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REPORT ON

ECOLOGICAL ASSESSMENT
Wetlands and Surface Waters associated with the proposed Coal Fired Power Station in the Witbank area.

Report No : E457/06/B

Submitted to:
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EXECUTIVE SUMMARY

ECOSUN cc was contracted by Ninham Shand Consulting Services (Pty) Ltd to conduct an ecological survey of two possible sites for the development of a new Coal Fired Power Station in the Witbank area with specific focus on aquatic and wetland ecosystems. The following assessments were conducted:

- *In situ* water quality assessment,
- General Habitat Assessment,
- South African Aquatic Scoring System (SASS5),
- Invertebrate Habitat Assessment System (IHAS) vers. 2,
- Wetland delineation,
- Present Ecological Status (PES) assessment of wetlands (wetland integrity),
- Wetland ecosystem services,
- Wetland flora and fauna, and an
- Assessment of potential impacts.

The above assessments reveiled that area Site Y has a higher aquatic biotic integrity (Class A/B, based on SASS5 scores) when compared to Site X (Class E). Two specimens of the Shortspine suckermouth (*Chiloglanis pretoriae*) were sampled in the Wilge River (site WR1). The presence of this species is of special significance, since it is extremely scarce in the upper Olifants River Catchment. The wetlands of Site Y were also found to have a higher level of integrity and offer a higher level of ecosystem services than Site X.

Mitigation measures for both sites included alternate layouts for the power station. However, based on above information, from an aquatic biota and wetland perspective, Site X would be the preferred option for the development of the proposed Coal Fired Power Station.

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1 INTRODUCTION

1.1 Background

ECOSUN cc was contracted by Ninham Shand Consulting Services (Pty) Ltd to conduct an aquatic and wetland assessment of two potential sites for the construction of a new power station by Eskom in the Kendal area, in the Mpumalanga and Gauteng provinces (Areas X and Y in Figure1). The main aim of the study was to assess whether any important ecological attributes could be identified within the two proposed regions earmarked as possibly suitable sites for the development of the proposed power station. Within these two areas a site outlay for a power station, coal storage facility and ash dam were further proposed. The proposed regions fall within the larger Wilge River catchment with land use mainly confined to commercial pastoral and agricultural farming areas and, as such, are subject to grazing, cultivation and fire management practices.

In order to evaluate the potential impact of the proposed development an assessment of the status and conservation importance of the aquatic ecosystems and wetlands was undertaken. Information from this assessment was used as the basis to assess the significance of impacts that may affect important ecological attributes associated with the aquatic ecosystems and wetlands.

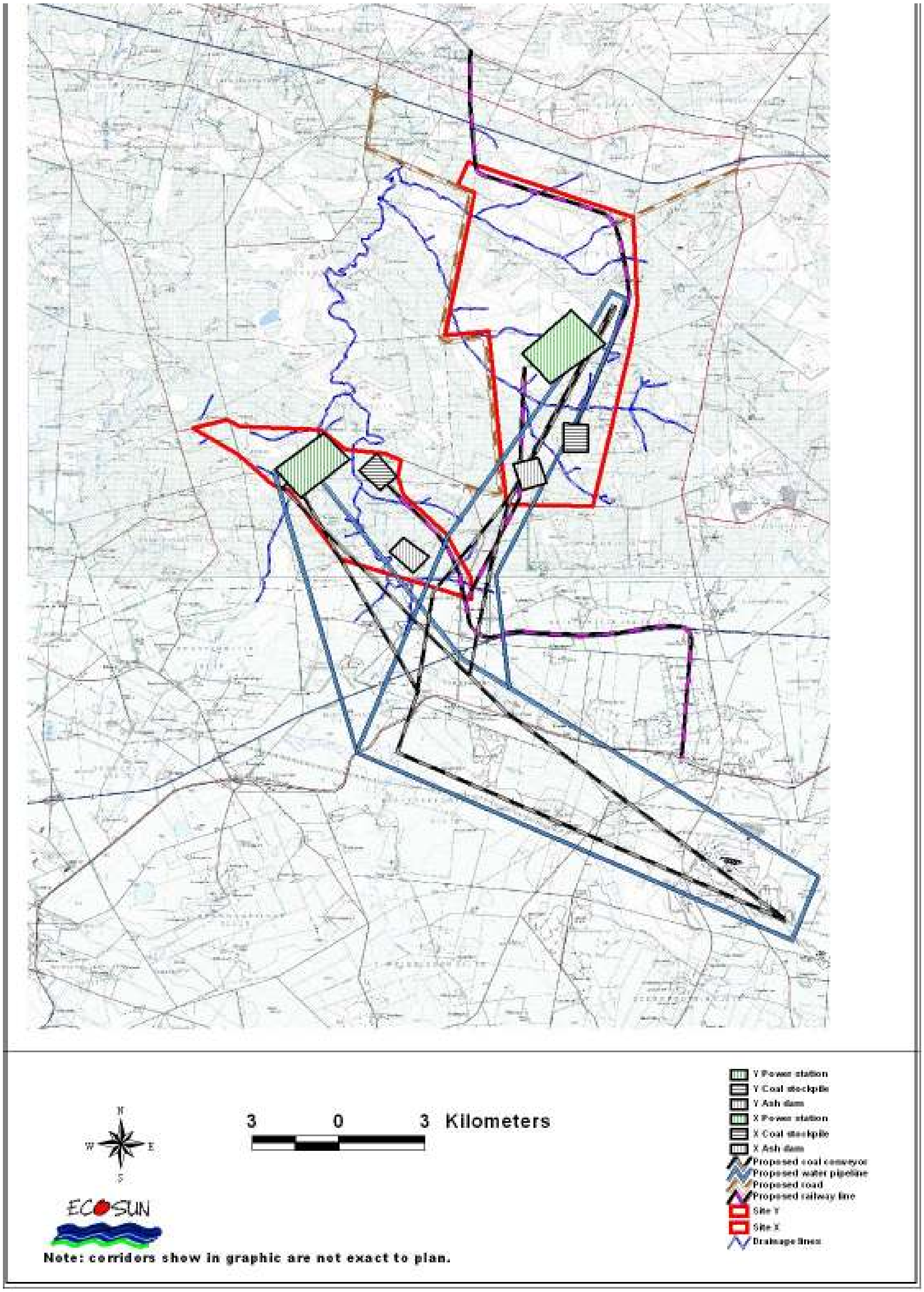


Figure 1: Locality map of Sites X and Y for the proposed Coal Fired Power Station in the Witbank area.

1.2 Objectives

The overall objective of this study was to provide a broad description of the wetlands and streams associated with the proposed development and included the following specific objectives:

- An assessment of biodiversity patterns & processes associated with wetlands and streams;
- A biotic integrity assessment and associated habitat classification;
- Delineation of aquatic ecosystems, as well as their ecological significance;
- Wetland and biotic status assessment;
- An impacts significance assessment and recommendations to prevent or mitigate identified impacts; and
- A recommendation regarding the preferred site in terms of aquatic and wetland ecosystems, with and without mitigation measures.

1.3 Approach

The approach was implemented along the following basic tasks:

- Desktop assessment – obtain relevant information (e.g. satellite imagery, existing literature) verify the likely presence of important ecological attributes – rare and endangered species (R&E), and important habitat types.
- Conduct a desktop delineation of the wetlands associated with the areas proposed for development;
- Design a field survey through identifying river reaches and wetland segments most likely to be under threat from impacts that may result from the proposed development. Select survey sites to represent these reaches of likely impact;
- Conduct a field survey to verify desktop delineations and the likely presence of important ecological attributes (e.g. biodiversity patterns and processes);
- Analyses of results and data interpretation involving the following:
  - Classification of aquatic and wetland areas into discernable ecosystem units;
  - Assessment of each unit’s ecosystem integrity and services provided.

- Overlay proposed development footprints on important ecological attributes and assess likely impact significance;

- Generation of mitigation measures with the guiding principal of deferring impacts to ecosystem units with low integrity and services;

- Propose possible mitigation measures;

- Report the outcome.

1.4 Limitations

The study was conducted during September 2006, before the advent of the summer rains. Unequivocal identification of some of the species was therefore impossible, and some species (especially some annuals) may have been overlooked. This is of specific significance regarding the presence of red data species in relation to the proposed development. Many of the annual grass and forb species had also, as yet, not emerged. Many of the migratory bird species, which may inhabit this area in summer, had not yet returned from their migration to the northern hemisphere. These species were, therefore, not observed or included in this study. At some of the sites extensive burning of moribund material had also taken place and re-growth was negligible, making identification of the majority of floral species in these areas impossible.

The wetland and riparian assessment was conducted mainly at a desktop level to focus field survey efforts and assist in identifying the likely impacts associated with the different layouts to facilitate a preliminary impact significant assessment and identify major risks associated with the different layouts in order to recommend layouts with the least significant impacts.

2 STUDY AREA

The study area consists of two potential sites (Site X and Site Y, figure1) which lie approximately 35km east south east of Witbank. Situated in the Olifants River Catchment (Quaternary Catchment B20F) the study area falls within the Veld Types 61 (Bankenveld) and 19 (Sourish Mixed Bushveld) (Acocks, 1988). The location and description of the aquatic sampling sites, wetland and soils transects are given in Table 1 and illustrated in Figures 2 and 3 .

Table 1: Monitoring sites in sections of the Wilge River, Klipspruit, Klipfonteinspruit and Holfontienspruit associated with the proposed Coal Fired Power Staion.

Sample point	Description	Latitude	Longitude
Aquatic Sample points			
XHFSAD	Holfonteinspruit	-25.97046	28.90602
XKFSDS	Klipfonteinspruit downstream	-25.92415	28.88391
XKFSCSAD	Klipfonteinspruit downstream from the coal stockpile and ash dam	-25.94014	28.89805
XPSPAN	Pan in Site X	-25.91005	28.91005
XKFSPS	Klipfonteinspruit at Kendal Power Station	-25.92723	28.92301
YKSDS	Klipspruit, upper reaches of the Wilge River Catchment	-25.97013	28.83373
YKSUS	Klipspruit upstream	-25.97093	28.83352
YWRDS	Wilge River downstream	-25.9678	28.85118
YWRUS	Wilge River upstream	-25.99428	28.86267
Terrestrial Transects			
XKFSPS start	Site X, Transect on Klipfonteinspruit - Power Station, Start	-25.92795	28.92187
XKFSPS end	Site X, Transect on Klipfonteinspruit - Power Station, End	-25.92662	28.92238
XPAN start	Site X, Transect on Pan, Start	-25.93466	28.91048
XPAN end	Site X, Transect on Pan, End	-25.93797	28.90954
XKFSCFAD start	Site X, Transect on Klipfonteinspruit - Ash Dam & Coal Stockpile, Start	-25.93948	28.89854
XKFSCFAD end	Site X, Transect on Klipfonteinspruit - Ash Dam & Coal Stockpile, End	-25.94102	28.89846
XKFSAD start	Site X, Transect on Klipfonteinspruit - Ash Dam, Start	-25.97054	28.90722
XKFSAD end	Site X, Transect on Klipfonteinspruit - Ash Dam, End	-25.96925	28.90462
XKFSDS start	Site X, Transect on Klipfonteinspruit - Downstream, Start	-25.92337	28.87981
XKFSDS end	Site X, Transect on Klipfonteinspruit - Downstream, End	-25.92413	28.88360
YKSDS1start	Site Y, Transect 1 on Klipspruit, Downstream, Start	-25.95646	28.83742
YKSDS1 end	Site Y, Transect 1 on Klipspruit, Downstream, End	-25.95652	28.84085
YKSDS2 start	Site Y, Transect 2 on Klipspruit, Downstream, Start	-25.95267	28.83827
YKSDS2 end	Site Y, Transect 2 on Klipspruit, Downstream, End	-25.95407	28.84122
YKSUS start	Site Y, Transect on the Klipspruit, Start	-25.97133	28.83153
YWRDS start	Site Y, Transect on the Wilge River, Downstream, End	-25.97050	28.85016
YWRDS end	Site Y, Transect on the Wilge River, Downstream,	-25.97006	28.85194

	End		
YWRUS start	Site Y, Transect on the Wilge River, Upstream, Start	-25.96881	28.85403
YWRUS end	Site Y, Transect on the Wilge River, Upstream, End	-25.95912	28.85163
Soil Transects			
XST1S	Site X, Soil Transect 1, Start	-25.92270	28.91780
XST1E	Site X, Soil Transect 1, End	-25.92990	28.91790
XST2S	Site X, Soil Transect 2, Start	-25.92500	28.91430
XST2E	Site X, Soil Transect 2, End	-25.92490	28.92230
XST3S	Site X, Soil Transect 3, Start	-25.94270	28.91070
XST3E	Site X, Soil Transect 3, End	-25.95860	28.90260
XST4S	Site X, Soil Transect 4, Start	-25.94730	28.89310
XST4E	Site X, Soil Transect 4, End	-25.95160	28.91440
XST5S	Site X, Soil Transect 5, Start	-25.96730	28.90150
XST5E	Site X, Soil Transect 5, End	-25.97230	28.91160
XST6S	Site X, Soil Transect 6, Start	-25.96830	28.91210
XST6E	Site X, Soil Transect 6, End	-25.97800	28.90670
XST7S	Site X, Soil Transect 7, Start	-25.97500	28.91510
XST7E	Site X, Soil Transect 7, End	-25.97320	28.92080
YST1S	Site Y, Soil Transect 1, Start.	-25.95560	28.83290
YST1E	Site Y, Soil Transect 1, End	-25.95560	28.83390
YST2S	Site Y, Soil Transect 2, Start	-25.96330	28.83230
YST2E	Site Y, Soil Transect 2, End	-25.96330	28.84660
YST3S	Site Y, Soil Transect 3, Start	-25.95880	28.84270
YST3E	Site Y, Soil Transect 3, End	-25.96810	28.84270
YST4S	Site Y, Soil Transect 4, Start	-25.96720	28.82980
YST4E	Site Y, Soil Transect 4, End	-25.97490	28.84040
YST5S	Site Y, Soil Transect 5, Start	-25.97120	28.83850
YST5E	Site Y, Soil Transect 5, End	-25.97630	28.83360
YST6S	Site Y, Soil Transect 6, Start	-25.96730	28.84990
YST6E	Site Y, Soil Transect 6, End	-25.97590	28.84970
YST7S	Site Y, Soil Transect 7, Start	-25.97010	28.85230
YST7E	Site Y, Soil Transect 7, End	-25.95880	28.85610
YST8S	Site Y, Soil Transect 8, Start	-25.97630	28.85710
YST8E	Site Y, Soil Transect 8, End	-25.97680	28.85160

The location of the sampling sites and transects in the Wilge River Catchment is shown in Figures 2 and 3.

