such intensive work. In addition, birds were also identified by means of feathers, nests, signs, droppings, burrows or roosting sites. Locals were interviewed to confirm occurrences or absences of species.

4.2 Desktop Surveys

The presence of suitable habitats was used to deduce the likelihood of presence or absence of avifaunal species, based on authoritative tomes, scientific literature, field guides, atlases and databases. This can be done irrespective of season.

The likely occurrence of key avifaunal species was verified according to distribution records obtained during the Southern African Bird Atlas Project 1 (SABAP1) period from 1981 to 1993 (Harrison *et al.* 1997). Earlier records of only Red Data avifaunal species were obtained from the period between 1974 and 1987 according to Tarboton *et al.* (1987). The most recent avifaunal distribution data were obtained from the current SABAP2 project which commenced on 1 July 2007.

FULL SURVEY: The occurrence and historic distribution of likely avifaunal species, especially all Red Data avifaunal species recorded for the q.d.g.c. 2529CD, were verified from SABAP1 (southern Africa Bird Atlas Project 1) data (Harrison *et al.* 1997), Tarboton *et al.* (1987) and the current SABAP2 project (SABAP2 data for the 2529CD q.d.g.c and for the 2545_2925 pentad). The reporting rate for each avifaunal species likely to occur on the study site, based on Harrison *et al*. (1997), was scored between 0 – 100% and was calculated as follows: Total number of cards on which a species was reported during the Southern African Bird Atlas SABAP1 and, Red Data species only, the current SABAP2 project period X 100 ÷ total number of cards for the particular q.d.g.c. (Harrison *et al*., 1997) and pentad(s) (SABAP2). It is important to note that a q.d.g.c. (SABAP1 Protocol) covers a large area: for example, q.d.g.c. 2529CD covers an area of ±27 X 25 km (±693 km²) (15 minutes of latitude by 15 minutes of longitude, 15' x 15') and a pentad (SABAP2 Protocol) and area of ±8 X 7.6 km (5 minutes of latitude by 5 minutes of longitude, 5' x 5') and it is possible that suitable habitat will exist for a certain Red Data avifaunal species within this wider area surrounding the study site. However, the specific habitat(s) found on site may not suit the particular Red Data species, even though it has been recorded for the q.d.g.c or pentad. For example, the Cape Vulture occurs along the Magaliesberg but will not favour the habitat found within the Pretoria CBD, both of which are in the same q.d.g.c. Red Data bird species were selected and categorised according to Barnes (2000).

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An avifaunal diversity index, that gives an indication of which habitat system on the study site will hold the richest avifaunal species diversity, was calculated as the sum of the probability of occurrence of bird species within a specific habitat system on site. For each species and habitat, the probability of occurrence was ranked as: 5 = present on site, 4 = not observed on site but has a high probability of occurring there, 3 = medium probability, 2 = low probability, 1 = very low probability and 0 = not likely to occur.

5. RESULTS

Avifaunal Habitat Assessment:

Figure 2 illustrates the major habitat systems identified as likely to be used by bird species expected to occur on the study site.

Three major avifaunal habitat systems were identified on the study site. A short description of each habitat type follows, ranked from most to least important (refer to figure 2):

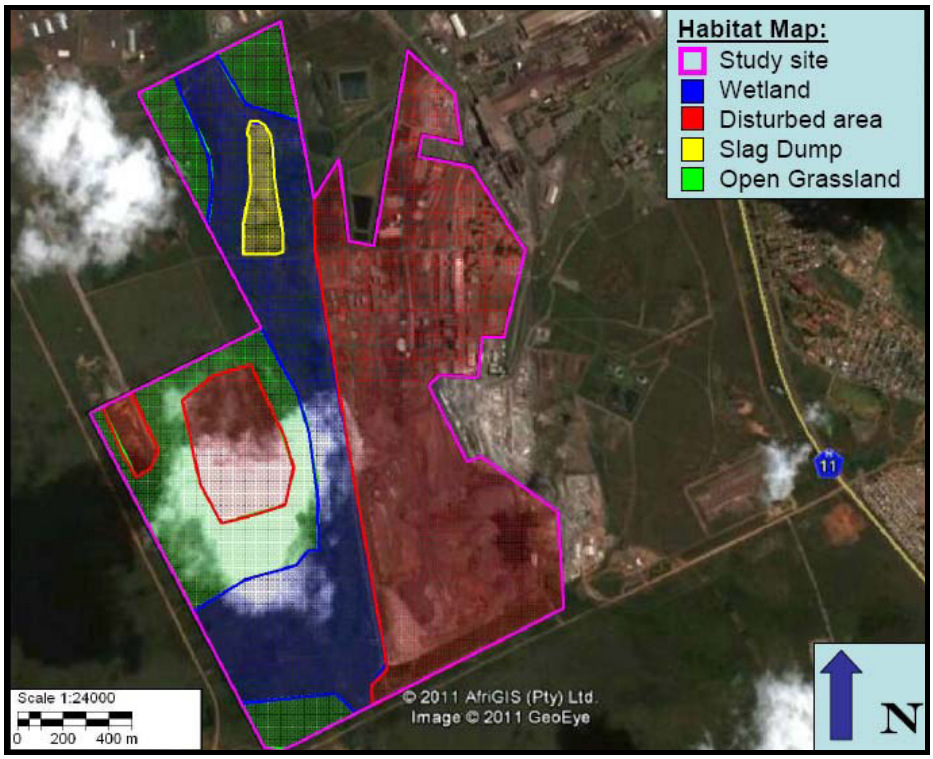

Figure 2: **Bird habitat systems identified from the study site.**

Wetlands:

The wetland on the study site consists largely of Palustrine wetlands which are wetlands that have a high ground water content, but which can often dry up during the dry season (Ginkel *et al.* 2011) during the winter season. Water accumulates during the wet summer rainy season and the plants that are adapted to these conditions grow in this habitat where obligate plants are often found. This wetland is formed by the Vaalbank Spruit and bisects the central portion of the study site with a south to north water flow. The wetland consists of static or slow-flowing shallow water and is largely overgrown by *Typha capensis*, *Phragmites australis* and other aquatic and semi-aquatic plants. Vlei's and marches forms in the poorly drained, moist and non-saline soils that flanks the seasonally flooded areas of the main stream of the Vaalbank Spruit and consists of a variety of wetland plant such as *Imperata cylindrica* situated between the transitional zone, between the aquatic vegetation (see vegetation report) and the adjacent grassland (terrestrial) area (Figure 3).

Further away from this transitional zone described above, a Lucustrine wetland have been created in the form of water filled quarries and settling ponds. This wetland has permanent wet conditions. Here plants often grow in the water, although certain floodplain areas can become dry during the winter rainy season forming shoreline and mud flats ideal for shoreline feeding birds such as waders (Figure 4).

The Palustrine wetland habitat is ideal for birds such as rails, warblers, crakes and moorhen that hunt and feed in the undergrowth at water level. Bishops and weavers, that use the rushes for roosting and breeding, and birds such as snipes and some duck species, that use the short march grass on the edge of the wetland for feeding and breeding, also prefer this habitat. This is a mainly a permanent wetland area and probably never dries up completely except in times of drought. During the winter the water flow is limited to a shallow and narrow stream that meanders through the wetland area but in summer, during high rainfall, the meandering stream floods its banks creating a broad wetland stretch and create ideal habitat for wetland avifaunal species. In winter

the aquatic and semi-aquatic vegetation becomes dry and brown due to limited water or due to cold and frost or burnt completely and during summer the vegetation becomes lush and green especially after good rains. Some swallows and martins make use of this wetland habitat for roosting or forages over the wetland area. The Lucustrine wetland system will favour more open water wetland avifaunal species such as ducks and grebes and shoreline feeding birds such as plovers, sandpipers, lapwings and herons.

Figure 3: Palustrine wetlands with *Imperata cylindrica* wetland grass in the foreground.

Figure 4: Lucustrine wetland

Open grassland:
The terrestrial habitat that flanks the grassland area consists of open grassland and varies from highly disturbed areas to areas with relatively undisturbed grassland (Figure 5).

Figure 5: Open grassland Habitat

Open grassland is the most important habitat type for South Africa's threatened bird species in the region with a proportional importance of 27%. The highest diversity of threatened bird species occurs within this grassland habitat, many of which are under the highest categories of threat (Barnes 2000).

This habitat also includes the grassland area bordering wetlands, which are used by many Red Data bird species in combination with adjacent wetland habitat, crop or fallow fields and pastures.

The presence and abundance of bird species in this habitat will vary from season to season - lush and green in summer after summer rains and dry, brown, frosted or burnt during winter. The habitat favours ground-living bird species, such as lapwings, francolins, pipits, longclaws, larks and chats. These birds hunt for insects and/or breed on the ground, in burrows in the ground, or between the grasses. Weavers and widowbirds make use of such habitat for feeding on ripe seeds during late summer and early winter when the grass is not burnt, and widowbirds and cisticolas will also breed in the tall grass during summer. Species such as weavers and bishops that breed in the wetland habitat during summer will also make use of the open grassland habitat for feeding during winter after the grasses have seeded. Aerial feeding birds such as martins, swifts and swallows will also hunt for insects over the grasslands.

Disturbed Areas:
This area is limited to the areas where the mining activities and structures is situated, garden areas between the buildings and other transformed areas such as the runway and slimes dam.

Only birds that are able to adapt to areas transformed by man will occur in this area such as garden birds and alien birds species.

In general, rural and suburban gardens have created an evergreen habitat for many bird species, where birds can hide, breed and forage for food. Natural predators such as snakes and smaller wild-cat species, which largely are persecuted by man, have been driven out of these areas, making it a relatively safe environment for birds apart from domestic cats and dogs. Many bird species have adapted to human-altered areas and these species are mainly the more common bird species found within southern Africa.

The ranges of some species have also increased and species not previously known to occur within Gauteng suburbs are now common, e.g. Grey-go-away Bird and Thick-billed Weaver. Some species, which are mainly alien species, are dependent on humans for survival such as the House Sparrow and Common Myna.

Fruit-bearing trees are also an important food supply for many bird species. Most of these bird species are not habitat specific and, due to their high level of adaptability, are also not threatened.

Observed and Expected Species Richness
Of the 260 bird species recorded for the 2529CD q.d.g.c., 167 (64.2 %) are likely to occur on the study site and 60 (35.9 %) of these bird species were actually observed on site.

The avifaunal diversity index (ADI) indicates that the largest bird species diversity is likely to occur within the wetland habitat system on site, with a avifaunal diversity index (ADI) of, followed by the open grassland (ADI 344) and the disturbed areas (ADI 299).

The bird species listed in Table 1 are in the species order according to *Roberts - Birds of Southern Africa* VIIth edition (Hockey *et al*, 2005). These comprise the 167 species actually observed on site (**in bold**) or likely to occur within the specific habitat(s) found on site. This does not include overflying birds or rare vagrants. The reporting rate for each species is the percentage for the q.d.g.c. according to the SABAP 1 atlas (Harrison *et al.* 1997). Our habitat preference scores for each species are shown under the recognised habitat types on site: **WT = WetLand, OG = Open Grassland** and **DA = Disturbed Areas** with their possibility of occurrence in these specific habitats rated as 5 = present, 4 = High, 3 = Medium, 2 = Low, 1 = Very low and 0 = Not likely to occur.

Table 1: Bird species observed and that are likely to occur on the study site.

SCIENTIFIC NAMES	COMMON NAMES	R rate %*	Habitat preference		
		SABAP1	WT	OG	DA
Struthio camelus	**Common Ostrich**	**3**	0	0	5
Pternistis swainsonii	Swainson's Spurfowl	**40**	4	5	3
Coturnix coturnix	Common Quail	**<1**	0	2	0
Numida meleagris	**Helmeted Guineafowl**	**49**	4	5	3
Dendrocygna bicolor	Fulvous Duck	**<1**	1	0	0
Dendrocygna viduata	**White-faced Duck**	**2**	5	0	0
Alopochen aegyptiaca	Egyptian Goose	**50**	5	0	4
Plectropterus gambensis	**Spur-winged Goose**	**14**	5	3	0
Anas capensis	Cape Teal	**7**	2	0	0
Anas sparsa	African Black Duck	**22**	3	0	0
Anas undulata	Yellow-billed Duck	**43**	4	0	0
Anas smithii	Cape Shoveler	**7**	1	0	0
Anas erythrorhyncha	**Red-billed Teal**	**23**	5	0	0
Jynx ruficollis	Red-throated Wryneck	**27**	2	3	2
Tricholaema leucomelas	Acacia Pied Barbet	**14**	0	1	2
Lybius torquatus	Black-collared Barbet	**16**	2	0	4
Trachyphonus vaillantii	Crested Barbet	**28**	2	0	4
Upupa africana	African Hoopoe	**35**	2	3	4
Phoeniculus purpureus	Green Wood-Hoopoe	**7**	0	0	4
Alcedo cristata	**Malachite Kingfisher**	**23**	5	0	0
Halcyon albiventris	Brown-hooded Kingfisher	**6**	2	0	3
Megaceryle maximus	Giant Kingfisher	**23**	3	0	0
Ceryle rudis	Pied Kingfisher	**51**	3	0	0
Merops bullockoides	White-fronted Bee-eater	**6**	3	2	0
Merops apiaster	**European Bee-eater**	**<1**	4	5	1
Colius striatus	Speckled Mousebird	**65**	3	0	4
Urocolius indicus	Red-faced Mousebird	**2**	3	0	4
Chrysococcyx caprius	**Diderick Cuckoo**	**26**	5	5	4
Centropus burchellii	Burchell's Coucal	**<1**	4	0	3
Cypsiurus parvus	**African Palm-Swift**	**22**	4	5	4
Apus barbatus	African Black Swift	**1**	2	2	1
Apus affinis	**Little Swift**	**31**	4	5	5
Apus horus	Horus Swift	**2**	2	3	1
Apus caffer	**White-rumped Swift**	**29**	5	5	4
Tyto alba	Barn Owl	**1**	2	3	4
Tyto capensis	**African Grass-Owl (VU)**	**<1**	5	4	0
Bubo africanus	Spotted Eagle-Owl	**3**	2	3	3
Asio capensis	Marsh Owl	**20**	4	4	0
Columba livia	Rock Dove	**16**	2	2	4

SCIENTIFIC NAMES	COMMON NAMES	R rate %*	Habitat preference		
		SABAP1	WT	OG	DA
Columba guinea	Speckled Pigeon	**74**	4	4	4
Streptopelia senegalensis	**Laughing Dove**	**96**	5	5	5
Streptopelia capicola	**Cape Turtle-Dove**	**89**	4	5	5
Streptopelia semitorquata	**Red-eyed Dove**	**48**	5	5	5
Rallus caerulescens	**African Rail**	**1**	5	0	0
Amaurornis flavirostris	Black Crake	**5**	4	0	0
Porphyrio madagascariensis	African Purple Swamphen	**2**	3	0	0
Gallinula chloropus	**Common Moorhen**	**24**	5	0	0
Fulica cristata	Red-knobbed Coot	**73**	4	0	0
Gallinago nigripennis	**African Snipe**	**5**	5	0	0
Tringa stagnatilis	Marsh Sandpiper	**5**	3	0	0
Tringa nebularia	Common Greenshank	**4**	3	0	0
Tringa glareola	Wood Sandpiper	**6**	4	0	0
Actitis hypoleucos	Common Sandpiper	**26**	4	0	0
Calidris minuta	Little Stint	**5**	1	0	0
Philomachus pugnax	Ruff	**6**	2	0	0
Burhinus capensis	Spotted Thick-knee	**29**	2	4	4
Himantopus himantopus	Black-winged Stilt	**8**	1	0	0
Charadrius tricollaris	**Three-banded Plover**	**27**	5	3	0
Vanellus armatus	**Blacksmith Lapwing**	**88**	5	4	4
Vanellus senegallus	African Wattled Lapwing	**45**	4	4	0
Vanellus coronatus	Crowned Lapwing	**79**	0	5	4
Cursorius temminckii	Temminck's Courser	**<1**	0	2	0
Larus cirrocephalus	Grey-headed Gull	**50**	2	0	0
Chlidonias hybrida	**Whiskered Tern**	**9**	5	3	0
Chlidonias leucopterus	White-winged Tern	**16**	4	3	0
Elanus caeruleus	**Black-shouldered Kite**	**42**	3	5	0
Milvus migrans	Black Kite	**3**	2	2	2
Buteo vulpinus	Steppe Buzzard	**4**	1	3	0
Falco naumanni	Lesser Kestrel (**VU**)	**5**	0	2	0
Falco rupicolus	Rock Kestrel	**2**	0	1	0
Falco rupicoloides	Greater Kestrel	**2**	0	2	0
Falco amurensis	Amur Falcon	**13**	0	3	0
Tachybaptus ruficollis	Little Grebe	**48**	4	0	0
Anhinga rufa	**African Darter**	**40**	5	0	0
Phalacrocorax africanus	**Reed Cormorant**	**71**	5	0	0
Phalacrocorax lucidus	**White-breasted Cormorant**	**44**	5	0	0
Egretta garzetta	Little Egret	**26**	4	0	0
Egretta intermedia	Yellow-billed Egret	**15**	2	0	0
Ardea cinerea	Grey Heron	**38**	4	0	0
Ardea melanocephala	Black-headed Heron	**50**	4	4	0
Ardea purpurea	**Purple Heron**	**24**	5	0	0
Bubulcus ibis	**Cattle Egret**	**82**	5	5	3
Ardeola ralloides	Squacco Heron	**9**	3	0	0
Butorides striata	Green-backed Heron	**2**	2	0	0
Ixobrychus minutus	Little Bittern	**1**	3	0	0
Scopus umbretta	**Hamerkop**	**37**	5	1	0
Plegadis falcinellus	Glossy Ibis	**8**	3	0	0
Bostrychia hagedash	Hadeda Ibis	**87**	5	3	4

SCIENTIFIC NAMES	COMMON NAMES	R rate %*	Habitat preference		
		SABAP1	WT	OG	DA
Threskiornis aethiopicus	African Sacred Ibis	**53**	4	0	0
Platalea alba	African Spoonbill	**20**	1	0	0
Laniarius ferrugineus	Southern Boubou	**5**	0	0	3
Telophorus zeylonus	Bokmakierie	**40**	2	4	3
Corvus albus	**Pied Crow**	**14**	4	5	4
Lanius collurio	**Red-backed Shrike**	**1**	4	5	1
Lanius minor	Lesser Grey Shrike	**1**	3	4	0
Lanius collaris	**Common Fiscal**	**93**	3	5	5
Riparia paludicola	**Brown-throated Martin**	**38**	5	3	0
Riparia cincta	**Banded Martin**	**5**	4	5	0
Hirundo rustica	Barn Swallow	**33**	4	4	4
Hirundo albigularis	**White-throated Swallow**	**37**	5	4	4
Hirundo cucullata	**Greater Striped Swallow**	**38**	5	5	4
Hirundo abyssinica	Lesser Striped Swallow	**12**	3	3	3
Hirundo semirufa	Red-breasted Swallow	**7**	1	2	0
Hirundo spilodera	**South African Cliff-Swallow**	**9**	5	5	0
Hirundo fuligula	Rock Martin	**14**	3	4	4
Delichon urbicum	Common House-Martin	**3**	3	3	2
Pycnonotus tricolor	Dark-capped Bulbul	**63**	4	0	4
Sphenoeacus afer	Cape Grassbird	**2**	3	0	0
Bradypterus baboecala	Little Rush-Warbler	**<1**	2	0	0
Acrocephalus baeticatus	**African Reed-Warbler**	**<1**	5	0	0
Acrocephalus palustris	Marsh Warbler	**<1**	0	0	1
Acrocephalus arundinaceus	Great Reed-Warbler	**3**	3	0	1
Acrocephalus gracilirostris	**Lesser Swamp-Warbler**	**11**	5	0	0
Phylloscopus trochilus	Willow Warbler	**<1**	4	0	4
Zosterops virens	Cape White-eye	**23**	4	0	4
Cisticola tinniens	**Levaillant's Cisticola**	**23**	5	2	0
Cisticola fulvicapilla	Neddicky	**7**	4	3	4
Cisticola juncidis	**Zitting Cisticola**	**14**	4	5	1
Cisticola aridulus	Desert Cisticola	**2**	0	3	0
Cisticola textrix	Cloud Cisticola	**2**	0	2	0
Prinia subflava	Tawny-flanked Prinia	**14**	4	4	4
Prinia flavicans	**Black-chested Prinia**	**11**	3	5	4
Mirafra africana	**Rufous-naped Lark**	**20**	1	5	0
Mirafra fasciolata	Eastern Clapper Lark	**2**	0	2	0
Chersomanes albofasciata	Spike-heeled Lark	**6**	0	3	0
Calandrella cinerea	Red-capped Lark	**6**	0	2	0
Psophocichla litsitsirupa	Groundscraper Thrush	**4**	1	1	3
Turdus smithi	**Karoo Thrush**	**42**	4	0	5
Sigelus silens	Fiscal Flycatcher	**8**	0	0	3
Muscicapa striata	Spotted Flycatcher	**1**	2	0	3
Cossypha caffra	Cape Robin-Chat	**23**	4	0	4
Saxicola torquatus	African Stonechat	**5**	4	4	0
Cercomela familiaris	Familiar Chat	**2**	0	2	3
Myrmecocichla formicivora	Ant-eating Chat	**51**	0	2	0
Onychognathus morio	Red-winged Starling	**25**	2	0	4
Lamprotornis nitens	Cape Glossy Starling	**44**	1	3	4
Cinnyricinclus leucogaster	Violet-backed Starling	**3**	1	0	2

SCIENTIFIC NAMES	COMMON NAMES	R rate %*	Habitat preference		
		SABAP1	WT	OG	DA
Spreo bicolor	Pied Starling	**29**	2	4	3
Acridotheres tristis	**Common Myna (INT)**	**24**	0	0	5
Chalcomitra amethystina	Amethyst Sunbird	**20**	1	0	4
Cinnyris talatala	White-bellied Sunbird	**9**	1	0	4
Ploceus capensis	Cape Weaver	**14**	4	3	4
Ploceus velatus	**Southern Masked-Weaver**	**70**	5	5	5
Quelea quelea	**Red-billed Quelea**	**4**	5	4	3
Euplectes afer	Yellow-crowned Bishop	**11**	4	3	0
Euplectes orix	**Southern Red Bishop**	**48**	5	4	4
Euplectes axillaris	**Fan-tailed Widowbird**	**2**	5	2	0
Euplectes albonotatus	White-winged Widowbird	**3**	4	3	0
Euplectes ardens	**Red-collared Widowbird**	**4**	5	2	0
Euplectes progne	**Long-tailed Widowbird**	**65**	5	5	0
Amblyospiza albifrons	**Thick-billed Weaver**	**pers obs**	5	3	2
Sporaeginthus subflavus	**Orange-breasted Waxbill**	**2**	5	3	0
Amadina erythrocephala	Red-headed Finch	**30**	2	2	3
Estrilda astrild	**Common Waxbill**	**9**	5	4	2
Spermestes cucullatus	Bronze Mannikin	**5**	4	4	4
Vidua macroura	**Pin-tailed Whydah**	**29**	5	4	4
Passer domesticus	**House Sparrow (INT)**	**45**	0	0	5
Passer melanurus	**Cape Sparrow**	**89**	5	5	5
Passer diffusus	Southern Grey-headed Sparrow	**18**	4	4	4
Motacilla capensis	**Cape Wagtail**	**75**	5	1	4
Macronyx capensis	**Cape Longclaw**	**45**	5	5	0
Anthus cinnamomeus	African Pipit	**23**	0	4	3
Serinus canicollis	**Cape Canary**	**12**	4	4	5
Serinus alario	**Black-headed Canary**	**23**	4	5	4
Crithagra mozambicus	Yellow-fronted Canary	**6**	1	2	3
Crithagra gularis	Streaky-headed Seedeater	**1**	1	1	2
Emberiza tahapisi	Cinnamon-breasted Bunting	**2**	0	1	2
	Avifaunal Diversity Index:		503	344	299

*The reporting rate is calculated as follows: Total number of cards on which a species was reported X 100 ÷ total number of cards for a particular quarter degree grid cell. **INT** = Introduced or alien birds species to Southern Africa.

Red Data Species Categories for the birds (Barnes, 2000)
RE = Regionally extinct, **CR** = Critically Endangered **EN** = Endangered, **VU** = Vulnerable, **NT** = Near-threatened.

The biodiversity index gives an indication of which habitat will hold the richest bird diversity on site. The likelihood of occurrence of each species in the specific habitat systems on the study site are as follow: 5 = present, 4 = High, 3 = Medium, 2 = Low, 1 = very low, and 0 = Not likely to occur.

Threatened and Red Listed Bird Species

The following Red Data avifaunal species were recorded for the 2529CD q.d.g.c according to Tarboton *et al* (1987), the SABAP1 data (Harrison *et al.* 1997) and the SABAP2 data for the 2529CD q.d.g.c and 2545_2925 pentad (Table 2).

Table 2: Red Data bird species recorded for the 2529CD q.d.g.c.

SCIENTIFIC NAMES	ENGLISH NAMES	Reporting rate (%) SABAP1/SABAP2/Pentad
Alcedo semitorquata	Half-collared Kingfisher (NT)	2 / 0 / 0
Tyto capensis	**African Grass-Owl (VU)**	<1 / 0.3 / 0.4
Neotis denhami	Denham's Bustard (VU)	<1 / 0 / 0 (T)
Eupodotis senegalensis	White-bellied Korhaan (VU)	<1 / 0.6 / 0.4
Anthropoides paradiseus	Blue Crane (VU)	1 / 0 / 0
Podica senegalensis	African Finfoot (VU)	<1 / 0 / 0
Sterna caspia	Caspian Tern (NT)	6 / 0 / 0
Circus ranivorus	African Marsh-Harrier (VU)	0 / 0.6 / 0.4 (T)
Sagittarius serpentarius	Secretarybird (NT)	3 / 0 / 0
Falco naumanni	Lesser Kestrel (VU)	5 / 1.8 / 1.5
Falco biarmicus	Lanner Falcon (NT)	0 / 0 / 0 (T)
Phoenicopterus ruber	Greater Flamingo (NT)	7 / 0.3 / 0
Phoenicopterus minor	Lesser Flamingo (NT)	2 / 0.3 / 0 (T)
Geronticus calvus	Southern Bald Ibis (VU)	<1 / 30.4 / 37.3 (T)
Mycteria ibis	Yellow-billed Stork (NT)	2 / 0 / 0
Ciconia nigra	Black Stork (NT)	<1 / 0 / 0
Buphagus erythrorhynchus	Red-billed Oxpecker (NT)	<1 / 0 / 0
	SABAP1:	15
	Tarboton *et al.* (1987) present:	5
	SABAP2 (q.d.g.c.):	7
	SABAP2 2524_2925 pentad:	5
	Site survey 1/12/2011:	1

*The reporting rate of SABAP1 and SABAP2 is calculated as follows: Total number of cards on which a species was reported X 100 ÷ total number of cards for a particular quarter degree grid cell. The colour codes for each species are represented as follows: yellow = very low, light orange = low, dark orange = medium and red = high with reference to the specific habitat systems found on site.

Red Data Species Categories for the birds (Barnes, 2000)

RE = Regionally extinct, **CR** = Critically Endangered **EN** = Endangered, **VU** = Vulnerable, **NT** = Near-threatened.

A total of 17 Red Data avifaunal species have been recorded within the 2529CD q.d.g.c. (Table 2). One of these species, the Lanner Falcon, appear to have disappeared from the area or were not recorded for this q.d.g.c. during the time of the southern African Bird Atlas 1 and 2 projects. It is unlikely that they will ever recur in this region again except maybe on rare occasions in protected areas. Four of these species have been recorded for SABAP1 and SABAP2 and only one species, the Southern Bald Ibis, has been recorded for SABAP1, SABAP2 and the period prior to 1987 (Tarboton *et al.,* 1987). Seven of the 17 species were recorded for the 2529CD q.d.g.c. during SABAP2 and five were recorded for the 2545_2925 pentad. One species, the African Grass-Owl, was observed in the wetland area on the study site.

Summary of the Red Data bird species

Table 3 provides a list of the Red Data bird species recorded for the 2529CD q.d.g.c. according to Harrison *et al.* (1997) and an indication of their likelihood of occurrence on the study site based on habitat and food availability.

Table 3: Red Data bird species assessment for the 2529CD q.d.g.c.

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
Alcedo semitorquata (Half-collared Kingfisher) (**NT**)	Yes: Requires fast-flowing streams, rivers and estuaries, usually with dense marginal vegetation (Maclean, 1993), especially perennial streams and smaller rivers with overhanging riparian vegetation on their banks. Nests in sand/earth banks (Tarboton *et al.* 1987) and requires riverbanks in which to excavate nest tunnels (Harrison *et al.* 1997a). Most typically occurs along fast-flowing streams with clear water and well-wooded riparian growth, often near rapids. It most frequently favours broken escarpment terrain and requires at least 1 km up and down stream of undisturbed river and riparian vegetation while breeding. It occurs from sea-level to 2000 m.a.s.l. in southern Africa. Usually perches low down on the banks of rivers and streams, often on exposed roots, as well as exposed rock and low overhanging tree branches.	Highly unlikely Due to a lack of suitable foraging and breeding habitat.
Tyto capensis (African Grass-Owl) (**VU**)	Yes: Occurs predominately in rank grass, typically but not always at fairly high altitudes. Breeds mainly in permanent and seasonal vleis, which it vacates while hunting or during post-breeding although it will sometimes breed in any area of long grass, sedges or even weeds (Van Rooyen, pers comm.) and not necessarily associated with wetlands (Tarboton *et al.* 1987) although this is more the exception than the rule. Foraging mainly confined to tall grassland next to their wetland vegetation and rarely hunts in short grassland, wetlands or croplands nearby (Barnes, 2000). Mainly restricted to wet areas (marshes and vleis) where tall dense grass and/or sedges occur. Prefers permanent or seasonal vleis and vacates the latter when these dried up or are burnt. Roosts and breeds in vleis but often hunt elsewhere e.g. old lands and disturbed grassland although this is suboptimal habitat conditions (Tarboton *et al.* 1987). May rarely occur in sparse *Acacia* woodland where patches of dense grass cover are present (Harrison *et al.* 1997a).	Confirmed This species was observed in the wetland habitat on the study site.
Neotis denhami (Denham's Bustard) (**VU**)	None on site: In the grassland biome, its habitat is high-rainfall open, exposed, hilly, sour grassland during its breeding season (Tarboton *et al.* 1987). They move into cultivated pastures and cereal cropland in the nonbreeding season, where they prefer harvested fields; ploughed fields and fields with growing cereal crops are avoided (Herhold 1988; Allan 1993).	Highly unlikely Due to the disturbance of the grassland, small extent of the grassland and disturbance surrounding the study site.
Eupodotis senegalensis (White-bellied Korhaan) (**VU**)	None on site: Occurs in fairly tall, dense grassland, especially sour and mixed grassland, in open or lightly wooded, undulating to hilly country. In winter, occasionally on modified pastures and burnt ground (Harrison *et al.* 1997a).	Highly unlikely Due to disturbance surrounding the study site.
Anthropoides paradiseus (Blue Crane) (**VU**)	None on site: Midlands and highland grassland, edge of karoo, cultivated land and edges of vleis (Maclean, 1993). Nests in both moist situations in vleis which have short grass cover and in dry sites far from water, usually exposed places such as on	Highly unlikely Due to the small extent of the grassland,

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
	hillsides; forages in grassland and cultivated and fallow lands; roosts communally in the shallow water of pans and dams (Tarboton *et al*. 1987). Short dry grassland, being more abundant and evenly disturbed in the eastern "sour" grassland, where natural grazing of livestock is the predominant land use. Prefers to nest in areas of open grassland (Barnes, 2000) In the fynbos biome it inhabit cereal croplands and cultivated pastures and avoids natural vegetation. By contrast, it is found in natural vegetation in the Karoo and grassland biomes, but it also feeds in crop fields (Harrison *et al*. 1997a).	disturbance surrounding the study site and high human presence surrounding the study site.
Podica senegalensis (African Finfoot) (**VU**)	None on site: Occurs mostly along quiet, wooded streams and rivers flanked by thick riparian vegetation and overhanging trees. Also dam verges, especially where there is sufficient overhanging vegetation and reed cover. Avoids both stagnant and very fast-flowing watercourses, with a preference for clear, rather than silted water (Hockey *et al*., 2005).	Highly unlikely Due to a lack of suitable breeding and foraging habitat, on and surrounding the study site.
Sterna caspia (Caspian Tern) (**NT**)	None on site: Occurs along coast, mostly in sheltered bays and estuaries. Inland, at large water bodies, both natural and man-made, with preference for saline pans and large impoundments. Coastal breeding habitat primarily offshore islands, but with increasing use of sandy beaches and islands in saltworks, where protection is offered. Inland, breeds on small, low islets in pans and dams (Hockey *et al*. 2005).	Highly unlikely Due to a lack of suitable foraging and breeding habitat.
Circus ranivorus (African Marsh-Harrier) (**VU**)	Yes: Almost exclusively inland and coastal wetlands (Hockey *et al*. 2005). Wetland and surrounding grasslands. Most highveld wetlands > 100 ha support a breeding pair (Tarboton & Allan 1984). Nests in extensive reed beds often nigh above water. Forages over reeds, lake margins, floodplains and occasionally even woodland. Almost entirely absent from areas below 300 mm of rainfall (Harrison et al., 1997a). Marsh, vlei, grassland (usually near water); may hunt over grassland, cultivated lands and open savanna (Maclean, 1993). Dependant on wetlands, particularly permanent wetlands for breeding, roosting and feeding. May utilise small wetlands 1-2 ha in extent for foraging, but larger wetlands are required for breeding (Barnes, 2000).	Likely The wetland habitat does offer suitable breeding and foraging habitat for this species.
Sagittarius serpentarius (Secretarybird) (**NT**)	None on site: Open grassland with scattered trees, shrubland, open *Acacia* and *Combretum* savanna (Hockey *et al*. 2005). Restricted to large conservation areas in the region. Avoids densely wooded areas, rocky hills and mountainous areas (Hockey *et al*. 2005 & Barnes, 2000). Requires small to medium-sized trees with a flat crown for nesting, and often roosts in similar locations. Nesting density only about 150 km^2/pair (n = 4, Kemp, 1995).	Highly unlikely Due to the small extent of the study site and the disturbance surrounding it.
Falco naumanni (Lesser Kestrel) (**VU**)	Yes: Non-breeding Palaearctic migrant. Forages preferentially in pristine open grassland but also hunts in converted grassland such as small scale pastures provided the conversion is not as total as in	Likely Only on rare occasions

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
	plantation forestry or in areas of consolidated agricultural monoculture (Barnes, 2000; Hockey *et al*. 2005) such as maize, sorghum, peanuts, wheat, beans and other crops (Tarboton & Allan 1984) where they hunt for large insects and small rodents, but avoid wooded areas except on migration. They roost communally in tall trees, mainly *Eucalyptus*, in urban areas (Barnes, 2000), often in towns or villages, but also in farm lands (pers. obs). Favour a warm, dry, open or lightly wooded environment, and are concentrated in the grassy Karoo, western fringes of the grassland biome and southeast Kalahari. Generally avoids foraging in transformed habitats but occurs in some agricultural areas, including croplands, in fynbos and renosterveld of the Western Cape (Hockey *et al*. 2005). Large numbers congregate in sweet and mixed grasslands of the highveld regions.	
Falco biarmicus (Lanner Falcon) (**NT**)	None on site: Most frequent in open grassland, open or cleared woodland, and agricultural areas. Breeding pairs generally favour habitats where cliffs are available as nest and roost sites, but will use alternative sites such as trees, electricity pylons and building ledges if cliffs are absent (Hockey *et al*. 2005). Mountains or open country, from semi desert to woodland and agricultural land, also cities (Maclean, 1993), even on forest-grassland ecotones. Generally a cliff nesting species and its wider distribution is closely associated with mountains with suitable cliffs. Able to breed on lower rock faces than Peregrine Falcon *Falco peregrinus* and also utilises the disused nests of other species, such as crows, other raptors and storks, on cliffs, in trees and on power pylons, and also quarry walls (Tarboton *et al*. 1987). Generally prefers open habitats e.g. alpine grassland and the Kalahari, but exploits a wide range of habitats – grassland, open savanna, agricultural lands, suburban and urban areas, rural settlements – in both flat and hilly or mountainous country. Also breeds in wooded and forested areas where cliffs occur (Harrison *et al*. 1997a).	Highly unlikely Due to a lack of suitable breeding habitat.
Phoenicopterus ruber (Greater Flamingo) (**NT**)	None on site: Breeds at recently flooded, large, eutrophic wetlands (favoured foraging habitat), shallow salt pans; at other times, at coastal mudflats, inland dams, sewage treatments works, small ephemeral pans and river mouths (Hockey *et al*. 2005). Usually breeds colonially on mudflats in large pans (Harrison *et al*. 1997a). Shallow pans, especially saline pans when they have water; also occasionally on other bodies of shallow water such as dams and vleis (Tarboton *et al*. 1987). Large bodies of shallow water, both inland and coastal; prefers saline and brackish water (Maclean 1993). Occasionally forages along sandy coasts.	Highly unlikely Due to a lack of suitable foraging and breeding habitat.
Phoenicopterus minor (Lesser Flamingo) (**NT**)	None on site: Primarily open, shallow eutrophic, wetlands and coastal lagoons and may occur on water bodies which are more saline and more alkaline than those used by *Phoenicopterus ruber* (Greater Flamingo). Breeds on saline lakes, salt	Highly unlikely Due to a lack of suitable foraging and breeding habitat.