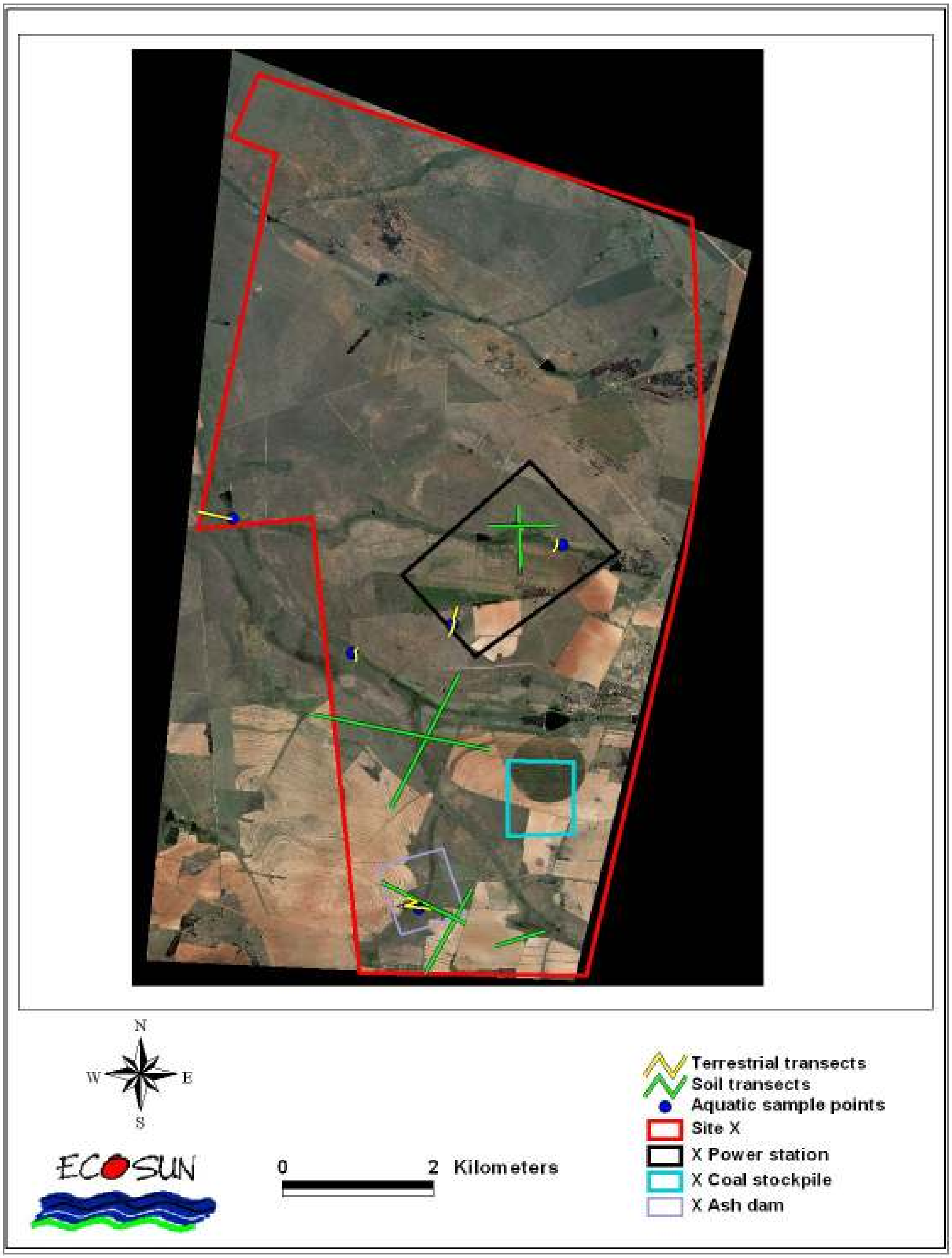


Figure 2: Aquatic sample sites, terrestrial and soil transects at Site X.

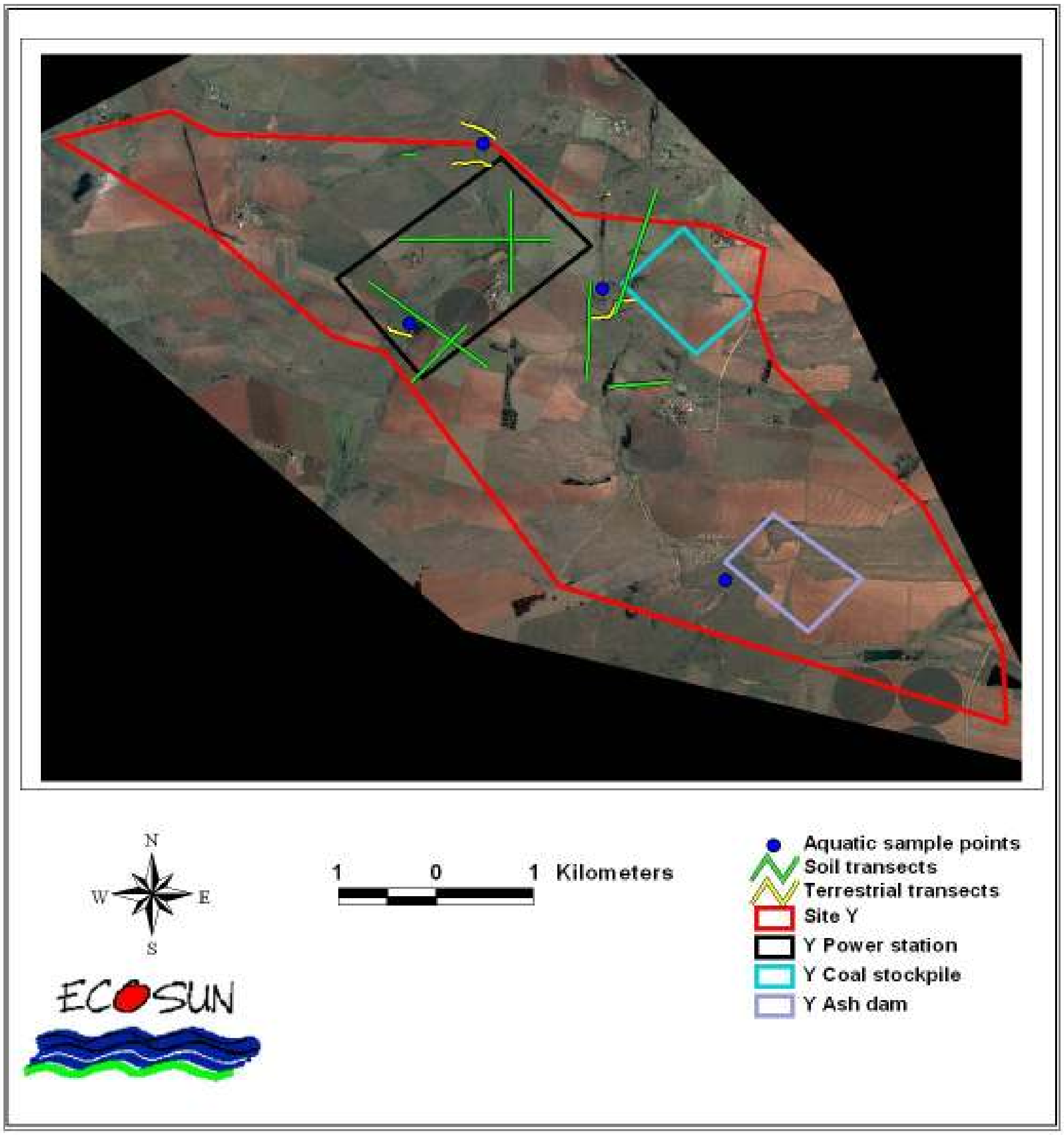


Figure 3: Sampling sites and soil transects at Site Y.

3 METHODOLOGY

In order to enable a characterization of the general integrity of the aquatic, littoral and riparian environments, certain ecological indicators were selected to represent each of the responding, habitat and stressor components involved in the natural environment. These included:

Stressor Indicators

- *In situ* water quality

Habitat Indicators

- General Habitat Assessment
- Invertebrate Habitat Assessment System (IHAS, version 2)
- Habitat Assessment for Low Gradient Streams
- Soils

Response Indicators

- Aquatic Macroinvertebrates (including SASS5)
- Ichthyofauna
- Small mammals
- Herpetofauna
- Avifauna
- Vegetation

3.1 In-stream Assessment

3.1.1 *In situ* water quality

During the field survey the following variables were determined on site with lightweight, compact field instruments:

- Total Dissolved Salts (TDScan)

- pH (pHScan)
- Dissolved Oxygen (Oxyguard Handy Alpha)
- Temperature (Alcohol Thermometer)

Water quality has a direct influence on aquatic life forms. Although these measurements only provide a “snapshot”, they can provide valuable insight into the characteristics of a specific sampling site.

3.1.2 General Habitat Assessment

Habitat assessment can be defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour *et al.*, 1996). Habitat quality and availability plays a critical role in the occurrence of aquatic biota. For this reason habitat evaluation is conducted simultaneously with biological evaluations in order to facilitate the interpretation of results.

3.1.3 Invertebrate Habitat Assessment System (IHAS, version 2)

The Invertebrate Habitat Assessment System (IHAS, version 2) was applied in order to assess the suitability of biotopes present for aquatic macroinvertebrates. The IHAS was developed specifically for use with the SASS5 index in South Africa (McMillan, 1998).

According to the SASS5 methodology, three major biotopes need to be evaluated at each site (Dickens and Graham, 2001). These are:

1. Stones-in-current (including stones-out-of-current & bedrock)
2. Sand, mud, gravel
3. Vegetation

The Invertebrate Habitat Assessment System (IHAS) evaluates the availability of these three biotopes at each site and expresses the availability & suitability as a percentage, where 100% represents "ideal" habitat availability. It is presently thought that a total score of over 65% represents good habitat conditions, and over 55% indicates adequate habitat conditions (McMillan, 2002).

3.1.4 Habitat Assessment for Low Gradient Streams

The US EPA generic habitat assessment approach for low-gradient streams was applied at selected sites in the study area (Plafkin *et al.*, 1989). Each sampling reach was evaluated in terms of epifaunal substrate/available cover, pool substrate, pool variability, channel alteration, sediment deposition, channel sinuosity, flow, bank vegetation protection, bank stability, riparian vegetation zone width. This data was used to facilitate interpretation of biological data.

3.1.5 Soils

In order to meet the objective of the investigation, the following method of investigation was employed (see APPENDIX 16):

- Undertake a preliminary delineation of the wetland boundaries using an ortophoto or topocadastral map together with airphoto interpretation.

- Verify and adjust the preliminary delineation of the wetland using field verification.

3.1.6 Aquatic Macroinvertebrates

The monitoring of benthic macroinvertebrates forms an integral part of the monitoring of the biotic integrity of an aquatic ecosystem as they are relatively sedentary and enable the detection of localized disturbances. Their relatively long life histories (±1 year) allow for the integration of pollution effects over time. Field sampling is easy and since the communities are heterogeneous and several phyla are usually represented, response to environmental impacts is normally detectable in terms of the community as a whole (Hellawell, 1977).

Aquatic macroinvertebrates were sampled using the qualitative kick sampling method generally referred to as SASS5 (South African Scoring System version 5) (Dickens and Graham, 2001). SASS5 was designed to incorporate all available biotypes at a given site and to provide an indication of the quality of the aquatic environment through recording the presence of various macroinvertebrate families at each site. The SASS5 protocol is essentially a biotic index of the condition of a river or stream, based on the resident macroinvertebrate community, whereby each taxon is allocated a score according to its level of tolerance to river health degradation (Dallas, 1997).

This method relies on churning up the substrate with your feet and sweeping a finely meshed SASS net, with a pore size of 1000 micron mounted on a 300 mm square frame, over the churned up area several times. In stony bottomed flowing water biotopes (rapids, riffles, runs, etc.) the net was rested on the bottom and the area immediately upstream of the net disturbed by kicking the stones over and against each other to dislodge benthic invertebrates. The net was also swept under the edge of marginal and aquatic vegetation to cover from 1-2 meters. Identification of the organisms was made to family level (Thirion *et al.*, 1995; Davies & Day, 1998; Dickens & Graham, 2001; Gerber & Gabriel, 2002).

Habitat is a major determinant of aquatic community potential. Both the quality and quantity of available habitat affect the structure and composition of benthic macroinvertebrate communities. The Invertebrate Habitat Assessment System (IHAS) was used to semiqualitatively evaluate the condition of the habitat at the selected sampling site and to assess the impact of physical habitat degradation on the SASS score.

The endpoint of any biological or ecosystem assessment is a value expressed either in the form of measurements (data collected) or in a more meaningful format by summarising these measurements into one or several index values (Cyrus *et al.*, 2000) The indices used for this study were, total score and average score per taxon (ASPT). The biotic integrity of the site was scored, according to these indices, based on macroinvertebrate diversity.

3.1.7 Ecological State based on SASS5 Results

Reference conditions reflect the best conditions that can be expected in rivers and streams within a specific area and also reflect natural variation over time. SASS and ASPT reference conditions were modelled for the Highveld Ecoregion by DWAF (Table 2) (data obtained from Gauteng Nature Conservation, Mr. Piet Muller).

Table 2: Classification protocol for determining the Present State Class as modelled for the Highveld Ecoregion, based on SASS5 & ASPT scores.