SCIENTIFIC NAME	PRESENCE OF SUITABLE HABITAT AND HABITAT REQUIREMENTS	LIKELIHOOD OF OCCURRENCE ON STUDY SITE
	pans and mudflats far out in pans and lakes (Harrison *et al.* 1997a). Non-breeding birds aggregate at coastal mudflats, salt works and sewage treatment works where salinities is high. Small, ephemeral freshwater wetlands very important for birds dispersing from breeding grounds (Hockey *et al.*, 2005). Shallow pans, especially saline pans when they contain water (Tarboton *et al.*, 1987). Large brackish or saline inland and coastal waters (Maclean, 1993).	
Geronticus calvus (Southern Bald Ibis) (**VU**)	None on site: High-altitude (1 200 – 1 850 m), high-rainfall (>700 mm/yr), sour and alpine treeless grasslands, characterised by short, dense grass swards; favours recently burnt, ploughed, mowed or heavily grazed fields, also cultivated land with short grass or stubble. Almost exclusively in grassland early in wet season, moving to pastures during winter. On Polokwane plateau and in ne KwaZulu-Natal, in lightly wooded and relatively arid country (Hockey *et al.* 2005)	Highly unlikely Due to high level of disturbance surrounding the study site and lack of suitable foraging and breeding habitat.
Mycteria ibis (Yellow-billed Stork) (**NT**)	None on site: Utilises diverse wetlands and permanent and seasonal habitats, including alkaline and freshwater lakes, river, dams, pans, flood plains, large marshes, swamps, estuaries, margins of lakes or rivers, flooded grassland and small pools or streams where there are areas of shallow water free of emergent vegetation (Tarboton *et al.,* 1987); less often marine mudflats and estuaries (Hockey *et al.*, 2005). Nests colonially on large trees adjacent to productive wetlands, but only locally and erratically during ideal conditions.	Highly unlikely Due to a lack of suitable habitat
*Ciconia nigra** (Black Stork) (**NT**)	None on site: Dams, pans, flood plains, shallows of rivers, pools in dry riverbeds, estuaries and sometimes on marshland and flooded grassland; uncommon at seasonal pans lacking fish. Associated with mountainous regions (Hockey *et al.*, 2005) where they nest (Maclean, 1993) on cliffs (Harrison *et al.* 1997a). Feeds in shallow water, but occasionally on dry land, in streams and rivers, marshes, floodplains, coastal estuaries and large and small dams; it is typically seen at pools in large rivers.	Highly unlikely Due to a lack of suitable breeding and foraging habitat
Buphagus erythrorhynchus (Red-billed Oxpecker) (**NT**)	None on site: Open savanna, up to 3 000 m.a.s.l. (Hockey *et al.*, 2005). Uses mammal feeding hosts in a variety of woodlands, all in rainfall zones of more than 400 mm/annum. Needs holes in trees for nesting and uses Ilala Palms, tree Aloes, reed beds and rarely larger game to roost on at night (Harrison *et al.* 1997a). Their presence is highly dependent on the availability of tick on large game species and cattle.	Highly unlikely There are grazing livestock on site and due to a lack of suitable habitat.

6. FINDINGS AND POTENTIAL IMPLICATIONS

The wetland habitat is the most sensitive habitat on the study site as well as at least 200m of adjacent terrestrial (grassland) area for foraging purposes and to act as a buffer zone.

The following Red Data avifaunal species was confirmed from the study site and suitable breeding, roosting and foraging habitat was confirmed:

African Grass-Owl (*Tyto capensis*):
Criteria for IUCN threatened category: A2c; C1. Status: Vulnerable.
Habitat: The African Grass Owl is found exclusively in rank grass at fairly high altitudes (Cyrus & Robson 1980) and has been recorded breeding in permanent vleis. It will also breed in long grass usually close to some kind of wetland system but according Tarbonton (*in litt*) their breeding habitat is or not necessarily associated with wetlands. They nest within a system of tunnels on the ground in tall grass (Figure 6) with the peak breeding season being between February to April which usually coincides with maximum grass cover (Steyn 1982). In years when rodents are abundant they will hunt during the night over adjacent grassland and dry savanna, which is typically regarded as a sub-optimal habitat (Kemp & Calburn, 1987). Their hunting does not extend to agricultural croplands or to short grasslands and seems to be confined to tall grasslands (Kemp & Calburn, 1987).
Threat: Land-use change, habitat loss and fragmentation of their ecological requirements are the largest factors that impact this species negatively (Barnes 2000).
On site conclusion: Three African Grass-Owls were observed in the transition zone between the main stream of the wetland and the open grassland area (Figure 7). They were observed roosting in *Imperata cylindrica* wetland grass (25°47'52.6" S 29°29'04.3" E). These were roosting tunnels and they possibly could breed in the same area during February to April. SABAP1 and SABAP2 data indicate a stable reporting rate of less than one present. This record was the first record of African Grass-Owls for the 2545_2925 pentad as well as for the q.d.g.c. according to the SABAP2 data. This area is restricted for the general public and this could be the reason why this species was not recorded for this particular pentad and it is likely that there is no other suitable habitat for this species within the boundaries of the pentad, stressing the importance of this wetland system. Proper veld management practices should be implemented to prevent any veld fires in the wetland especially during the breeding season of African Grass-Owls.

Figure 6: Roosting tunnel of African Grass-Owl in *Imperata cylindrica* wetland grass.

Figure 7: Roosting site of African Grass-Owl.

The following Red Data avifaunal species for which suitable foraging, breeding and roosting habitat was confirmed from the study site as well as areas to the south of the study site.

African Marsh-Harrier (*Circus ranivorus*):
Criteria for IUCN threatened category: A1c; A2b,c; C1; Status: Vulnerable
Habitat: The African March-Harrier is dependent on permanent wetlands for feeding, roosting and breeding purposes. It may forage on small wetlands of 1 – 2 ha but requires large wetland with suitable reedbeds greater than 100 ha for breeding.
Threat: The larges threat to this species on loss of its preferred wetland habitat.
On site conclusion: The dense *Typha capensis* and *Phtagmites australus* reed beds offer suitable habitat for African March-Harrier for mainly foraging purposes. They are unlikely to breed within the habitat but it is likely that they will forage within the wetland habitat.

Lesser Kestrel (*Falco naumanni*):
Criteria for IUCN threatened category: A1a,c,e. Status: Vulnerable.
Habitat: Lesser Kestrels frequents open grassland areas of the Highveld. The area on which the development is to take place might favour this species but falls outside its core distribution range of this species within southern Africa.
Threat: The Lesser Kestrel is sensitive to dense human disturbance and population and will more than likely not use the area despite the presence of suitable hunting habitat found on site. Future development of adjacent undisturbed grassland will result in fragmentation of its preferred open grassland habitat, which is one of the main threats to this species (Barnes 2000) as well as the human disturbance that comes with development. The primary threat to this species is however based in the Palaearctic breeding grounds and will most likely find suitable habitat for foraging purposes elsewhere within its southern African core distribution range.
On site conclusion: Lesser Kestrel might on rare occasions move through the area during migration and might use the area for hunting purposes.

7. LIMITATIONS, ASSUMPTIONS AND GAPS IN KNOWLEDGE

The Galago Environmental team has appropriate training and registration, as well as extensive practical experience and access to wide-ranging data bases to consider the derived species lists with high limits of accuracy. In this instance the biodiversity of all Alignments has to a greater or lesser extent been jeopardized, which renders the need for field surveys unnecessary. In instances where uncertainty exists regarding the presence of a species it is listed as a potential occupant, which renders the suggested mitigation measures and conclusions more robust.

Even though every care is taken to ensure the accuracy of this report, environmental assessment studies are limited in scope, time and budget. Discussions and proposed mitigations are to some extent made on reasonable and informed assumptions built on *bone fide* information sources, as well as deductive reasoning. Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage. Galago Environmental can thus not accept responsibility for conclusions and mitigation measures made in good faith based on own databases or on the information provided at the time of the directive. This report should therefore be viewed and acted upon with these limitations in mind.

The general assessment of species rests mainly on the 1987 atlas for birds of the then-Transvaal (Tarboton *et al*. 1987) and comparison with the 1997 SABAP1 (Harrison et al. 1997) and SABAP2 atlas data, so any limitations in these studies will by implication also affect this survey and conclusions.

8. RECOMMENDED MITIGATION MEASURES

The following mitigation measures are proposed by the specialist:

- ≥100 ha of suitable foraging habitat around the roost/nest site at 25°47’52.6” S 29°29’04.3” E, with a minimum terrestrial buffer of ≥170 m from the edge of a wetland/stream should be left undisturbed to act as suitable breeding and foraging habitat for African Grass-Owls.
- African Marsh-Harrier: Wetlands ≥100 ha identified as suitable habitat for this species must be buffered by ≥200 m of terrestrial habitat.
- Proper veld management practises should be implemented with respect to grazing, burning and control of woody invasions.
- **No vehicles should be allowed to move in or across the wet areas or drainage lines and possibly get stuck.** This leaves visible scars and destroys habitat, and it is important to conserve areas where there are tall reeds or grass, or areas were there is short grass and mud.
- It is suggested that where work is to be done close to the drainage lines, these areas **be fenced off during construction,** to prevent heavy machines and trucks from trampling the plants, compacting the soil and dumping in the system.
- Alien and invasive plants must be removed.

9. CONCLUSIONS

The wetland habitat offers ideal breeding, roosting and/or foraging habitat for two Red Data avifaunal species, the African Grass-Owl and African Marsh-Harrier. African Grass-Owls was observed roosting within the *Imperata cylindrica* wetland grass and it is possible that they also will breed within the area during February to April. The African Marsh-Harrier was not observed on the study site but the wetland habitat will favour this species, at least for foraging purposes. An area of at least 200 meter from the edge of the wetland should be left undisturbed to act as a buffer zone for both the African Grass-owl and the African Marsh-owl. The rest of the grassland area could offer ideal foraging habitat for Lesser Kestrel. However they are only likely to forage over the area on occasion, since more suitable open grassland habitat can be found surrounding the study site that will favour this species. The threat to this species is mainly focused on the northern Palaearctic range where this species breed.

It is important to realise that rehabilitation of the slimes dam area could result in disturbance to the red listed African Grass-Owls, either during the breeding season or during the non-breeding season when this species roost in the area. The area to be rehabilitated is situated to the south of the wetland area where the African Grass-Owls were found. It is therefore recommended that rehabilitation practices be implemented as far away from the wetland system as possible. Heavy vehicles that transport topsoil to the slimes dam should stay clear of the sensitive wetland area and use the shortest route over the wetland as possible. Noise by implements sloping the slimes dam or working in the area must be kept to a minimum.

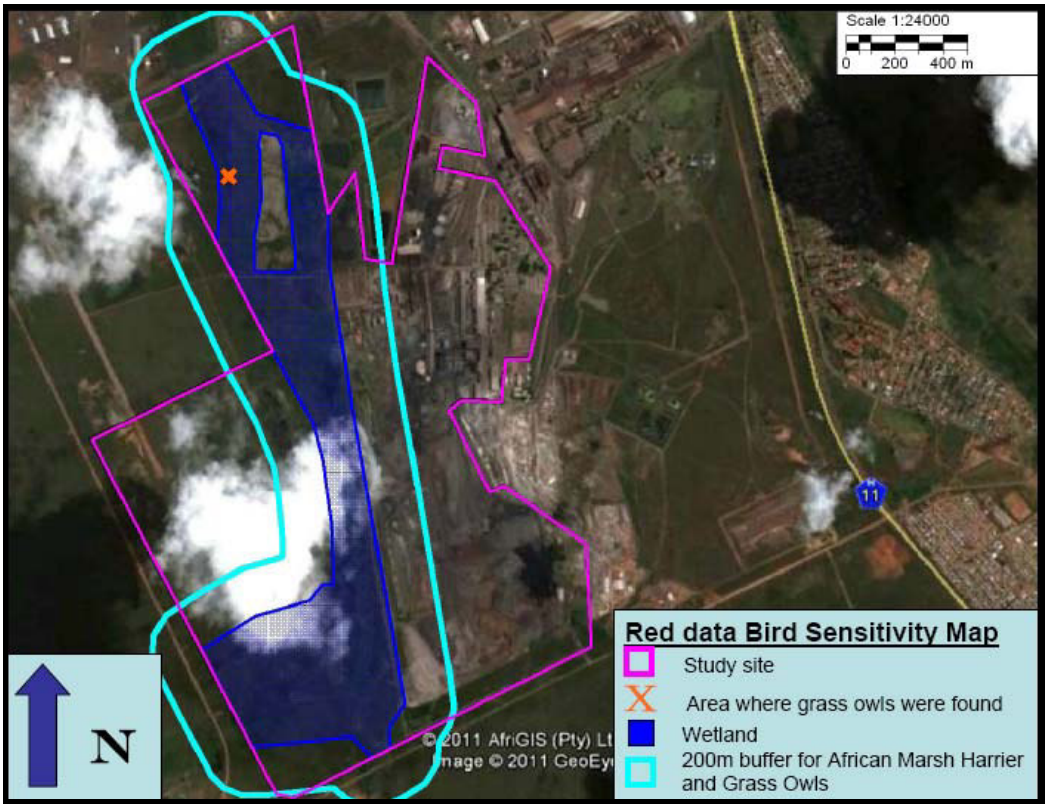

Figure 8: Map showing the Red data Avifaunal Sensitivity areas

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APPENDIX D: HERPETOFAUNA REPORT

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Herpetofaunal Habitat Assessment

of

SAMANCOR MIDDELBURG FERROCHROME TERRAIN

March 2012

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1. INTRODUCTION

Galago Environmental CC was appointed to undertake a reptile and amphibian habitat survey for the portion of Middelburg Town and Townlands 287 JS occupied by Samancor and associated firms. Special attention was paid to the slimes dam which is scheduled for rehabilitation.

The objective was to determine which species might still reside on the site. Special attention had to be given to the habitat requirements of all the Red Data species which may occur in the area. This survey focuses on the current status of threatened herpetofaunal species occurring, or which are likely to occur, on the proposed development site and a description of the available and sensitive habitats on the site.

2. OBJECTIVES OF THE HABITAT STUDY

- To assess the current status of the habitat component and current general conservation status of the property;
- To provide lists of reptiles and amphibians which occur or might occur, and to identify species of conservation importance;
- To highlight potential impacts of the development on the herpetofauna of the study site; and
- To provide management recommendations to mitigate negative and enhance positive impacts should the proposed development be approved.

3. SCOPE OF STUDY

This report:

- Is a reptile and amphibian survey based on sightings and literature, with comments on preferred habitats;
- Comments on ecological sensitive areas;
- Evaluates the conservation importance and significance of the site with special emphasis on the current status of resident threatened species;
- Offers recommendations to reduce or minimise impacts, should the proposed development be approved.

4. STUDY AREA

The area, which covers 350 ha of Rand Highveld Grassland (Mucina et al, 2006), is situated on the southeastern edge of the town of Middelburg, Mpumalanga Province, in the quarter degree grid cell 2529 CD. The study site is part of the wetland formed in the broad drainage valley of the Vaalbank Spruit, which runs northwards into the Klein Olifantsrivier. A densely developed industrial complex associated with Samancor chromium preparation encroaches this wetland along the eastern and southeastern edges. It appears that the water of this spruit is very contaminated by sewage or other

discharges from the factories, which reduces its suitability as habitat for amphibians and reptiles.

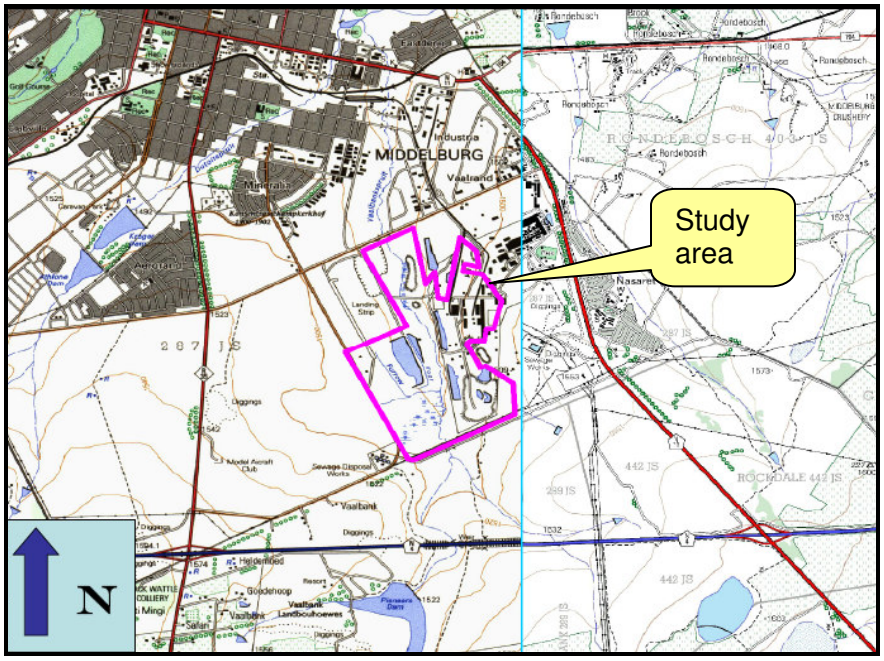

Figure 1: Locality map of the study area

5. METHOD

A site visit was conducted on 1 December 2011 in the company of other specialists of the Galago Environmental CC team. During this visit the observed and derived presence of herpetofauna associated with the recognised habitat types of the study site were recorded. This was done with due regard to the known distributions of Southern African herpetofauna.

The 500 meters of adjoining properties were scanned for important faunal habitats.

5.1.1 Field Surveys

During the site visit it was attempted to identify reptiles and amphibians visually during random transect walks. Possible burrows or reptile habitats were inspected for any inhabitants. Amphibians may also be identified by their characteristic vocalisations, but none were heard. The weather was overcast and cool.

After undergoing an induction at the security section at the entrance to the premises, the group was driven by two company officers to the wetland area. The lay of the land was explained with a view from the old landing strip. After this introduction the team were dropped on the eastern side of the river near the gate. From there the site was inspected on foot.

Following an old track through the reeds to the southern end of the dumping site, it was attempted to detect the presence of any amphibians and reptiles. From an elevated position on a hardened pile of slag (25 48'04.8"S, 29 29'11.0"E) some time was spent

observing the piles of building rubble for the possible presence of reptiles, such as skinks. No reptile or amphibian was seen. Walking onto the large solid slab of former slag and then returning via a different track to the gate, from whence the track westwards across the bridge amongst the reeds was followed, the group which had gathered at the waiting vehicle was rejoined. The team were then driven to the southern portion of the wetland, where the area around the former large southwestern dam site, which is now filled in, was inspected. No amphibians or reptiles were seen.

5.1.2 Desktop Surveys

As the majority of reptiles and amphibians are secretive, nocturnal and/or poikilothermic or seasonal, distributional ranges and the presence of suitable habitats were used to deduce the presence or absence of these species based on authoritative tomes, scientific literature, field guides, atlases and databases (Virtual Museum 2011). This can be done irrespective of season.

The probability of occurrences of herpetofauna species was based on their respective geographical distributional ranges and the suitability of on-site habitat. In other words, *high* probability would be applicable to a species with a distributional range overlying the study site as well as the presence of prime habitat occurring on the study site. Another consideration for inclusion in this category is the inclination of a species to be common, i.e. normally occurring at high population densities.

Medium probability pertains to a herpetofaunal species with its distributional range peripherally overlapping the study site, or required habitat on the site being sub-optimal. The size of the site as it relates to its likelihood to sustain a viable breeding population, as well as its geographical isolation is also taken into consideration. Species categorised as *medium* normally do not occur at high population numbers, but cannot be deemed as rare. A *low* probability of occurrence will mean that the species' distributional range is peripheral to the study site and habitat is sub-optimal. Furthermore, some herpetofauna categorised as *low* are generally deemed rare.

Based on the impressions gathered during this visit and records in the Transvaal Museum, the documentation of the herpetofauna of the then Transvaal by Dr N. H. G. Jacobsen (Unpublished Ph.D. thesis, University of Pretoria, 1989), the "Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland" (Minter, et al, 2004) and 'The Virtual Museum' programme (2011), the following list of species which may occur on this site was compiled. The vegetation type was analysed according to the standard handbook by Mucina and Rutherford (eds) (2006).

5.1.3 Specific Requirements

During the visit the site was surveyed and assessed for the potential occurrence of Red Data species such as:

- **Giant Bullfrogs** (*Pyxicephalus adspersus*): This species has not been recorded from this quarter degree grid cell, although it could occur marginally as it is known from the adjacent cell 2529DC.
- **Striped Harlequin Snake** (*Homoroselaps dorsalis*): This species has been recorded from this quarter degree cell, although this record appears to be quite isolated as none of the surrounding cells indicate its presence. As only a few live

termitaria were observed in the vicinity, this suggests that the environment is not particularly suitable for this snake.

- **Southern African Python** (*Python natalensis*). This species has been recorded from this and an adjacent quarter degree grid cell to the north, 2529CB. These are right at the edge of the range of this species, near the periphery of the town, and as the habitat is not typical savannah (Rand Highveld Grassland) the presence is assumed to be low.

6. RESULTS

Amphibians

The Giant Bullfrog has not been recorded from this grid cell, only from the adjacent cell to the east. The terrain, which is fairly sloping towards the course of the Vaalbank Spruit, and the sandy substrate are not suitable for pan formation, which is required for bullfrog reproduction. The river is not suitable as habitat for this frog. The list of potentially present amphibians is fairly long as it involves a number of wetland and water frogs.

Figure 2: **View across Vaalbank Spruit wetland towards Samancor industrial complex with the southern tip of slag dump amongst reed beds on the left.**

Reptiles

This terrain is covered by relatively homogeneous grassveld and extensive reedbeds as well as the areas covered by the hardened, dumped waste. There is no habitat specifically suited for reptiles, although the edges of the water bodies may be utilised by the Nile Monitor and snakes feeding on amphibians. This depends on the water quality, which if satisfactory may allow amphibians to utilise it. A few intact termitaria occur on the western side of the river near the former large dam, but no old damaged specimens, suitable as retreats for small vertebrates, such as snakes, lizards and amphibians were observed.

The records of the Southern African Python are only known from this quarter degree grid cell and 2529 CB, which indicates that they occurred to the the east of the town. That area was basically grassveld, now with some maize fields and groves of gum, pine and wattle trees. This does not appear to be ideal python habitat and the species' presence is doubtful.

Figure 3: **The slimes dam in the background of the photo**

Table 1: **The Reptiles and Amphibians that could occur on the site**

Scientific Name	Common Name	Probability of occurrence
CLASS: AMPHIBIA	**AMPHIBIANS**	
Order: ANURA	**FROGS**	
Family: Bufonidae	**Toads**	
Amietophrynus gutturalis	Guttural Toad	Medium
Amietophrynus garmani	Eastern Olive Toad	Low
Amietophrynus rangeri	Ranger's Toad	Low
Schismaderma carens	Red Toad	Medium
Family: Pipidae	**Platannas**	
Xenopus laevis	Common Platanna	Medium
Family: Pyxicephalidae	**Common Frogs**	
Amietia angolensis	Common River Frog	Medium
Strongylopus fasciatus	Striped Stream Frog	Medium
Strongylopus grayii	Clicking Stream Frog	Low
Tomopterna cryptotis	Tremolo Sand Frog	Medium
Tomopterna natalensis	Natal Sand Frog	Low
Cacosternum boettgeri	Common Caco	High
Family: Phrynobatrachidae	**Puddle Frogs**	
Phrynobatrachus natalensis	Snoring Puddle Frog	Medium
Family: Ptychadaenidae	**Grass Frogs**	
Ptychadena anchietae	Plain Grass Frog	Low
Family: Hyperoliidae	**Reed Frogs**	
Kassina senegalensis	Bubbling Kassina	Medium
Semnodactylus wealii	Rattling Frog	Low
CLASS: REPTILIA	**REPTILES**	
Order: TESTUDINES	**CHELONIANS**	
Suborder: CRYPTODYRA	**MODERN CHELONIANS**	
Family: Testudinidae	**Land Tortoises**	
Kinixis lobatsiana	Lobatsi Hinge-backed Tortoise	Low

Scientific Name	Common Name	Probability of occurrence
Stigmochelis pardalis	Leopard Tortoise	Low
Order: SQUAMATA	**SCALE-BEARING REPTILES**	
Sub-order: LACERTILIA	**LIZARDS**	
Family: Gekkonidae	**Geckos**	
Pachydactylus affinis	Transvaal Thick-toed Gecko	Low
Pachydactylus capensis	Cape Thick-toed Gecko	Low
Family: Agamidae	**Agamas**	
Agama aculeata distanti	Distant's Ground Agama	Low
Family: Scincidae	**Skinks**	
Trachylepis punctatissima	Speckled Skink	Low
Trachylepis capensis	Cape Skink	Low
Trachylepis varia	Variable Skink	Low
Panaspis wahlbergii	Wahlberg's Snake-eyed Skink	Low
Family: Lacertidae	**Lacertids**	
Nucras holubi	Holub's Sandveld Lizard	Low
Family: Gerrhosauridae	**Plated Lizards**	
Gerrhosaurus flavigularis	Yellow-throated Plated Lizard	Low
Family: Cordylidae	**Girdled Lizards**	
Cordylus vittifer	Transvaal Girdled Lizard	Low
Chamaesaura aenea	Coppery Grass Lizard	Low
Family: Varanidae	**Monitor Lizards**	
Varanus niloticus	Nile Monitor	Low
Sub-order: SERPENTES	**SNAKES**	
Family: Typhlopidae	**Blind Snakes**	
Afrotyphlops bibronii	Bibron's Blind Snake	Low
Family: Leptotyphlopidae	**Thread Snakes**	
Leptotyphlops distanti	Distant's Thread Snake	Low
Family: Atractaspididae	**African Burrowing Snakes**	
Atractaspis bibronii	Bibron's Stiletto Snake	Low
Aparallactus capensis	Cape Centipede-eater	Low
Homoroselaps dorsalis	Striped Harlequin Snake	Low
Family: Colubridae	**Typical Snakes**	
Boaedon capensis	Brown House Snake	Low
Lycodonomorphus rufulus	Brown Water Snake	Low
Pseudaspis cana	Mole Snake	Low
Philothamnus natalensis occidentalis	Western Natal Green Snake	Low
Psammophylax rhombeatus	Rhombic Skaapsteker	Low
Psammophis brevirostris	Short-snouted Sand Snake	Low
Crotaphopeltis hotamboeia	Red-lipped or Herald Snake	Low
Dasypeltis scabra	Rhombic Egg-eater	Low
Family: Elapidae	**Cobras, Mambas,other Elapids**	
Elapsoidea media	Highveld Garter Snake	Low
Hemachatus haemachatus	Rinkhals	Low
Naja mossambica	Mozambique Spitting Cobra	Low
Naja annulifera	Snouted Cobra	Low

Scientific Name	Common Name	Probability of occurrence
Family: Viperidae	**Adders**	
Bitis arietans	Puff Adder	Low
Causus rhombeatus	Rhombic Night Adder	Low

7. FINDINGS AND POTENTIAL IMPLICATIONS

Although the terrain looks lush and flourishing, the investigation produced an impression of lifelessness. In the area where the lumps of building rubble have been dumped one would expect to see recesses and retreats suitable for reptiles, but careful scanning did not reveal any lizards or snakes nor did the presence of faeces indicate that such animals might utilise the area. The fact that the sky was lightly overcast and the weather relatively cool might have contributed to the inactivity of any possibly present herpetofauna.

8. LIMITATIONS, ASSUMPTIONS AND GAPS IN KNOWLEDGE

The Rand Highveld Grassland herpetofauna tends to consist of a relatively monotonous combination of grassveld specialists, unless environmental abnormalities, such as rocky outcrops, mountains or waterbodies intrude into the environment and thereby provide specialised habitats suitable for rupicolous or water associated species. The Middelburg area is a Highveld habitat, but has been seriously affected by urban and industrial development and intensive farming activities.

9. RECOMMENDED MITIGATION MEASURES

None

10. CONCLUSION

The habitat which is considered for rehabilitation has been severely disturbed since the 1960s. As this has created near lifeless areas with regards to amphibians and reptiles, with edge effects on the adjacent terrain, it is a commendable proposal to rehabilitate. At present the impression is that a reasonable list of amphibians and reptiles has been documented in the past from the relevant quarter degree grid cell, but little evidence exists that these species are still present. Population densities appear to be very low, which may be due to additional stresses, such as toxic effluent and air pollution in the vicinity of the industrial centre. Rehabilitation of the slimes dam with the proper slopes could improve the herpetofaunal biodiversity on the site, if vegetation species could attract insects and other small mammals that is a food source.

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Aquatic Ecology Report

For the proposed closure of the slimes dam
(Samancor)

Prepared for:
Environmental Assurance (Pty) Ltd

Date:
March 2012

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Declaration

I, Lorainmari den Boogert, declare that -

- I act as the independent specialist;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of specialist

Yggdrasil Scientific Services (Pty) Ltd.

Name of company

15 March 2012

Date

Executive summary

This document reports on the findings made during the aquatic ecology study conducted on the 20th of February 2012 along the Vaalbankspruit..

The aquatic ecology study was conducted in order to determine the following:

1. Current aquatic health of the Vaalbankspruit;

2. The potential impacts that the closure of the slimes dam may have on the Vaalbankspruit

3. Supply suitable recommendations to prevent and minimise the predicted negative impacts.

The study area (Samancor Middelburg Ferrochrome) is situated approximately 2km southwest of Middelburg in the Mpumalanga Province. Sampling points were located on the Vaalankspruit. The Vaalbankspruit is a tributary of the Klein Olifants River. The study area falls within the B12D quaternary catchment which forms part of the Olifants River System

Three sites were sampled along the Vaalbankspruit (sites S2, E1 and E2). Water chemistry data were collected as well as aquatic fauna data.

The SASS5 rapid bioassessment method (South African Scoring System, version 5) was used to determine the species composition of aquatic macroinvertebrates, and in particular to indicate 'good' or 'poor' water quality, at the three sites. The slimes dam has been rehabilitated and no notable impact can be seen on the river health of the Vaalbankspruit. The results showed that the Vaalbankspruit was in a good condition at two of the sites (S2 & E2) whilst E1 (control site upstream) was in a poor condition. This highlights the fact that the Vaalbankspruit provides the ecosystem with valuable ecosystem services. The source of chromium pollution is unknown and it is highly recommended that this issue be further investigated. The Vaalbankspruit is a Critically Endangered river type and is one for which there are few remaining rivers occurring in healthy subcatchments and for which rehabilitation of catchments is required in order to meet biodiversity targets. Any future rehabilitation of the slimes dam should be aimed at preventing any further deterioration to the Vaalbankspruit ensuring increase in the river health of the Vaalbankspruit, thereby helping Mpumalanga reach their aquatic ecological conservation targets.

Abbreviations

ASPT – Average Score per Taxon

BPG – Best Practice Guideline

DWA – Department of Water Affairs

DWAF – Department of Water Affairs and Forestry

EIA – Environmental Impact Assessment

GMS – Gravel, Sand and Mud

GPS – Global Positioning System

ICP – Inductively-coupled Plasma

mamsl – Metres Above Mean Sea Level

NEMA – National Environmental Management Act

PESC – Present Ecological State Category

SANAS - South African National Accreditation System

SASS – South African Scoring System

TDS –Total Dissolved Solids

TWQR – Target Water Quality Range

UP – University of Pretoria

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1 Introduction

1.1 Project outline

This document reports on the findings made during the aquatic ecology study conducted on the 20th of February 2012 along the Vaalbankspruit. The study will be incorporated into the documents needed for obtaining a closure certificate of the slimes dam.

The study was conducted by Yggdrasil Scientific Services (Pty) Ltd (from here on known as YSS), an independent ecological specialist company based in Pretoria, Gauteng, on behalf of Environmental Assurance (Pty) Ltd (from here on known as ENVASS). Lorainmari den Boogert (MSc. Plant Science, UP & SASS5 accredited, Department of Water Affairs) was responsible for the fieldwork, data interpretation as well as report writing.

1.2 Terms of reference

The aquatic ecology study was conducted in order to determine the following:

- Current aquatic health of the Vaalbankspruit;
- The potential impacts that the closure of the slimes dam may have on the Vaalbankspruit
- Supply suitable recommendations to prevent and minimise the predicted negative impacts.

2 Project location

The study area (Samancor Middelburg Ferrochrome) is situated approximately 2km southwest of Middelburg in the Mpumalanga Province (Figure 1).

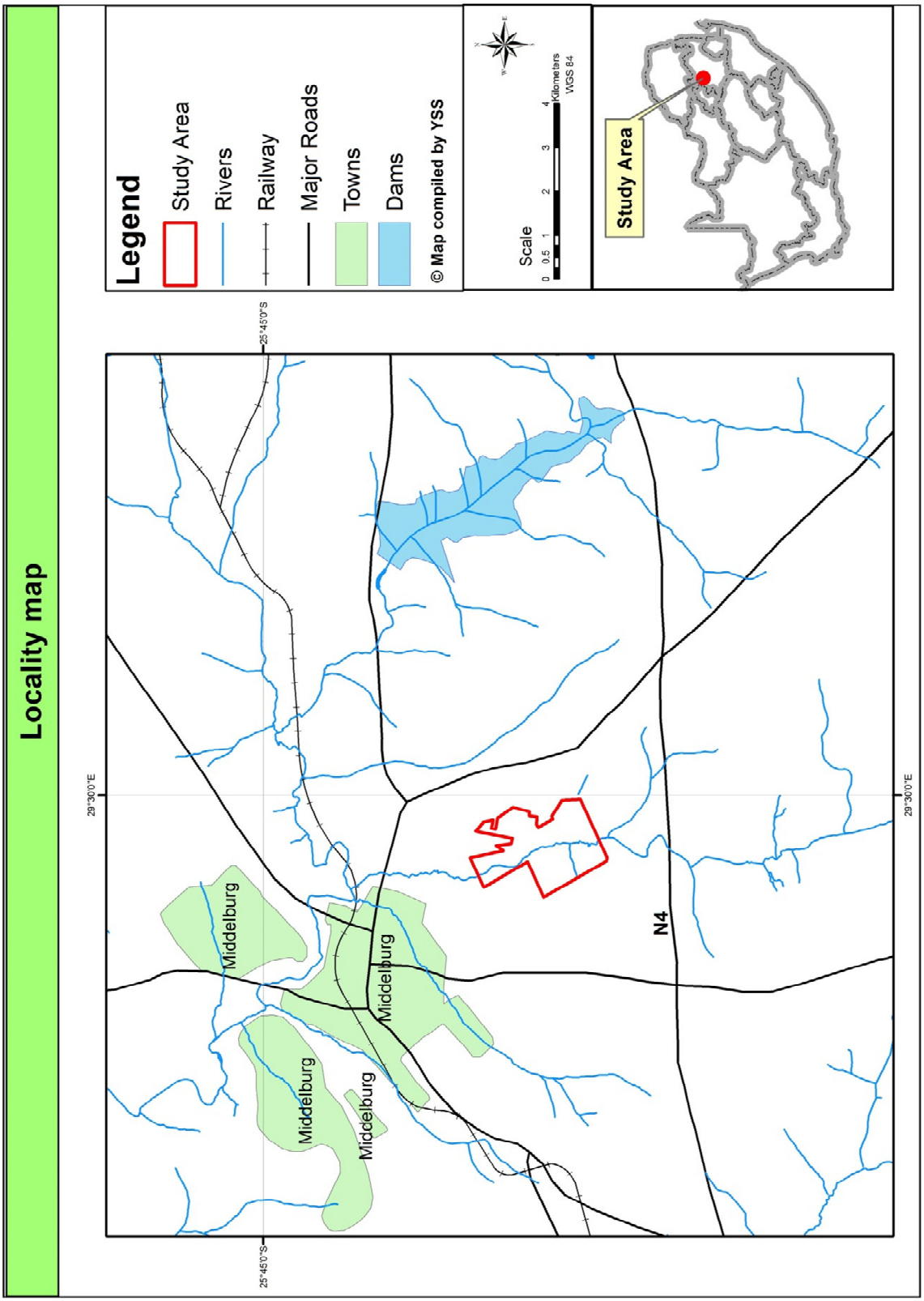

Figure 1. Location of the study area. The closest town is Middelburg. (approximately 2km away).

3 Description of the surrounding environment

3.1 The abiotic environment

3.1.1 *Climate and rainfall*

Climate data were obtained from the Agricultural Research Council – Institute for Soil, Climate and Water (ARC-ISCW) Climate Information System (www.arc.agri.za). The nearest reliable station with sufficient data (2001 to 2010) is that of Middelburg (30461) with altitude 1600mamsl and GPS coordinates 25.86352°S; 29.64211°E. The climate is typical of the Highveld, with warm summers (December to February) and cold winters (June to August). Rainfall typically occurs as thunderstorms of high intensity and short duration. All data are shown as mean ± standard error.

3.1.1.1 Rainfall

The site experience strongly seasonal summer rainfall, with very dry winters. The mean annual precipitation is 710.30 ± 13.75 mm (Figure 3), with the vast majority of the rainfall occurring as thunderstorms in the warm summer months (Figure 2), relatively uniform across most of the surrounding area (Barnard, 1999, Mucina and Rutherford, 2006). Incidence of frost ranges from 10 to 35 days per annum (Mucina and Rutherford, 2006).