Class	Condition	SASS score	ASPT value
A	Excellent – Unimpaired; community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.	>120	>6
B	Very Good – Minimally impaired; Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged	91-120	5-6
C	Good – Moderately impaired; community structure and function less than the reference condition. Community composition lower than expected due to loss of some sensitive forms. Basic ecosystem functions are still predominantly unchanged.	71-90	4.5-5.5
D	Fair- Largely impaired; fewer families present than expected, due to loss of most intolerant forms. Basic ecosystem functions have changed.	56-70	4.5-5.5
E	Poor – Seriously impaired; few aquatic families present, due to loss of most intolerant forms. An extensive loss of basic ecosystem functions has occurred.	30-55	Variable
F	Very Poor – Critically impaired; few aquatic families present. If high densities of organisms, then dominated by a few taxa. Only tolerant organisms present.	<30	Variable

3.1.8 Ichthyofauna

Whereas invertebrate communities are good indicators of localised conditions in a river over the short-term, fish being relatively long-lived and mobile,

- are good indicators of long-term influences,
- are good indicators of general habitat conditions,
- integrate effects of lower trophic levels, and
- are consumed by humans (Uys *et al*., 1996).

Fish samples were collected by means of a portable battery driven electrofishing device (DC 12V pulsating). Electrofishing is the use of electricity to catch fish. The electricity is generated by a system whereby a high voltage potential is applied between two electrodes that are placed in the water (USGS, 2004). The responses of fish to electricity are determined largely by the type of electrical current and its wave form. These responses include avoidance, electrotaxis (forced swimming), electrotetanus (muscle contraction), electronarcosis (muscle relaxation or stunning) and death (USGS, 2004). Electrofishing is regarded as the most effective single method for sampling fish communities in streams (Plafkin *et al*., 1989).

3.2 Riparian and Wetland Assessment

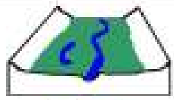
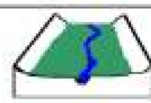
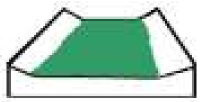
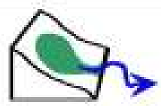
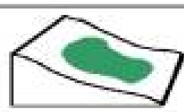
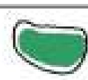
The wetland assessment consisted of the following aspects:

- Wetland classification and delineation;
- Wetland integrity;
- Ecosystem services supplied by the wetlands;
- Fauna & Flora survey;
- Soils survey.

3.2.1 Wetland Classification and delineation

The classification of the wetlands in the study area into different wetland types was based on the WET-EcoServices technique (Kotze *et al*, 2005). The WET-EcoServices technique identifies seven main types of wetland based on hydro-geomorphic characteristics (Table 3).

Table 3: Wetland Unit types based on hydro-geomorphic characteristics (Adapted from Kotze *et al*, 2005).

Hydro-geomorphic type	Code	Illustration	Description
Flood Plain	FP		Valley bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley Bottom with a Channel	VBC		Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley Bottom Without a channel	VB		Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.
Channelled Hillslope Seepage feeding a Water course	CHSW		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a watercourse.
Hillslope Seepage feeding a Water course	HSW		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow connecting the area directly to a watercourse.
Hillslope Seepage not feeding a water course	HS		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a watercourse.
Depression	D		A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent.

The field procedure for the wetland delineation was conducted according to the Guidelines for delineating the boundaries of a wetland (South African Water Act, DWAF, 1999). Due to the transitional nature of wetland boundaries, these are often not clearly apparent and the delineations should therefore be regarded as a human construct. The delineations are based on scientifically defensible criteria and are aimed at providing a tool to facilitate the decision making process regarding the assessment of the significance of impacts that may be associated with the proposed developments.

According to DWAF (1999) the following general principals should be applied as the basis to undertaking a wetland delineation:

1. *"A wetland is defined 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 under normal circumstances supports or would support vegetation typically adapted to life in saturated soil* "(Water Act 36 of 1998 In DWAF, 2005).

2. Thus a wetland can be defined in terms of hydrology (flooded or saturated soils), plants (adapted to saturated soils) and soil (saturated).

3. Due to the variable nature of South Africa's climate the direct presence of water is often an unreliable indicator of wetland conditions.

4. Prolonged saturation of soil has a characteristic effect on soil morphology, affecting soil matrix chroma and mottling in particular.

The following procedure was followed during the delineation of the wetland boundaries and zones:

- Desktop delineations were undertaken using satellite imagery of the study sites (Quickbird, 30cm, Natural Colour).
- Areas for verification were identified and transects for vegetation and soil specialists were generated.
- Each transect was then assessed by the respective specialists to verify the boundaries and zones.
- These verifications were then incorporated and adjustments to the desk top delineation were made to produce the final delineations.

3.2.2 Wetland Integrity

The Present Ecological Status (PES) Method (DWAF 2005) was used to establish the integrity of the wetlands in the study area and was based on the modified Habitat Integrity approach developed by Kleynhans (1996, 1999 In DWAF 2005). The delineated wetland units (as described under section 3.2.1.) were used as the basis to divide the wetlands into different segments to increase the resolution of the integrity assessment. Table 4 shows the criteria for assessing the habitat integrity of palustrine wetlands along with Table 5 describing the allocation of scores to attributes and the rating of confidence levels associated with each score. These criteria were selected based on the assumption that anthropogenic modification of the criteria and attributes listed under each selected criterion can generally be regarded as the primary causes of the ecological integrity of a wetland.

Table 4: Habitat integrity assessment criteria for palustrine wetlands (DWAF, 2005).

Criteria and Attributes	Relevance
Hydrologic	
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floralistic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.
Water Quality	
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.
Hydraulic/Geomorphic	
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduces or changes wetland habitat directly in inundation patterns.
Biota	
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.

Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).
Alien Fauna	Presence of alien fauna affecting faunal community structure.
Over utilisation of Biota	Overgrazing, over fishing, etc.
Total	
Mean	

Table 5: Scoring guidelines and relative confidence scores for the habitat integrity assessment for palutrine wetlands (DWAF, 2005).

Scoring Guidelines per Attribute:	
Natural/Unmodified	5
Largely Natural	4
Moderately Modified	3
Largely Modified	2
Seriously Modified	1
Critically Modified	0
Relative Confidence of Scores:	
Very High Confidence	4
High Confidence	3
Moderate Confidence	2
Marginal/Low Confidence	1

Table 6 provides guidelines for the determination of the Present Ecological Status Category (PESC), based on the mean score determined for Table 4. This approach is based on the assumption that extensive degradation of any of the wetland attributes may determine the PESC (DWAF, 2005).

Table 6: Category's assigned to the scores achieved in the wetland habitat assessment (DWAF, 2005).

Category	**Mean Score**	**Category Description**
Within generally acceptable range		
A	>4	Unmodified or approximated natural condition.
B	>3 and <=4	Largely natural with few modifications, but with some loss of natural habitats.
C	>2 and <=3	Moderately modified, but with some loss of natural habitats.
D	2	Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
Outside generally acceptable range		
E	>0 and <2	Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.

F	0	Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

3.2.3 Ecosystem Services Supplied by Wetlands

The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et* al (2005). A Level 2 assessment was undertaken which examines and rates the following services:

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

The characteristics were scored according to the following general levels of services provided:

Table 7: Level of service ratings.

Score	Services Rating
0	Low
1	Moderately Low
2	Intermediate
3	Moderately High
4	High

The different wetland units (as delineated under section 3.2.1) were used as the basis for the level 2 assessment. The assessment was further focussed on those wetland units within the segments of likely impact associated with the different proposed site layouts. The relative importance of the different units, in relation to one another and between the two sites (X and Y), were then evaluated by summing the number of services regarded as high (scoring levels higher than intermediate) (Table 7). The wetland units with the highest number of important functions were then delineated to facilitate decision making.

3.2.4 Wetlands fauna and flora

The baseline characterization of the wetland and riparian fauna and flora was conducted by means of visual assessment surveys through areas selected based on the reach of likely impact approach mentioned under section 1.3. The main focus of these investigations was to classify vegetation communities as a main surrogate for biodiversity patterns and to assist with the wetland delineations and was conducted on a transect basis through the selected reaches. These transects were traversed on foot and all observed species (vegetation & vertebrates – visual sightings, scats, nests, calls) were recorded. Plant species that could not be identified during the site investigation were sampled and identified in the laboratory from field guides or comparison with herbarium examples. During the desktop analysis phase the data was captured in a database and preliminary species lists were compiled.

In order to assess the status of red data species in the study area, the following sources were used:

- South African Red Data Book – Reptiles and Amphibians (Branch, 1998);
- Red Data Book of the Mammals of South Africa (EWT, 2004);
- South African Red Data Book – Butterflies (Henning, S.F. & Henning, G.A,1989);
- IUCN Red List Categories and Criteria (IUCN, 2001);
- IUCN Red List of Threatened Species (IUCN, 2003);
- Atlas and Red Data Book of the Frogs of South Africa (Minter, Burger, Harrison, Braack, Bishop & Loafer, 2004); and
- South African Red Data Book – Terrestrial Mammals (Smithers, 1986).

4 RESULTS

4.1 *In situ* water quality

Water quality was measured (TDS, pH, Dissolved Oxygen, Temperature) in the field with lightweight compact field instruments and the results presented in Table 8. These results are important to assist in the interpretation of biological results because of the direct influence water quality has on aquatic life forms. Thus, an integrative approach, which included physical-chemical, habitat and biological assessments, was followed to provide increased accuracy.

Table 8: *In situ* water quality

Site	Time	pH	DO* (mg/ℓ)	TDS** (mg/ℓ)	Temp (ºC)
WR1	16h10	8.1	12.9	225	23
WR2	13h10	7.9	10.4	190	18.5
KS1	8h20	7.7	7.1	175	16
KS2	15h20	8.0	10.4	165	19
KFS1	8h15	7.9	6.4	30	12
KFS2	11h30	7.7	8.0	120	16
KFS3	15h00	7.9	14.2	140	21

* Dissolved Oxygen; ** Total Dissolved Salts;

The pH of natural waters is determined by both geological and atmospheric influences, as well as by biological activities. Most fresh waters are usually relatively well buffered and more or less neutral, with a pH range from 6 to 8, and most are slightly alkaline due to the presence of bicarbonates of the alkali and alkaline earth metals (DWAF, 1996). The *in situ* pH values measured in the study area were alkaline ranging between 7.7 and 8.1 (5.5) (Table 8). According to the South African Water Quality Guidelines for Aquatic Ecosystems (DWAF, 1996), the pH value should not be allowed to vary from the range of the background pH values for a specific site and time of day, by >0.5 of a pH unit, or by 5%, and should be assessed by whichever estimate is the more conservative.

The maintenance of adequate dissolved oxygen (DO) is critical for the survival and functioning of the aquatic biota because it is required for the respiration of all aerobic organisms. Therefore, DO concentration provides a useful measure of the health of an ecosystem (DWAF, 1996). The median guideline for DO for the protection of aquatic biota is >5mg/ℓ (Kempster *et al*., 1980). During the current survey the *in situ* DO concentrations in the surface waters ranged between 6.4mg/l and 12.9mg/l, and are therefore not expected to have a limiting effect on aquatic biota (Table 8).

Most macroinvertebrate taxa are sensitive to salinity, with toxic effects likely to occur in sensitive species at salinities > 1000mg/ℓ (DWAF, 1996). *In situ* TDS concentrations in the study area were relatively low, ranging between 30mg/l and 225mg/l (Table 8). According to the South African Water Quality Guidelines for Aquatic Ecosystems, the TDS concentrations should not be changed by more than 15% from the normal cycles of an inland water body under unimpacted conditions at any time of the year, and the amplitude and frequency of natural cycles in TDS concentrations should not be changed (DWAF, 1996).

Water temperature plays an important role in aquatic ecosystems by affecting the rates of chemical reactions and therefore also the metabolic rates of organisms (DWAF, 1996). Temperature affects the rate of development, reproductive periods and emergence time of organisms (DWAF, 2005). According to the South African Water Quality Guidelines (1996), water temperature should not be allowed to vary from the ecosystems background average daily temperature considered to be normal for that specific site and time of day by > 2˚C, or by > 10%, whichever estimate is the more conservative. The temperatures of inland waters in South Africa generally range from 5 - 30 ˚C (DWAF, 1996). During the current survey the water temperature ranged between 12^{o}C and 23^{o}C (Table 8).

4.2 Habitat Assessment

4.2.1 Invertebrate Habitat Assessment System, Version 2 (IHAS)

The quality of the instream and riparian habitat influences the structure and function of the aquatic community in a stream; therefore evaluation of habitat availability is critical to any assessment of aquatic biota.

Based on the IHAS scores, habitat availability for aquatic macroinvertebrates was generally adequate for the aquatic systems associated with site Y (Wilge River and Klipspruit) and poor for the streams of site X (Klipfonteinspruit) (Table 9). Based on this assessment habitat availability can only be considered as a limiting factor for aquatic macroinvertebrate diversity associated with site X.

Table 9: IHAS index conducted as part of the biomonitoring survey. Good is scripted in green, adequate/fair is scripted in blue and poor is scripted in red.

Site	IHAS (%)	
	Score	Description
WR1	72	Good
WR2	67	Good
KS1	66	Good
KS2	55	Fair
KFS1	42	Poor

KFS2	**52**	Poor
KFS3	**52**	Poor

Habitat availability in the Wilge River (WR1 & WR2) and in the upstream Klipsruit (KS1) was good, with IHAS values ranging between 66 and 72% (Table 4). Site KS2 displayed adequate habitat availability. Habitat availability in the Klipfonteinspruit was poor, ranging between 42 and 52%. The stones-in-current biotope was absent from all three sites in the Klipfonteinspruit.

4.3 Aquatic Macroinvertebrates

Aquatic macroinvertebrates collected in the sample area are listed in APPENDIX 1. A total of 40 aquatic macroinvertebrate taxa (10 to 28 taxa per site) were sampled in the study area. Pollutant sensitive Ephemeropterans (notably >2spp Baetidae, Heptagenidae and Leptophlebiidae) were sampled in the Wilge River (sites WS1 and WS2) and in the Klipspruit (sites KS1 and KS2) (APPENDIX 1). The low number of taxa sampled in the Klipfonteinspruit could largely be attributed to limited habitat availability, with an absence of the stones-in-current biotope which provides habitat for the majority of aquatic macroinvertebrate fauna.

4.3.1 South African Scoring System, Version 5 (SASS5)

SASS5 scores of 145 and 116 were recorded in the Wilge River and 110 and 128 in the Klipspruit. SASS5 scores recorded in the Klipfonteinspruit were significantly lower ranging between 38 and 53 (Table 10).

Table 10: SASS5 scores, Number of Taxa and ASPT* scores obtained during the aquatic survey.

Site	SASS5 Score	Number of Taxa	ASPT*
YWR1	145	28	5.2
YWR2	116	20	5.8
YKS1	110	18	6.1
YKS2	128	25	5.1
XKFS1	38	10	3.8
XKFS2	47	10	4.7
XKFS3	53	13	4.1

* * Average Score Per Taxon

4.3.2 Biotic Integrity based on SASS5 Results

Biotic integrity for the sample area concerned was derived based on the modelled reference conditions for the Highveld region (Table 11).

Based on SASS5 results, biotic integrity in the Wilge River is regarded as Unimpaired to Minimally Impaired at site WR1 (Class A/B) and Minimally Impaired at site WR2 (Class B).

Class A/B recorded in the Klipspruit is indicative of Minimally Impaired biotic integrity, while that in the Klipfonteinspruit was indicated to be Seriously Modified (Class E at sites KFS1, KFS2 and KFS3). The latter is ascribed mainly to limited habitat availability, rather than water quality impairment.

Table 11: Biological integrity based on SASS5 and ASPT scores.

Site	Present Ecological State (PES)	
	Class	Description
WR1	A/B	Unimpaired/Minimally Impaired
WR2	B	Minimally Impaired
KS1	A/B	Unimpaired/Minimally Impaired
KS2	A/B	Unimpaired/Minimally Impaired
KFS1	E	Seriously Impaired
KFS2	E	Seriously Impaired
KFS3	E	Seriously Impaired

4.4 Ichthyofauna

A total of 121 specimens comprising 4 species were sampled in the study area. These include *Barbus anoplus* (Chubbyhead barb), *Chiloglanis pretoriae* (Shortspine suckermouth), *Pseudocrenilabrus philander* (Southern mouthbrooder) and *Tilapia sparrmanii* (Banded tilapia) (Table 7).

Table 12: Number of species of fish sampled in the study area.

Species	WR1	WR2	KS1	KS2	KFS1	KFS2	KFS3	TOTAL
CYPRINIDAE								
Barbus anoplus	12	52	14				8	86
MOCHOKIDAE								
Chiloglanis pretoriae	2							2
CICHLIDAE								
Pseudocrenilabrus philander	7	8	9					24
Tilapia sparrmanii	3	6						9
TOTAL	24	66	23	0	0	0	8	121

Barbus anoplus was the most abundant species in the study area comprising 71% of the total catch. This species has a wide distribution from the Highveld tributaries of the Limpopo to the highlands of Kwazulu-Natal, Transkei and the middle- and upper Orange River Basins including the Karoo. It prefers cool waters and occurs in a wide range of habitats (Skelton, 2001).

The cichlids *Tilapia sparrmanii* and *Pseudocrenilabrus philander* are common in different portions of particular habitats, but both prefer vegetated areas (Skelton, 1986; Skelton, 2001). Both these species were sampled in the Wilge River, while only *P. philander* was sampled in the Klipspruit (Table 12).

The presence of the Shortspine suckermouth (*Chiloglanis pretoriae*) in the Wilge River is of special significance. This species is intolerant towards poor water quality and has specialized habitat requirements. It is dependent on flowing water habitats and has a preference for substrate cover (Skelton, 2001). Two specimens of this species were sampled in the upstream section of the Wilge River at site WR1 (Table 7). Which probably represents one of the last remaining populations in the upper Olifants Catchment. No Red Data Fish species are expected to occur in the study area (IUCN, 2006; Skelton, 2001).

4.5 Wetland and Riparian Flora

According to Van Oudtshoorn (1999), approximately 110 (APPENDIX 2) grass species occur within the study area. Of these species 78 species were recorded during the study (APPENDIX 3.

Of these species 28 species were wetland grass types, 20 species were species associated with both wetlands and veld/grassland areas and 30 species were grass species associated with non-wetland grassland or veld. None of the species identified were classified as Red Data Book species. Wetland grasses such as *Imperata cylindrica* and *Pennisetum macrourum* were used to aid in the delineation of the wetlands for this study.

Falling within what can be described as a grassland area (Van Wyk & Van Wyk, 1997) tree species were not numerous and of the 45 indigenous species (APPENDIX 4) occurring in the region only 6 species were identified within the study area (APPENDIX 5).

All of the species recorded were common species and no Red Data list tree species were recorded. Plant and forb species were also not numerous and only 24 species were recorded, of which none are considered Red Data Book species.

4.6 Wetland and Riparian Fauna

Of the 346 bird species known to occur within the study area according to Harrison et al (1997a and b) (APPENDIX 6), only 73 species were recorded during the duration of the study (APPENDIX 7).

Most of the species recorded were wetland or grassland species with the Grass Owl being the only species found known to be a Red Data List species.

Of the 45 small mammals known to be resident in the region (APPENDIX 8) ten were recorded within the study area, of these none of the recorded species are classified as Red Data species (APPENDIX 9).

Twelve amphibian species are known to occur within the study area (Carruthers, 2001) (APPENDIX 10). Of these species only 4 (APPENDIX 11) species were recorded during the study. These species are common in the area and in many other areas in the country and are not listed as Red data species.

Of the 34 reptile species of the area (APPENDIX 12) (Branch, 1996)) four were recorded during the study. All of the recorded species are common and no Red Data species were recorded (APPENDIX 13).

4.7 Wetland Classification and delineation

From Figure 4 it is evident that site X supports six different wetland types: channelled valley bottom; hillslope feeding a watercourse; hillslope not feeding a watercourse; non channelled valley bottom; floodplain and depression wetland types.

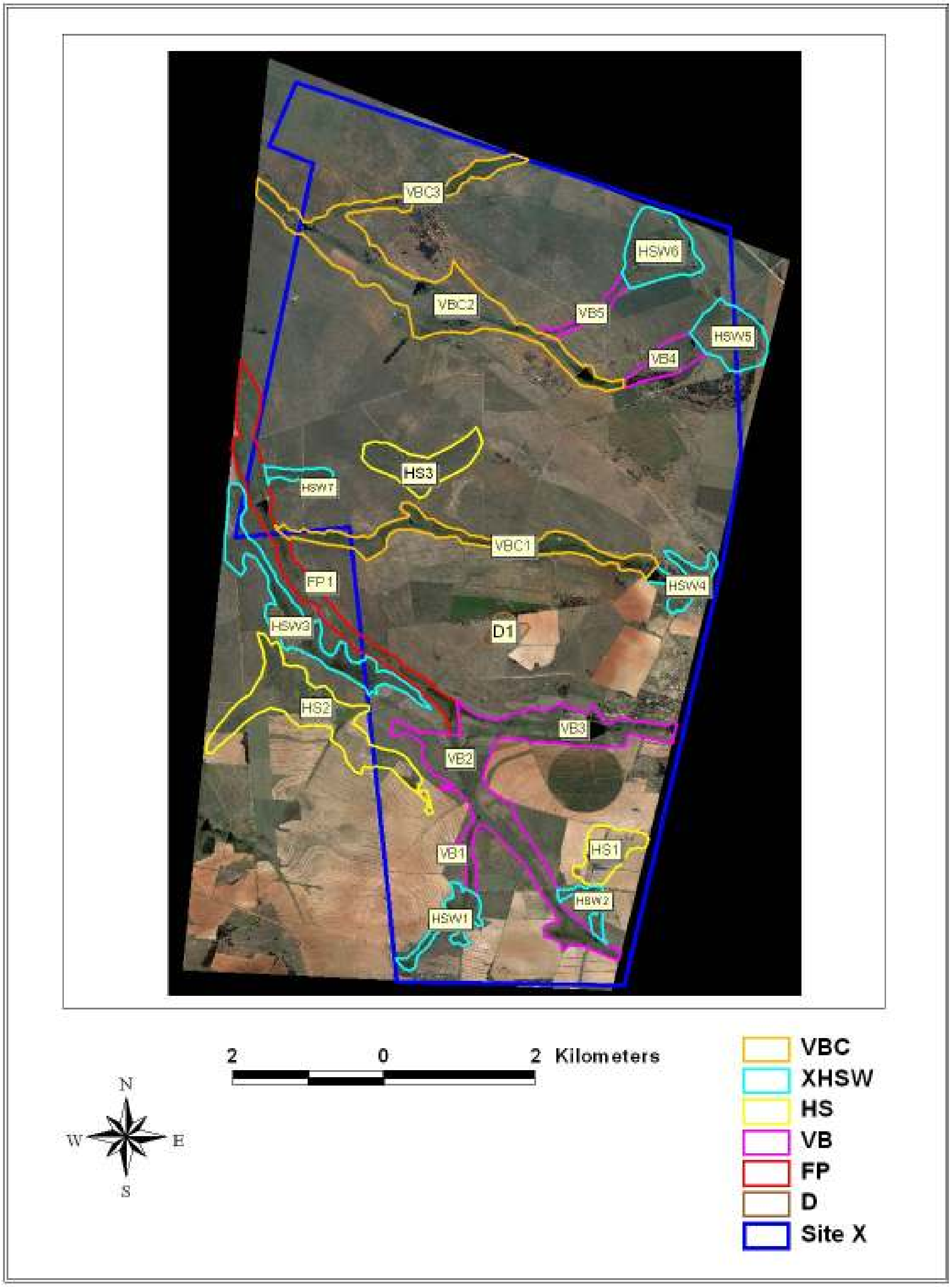


Figure 4: Site X wetland types**.**

Site Y supports five different wetland types: hillslope feeding a watercourse; channelled valley bottom; channelled hillslope feeding a watercourse; non channelled valley bottom and floodplain wetland types (Figure 5)

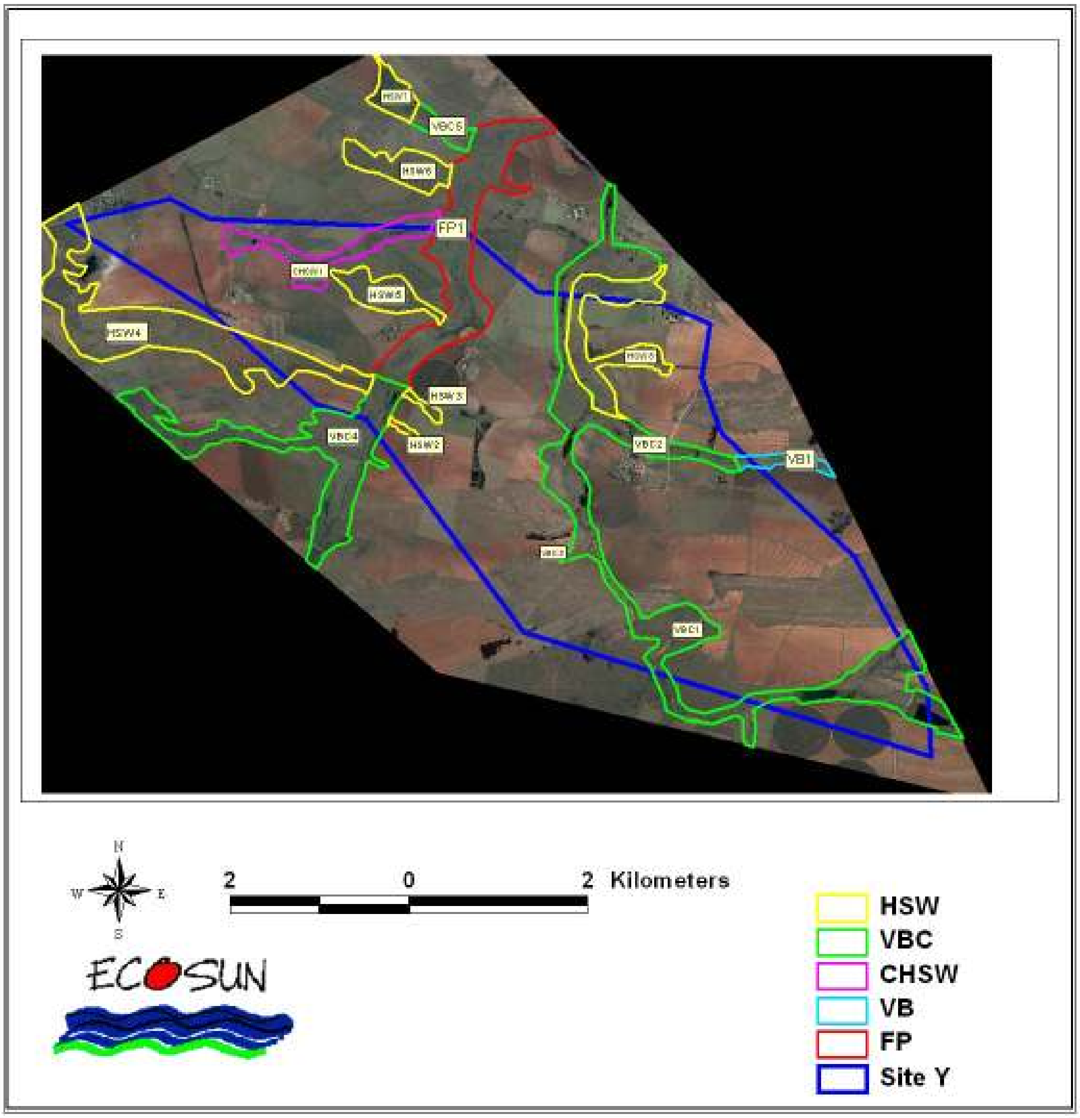


Figure 5: Site Y wetland types.