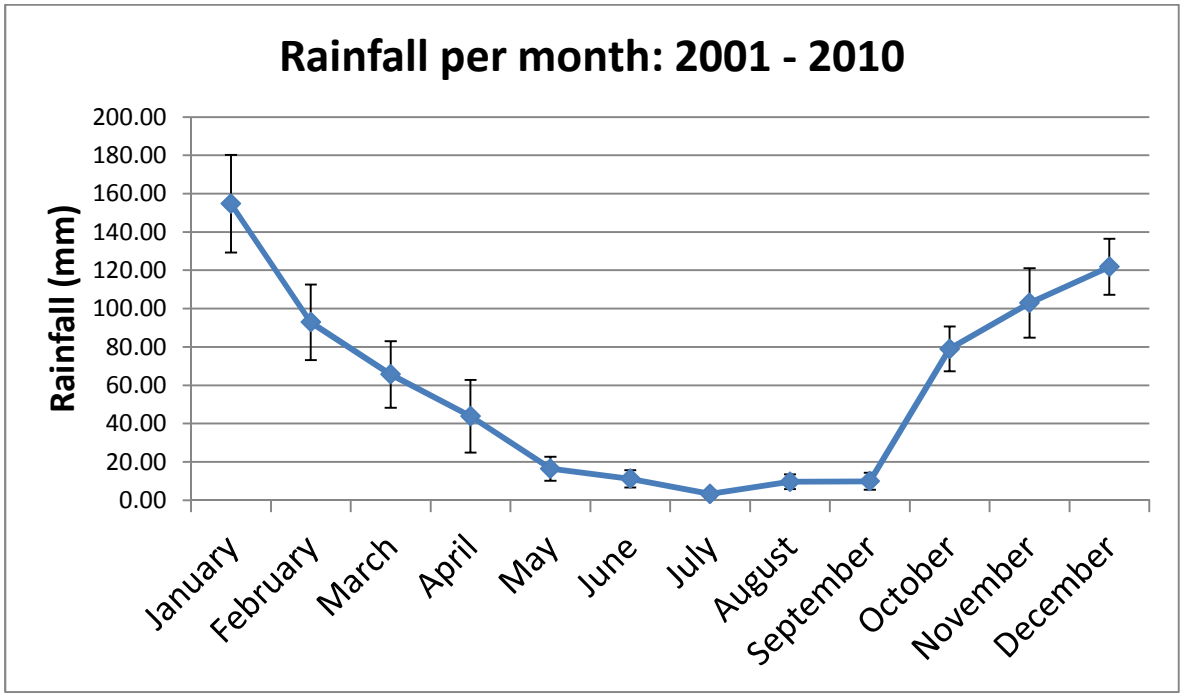

Figure 2. Mean monthly rainfall for Middelburg from 2001 to 2010.

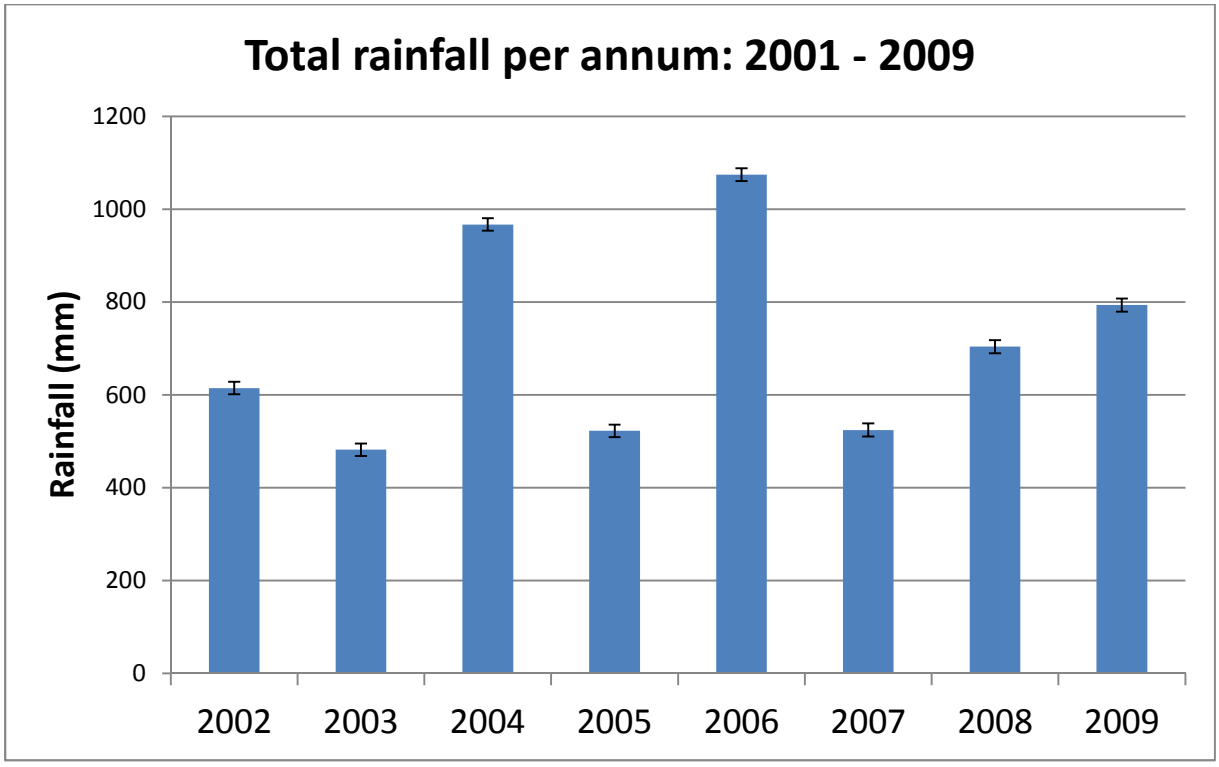

Figure 3. Mean annual rainfall for Middelburg from 2001 to 2010.

3.1.1.2 Temperature

The temperature recorded from the Middelburg station is summarized in Figure 4. Temperatures in the vicinity of the mine should approximate these temperatures. The mean maximum daily temperature exceeds 27°C between November and February, the hottest months, while the mean maximum daily temperature in the winter months (May to August) is just below 1°C.

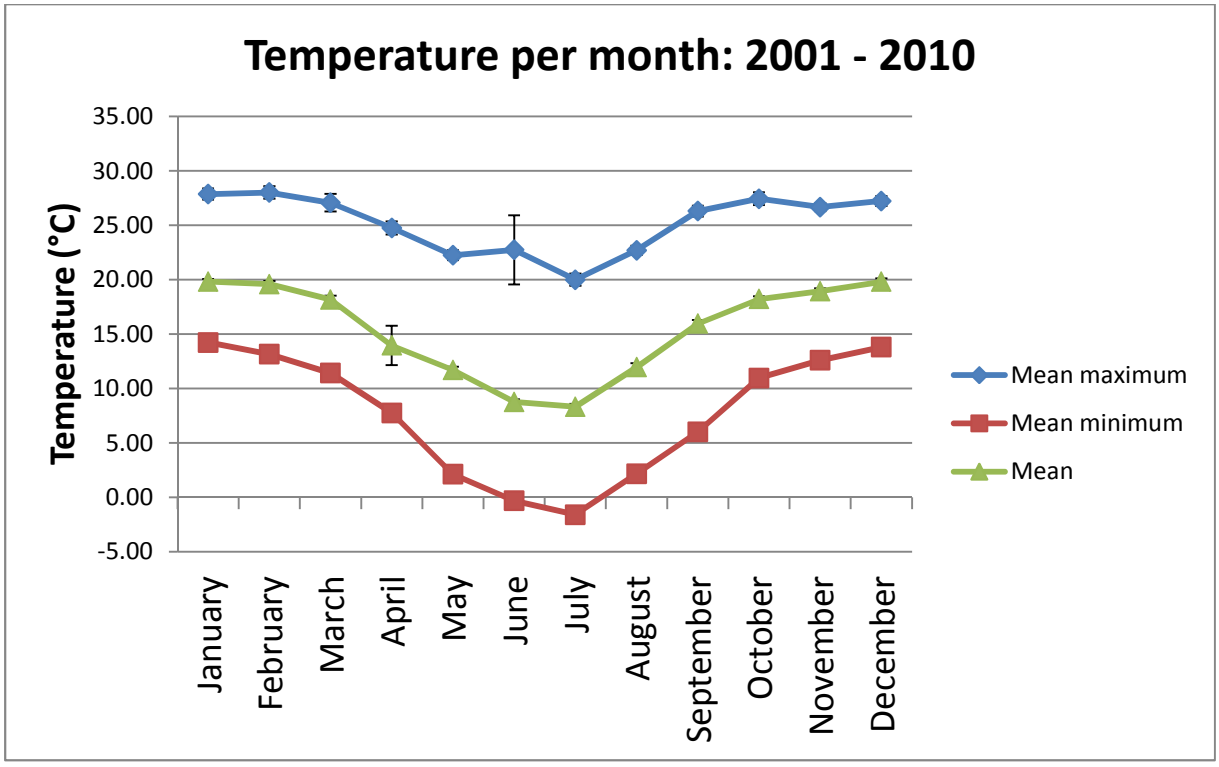

Figure 4. Mean maximum and minimum temperatures for Middelburg from 2001 to 2010.

3.1.1.3 Extreme weather conditions

The mine is situated in the Highveld zone which is characterized by occasional tornadoes and summer hailstorms. These hailstorms normally occur between mid-November and mid-April in the Witbank area. Thunderstorms occur frequently during summer and are usually accompanied by lightning, heavy rain, strong winds and occasional hail. Storms are localised and rainfall can vary considerable over short distances. An average of six hailstorms can be expected per annum. Frost occurs in the winter months, peaking with a mean occurrence of nine days in June. No definite pattern of draught could be determined from data.

3.1.2 *Topography and drainage*

Most of the study area is situated on valley bottom and hillslopes. The Vaalbankspruit runs through the study area (Figure 5). Sampling points were located on the Vaalankspruit. The Vaalbankspruit is a tributary of the Klein Olifants River. The study area falls within the B12D quaternary catchment (Figure 5) which forms part of the Olifants River System.

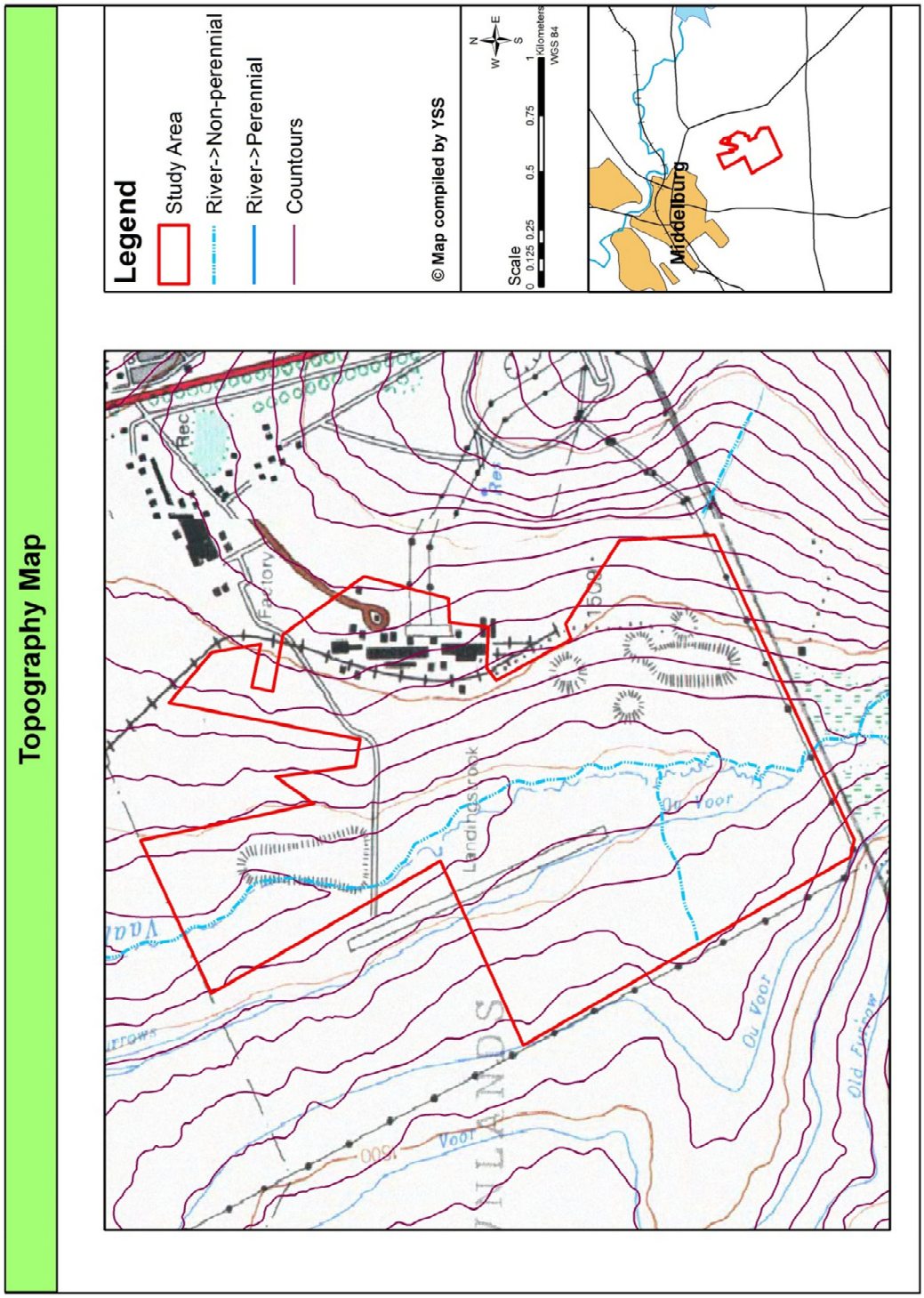

Figure 5. Topography and drainage patterns surrounding the sampling points. All sampling points were situated on the Vaalbankspruit.

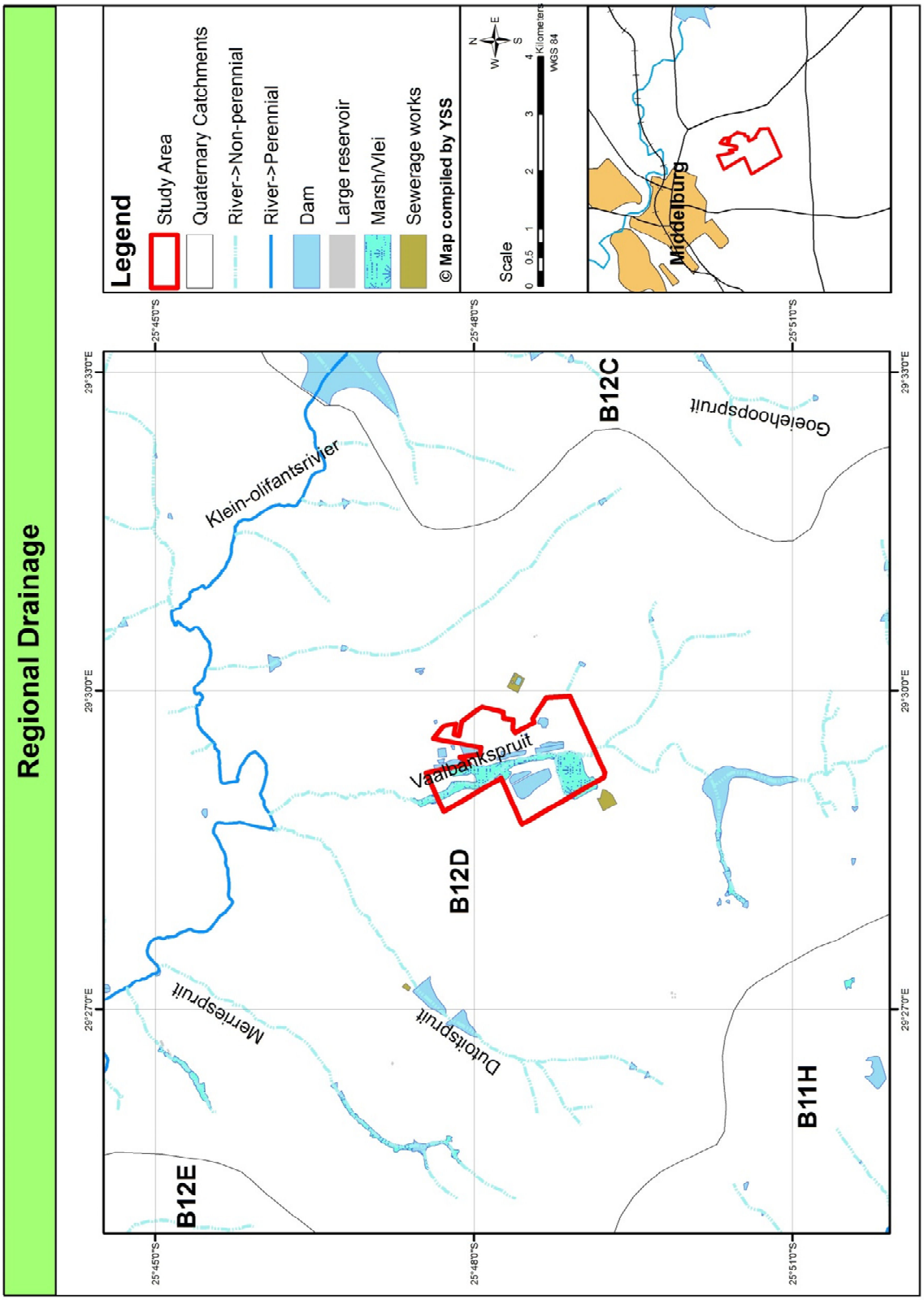

Figure 6. Regional drainage surrounding the study area

3.1.3 *Surrounding land use*

Land use surrounding the study area is best described as light industrial. Other surrounding land uses include:

- The Nasaret township
- Sewerage treatment plants,
- Farming and tourism.

3.2 Biotic environment

3.2.1 *Vegetation*

According to Acocks (1988) the natural veld-type which occurs in the project area can be described as 'Bankenveld vegetation' classified under the Grassland Biome. In terms of the new vegetation map constructed under the editorship of Mucina & Rutherford (2006) the study area falls within the Rand Highveld Grassland (Gm11). Other vegetation units in close proximity of the study area include the Eastern Highveld Grassland (Gm 12) and the Eastern Temperate freshwater (Figure 7).