4.8 Wetland Integrity

The general integrity of the wetlands associated with site X can be regarded as impaired with only two wetland sections of high integrity (Figure 6).

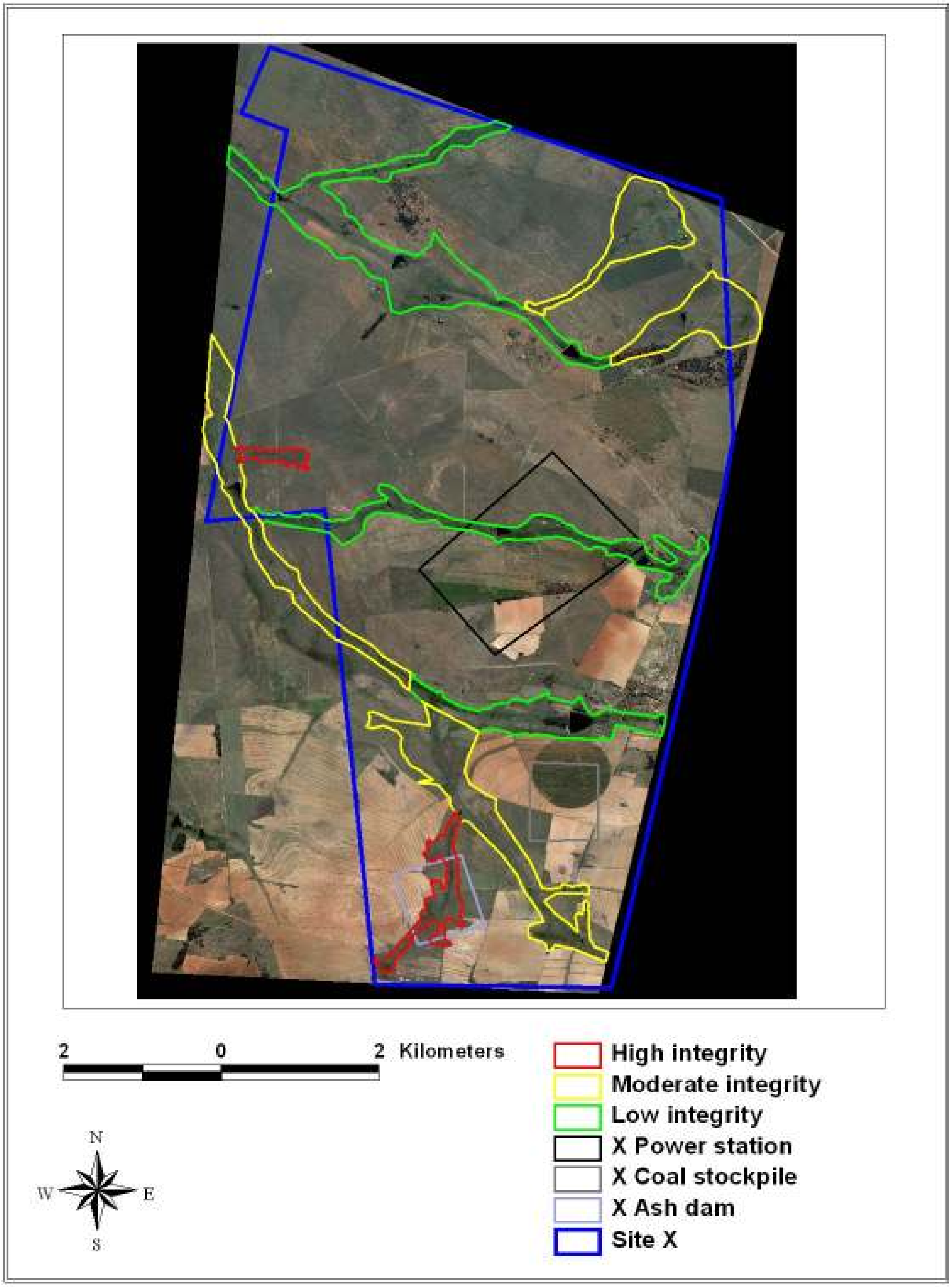


Figure 6: Site X wetland integrity**.**

The wetlands associated with site Y are generally of a higher integrity specifically those sections associated with the proposed lay-outs (Figure 7)

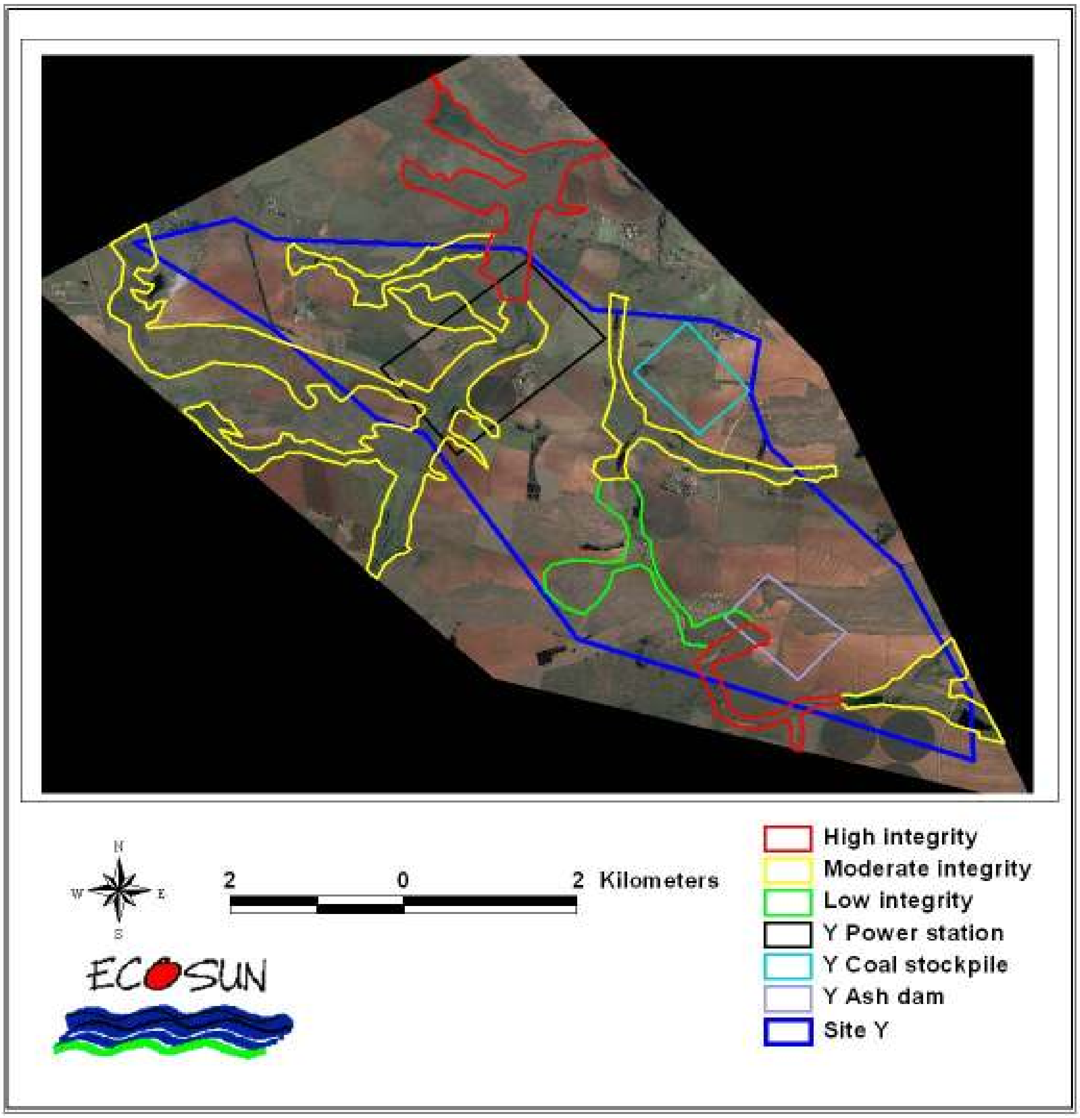


Figure 7: Site Y wetland integrity.

4.9 Ecosystem Services Supplied by the Wetlands

The ecosystems services supplied by the different wetland types present a similar picture to that of the wetland integrities with the most important and diverse services provided by the wetlands associated with site Y and specifically those wetland units that will be impacted upon by the proposed layouts (Figures 8 & 9).

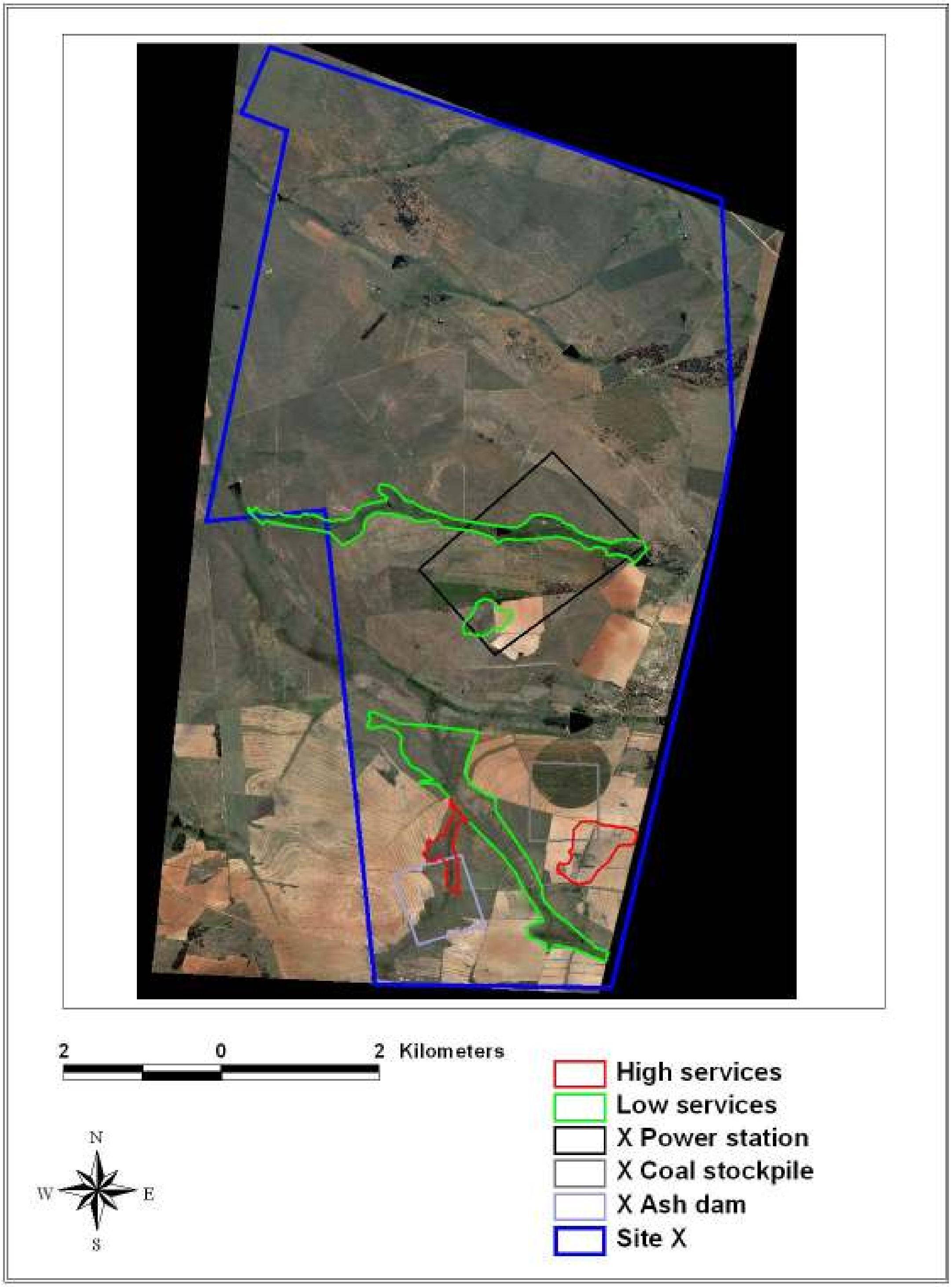


Figure 8: Site X wetland services.

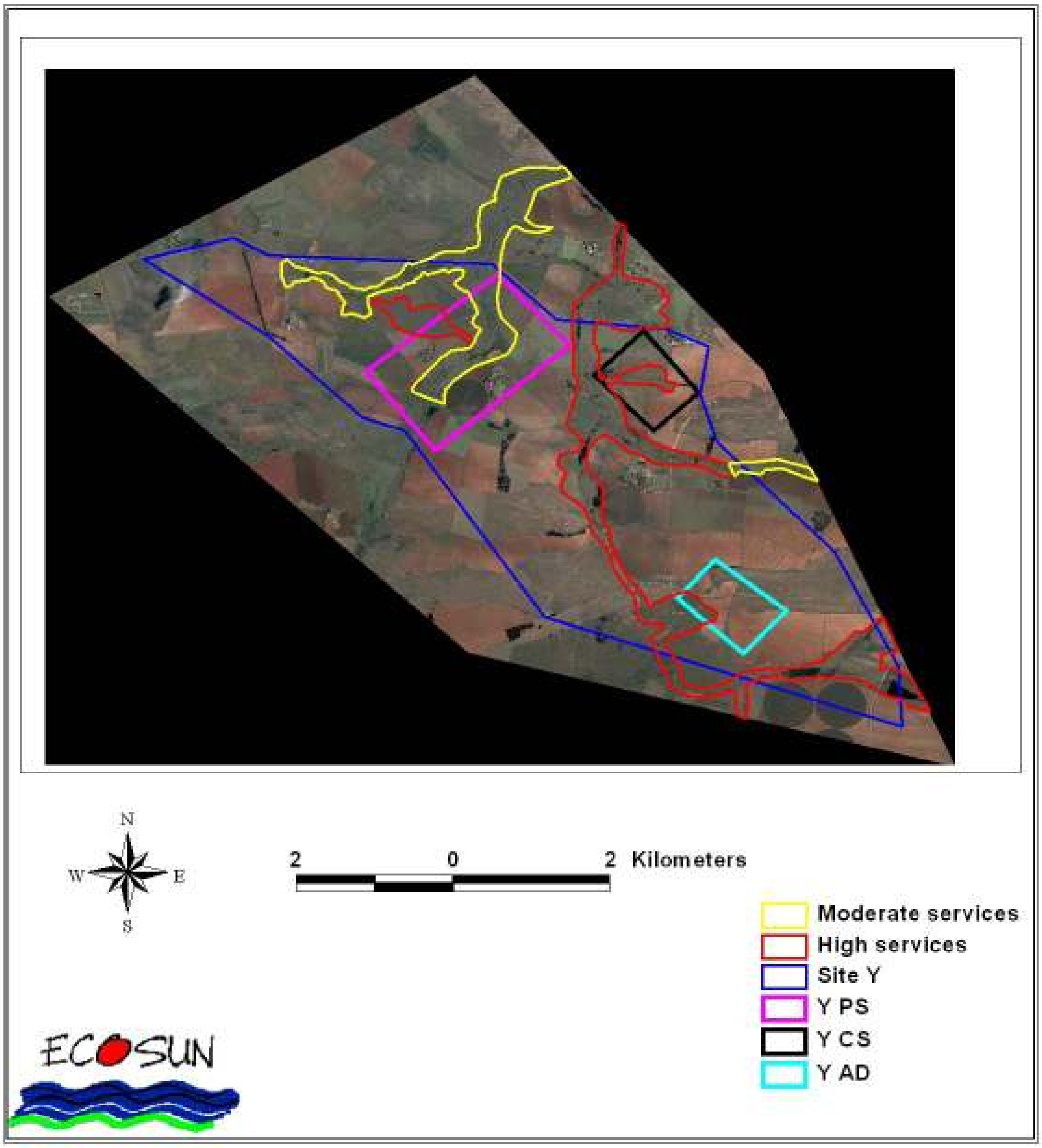


Figure 9: Site Y wetland services.

5 DISCUSSION

The most important ecological attributes associated with both study areas are regarded as:

- The presence of the water quality sensitive fish (*Chiloglanis pretoriae*) in the headwaters of the Wilge River at site Y;
- The importance of maintaining the integrity in the Wilge given the degraded state of the upper Olifant's River catchment;

- The consistently higher biodiversity at survey sites of area Y (Table 13);
- The high integrity of the wetlands associated with site Y; and
- The high number of ecosystem services provided by the wetlands of site Y.

Table 13: Comparison of species numbers.

	Number of Species						
	YWR1	YWR2	YKS1	YKS2	XKFS1	XKFS2	XKFS3
Aquatic Macro-invertebrates	28	20	18	25	10	10	13
Ichthyofauna	4	3	2	1	0	0	1
Grasses	45	43	46	43	32	38	No data
Plants/Forbs	18	12	11	16	11	10	No data
Trees	3	1	1	3	4	3	4
Birds	36	34	42	31	21	14	34
Small mammals	4	3	4	4	1	2	4
Reptiles	1	0	2	1	0	1	2
Amphibians	2	2	1	2	0	0	2
Total number of species	141	118	127	126	79	78	60

The generally poor riparian and wetland faunal and floral species richness (APPENDIX 3, 5, 7, 9, 11 and 13) can be attributed to a number of possible factors, which include the fact that the area has been greatly impacted upon by cropping, grazing and burning practices, as well as the fact that the study took place during a time when species richness is known to be reduced due to the adverse winter conditions and the fact that the wet season had not yet started.

It must be reiterated that this study did not take place during a time of optimum possible diversity and it is recommended that the study be repeated during the summer season in order to take optimal diversity into consideration and verify the likely presence of red data species.

6 ASSESSMENT OF POTENTIAL IMPACTS

Any development in a natural or semi-natural system will impact on the environment, usually with adverse effects. This phase of the study assesses the significance of potential impacts of current and proposed future activities at the study site on the receiving aquatic environment of the study area, and is intended to achieve the following:

- Describe and assess future impacts arising from activities on the fauna and flora of the streams and wetlands of the study area.
- Recommend mitigation measures to address significant impacts.
- Identify aspects which may require further study.

6.1 Assessment of Significance

From a technical, conceptual or philosophical perspective the focus of impact assessment ultimately narrows down to a judgment on whether the predicted impacts are significant or not (DEAT, 2002). The concept of significance is at the core of impact identification, prediction, evaluation and decision-making (DEAT, 2002). The determination of significant impacts relates to the degree of change in the environmental resource measured against some standard or threshold (DEAT, 2002). This requires a definition of the magnitude, prevalence, duration, frequency and likelihood of potential change (DEAT, 2002). The following criteria have been proposed by the Department of Environmental Affairs and Tourism (DEAT, 2002) for the description of the magnitude and significance of impacts (DEAT, 2002).

The *consequence* of impacts can be derived by considering the following criteria:

- Extent or spatial scale of the impact
- Intensity or severity of the impact
- Duration of the impact
- Potential for Mitigation
- Acceptability
- Degree of certainty/Probability
- Status of the impact
- Legal Requirements

Describing the potential impact in terms of the above criteria provides a consistent and systematic basis for the comparison and application of judgments (DEAT, 2002).

Calculation of the severity of the impact is based on the Department of Environmental Affairs' guideline document on EIA Regulations, April 1998.

Significance of Impact = Consequence (magnitude + duration + spatial scale) x Probability

Magnitude relates to how severe the impact is. Duration relates to how long the impact may be prevalent for and the spatial scale relates to the physical area that would be affected by the impact. Having ranked the severity, duration and spatial scale using the criteria outlined in Table 14, the overall consequence of impact can be determined by adding the individual scores assigned in the severity, duration and spatial scale. Overall probability of the impacts must then be determined. Probability refers to how likely it is that the impact may occur.

Table 14: Consequence and probability ranking.

Magnitude/Severity	Duration	Spatial Scale	Probability
10 - Very high/don't know	5 - Permanent	5 - International	5 - Definite/don't know
8 - High	4 - Long-term (impact ceases after operational life)	4 - National	4 - Highly probable
6 - Moderate	3 - Medium-term (5-15 years)	3 - Regional	3 - Medium probability
4 - Low	2 - Short-term (0-5 years)	2 - Local	2 - Low probability
2 - Minor	1 - Immediate	1- Site only	1 - Improbable
0 - None			0 - None

The maximum value, which can be obtained, is 100 significance points (**SP**). Environmental effects are rated as either of **High, Moderate, Low** or **No Impact** significance on the following basis:

SP>60 Indicates high environmental significance;

SP 30 to 60 Indicates moderate environmental significance;

SP<30 Indicates low environmental significance.

SP = 0 Indicated no environmental impact

The descriptors for the ratings are provided in Table 15 (DEAT, 2002).

Table 15: Categories for the rating of impact magnitude and significance.

High	Of the highest order possible within the bounds of impacts that could occur, There is no possible mitigation that could offset the impact, or mitigation is difficult.
Moderate	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. Mitigation is both feasible and fairly easily possible.
Low	Impact is of a low order and therefore likely to have little real effect. Mitigation is either easily achieved or little mitigation is required, or both.
No Impact	Zero Impact

Activities considered during the impact assessment are:

- Coal storage (seepage, habitat destruction, wind-blown coal dust)
- Ash dams (seepage, habitat destruction, wind-blown dust)
- Power Station (run-off, habitat destruction)

The phases considered are:

- Construction Impact
- Operational Phase Impact
- Residual/Remedial Risk

6.2 Description of Impact Mechanisms

A considerable development footprint will be caused by the construction of the power plant, coal storage facility and ash dams. In these areas the natural habitat will be completely removed with little or no chance of rehabilitation at a later stage. The seepage from ash dams or coal storage facilities to the surrounding areas and dust blowing from ash dams and coal storage facilities can be mitigated by putting certain procedures in place.

6.3 Development of Mitigation Measures

The quantitative accuracy and precision of impact predictions is particularly important for prescribing mitigation measures (DEAT, 2002). This is especially important for those impacts, pollutants or resources that require the setting of a site-specific discharge limit or need to be within legislated standards (DEAT, 2002). A common approach to describing mitigation measures for critical impacts is to specify a range of targets with predetermined acceptable range and an associated monitoring and evaluation plan (DEAT, 2002).

To ensure successful implementation, mitigation measures should be an unambiguous statement of actions and requirements that are practical to execute (DEAT, 2002). Table 16 summarizes the different approaches to prescribing and designing mitigation measures.

Table 16: Categories for prescribing and designing mitigation measures

Avoidance	Mitigation by not carrying out the proposed action.
Minimization	Mitigation by scaling down the magnitude of a development, reorienting the layout of the project or employing technology to limit the undesirable environmental impact.
Rectification	Mitigation through the restoration of environments affected by the action.
Reduction	Mitigation by taking maintenance steps during the course of the action.
Compensation	Mitigation through the creation, enhancement or acquisition of similar environments to those affected by the action.

6.4 Assessment of Potential Impacts

Table 17:X Alternative: Constructional and Operational Phase Impacts, Proposed Mitigation and Remedial Risk (SBM - significance before mitigation; SAM - significance after mitigation; L - low; M - moderate; H - high; P - probability; D - duration; SS – Spatial scale; Mag - Magnitude)

	Environmental Significance Score						
Current Impacts	**P**	**D**	**SS**	**Mag**	**TOTAL**		**Discussion and Recommended Mitigation**
CONSTRUCTIONAL PHASE							
Potential impacts on water quality due to construction activities, accidental spills	4 3	2 2	2 2	4 4	32 24	SBM M SAM L	For example, should any cement or aggregate reach the surface waters it could result in a temporary pH increase. This in turn will reduce availability of food for fish and invertebrates and induce physiological stress on aquatic fauna. This could affect sensitive species, thereby changing species diversity. This potential impact can be managed and mitigated by effective control of seepage and run-off. Seepage could be controlled by lining the ash dams, and placing the ash dams and coal stock piles clear from surface waters (at least not within the 1:100 year floodline). Run-off could be contained by placing cut-off berms around the ash dams and coal stock piles and containing any run-off water in a dam designed for this purpose.
Aquatic habitat degradation due to increased sedimentation.	4 3	2 2	2 2	4 4	32 24	SBM M SAM L	Increased turbidity and suspended solids in the receiving surface water systems could reduce light penetration, thereby reducing photosynthesis; reduce visibility for food, reduce availability of food, clogging of gill filaments and gillrakes, physical abrasion of delicate structures such as gills, reduce breeding success, reduce growth rate of fish and their resistance to disease, affect oxygen consumption, haematology and social behaviour of aquatic fauna and affect sensitive species, thereby changing species diversity. These impacts may be mitigated by keeping dust to a minimum (this may be done by keeping construction areas damp to reduce dust), and containment of run-off (by placing cut-off

							berms around the area of construction).
Potential impacts on terrestrial biota due to construction activities, accidental spills and seepage.	5 4	2 2	2 1	6 4	50 28	SBM M SAM L	Construction of the power generation plant, ash dam and coal storage facility will, by nature cause the destruction of a substantial amount of terrestrial habitat. Furthermore, habitat may be degraded by accidental spills during the construction phase of the power plant. Certain species of biota such as some birds, small mammals and reptiles may be affected by noise associated with construction. This potential impact can be managed and mitigated by effective control of seepage and run-off. Seepage could be controlled by lining the ash dams. Run-off could be contained by placing cut-off berms around the ash dams and coal stock piles and containing any run-off water in a dam designed for this purpose. Many of the impacts, such as habitat destruction and noise cannot be mitigated and it is advisable that the facilities are placed in areas so as to minimise the effects on sensitive areas and biota and that the spatial footprint be kept to a minimum.
Terrestrial habitat degradation due to increased dust blown from exposed soil, airborne pollutants and noise.	5 3	2 2	3 2	4 3	45 21	SBM M SAM L	Increased dust during the construction phase may cause the exacuation of the area by sensitive species or death of species of vegetation. Affected biota may include sensitive plant species, species of arthropod, bird and small mammal species. Noise may affect mainly small mammal species, bird species and some species of reptiles. These impacts may be mitigated by keeping dust to a minimum (this may be done by keeping construction areas damp to reduce dust. Other factors such as airborne pollution and noise are not easily mitigated and therefore it is advisable that the facilities are placed in areas so as to minimise the effects on sensitive areas and biota and that the spatial footprint be kept to a minimum.
Power station outlay: Loss of wetland units XVBC1 and XD1 with low integrity and low service provision	5 2	5 4	2 1	6 4	65 18	SBM H SAM	Construction of the power station over the wetland units will result in the destruction of this wetland type, the loss of its integrity as well as its services. Mitigation actions are limited to moving the outlay to minimize footprint area over the wetland see Figure 10. Mitigation will reduce impact and prevent loss of wetland units.