The Rand Highveld Grassland lies within a highly variable landscape with extensive sloping plains and a series of ridges slightly elevated over undulating surrounding plains. The vegetation is species-rich, wiry, sour grassland alternating with low, sour shrubland on rocky outcrops and steeper slopes. It is rich in plant taxa (especially when in pristine condition) and constitutes sour grassland dominated by graminoid genera such as *Themeda*, *Heteropogon*, *Eragrostis* and *Elionurus*. The forb composition is equally diverse and well represented by members of the Asteraceae family, while the woody community forms a typical, albeit sparse, component of the ridges. It is poorly conserved and good examples are preserved in the Bronkhorstspruit Dam Nature Reserve. Large parts of this ecological type have been transformed by agriculture, forestation and urbanisation (Mucina & Rutherford 2006).

The Eastern Highveld Grassland area is dominated by Highveld grasses (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya*) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Acacia caffra, Celtis africana, Diospyros lycioides* subsp *lycioides, Parinari capensis, Protea caffra, P. welwitschii* and *Searcia magalismontanum*). The conservation status for the area is endangered and some 44% of the land has been transformed primarily by cultivation, plantations, mines, urbanisation and building of dams (Mucina & Rutherford 2006).

The freshwater wetlands in the surrounding area fall within the Eastern Temperate vegetation unit according to Mucina & Rutherford (2006) (Figure 7). The landscape can be described as flat or shallow depressions filled with (temporary) water bodies supporting zoned systems of aquatic and hygrophilous vegetation of temporarily flooded grasslands and ephemeral herblands. Some 15% of the Eastern Temperate wetlands have been transformed to cultivated land, urban areas or plantations. In some places intensive grazing and use of wetlands as drinking pools by cattle and sheep cause major damage to the wetland vegetation (Mucina & Rutherford 2006).

3.2.2 *Aquatic ecosystems*

Aquatic ecosystems are defined as “the abiotic (physical and chemical) and biotic components, habitats and ecological processes contained within rivers and their riparian zones, reservoirs, lakes and wetlands and their fringing vegetation” (DWAF 1996d). Terrestrial biota, other than humans, dependent on aquatic ecosystems for survival are included in this definition. Despite being South Africa’s most important ecosystems aquatic ecosystems are also the most impacted (Ferrar & Lötter 2007).

1. Man depends on many "services" provided by healthy aquatic ecosystems, namely:
2. Maintaining the assimilative capacity of water bodies for certain wastes through self-purification;
3. Providing an aesthetically pleasing environment;
4. Serving as a resource used for recreation;
5. Providing a livelihood to communities dependent on water bodies for food; and
6. Maintaining biodiversity and providing habitats to that biota dependent on aquatic ecosystems.

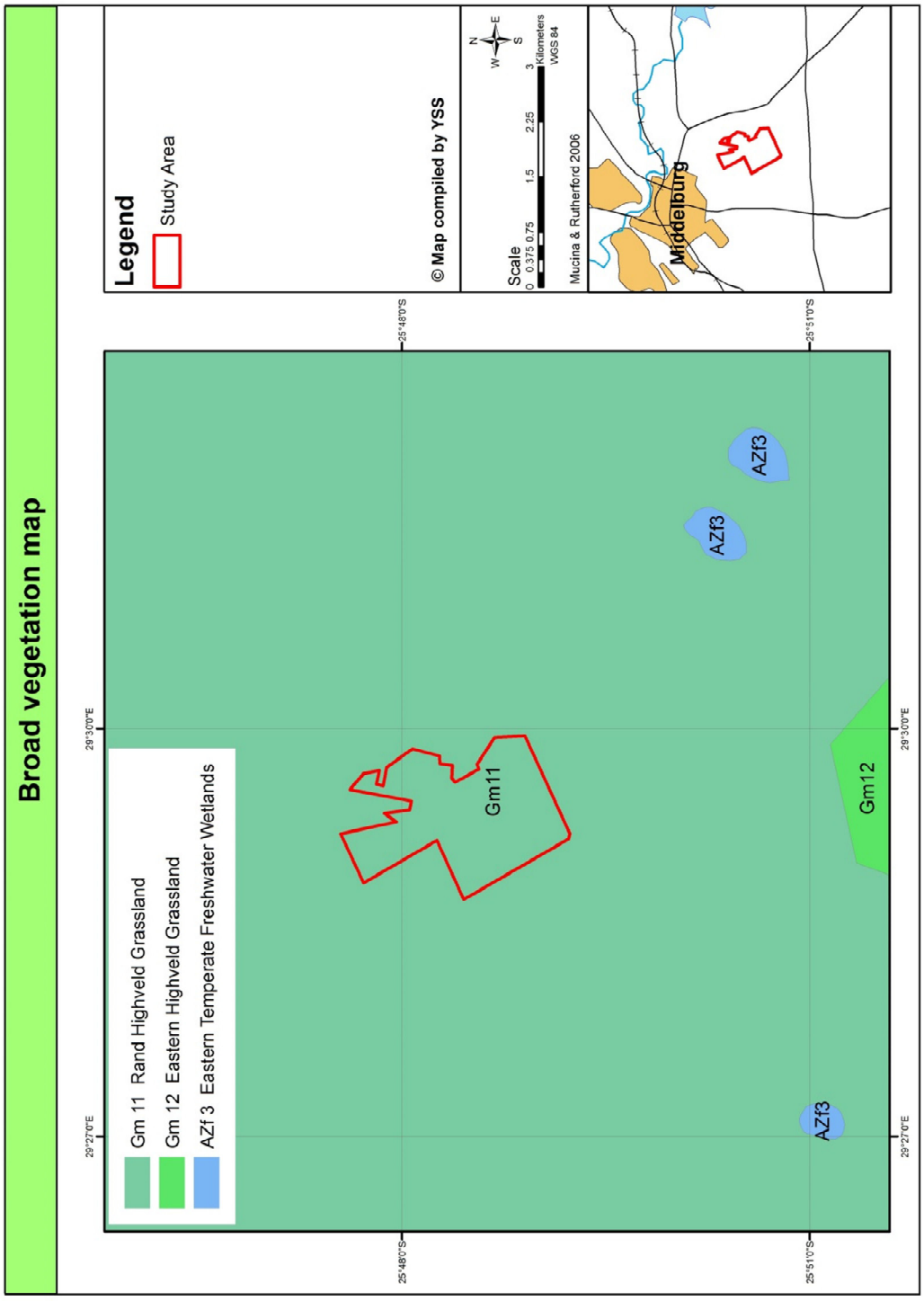

Figure 7. The study area falls within the Rand Highveld Grassland Gm11. Other vegetation units in close proximity to the study area are the Eastern Highveld Grassland (Gm12) and the Eastern Temperate Freshwater Wetlands (AZf3).

Aquatic ecosystems, as a resource base, must be effectively protected and managed to ensure that South Africa's water resources remain fit for agricultural, domestic, recreational and industrial uses on a sustained basis (DWAF 1996d).

Wetlands are defined by the South African National Water Act (Act No 36 of 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 soils”. All wetlands are protected by law (National Water Act 36 of 1998) because of their importance and their vulnerability to damaging impacts (Ferrar & Lötter 2007). Wetlands are important because they:

1. Provide hydrological control which helps prevent soil erosion (attenuate floods, store and release water slowly);
2. Recharge groundwater sources;
3. Purify water by trapping many pollutants, including sediment, heavy metals and disease causing organisms;
4. Are very productive since they supply nutrients and water in a stable environment for rapid plant growth and thus can be used as grazing areas if done on a sustainable basis; and
5. Are one of the most biodiverse ecosystems, providing life support for a wide variety of species, some totally reliant on wetlands for their survival (Davies and Day 1998; DWAF 2005).

Wetlands are, however, some of the most threatened habitats in world today (DWAF 2005). In some catchments in South Africa, studies have revealed that over 50% of the wetlands have already been destroyed. Mining and pollution are two of the many culprits which alter the water flow and water quality, which kill or damage wetlands. Continued wetland destruction will result in less pure water, less reliable water supplies, increased severe flooding, lower agricultural productivity, and more endangered species (DWAF 2005).

The Vaalbankspruit flows into the Klein Olifants River. The Klein Olifants River is a tributaty of the Olifants River System. The Vaalbankspruit is seen as “not intact” whilst the Klein Olifants River is seen as “Largely Modified” according to the National Freshwater Ecosystem Priority Areas (NFEPA) (DWA 2010) (Figure 8).

Freshwater fauna and surrounding flora are useful indicators of the ecological health of aquatic ecosystems and are important for the proper functioning of these ecosystems. The riparian vegetation and any surrounding wetlands present in the area will depend on the

proper functioning of the Vaalbankspruit River. If this river is impacted upon it will have an effect on the aquatic ecosystems downstream.

3.2.3 *Ecological importance*

Ecoregions are regions that share similar ecological characteristics and are "*based on the understanding that ecosystems and their biota display regional patterns that mirror causal factors such as climate, soils, geology, physical land surface and vegetation*" (Ferrar & Lötter 2007). The study area lies within the **Highveld (11)** Level 1 Ecoregion (Dallas 2005). The Highveld Ecoregion is an area of flat grasslands with undulating rocky areas and rich coal deposits covered by deep, red to yellow sandy soils (Ballance *et al.* 2001). Wetlands that overlie these deposits are threatened by potential mining activities in the area.

The Level 2 Ecoregion for the study area is **Highveld 2 (11_2)**. The in-stream and riparian habitats show a fair to unacceptable state according to the River Health Programme (RHP), with the general condition being poor in Ecoregion Highveld 2 (Ballance *et al.* 2001). The biological communities also reflect fair to unacceptable health for the area. Mining (mainly coal mining) and other industrial activities in the area have resulted in severe disturbance and are the main contributors to the poor in-stream and riparian habitat conditions (Ballance *et al.* 2001). Rivers in Ecoregion Highveld 2 mainly have a low pH and high concentrations of dissolved salts. In some places the riverbeds have even been eroded down to the bedrock, leaving little suitable habitat for fish and aquatic invertebrates (Ballance *et al.* 2001).

3.3 Mpumalanga Biodiversity Conservation Plan

The Mpumalanga Biodiversity Conservation Plan (MBCP) maps the distribution of the province's known aquatic biodiversity subcatchments into five categories. These are ranked according to ecological and biodiversity importance and their contribution to meeting the quantitative targets set for each biodiversity feature (Ferrar & Lötter 2007). The categories are:

- *Protected areas* – already protected and managed for conservation
- *Irreplaceable areas* – protection crucial, no other options available to meet targets
- *Highly Significant areas* – protection needed, very limited choice for meeting targets
- *Important and Necessary areas* – protection needed, greater choice in meeting targets
- *Ecosystem maintenance* – transformed/modified areas

According to the MBCP the area of the study area falls within the **Highly Significant** category (Figure 9). Highly Significant areas (50-99% irreplaceable) are described as areas where protection is needed and there is very limited choice for meeting targets according to Ferrar & Lötter (2007). Highly Significant areas need to be managed for the conservation of biodiversity.

The MBCP identifies subcatchments using a combination of PESC and loss of natural habitat in each subcatchment, as a measure to determine healthy rivers, tributaries and wetlands (Ferrar & Lötter 2007). Furthermore, in the MBCP the ecosystem status of river types was assessed as the proportion of each type occurring in healthy (natural, unmodified) subcatchments:

- *Least Threatened* – a river type has more than 80% of its length flowing through healthy subcatchments
- *Vulnerable* – a river type has 80-60% of its length flowing through healthy subcatchments
- *Endangered* – a river type has less than 60% but more than its biodiversity target length flowing through healthy subcatchments
- *Critically Endangered* – a river type has less than its target flowing through healthy subcatchments

According to Ferrar & Lötter (2007) the current status of the river ecosystems near the study area Critically Endangered (Figure 9). A Critically Endangered river type is one for which there are few remaining rivers occurring in healthy subcatchments and for which rehabilitation of catchments is required in order to meet biodiversity targets. This puts the biodiversity and ecosystems of these types of river systems at risk.

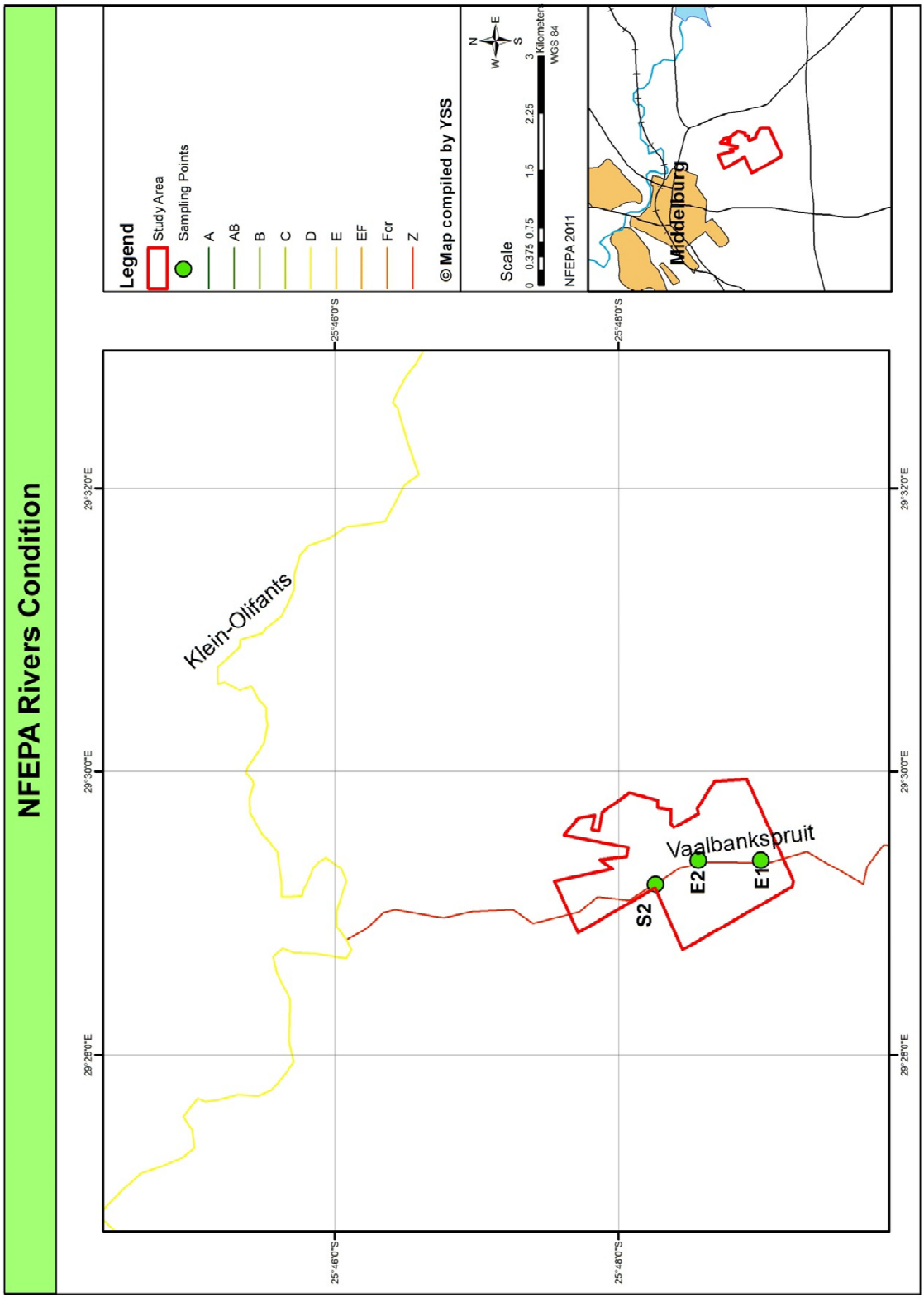

Figure 8. Sampling points and river condition according to NFEPA for the Vaalbankspruit and Klein Olifants River.

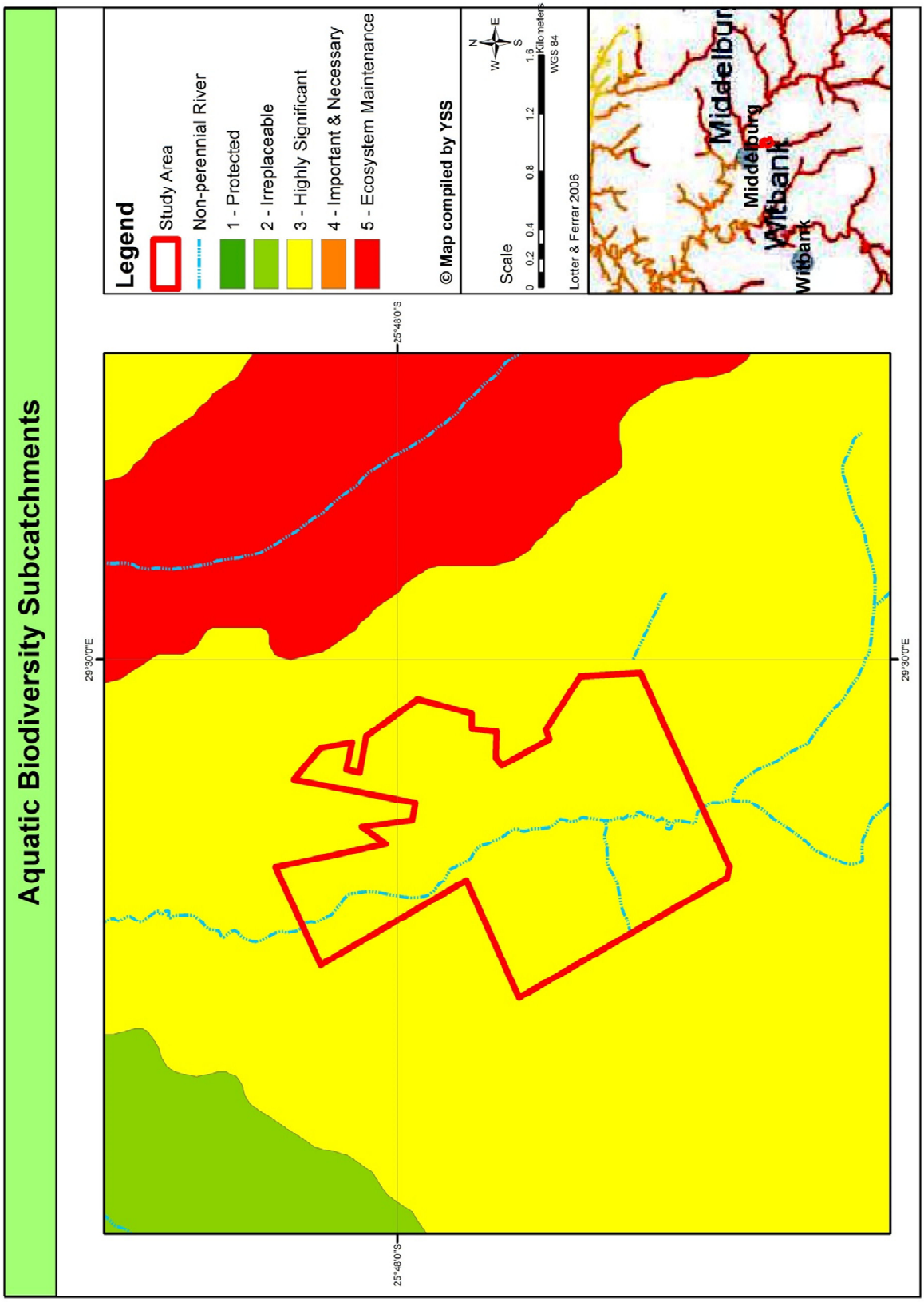

Figure 9. The study area falls within the Highly Significant category according to the aquatic biodiversity subcatchment categories based on the Mpumalanga Biodiversity Conservation Plan. The smaller block indicated that the current status of the river ecosystems near the study area are Critically Endangered (Lötter and Ferrar 2006).