						L	
Coal stockpile outlay: Affect wetland units XHS1, XHSW2 and XVB2, with moderate integrity and low service provision	3 3	4 4	1 1	4 2	27 21	SBM L SAM L	Construction of the coal stockpile in the wetland unit's catchment will result in the loss of its integrity as well as its services. Mitigation actions are limited to moving the outlay to minimize footprint area over the wetland see Figure 10.
Ash Dam outlay: Loss of wetland unit XHSW1 and XVB1 with high integrity and high service provision	5 2	5 4	3 2	10 4	90 20	SBM H SAM L	Construction of the Ash Dam over the sensitive wetland types will result in the loss of a scarce wetland type the high integrity as well as the services provided by these wetland units. Mitigation actions are limited to moving the outlay to minimize footprint area affecting the wetland see Figure 10. Movement of the Ash Dam into a catchment of a more degraded wetland will reduce the overall impact of the Ash Dam. This site also provides for opportunities to mitigate and rehabilitate currently degraded wetlands.
Corridors for roads, railways, coal conveyors and pipelines	5 2	5 5	5 2	5 4	75 22	SBM H SAM L	Corridors for roads, railways, coal conveyors and pipelines will be impacting upon a number of wetland systems both in site X and Y as well as in areas outside the study area. Make it very difficult to assess the possible impacts. Impcts of dust, airborn pollution, waterborn pollution and spills durin the construction phase can be reduced by minimiseng the impact of the corridors on wetlands and other sensitive areas. Corridors should be routed so as to avoid wetlands and other sensitive areas as delineated in this reportConveyor belts should be kept
OPERATIONAL PHASE							
Potential impacts on water quality due to seepage and/or run-off from coal stock piles	4	4	2	6	48	SBM M	Impacts on water quality may have significant impacts on the aquatic ecology of the study area due to increased physiological stress on aquatic fauna. In severe cases aquatic fauna may be completely eliminated from the sample area and for some distance downstream. This potential impact can be managed and mitigated by effective control of seepage and run-

	3	4	2	4	30	<u>SAM</u> L	off. Seepage could be controlled by lining the ash dams, and placing the ash dams and coal stock piles clear from surface waters (at least not within the 1:100 year floodline). Run-off could be contained by placing cut-off berms around the ash dams and coal stock piles and containing any run-off water in a dam designed for this purpose.
Aquatic habitat degradation due to increased sedimentation.	4 3	4 4	2 2	6 4	48 30	<u>SBM</u> M <u>SAM</u> L	The addition of wind blown dust from ash dams may result in increased sediment levels in the aquatic ecosystems, resulting in loss of vital habitats due to smothering, increased turbidity levels and decreased photosynthesis as well as placing physiological stress on aquatic organisms. These impacts may be mitigated by keeping dust to a minimum and containment of run-off.
Potential impacts on terrestrial biota due to seepage and/or run-off from coal stock piles	3 2	4 4	2 2	5 4	36 20	<u>SBM</u> M <u>SAM</u> L	Impacts on water quality may have significant impacts on the terrestrial ecology of the study area due to increased stress on vegetation. In severe cases terrestrial vegetation may be completely eliminated from the sample area causing the elimination of animal specie that utilise that vegetation. This potential impact can be managed and mitigated by effective control of seepage and run-off. Seepage could be controlled by lining the ash dams, and placing the ash dams and coal stock piles in areas of least terrestrial biological diversity thereby reducing the potential effect of these impacts. Run-off could furthermore be contained by placing cut-off berms around the ash dams and coal stock piles and containing any run-off water in a dam designed for this purpose.
Terrestrial habitat degradation due to increased dust blown from exposed soil, airborne pollutants and noise.	4 3	2 2	3 2	5 3	40 21	<u>SBM</u> M <u>SAM</u> L	Increased dust during the construction phase may cause the exacuation of the area by sensitive species or death of species of vegetation. Affected biota may include sensitive plant species, species of arthropod, bird and small mammal species. Noise may affect mainly small mammal species, bird species and some species of reptiles. Airborne pollution and noise are not easily mitigated and therefore it is advisable that the facilities are placed in areas so as to minimise the effects on sensitive areas and biota and that the spatial footprint be kept to a minimum.

Corridors for roads, railways, coal conveyors and pipelines	5 2	5 5	5 2	5 4	75 22	SBM H SAM L	Corridors for roads, railways, coal conveyors and pipelines will be impacting upon a number of wetland systems both in site X and Y as well as in areas outside the study area. Make it very difficult to asses the possible impacts. Impcts can be reduced by minimiseng the impact of the corridors on wetlands. This can be done by making sure as little disturbance within the wetland takes place as possible. Pipelines should where possible be kept above ground, as buried pipelines crossing wetlands may impede subterranean hydrology. Alternatively corridors should be routed so as to avoid wetlands and other sensitive areas as delineated in this report.

Table 18:Y Alternative: Constructional and Operational Phase Impacts, Proposed Mitigation and Remedial Risk (SBM - significance before mitigation; SAM - significance after mitigation; L - low; M - moderate; H - high; P - probability; D - duration; SS – Spatial scale; Mag - Magnitude)

	Environmental Significance Score						
Current Impacts	**P**	**D**	**SS**	**Mag**	**TOTAL**		**Discussion and Recommended Mitigation**
CONSTRUCTIONAL PHASE							
Potential impacts on water quality due to construction activities, accidental spills	4 3	2 2	3 3	8 4	52 27	SBM M SAM L	For example, should any cement or aggregate reach the surface waters it could result in a temporary pH increase. This in turn will reduce availability of food for fish and invertebrates and induce physiological stress on aquatic fauna. This could affect sensitive species, thereby changing species diversity. Of special concern in this regard is the presence of the Shortspine suckermouth (*Chiloglanis pretoriae*) in the Wilge River is of special significance. This species is intolerant towards poor water quality and has specialized habitat requirements. It is dependent on flowing water habitats and has a preference for substrate

							cover (Skelton, 2001). Two specimens of this species were sampled in the upstream section of the Wilge River at site WR1. This species is extremely scarce in the upper Olifants River Catchment, and this may well be the last remaining population in this area. In addition, the SASS5 data indicated the surface waters to be affected by the Y alternative footprint to be of good biotic integrity (Class A/B). This potential impact can be managed and mitigated by effective control of seepage and run-off. Seepage could be controlled by lining the ash dams, and placing the ash dams and coal stock piles clear from surface waters (at least not within the 1:100 year floodline). Run-off could be contained by placing cut-off berms around the ash dams and coal stock piles and containing any run-off water in a dam designed for this purpose.
Aquatic habitat degradation due to increased sedimentation.	4 3	2 2	3 2	6 4	44 24	SBM M SAM L	Increased turbidity and suspended solids in the receiving surface water systems could reduce light penetration, thereby reducing photosynthesis; reduce visibility for food, reduce availability of food, clogging of gill filaments and gillrakes, physical abrasion of delicate structures such as gills, reduce breeding success, reduce growth rate of fish and their resistance to disease, affect oxygen consumption, haematology and social behaviour of aquatic fauna and affect sensitive species, thereby changing species diversity. The good biotic integrity of the concerned aquatic systems is of special significance in this regard. These impacts may be mitigated by keeping dust to a minimum (this may be done by keeping construction areas damp to reduce dust), and containment of run-off (by placing cut-off berms around the area of construction).
Potential impacts on terrestrial biota due to construction activities, accidental spills and seepage.	5 5	2 2	2 1	10 8	70 55	SBM H SAM M	Construction of the power generation plant, ash dam and coal storage facility will, by nature cause the destruction of a substantial amount of terrestrial habitat. Furthermore, habitat may be degraded by accidental spills during the construction phase of the power plant. Certain species of biota such as some birds, small mammals and reptiles may be affected by noise associated with construction. This potential impact can be managed and mitigated by effective control of seepage and run-off. Seepage could be controlled by lining the ash dams. Run-off could be contained by placing cut-off berms around the ash dams and coal stock piles and containing any run-off water in a dam designed for this purpose. Many of the impacts, such as habitat destruction and noise cannot be mitigated and it is advisable that the facilities are placed in

							areas so as to minimise the effects on sensitive areas and biota and that the spatial footprint be kept to a minimum.
Terrestrial habitat degradation due to increased dust blown from exposed soil, airborne pollutants and noise.	5 3	2 2	3 2	6 4	55 24	<u>SBM</u> M <u>SAM</u> <u>L</u>	Increased dust during the construction phase may cause the exacuation of the area by sensitive species or death of species of vegetation. Affected biota may include sensitive plant species, species of arthropod, bird and small mammal species. Noise may affect mainly small mammal species, bird species and some species of reptiles. These impacts may be mitigated by keeping dust to a minimum (this may be done by keeping construction areas damp to reduce dust. Other factors such as airborne pollution and noise are not easily mitigated and therefore it is advisable that the facilities are placed in areas so as to minimise the effects on sensitive areas and biota and that the spatial footprint be kept to a minimum.
Corridors for roads, railways, coal conveyors and pipelines	5 2	5 5	4 2	5 4	70 22	<u>SBM</u> H <u>SAM</u> L	Corridors for roads, railways, coal conveyors and pipelines will be impacting upon a number of wetland systems both in site X and Y as well as in areas outside the study area. Make it very difficult to asses the possible impacts. Impcts of dust, airborn pollution, waterborn pollution and spills durin the construction phase can be reduced by minimiseng the impact of the corridors on wetlands and other sensitive areas. Corridors should be routed so as to avoid wetlands and other sensitive areas as delineated in this reportConveyor belts should be kept
OPERATIONAL PHASE							
Potential impacts on water quality due to seepage and/or run-off from coal stock piles	4 3	4 4	3 3	6 6	52 39	<u>SBM</u> M <u>SAM</u> M	Impacts on water quality may have significant impacts on the aquatic ecology of the study area due to increased physiological stress on aquatic fauna. In severe cases aquatic fauna may be completely eliminated from the sample area and for some distance downstream. Of special concern in this regard is again the presence of the Shortspine suckermouth (*Chiloglanis pretoriae*) in the Wilge River. This species is intolerant towards poor water quality (Skelton, 2001). The current high biotic integrity of the Wilgespruit and Klipspruit in this area is also a cause for concern. This potential impact can be managed and mitigated by effective control of seepage and run-off. Seepage could be controlled by lining the ash dams, and placing the ash dams and coal stock piles clear

							from surface waters (at least not within the 1:100 year floodline). Run-off could be contained by placing cut-off berms around the ash dams and coal stock piles and containing any run-off water in a dam designed for this purpose.
Aquatic habitat degradation due to increased sedimentation.	4 3	4 4	3 2	6 4	52 30	SBM M SAM L	Addition of wind blown dust from the ash dam may result in increased sediment levels in the aquatic ecosystems, resulting in loss of vital habitats due to smothering, increased turbidity levels and decreased photosynthesis as well as placing physiological stress on aquatic organisms. These impacts may be mitigated by keeping dust to a minimum and containment of run-off.
Potential impacts on terrestrial biota due to seepage and/or run-off from coal stock piles	4 3	4 4	2 2	6 4	48 30	SBM M SAM L	Impacts on water quality may have significant impacts on the terrestrial ecology of the study area due to increased stress on vegetation. In severe cases terrestrial vegetation may be completely eliminated from the sample area causing the elimination of animal specie that utilise that vegetation. This potential impact can be managed and mitigated by effective control of seepage and run-off. Seepage could be controlled by lining the ash dams, and placing the ash dams and coal stock piles in areas of least terrestrial biological diversity thereby reducing the potential effect of these impacts. Run-off could furthermore be contained by placing cut-off berms around the ash dams and coal stock piles and containing any run-off water in a dam designed for this purpose.
Terrestrial habitat degradation due to increased dust blown from exposed soil, airborne pollutants and noise.	5 3	2 2	3 2	6 4	55 24	SBM M SAM L	Increased dust during the construction phase may cause the exacuation of the area by sensitive species or death of species of vegetation. Affected biota may include sensitive plant species, species of arthropod, bird and small mammal species. Noise may affect mainly small mammal species, bird species and some species of reptiles. These impacts may be mitigated by keeping dust to a minimum. Other factors such as airborne pollution and noise are not easily mitigated and therefore it is advisable that the facilities are placed in areas so as to minimise the effects on sensitive areas and biota and that the spatial footprint be kept to a minimum.

Power station outlay: Loss of wetland units YFP1 and YHSW 2,3 and 5 with moderate to high integrity; and high service provision.	5 4	5 5	4 3	8 8	85 64	<u>SBM</u> H <u>SAM</u> H	Construction of the power station over the Klipspruit will result in the destruction of this wetland type, the loss of its integrity as well as its services. Mitigation actions are limited to moving the outlay to minimize footprint area over the wetland see Figure 11. Mitigation will reduce impact but affect other wetlands thus no overall change
Coal stockpile outlay: Loss of wetland unit YHSW8 with moderate integrity and high service provision.	4 4	5 4	3 3	8 6	64 54	<u>SBM</u> H <u>SAM</u> M	Construction of the coal stockpile over the wetland unit will result in the loss of its integrity as well as its services. Mitigation actions are limited to moving the outlay to minimize footprint area over the wetland see Figure 11.
Ash Dam outlay: Loss of wetland unit YVBC1 with moderate integrity and high service provision	5 4	5 5	3 3	10 8	90 64	<u>SBM</u> H <u>SAM</u> H	Construction of the Ash Dam in the upper Wilge threatens the *Chiloglanis* population which is regarded as of specific importance given the scarcity of this fish in the upper Olifants River catchment. Construction of the ash dam will also result in the loss of the high integrity as well as the services provided by this section. Mitigation actions are limited to moving the outlay to minimize footprint area affecting the wetland see Figure 11. The proximity of the overall development still threatens the continued survival of this population in the headwaters of the Wilge despite moving the Ash Dam.
Corridors for roads, railways, coal conveyors and pipelines	5 2	5 5	3 2	5 4	65 22	<u>SBM</u> H <u>SAM</u>	Corridors for roads, railways, coal conveyors and pipelines will be impacting upon a number of wetland systems both in site X and Y as well as in areas outside the study area. Make it very difficult to asses the possible impacts. Impcts can be reduced by minimiseng the impact of the corridors on wetlands. This can be done by making sure as little disturbance within the wetland takes place as possible. Pipelines should where possible be kept above ground, as buried pipelines crossing

						L	wetlands may impede subterranean hydrology. Alternatively corridors should be routed so as to avoid wetlands and other sensitive areas as delineated in this report.