4 Methodology

The work conducted during the aquatic ecology study included:

- Literature review of available material;
- Site description in order to determine the current surface water condition in the project and surrounding area;
- Fieldwork to collect surface water quality data in order to determine background water quality;
- A habitat assessment to assess the current impact of human disturbance on the riparian and instream habitats;
- Fieldwork to collect aquatic fauna data in order to determine the background fauna;
- Fieldwork to collect flora data in order to determine the background flora;
- Identification of potential impacts of the closure of the slimes dam and possible mitigation measures; and
- Recommendations based on the findings of the overall study

4.1 Site selection

The site visit was conducted on the 20th of February 2012 by Lorainmari den Boogert. Three sites were sampled along the Vaalbankspruit (sites S2, E1 and E2) (Figure 8). One site E1 was selected as a control site, this site is situated to the north of the N4. Site E2 is situated directly opposite the slimes dam and should give an indication of the runoff from the slimes dam into the Vaalbankspruit. Site S2 was selected as a site that was selected as a downstream site. This site was selected to ensure that it was before the dirt road crossing and downstream of the Vaalbankspruit.

4.2 Water samples

During sampling water samples were collected from each site. These samples were taken directly from running water in the river as close to the middle of the river as possible. Care was taken not to disturb the sediments and other matter during sampling. One 1 litre plastic sample bottle was filled at each sampling point.

The water samples were delivered to CHEMTECH Laboratory Services (Pty) Ltd (hereafter referred to as Chemtech), a SANAS accredited laboratory, for analysis within 48 hours after collection. Preservation by means of acidifying of the samples was conducted in the laboratory and sufficient time was given for precipitated metals to dissolve again. The samples were also filtered in the laboratory. These water samples were kept cool after collection by storing them in a cooler box.

Chemtech conducted an ICP analysis and tested for pH and chemical oxygen demand. The results from the laboratory analyses were compared to DWAF guidelines for domestic use, irrigation, livestock watering and the aquatic ecosystem (Table 4). These guideline documents prescribe the recommended concentration of the more common constituents found in water used for human consumption and agricultural use as well as the requirements for the aquatic ecosystem. The recommended concentrations are referred to as “Target Water Quality Range” (TWQR) which is described as the “No Effect Range” and specifies good or ideal water quality (DWAF, 1996a).

4.3 Biomonitoring

In Southern Africa, the SASS5 rapid bioassessment method (South African Scoring System, version 5) is used to identify changes in species composition of aquatic invertebrates, and in particular to use macroinvertebrates to indicate ‘good’ or ‘poor’ water quality (Dickens & Graham 2002). SASS is based on the identification of invertebrates to family level in the field and on the principle that some invertebrate taxa are more sensitive than others to pollutants.

Invertebrates are collected with a ‘kick net’ (SASS net) with a mesh size of no more than 1mm. The material on the bed of the river is literally kick-sampled. Holding the net downstream of the area to be sampled, the substratum is vigorously turned over with a gumboot- or wader-shod foot, so that the disturbed particles, including leaves, twigs, sediment and animals, are washed into the net by the flow of the water. All biotopes should be sampled (*stones in- and out-of-current; marginal vegetation; and GSM*).

The contents of the net are tipped into a white tray because animals are easiest to see against a white or pale background. The leaves, sticks and other debris are removed, and the invertebrate taxa are recorded on the SASS data sheet. In routine sampling, the sample in the tray is searched for 15 minutes, or for 5 minutes after the last 'new' taxon has been recorded. The entire sample is then returned to the river or retained alive or preserved for further identification.

Each taxon (usually each family) of invertebrates from South African rivers has been allocated a score, ranging from 1 for those taxa most tolerant of pollutants to 15 for those most sensitive to pollutants. The combined scores for all of the taxa at a particular site will be high if the taxa are mostly pollution-sensitive, and low if they are mostly pollution tolerant. The scores for all the taxa in the sample are summed (the SASS Score). The number of taxa are also counted and recorded. The SASS Score is then divided by the number of taxa to get the ASPT (Average Score per Taxon).

4.3.1 *SASS5 sampling*

The SASS5 procedure was followed in order to assess the freshwater invertebrate community at the selected sites within the Vaalbankspruit: Kick stones-in-current and bedrock for two minutes, maximum for five minutes; kick stones-out-of-current and bedrock for one minute; sweep marginal vegetation (in-current and out-of-current) for two metres total and aquatic vegetation for one metre^2; stir and sweep GSM for one minute total; hand picking and visual observation for one minute. A typical SASS net was used to collect the samples, keeping the results from each biotope separate. The invertebrates were observed and identified for 15 minutes per biotope or 5 minutes after no new taxa were seen. The abundances were recorded on the SASS data sheet as: 1 = 1, A = 2-10, B = 10-100, C = 100-1000, D = >1000. The SASS5 Score, number of taxa and ASPT were calculated for the all the biotopes combined.

4.4 Vegetation

Although physical sampling of plants did not occur, the vegetation surrounding each site (riparian) as well as instream vegetation was identified and the Braun-Blanquet cover classes were recorded. Species noted included trees, shrubs, grasses and forbs.

5 Site description

The site visit was conducted on the 20th of February 2012 by Lorainmari den Boogert. Three sites were sampled along the Vaalbankspruit (sites S2, E1 & E2) (Figure 8). The details of the three sites can be found in Table 1 and Table 2.

Table 1. Location details for the three sites sampled

Site number	GPS coordinates	Altitude (mamsl)
S2	25.80431 S 29.48628 E	1477
E1	25.81844 S 29.49019 E	1490
E2	25.80723 S 29.48898 E	1483

Table 2. Current condition of the sites on the Vaalbankspruit

Site number	Surrounding land use	Surrounding vegetation	Potential impacts	General notes
S2	Columbus stainless, Samancor, landing strip and vacant land.	Wetland	Road crossing from Samancor to landing strip situated to north. Runoff from Samancor.	River fast flowing. Water relatively clear. Some smaller rocks present.
E1	N4 road, Farming,sewerage works and vacant land	Wetland - grassland	Runoff from N4, weir upstream, dirt road upstream	Water flowing very slow, water clear but once disturbed becomes murky quick.
S2	Slimes dam, Samancor, Sewerage works, Eskom power lines and vacant land.	Wetland	Runoff from N4, runoff from sewerage works. Eskom power lines in close proximity.	Moderately fast flowing; water clear but becomes. Lots of instream vegetation. Lots of tadpoles present.

Site S2 was situated approximately 1 approximately 300m south from the dirt road between the access gate from Samancor to the landing strip. Culverts were present underneath the dirt road to allow water to flow underneath the dirt road and prevent flooding. This section had fast flowing water. The water was about 40cm deep and was relatively clear. Gravel and rocks were present. The surrounding vegetation included mainly *Phragmites mauritianus* as

well as other small wetland sedges and *Kniphofia porphyrantha* (Figure 10). A water sample and freshwater invertebrates were collected at the site. Fish were not caught at the site.

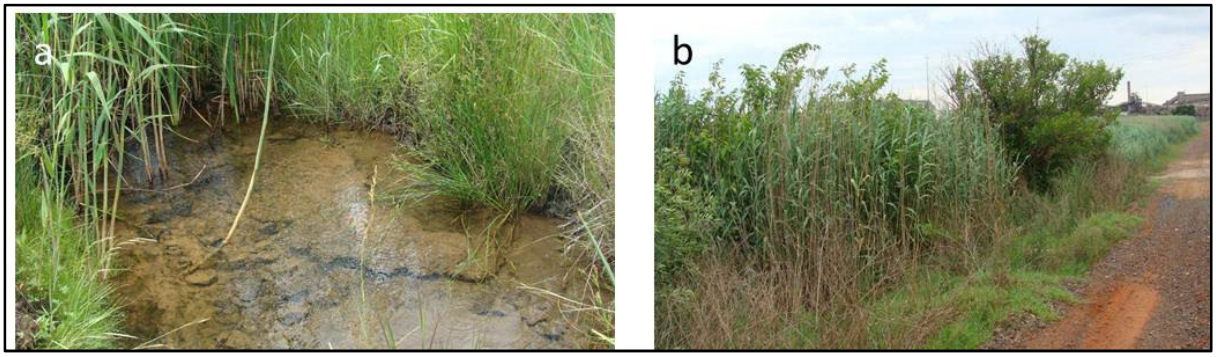

Figure 10. Site S2, a) Clear fairly shallow water with rocks and with medium sized rocks, b) Road that passes through the wetland area from the Samancor access gate to the landing strip.

Site E1 was situated 1.7 km from the N4 and is situated approximately 1km from the slimes dam. It is situated just within the boundaries of the study area. The water was 90 cm deep, and the Vaalbankspruit was 7m wide here. Flow was moderately fast and most of the river bed consisted out of gravel sand and mud. There was quite a lot of instream vegetation. A weir was present upstream and a dirt road crossing upstream of that. The river is quite impacted (Figure 11).

Site E2 was situated approximately 200m east of the slimes dam. The site have wetland as well as stream properties. At this site the Vaalbanspuit forms a narrow channel which passes the wetland vegetation on the western side. The vegetation surrounding the sampling point was dominanted by reeds. The reeds also occurred within the stream channel. The water depth was 60 cm and channel width was 3.2m. The channel bottom was covered by gravel sand and mud. Water was flowing relatively fast. Water samples as well as freshwater invertebrates were collected at the site (Figure 12).

Figure 11. Site E1. a &b) Vaalbankspruit as well as surrounding vegetation at site E1, c) Weir situated upstream of site E1.

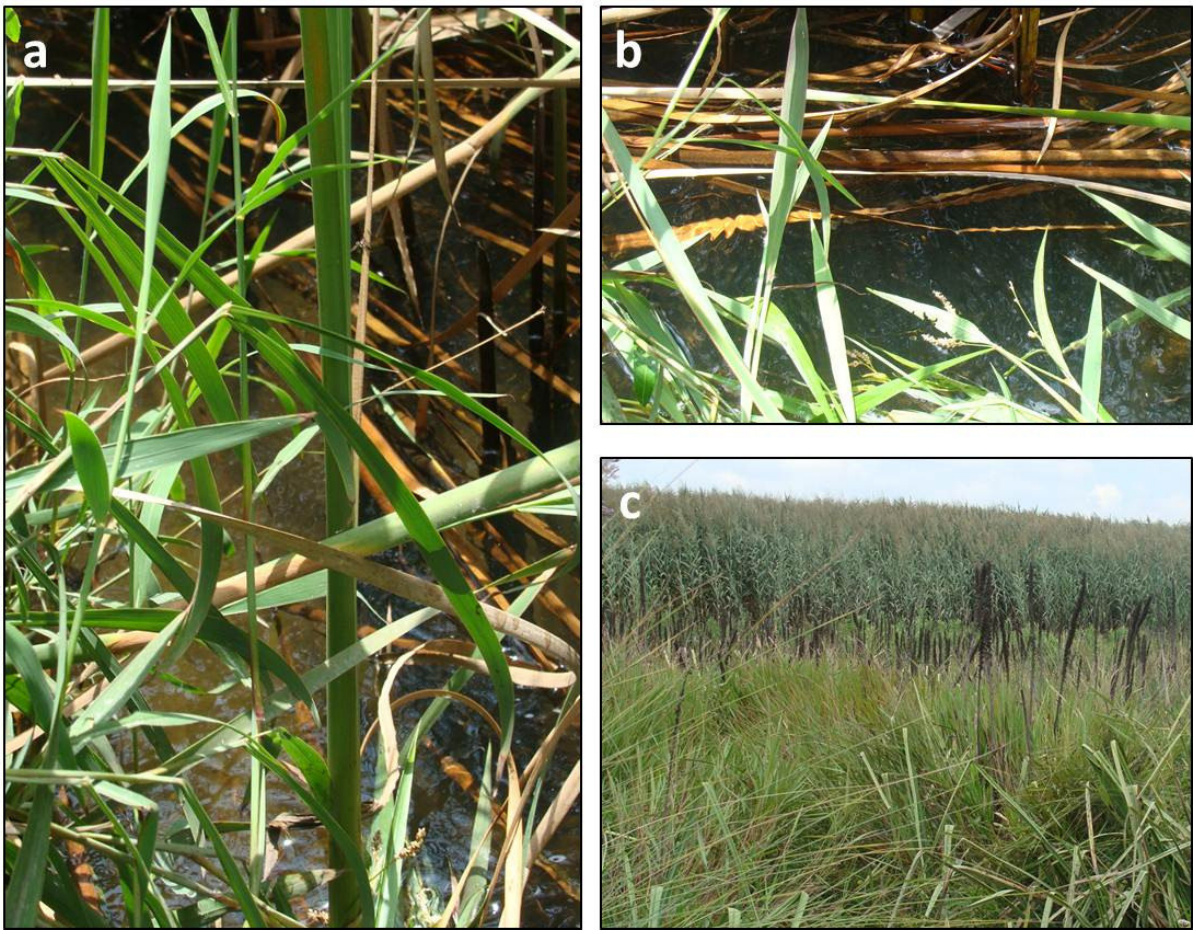

Figure 12. Site E2, a) Reeds present in the river channel, b) Clarity of the Vaalbankspruit with moderate flow, c) Wetland vegetation surrounding the sampling point.

6 Habitat description

The availability and diversity of habitats are major determinants of aquatic biota that are present in a river. It is important to assess the impact of human disturbance on the riparian and instream habitats; such as water abstraction and change of flow patterns, water quality, bed and channel modification, invasive alien plants and fauna, reduction of indigenous riparian plants and waste disposal on instream features.

The state of the riparian and in-stream vegetation is important for the proper functioning of aquatic ecosystems. This vegetation provides food which determines the number of animals a stream can support as well as the type and complexity of the food-web (Davies and Day 1998). Any alteration of this vegetation through the removal or addition of plants will affect the amount, timing and availability of plant material for the stream which will influence the responses of the flora and fauna.

Site S2 was situated in an area which had a gentle slope. The stream was meandering to a small extent. The river bed consisted of mud, gravel and rocks. Factors that could have an impact on this section of the stream could include runoff from Samancor and the road crossing the Vaalbankspruit to the north of S2.

Site E1 had almost no change in slope and a very slow flow. The channel floor consisted mostly of mud. There was instream vegetation present. Impacts that could have influenced the sampling point, includes runoff form the N4 as well as from the dirt road on the perimeter of the study area and the weir that was approximately 100m north of the sampling point.

The surrounding vegetation of site E2 is best described as wetland vegetation. The water was moderately fast flowing. Reeds were present in the stream channel and they were quite dense. The channel bed consisted of mud mostly but some gravel was also present. Factors that could have additionally influenced the sampling point was the infow of sewerage approximately 400m upstream of the site.

7 Physico-chemical parameters

The term water quality describes “the physical, chemical, biological and aesthetic properties of water which determine its fitness for a variety of uses and for protecting the health and integrity of aquatic ecosystems” (DWAF 1996a).

7.1 Physical parameters

The proportion of bedrock; large boulders; small cobbles; and gravel, sand and mud (GSM) were estimated at each site as these provide different habitats for freshwater fauna and flora (Table 3). Sampling site E1 & E2 had predominantly mud present with little to know small cobbles, boulders and bedrock. Site S2 consisted mainly of GSM but also had some smaller rocks present but no large boulders and bedrock (Table 3).

Table 3. The proportion of bedrock, large boulders, small cobbles and GSM

Site number	Bedrock (%)	Large boulders (%)	Small cobbles (%)	GSM (%)
S2	0	0	30	57
E1	0	0	0	100
E2	0	0	3	97

7.2 Chemical parameters

The water samples taken from all the sites were tested for pH, chemical oxygen demand, total dissolved solids and an ICP analysis was conducted. The results of the water samples will also be compared to Target Water Quality Ranges (TWQRs) set by DWAF and discussed accordingly,

Domestic water use includes primarily human consumption but also bathing and other household uses (washing, laundry, gardening, etc.) and requires a certain set of TWQRs (DWAF 1996a). Water quality is also important for agriculture use for irrigation and livestock watering. Changes in water quality of irrigation water may reduce crop yield, impair crop quality and soil suitability and damage irrigation equipment (DWAF 1996b). The TWQRs for irrigation water vary slightly and are sometimes less than those for domestic use (Table 4).

The water quality for livestock watering may be defined according to the palatability of the water which would affect intake and hence production, as well as its degree of contamination with a wide variety of pathogenic micro-organisms, algae and/or protozoa, hydrocarbons, pesticides and salts such as nitrates, sulphates, fluoride and the salts of heavy metals (DWAF 1996c). Water quality constituents that are potentially harmful with high incidence of occurrence include salinity, chloride, sulphate, arsenic, copper, sodium, calcium, fluoride, molybdenum, magnesium, nitrate and nitrite, and toxic algae (DWAF 1996c). Overall the TWQRs for livestock watering are greater than those for irrigation and domestic use (Table 4)

The water quality requirements for protecting and maintaining the health of aquatic ecosystems differ from those of other water uses (DWAF 1996d). It is difficult to determine the effects of changes in water quality on aquatic ecosystems as the cause-effect relationships are not well understood. Therefore, water quality criteria have to be derived indirectly through extrapolation of the known effects of water quality on a very limited number of aquatic organisms (DWAF 1996d). Certain quality ranges are required to protect and maintain aquatic ecosystem health (Table 4). Changes in water quality should be prevented rather than mitigated as it is seldom possible to mitigate the effects of poor water quality for aquatic ecosystems to the same degree as for other uses.

Table 4. South African Water Quality Guidelines set by the Department of Water Affairs and Forestry (DWAF) in 1996

Parameter	Unit	TWQR*: Domestic use[1]	TWQR: Irrigation[2]	TWQR: Livestock watering[3]	TWQR: Aquatic ecosystems[4]
pH	pH units	6 - 9	6.5 - 8.4		Limited to 5% of the background concentration
EC	mS/m µS/cm	0 – 70 0 – 700	0 – 40 0 – 400		
TDS	mg/ℓ	0 - 450		0 - 1000	Limited to 5% of the background concentration
Sulphate	mg/ℓ	0 - 200		0 - 1000	
Chromium	mg/ℓ	0-0.05	0- 0.10	0-1	·12 (µg/ ℓ)
Chloride	mg/ℓ	0 - 100	0 - 100	0 - 1500	
Chlorine	mg/ℓ				0.2
Calcium	mg/ℓ	0 - 32		0 - 1000	
Magnesium	mg/ℓ	0 - 30		0 - 500	
Manganese	mg/ℓ	0 - 0.05	0 - 0.02	0 - 10	0 - 0.18
Sodium	mg/ℓ	0 - 100	0 - 70	0 - 2000	
Potassium	mg/ℓ	0 - 50			
Nitrate	mg/ℓ	0 - 6		0 - 100	
Nitrite	mg/ℓ	0 - 6		0 - 100	
Nitrogen	mg/ℓ		0 - 5		Limited to 15% of the background concentration
Fluoride	mg/ℓ	0 - 1	0 - 2	0 - 2	750µg/ ℓ
Iron	mg/ℓ	0 - 0.1	0 - 5	0 - 10	Limited to 10% of the background concentration
TSS			0 - 50		Limited to 10% of the background concentration
Colour turbidity	Pt-Co units	15			

Turbidity	NTU	0 - 1			
Ammonia	mg/ℓ	0 - 1			7•g/ ℓ
Orthophosphate	mg/ℓ				Limited to 15% of the background concentration
Oxygen absorbed	mg/ℓ				
E. coli	counts/ 100 m^{r}	0-1	1		
Faecal coliform	counts/ 100 m^{r}	0	10000		

*TWQR: Target Water Quality Range
[1] DWAF 1996a; [2] DWAF 1996b; [3] DWAF 1996c; [4] DWAF 1996d

The only constituents which exceeded DWAF TWQR's for domestic use was Calcium (Ca) and Magnesium (Mg) and Chromium (Cr). All of the other constituents tested for fell into DWAF TWQR's (Table 4 & Table 5, DWAF 1996a).

Calcium exceeded DWAF TWQR's for domestic use at all s sites. Calcium levels at E1 were the lowest at 77.281 mg/ℓ exceeding the TWQR by 45.281 mg/ℓ. Site E2 had the highest concentration of calcium at 84.634 mg/ℓ exceeding the TWOR by 52.634 mg/ℓ. Site E2 contained 81.272 mg/ℓ. Calcium occurs naturally in most waters. Calcium is an essential element for all living organisms and is an important constituent of the bony skeleton of mammals. Calcium is an important mineral in the human diet. There is no conclusive evidence to support claims for the increase incidence of humans kidney and urinary tract stones resulting from the long-term consumption of water with high concentrations of calcium (DWAF 1996a).

Magnesium (Mg) exceeded the DWAF TWQR's for domestic use at all three sites. Site S2 had the highest concentration of contained 69.838 mg/ℓ magnesium. It exceeded the domestic use TWQR by 39.838 mg/ℓ magnesium. Site E2 containde the second highest concentration of magnesium namely 66.630 mg/ℓ. Site E1 contained 63.627 mg/ℓ exceeding TWQR by 33.627 mg/ℓ. Magnesium is a common constituent of water and solubility of magnesium is governed by pH. Magnesium is an essential nutritional element and magnesium in water can make a significant contribution to the total dietary intake. Magnesium is also a basic, essential element for plants and most other living organisms because it is a component of important enzyme co-factors. Magnesium has a bitter taste; this is a natural protection against the ingestion of potentially harmful concentrations. If

excess magnesium is present in one's body it is readily excreted by the kidney. Excess magnesium intake results in diarrhoea and rarely suppression of the central nervous system and heart function (DWAF 1996a).

The concentration of Chromium (Cr) exceeded TWQR for domestic (0.05 mg/ℓ) and irrigation use (0.01 mg/ℓ). Site E1 had the highest concentration of chromium, 0.358 mg/ℓ, exceeding domestic TWQR by 0.308 and irrigation TWQR by 0.368 mg/ℓ. Site E2 had the second largest concentration (0.271 mg/ℓ) and site S2 had the smallest concentration (0.240 mg/ℓ). The lab results did not indicate in which state the chromium is. There are several different states of chromium which all differ in toxicity. Chromium(VI) is a highly oxidised state of metallic chromium. It occurs as the yellow coloured dichromate salt under neutral or alkaline conditions and as the orange-coloured chromate salt under acidic conditions. Chromium(VI) is highly water soluble at all pH values. The reduced forms of chromium, namely, chromium(II) and chromium(III), are less soluble than chromium(VI), have much lower toxicity indices than chromium(VI), and do not constitute as serious a health hazard (DWAF 1996a,b).

The most common ore of chromium is chromite, in which chromium occurs in the trivalent state. Minerals containing chromium(VI) do occur, but are not common. Elevated concentrations of chromium(VI) found in the environment are due to industrial pollution. Because chromium(VI) is highly water soluble, it is very mobile in the environment and readily moves through the soil profile, resulting in contamination of ground water supplies. The equilibrium between chromium(VI) and its reduced forms is strongly influenced by **pH** and redox potential. The presence of oxidisable organic matter and **iron**(II) salts encourages the conversion of chromium(VI) to the lower, less toxic oxidation states. (DWAF 1996a). Rivers in Ecoregion Highveld 2, which include the Vaalbankspruit, mainly have a low pH and high concentrations of dissolved salts. The pH of the water samples were at a more or less neural pH. The lowest pH was found at Site S2.

Table 5 Concentration of constituents from laboratory analyses for water samples collected along the Vaalbankspruit. (Concentrations exceeding DWAF's TWQR are highlighted: orange – domestic use and red – irrigation)

Parameter	Unit	S2	E1	E2
Aluminium, Al	mg/ℓ	<0.031	<0.031	<0.031
Arsenic, As	mg/ℓ	<0.005	<0.005	<0.005
Cadmium, Cd	mg/ℓ	<0.005	<0.005	<0.005
Calcium, Ca	mg/ℓ	84.634	77.281	81.272
Chemical Oxygen Demand	mg/ℓ	20	18	20
Cobalt, Co	mg/ℓ	<0.009	<0.009	<0.009
Total Chromium, Cr	mg/ℓ	0.240	0.358	0.271
Copper, Cu	mg/ℓ	<0.050	<0.050	<0.050
Iron, Fe	mg/ℓ	<0.040	<0.040	<0.040
Lead, Pb	mg/ℓ	<0.01	0.027	0.033
Magnesium, Mg	mg/ℓ	69.838	63.627	66.630
Manganese, Mn	mg/ℓ	<0.01	<0.01	<0.01
Nickel, Ni	mg/ℓ	<0.01	<0.01	<0.01
pH	pH units	7.11	7.38	7.22
Potassium, K	mg/ℓ	25.955	24.264	24.954
Selenium, Se	mg/ℓ	<0.01	<0.01	<0.01
Sodium, Na	mg/ℓ	4.067	13.826	12.909
Vanadium, V	mg/ℓ	<0.031	<0.031	<0.031
Zinc, Zn	mg/ℓ	<0.010	<0.010	<0.010

Total hardness is the sum of the calcium and magnesium concentrations, expressed as mg/R of calcium carbonate. Other metals such as strontium, iron, aluminium, zinc and manganese may occasionally contribute to the hardness of water, but the calcium and magnesium hardness usually predominates. Excessive hardness of water can give rise to scaling in plumbing and household heating appliances and hence has adverse economic implications. It also poses a nuisance in personal hygiene (DWAF 1996a). Water hardness and pH affect the toxicity of both chromium(III) and chromium(VI) (DWAF 1996d). In general it seems that water quality increases along the Vaalbankspruit and it seems that the wetland is providing a valuable ecosystem service.

8 Fauna assessment

8.1 Aquatic invertebrates

The results from the aquatic sampling were used to determine the current ecological category of the Vaalbankspruit. Since the sampling sites lie within the Highveld Ecoregion, the SASS5 Score and ASPT can be compared to the results found by Dallas (2007) for the Highveld Ecoregion for the biological bands (Figure 13). The biological bands/ ecological categories are described in Table 6.

Table 6. Biological bands/ ecological categories for interpreting SASS data (adapted from Dallas 2007)

Biological band/ Ecological category	Ecological category name	Description
A	Natural	Unmodified natural
B	Good	Largely natural with few modifications
C	Fair	Moderately modified
D	Poor	Largely modified
E	Seriously modified	Seriously modified
F	Critically modified	Critically or extremely modified

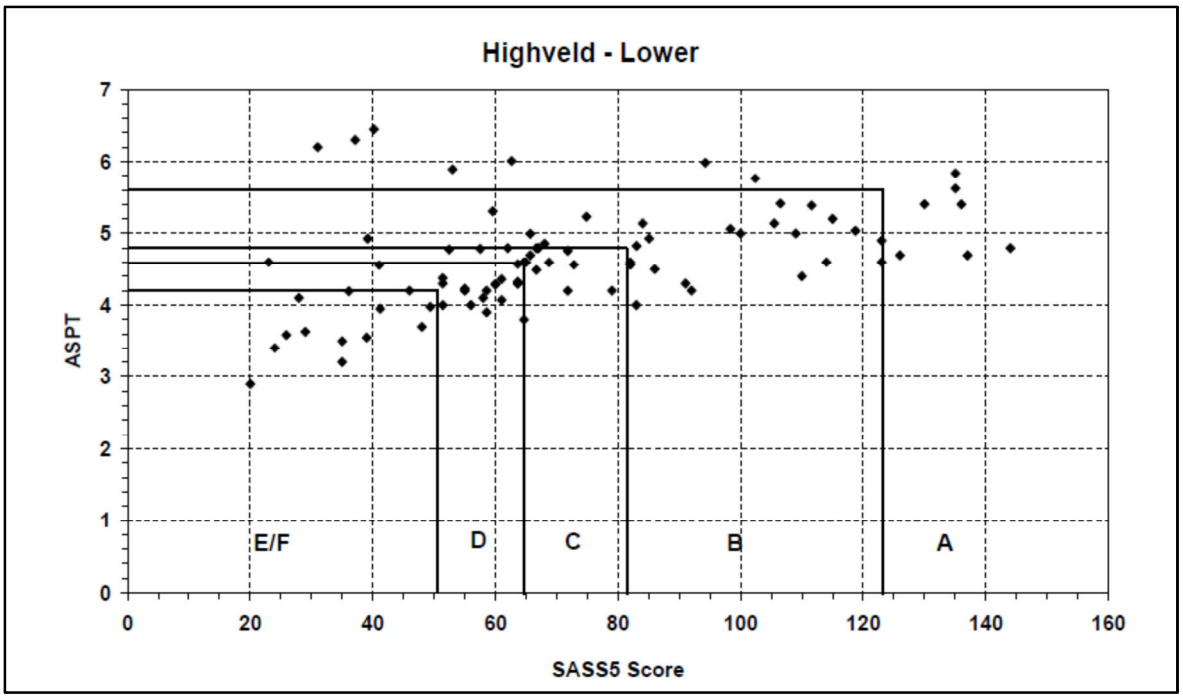

Figure 13. Biological bands for the Highveld Ecoregion from Dallas (2007).

The SASS5 Score, number of taxa and ASPT can be found inTable 7 for the sites sampled in the Vaalbankspruit.

Table 7. Results from SASS sampling at the sampling sites taken within the Vaalbankspruit.

Site number	SASS5 Score	Number of taxa	ASPT
S2	102	18	5.6
E1	69	16	4.31
E2	68	14	4.54

The SASS5 Score and ASPT for the three sites along the Vaalbankspruit were compared to the results found by Dallas (2007) for the biological bands (Figure 12). The results indicate that the site S2 falls within category A which indicates the river is in a natural condition. Sites E1 and E2 fell within the within the C category which indicates a fair river condition. The overall health for the Vaalbankspruit River was good according to SASS5.

As a tributary of the Olifants River, which is already not in very good condition, the Vaalbankspruit may further deteriorate the Olifants River System. The impacts on the Vaalbankspruit River should therefore be kept at the very minimum.

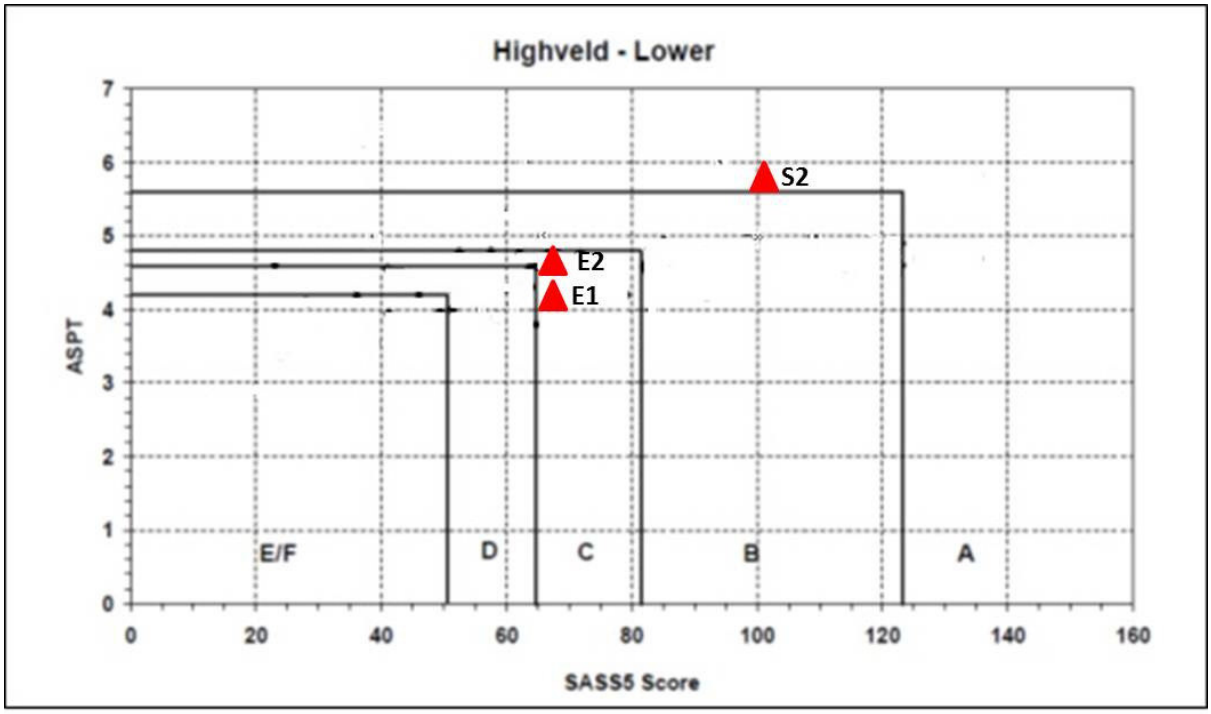

Figure 14. The SASS5 Score and ASPT for the sites sampled within the Vaalbankspruit River in comparison to the biological bands for the Eastern Bankenveld Ecoregion (lower zone) (from Dallas 2007)

8.2 Anurans

Anurans form an important part of healthy aquatic ecosystems as frogs predate on invertebrates and provide prey for birds, mammals, snakes and other frogs; while tadpoles are herbivorous and consume large amounts of algae and bits of vegetation as well as provide prey for other animals. Anurans are extremely sensitive to environmental stress as their skin is permeable and it absorbs moisture from the atmosphere. Anurans' skin is therefore sensitive to changes in water availability, temperature and humidity and can absorb pollutants. It is important to note their presence along the Vaalbankspruit as they could be useful indicators of pollution.

Baseline information on anurans recorded in the quarter degree grid square 2529CD was extracted from the Frog Atlas (Animal Demography Unit 2011). There have been twelve species recorded in the grid 2529CD (Table 8).

Table 8. Species recorded in grid 2529CD (adapted from the Frog Atlas)

Family	Genus	Species	Red data status
Bufonidae	*Bufo*	*gutturalis*	Least Concern
Bufonidae	*Bufo*	*rangeri*	Least Concern
Petropedetidae	*Cacosternum*	*boettgeri*	Least Concern
Hyperoliidae	*Kassina*	*senegalensis*	Least Concern
Petropedetidae	*Phrynobatrachus*	*natalensis*	Least Concern
Ranidae	*Ptychadena*	*porosissima*	Least Concern
Ranidae	*Afrana*	*angolensis*	Least Concern
Bufonidae	*Schismaderma*	*carens*	Least Concern
Hyperoliidae	*Semnodactylus*	*wealii*	Least Concern
Ranidae	*Strongylopus*	*fasciatus*	Least Concern
Ranidae	*Tomopterna*	*cryptotis*	Least Concern
Ranidae	*Tomopterna*	*natalensis*	Least Concern

The presence of anurans was not aptly sampled for, but it was recorded if a frog or tadpole were seen at the sampling sites. Tadpoles were recorded while sampling at Site E2 and S2.

9 Potential impacts

The rehablilitation on the slimes dam has already commenced. The vegetation has successful re-established. The slimes dam is situated 200m east of the Vaalbankspruit in an event of a flood the rehabilitated slimes dam and its contents can be washed/ carried into the Vaalbankspruit in a worst case scenario. The specialist is unsure if the slimes dam is situated within the 1-100 year floodline. It is therefore suggested that measures be put in place like surface water management to ensure that in the event of a flood the worst case scenario is prevented as far as humanly possible.

10 Recommendations

It is recommended that further investigation be done to ensure what the source of the chromium contamination in the water of the Vaalbankspruit is. This matter needs urgent attention. The slimes dam has been adequately rehabilitated and it is not likely that the slimes dam have any impact on the Vaalbankspruit.

10.1 Assumptions

It is assumed that the cause of the chromium contamination in the Vaalbankspruit will be further investigated.

10.2 Limitations

It is acknowledged that the knowledge of the aquatic specialist could be limited and there could be gaps in the information provided in this aquatic ecology study.

In order to obtain a comprehensive understanding of the dynamics of the aquatic ecosystem in the project area, ecological assessments should always consider investigations at different time scales (across seasons/years) and through replication. However, due to time constraints such long-term studies were not feasible and only one sampling trip was conducted in summer.

Sampling time also influences the presence of fish and anurans. No fish were found while sampling but it does not indicate that there are no fish present in the Vaalbankspruit. Due to technical difficulties only the presence of anurans was determined.

11 Conclusions

The slimes dam has been rehabilitated and no notable impact can be seen on the river health of the Vaalbankspruit.

The results showed that the Vaalbankspruit was in a good condition at two of the sites (S2 & E2) whilst E1 (control site upstream) was in a poor condition. This highlights the fact that the Vaalbankspruit provides the ecosystem with valuable ecosystem services. The source of chromium pollution is unknown and it is highly recommended that this issue be further investigated.

The Vaalbankspruit is a Critically Endangered river type and is one for which there are few remaining rivers occurring in healthy subcatchments and for which rehabilitation of catchments is required in order to meet biodiversity targets. Any future rehabilitation of the slimes dam should be aimed at preventing any further deterioration to the Vaalbankspruit ensuring increase in the river health of the Vaalbankspruit, thereby helping Mpumalanga reach their aquatic ecological conservation targets.

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