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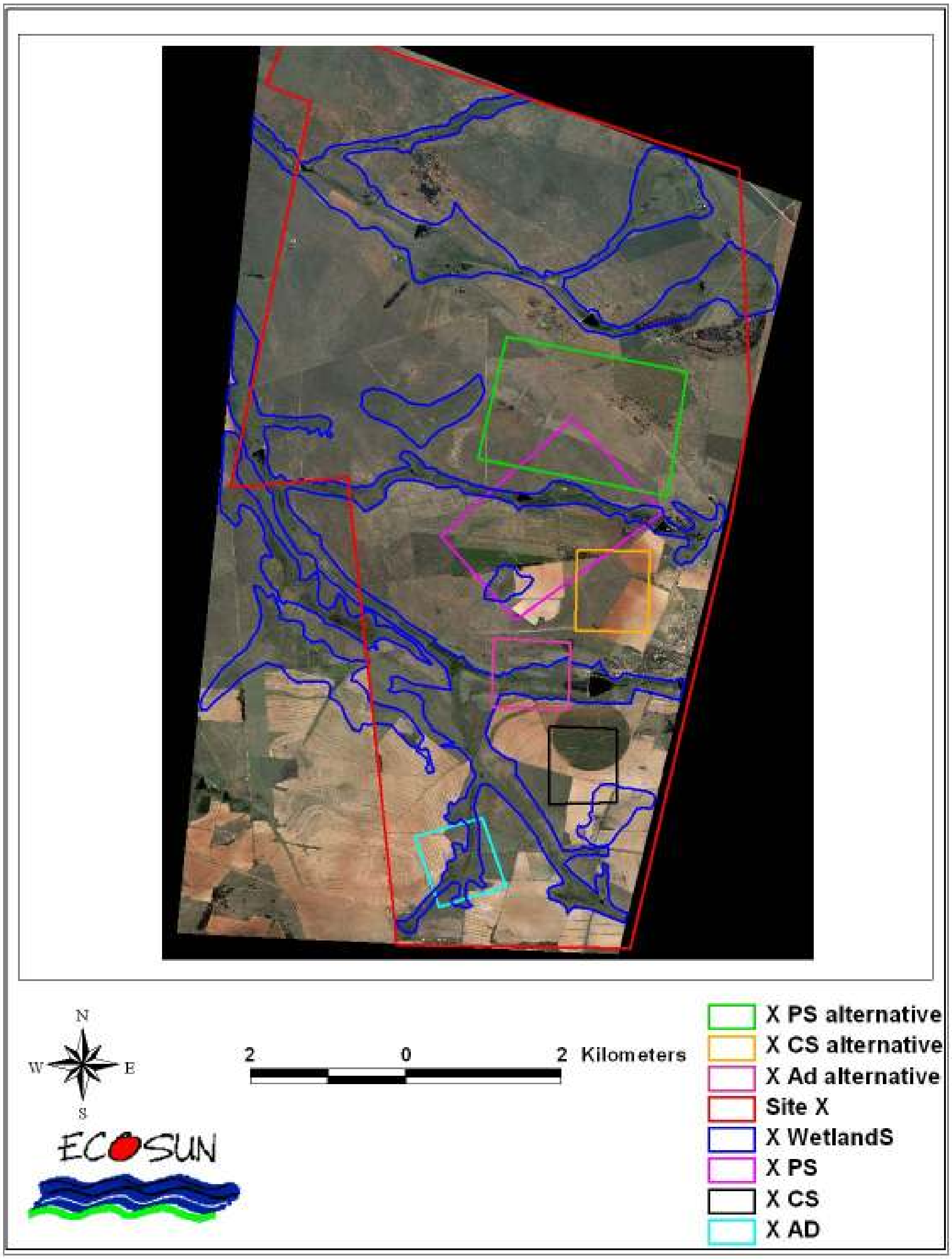

Figure 10: Present and alternate layouts for Site X

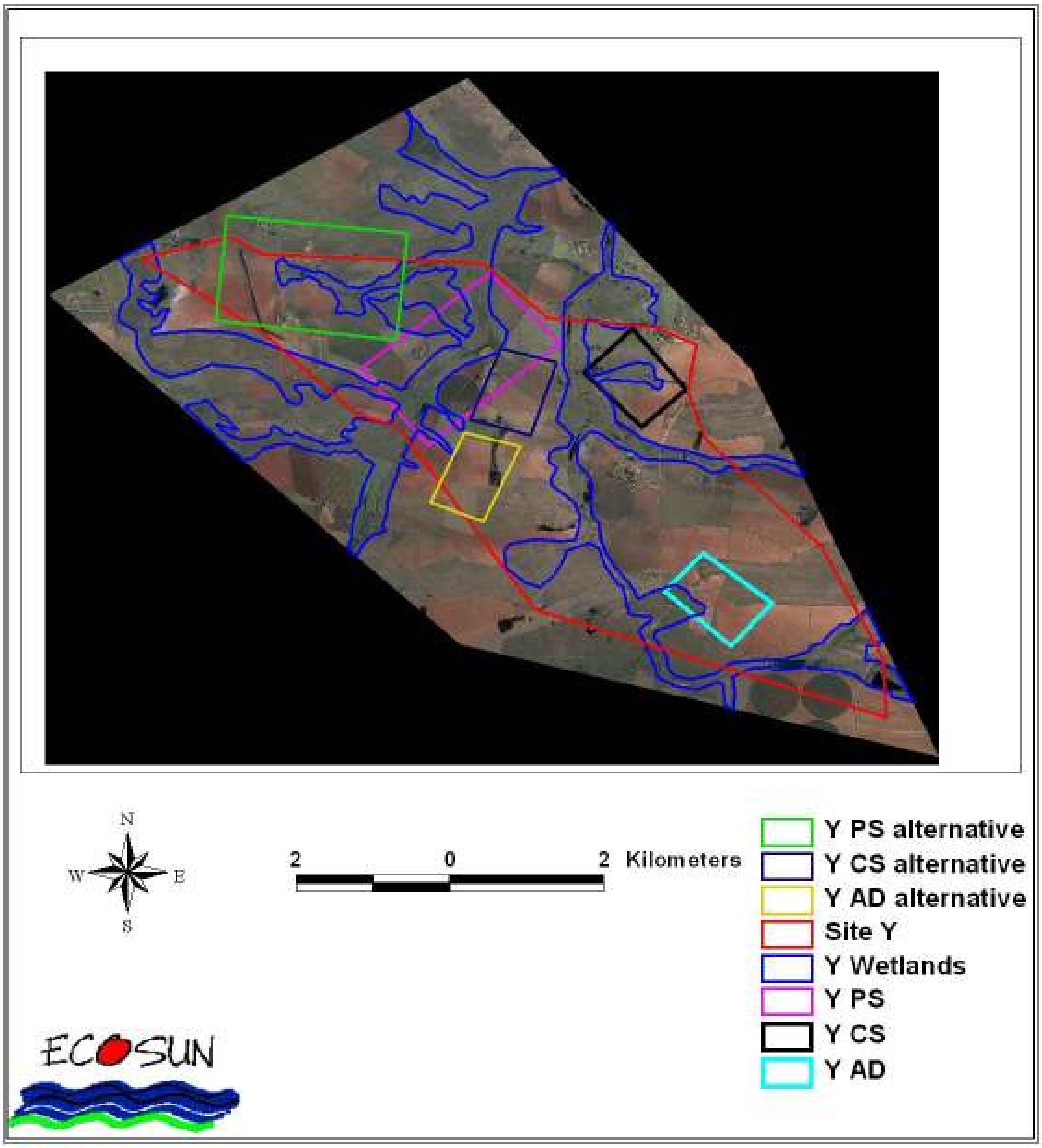

Figure 11: Present and alternate layouts for Site Y.

7 CONCLUSIONS

Site Y: The high biodiversity and biotic integrity (Class A/B, based on SASS5 scores) in the concerned sections of the Wilge River and Klipspruit is of specific significance. Fish species diversity and abundance in this area is also good with all expected species being sampled (i.e. the Chubbyhead barb *Barbus anoplus*, Banded tilapia *Tilapia sparrmanii* and the Southern Mouthbrooder *Pseudocrenilabrus philander*). In addition two specimens of the Shortspine suckermouth (*Chiloglanis pretoriae*) were sampled in the Wilge River (site WR1). The presence of this species is of special significance, since it is extremely scarce in the upper Olifants River Catchment. *Chiloglanis pretoriae* is intolerant towards poor water quality and has specialized habitat requirements. This high in-stream integrity as well as the high wetland integrity and service provision provides for an ecological template that is regarded as unsuitable for development.

Site X: The poor biotic integrity (Class E, based on SASS5 scores), low biodiversity and poor integrity associated with the site X option provides for a generally degraded section that (provided appropriate mitigation measures are implemented) will have a low impact on the Wilge River catchment and overall in the Olifants River upper catchment.

Corridors for pipelines, roads, railways and coal conveyors: The proposed corridors for transport to and from the power plants cross many wetland systems in both the case of site X and site Y. The number of systems traversed in site Y is, however slightly less than that of site X therefore indicating that the corridors should have less of an impact in site the case of site Y than site X. In order to mitigate these impacts it is suggested that the construction of the corridors as well as the route followed by these corridors should be planned in such a way as to minimised the impacts on wetlands An important method of mitigation would be to make sure that any construction in wetland areas be done so as to minimised disturbance of the pedology which would directly affect subterranean hydrology in wetland systems. (See Tables 17 and 18).

Based on above information, from an aquatic biota perspective, Site X would be the preferred option for the development of the proposed Coal Fired Power Station.

8 RECOMMENDATIONS

Conduct a detailed Rare and Endangered species survey as well as a wetland assessment focussing on the preferred layouts once these have been selected. It is of critical importance to conduct such a survey during the appropriate season.

The area outside of the study area of this study, but which will be directly impacted by transport corridors, should be investigated for possible serious impacts arising from the construction or operation of these transport corridors.

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APPENDIX 1

LIST OF AQUATIC MACRO INVERTEBRATES SAMPLED.

Taxon	Common Name	Sampling Site						
		WR1	WR2	KS1	KS2	KFS1	KFS2	KFS3
Turbellaria								
Planarians	Flatworms	A	B	A	A			
Annelida								
Oligochaeta	Segmented worms	1					A	1
Hirudinae								
	Leeches							
Crustacea								
Potamonautidae	Crabs	1	1		A			
	Shrimps							
Hydracarina	Water mites		A	A	A			
Ephemeroptera								
Polymitarcyidae	Pale Burrowers							
Baetidae 1sp	Small Minnow Mayflies					1		
Baetidae 2spp	Small Minnow Mayflies							A
Baetidae >2spp	Small Minnow Mayflies	B	C	C	C			
Heptageniidae	Flatheaded Mayflies	B						
Leptophlebiidae	Prongills	B	A	B	B			
Tricorythidae	Stout Crawlers							
Caenidae	Cainflies	B	B	B	B	A		
Odonata								
Lestidae	Damselflies							
Coenagrionidae	Damselflies	B	B	B	B			A
Gomphidae	Dragonflies				B	A	A	1
Aeshnidae	Dragonflies							
Corduliidae	Dragonflies							
Libellulidae	Dragonflies			1			A	A
Hemiptera								
Notonectidae	Backswimmers				A		A	
Pleidae	Pygmy backswimmers	B	A	A	A			

Naucoridae	Creeping Water Bugs							
Nepidae	Water scorpions					1		
Belostomatidae	Giant Water Bugs	B			B			A
Corixidae	Water Boatman	A				A	A	
Gerridae	Pond Skaters	A			A			
Veliidae	Ripple bugs	A			A		B	A
Trichoptera								
Hydropsychidae 1spp	Caddis flies							
Hydropsychidae 2spp	Caddis flies				A			
Hydropsychidae > 2spp	Caddis flies	B	B	B				
Other case larvae	Caddis larvae							
Coleoptera								
Dytiscidae	Predacious Diving Beetles	B	A	A	A	A		A
Elmidae	Riffle Beetles	A	1	1				
Gyrinidae	Whirligig Beetles	B	A	B	A	A		
Haliplidae	Crawling Water Beetles	A			A			
Hydraenidae	Minute Moss Beetles	A	A		A		A	A
Helodidae	Marsh Beetles			A				
Hydrophilidae	Water Scavenger Beetles		A		1			
Diptera								
Culicidae	Mosquitoes	A	1	A	A	1		A
Chironomidae	Midges	A	A	B	A	B	A	A
Dixidae	Dixid midge						A	
Ceratopogonidae	Biting Midges	A	A	A	A			
Simuliidae	Black flies	A	A	B	A			A
Tabanidae	Horse flies							
Tipulidae	Crane flies	A	1					
Muscidae	House flies/Stable flies	A						
Gastropoda								
Planorbidae	Orb snails	A						A
Physidae	Pouch snails							
Lymnaeidae	Pond snails							

Corbiculidae				1				
Ancylidae	Limpets	A	1		1			
Pelecypoda								
Unionidae	Perly mussels				1			
Sphaeridae	Clams	1						
Number of Taxa		**28**	**20**	**18**	**25**	**10**	**10**	**13**
% Air Breathers		**46**	**40**	**28**	**48**	**50**	**60**	**46**
BIOTOPE SCORES								
SIC		98	81	81	94	0	0	0
G,S,Mud and SOOC		53	57	45	66	0	26	19
Vegetation (MV & or AV)		75	84	69	73	38	26	46

Key: * Not present; SIC = Stones in current; SOOC = Stones out of current; MV = Marginal vegetation; AV = Aquatic vegetation

APPENDIX 2

LIST OF EXPECTED GRASS SPECIES

Common Name	**Biological Name**
Red grass	*Themeda triandra*
Broad leaved turpentine grass	*Cymbopogon excavatus.*
Narrow leaved turpentine grass	*Cymbopogon plurinodis*
Common thatching grass	*Hyparrhenia hirta*
Fine thatching grass	*Hyparrhenia filipendula*
Yellow thatching grass	*Hyperthelia dissolute*
Spear grass	*Heteropogon contortus*
One finger grass	*Digitaria monodactyla*
sickle grass	*Ctenium concinnum*
Blue buffalo grass	*Cenchrus ciliais*
Tassel three awn	*Aristida congesta* subsp. congesta
bur bristle grass	*Setaria verticillata*
Annual three awn	*Aristida adscensionis*
Bottlebrush Grass	*Enneapogon scoparius*
Shade erharta	*Ehrfarta erecta*
Pale three awn	*Aristida canescens*
Wether love grass	*Eragrostis nindensis*
Narrow heart love grass	*Eragrostis racemosa*
Bristle leaved red top	*Melinis nerviglumis*
Hairy love grass	*Eragrostis trichophora*
curly leaf	*Eragrostis rigidor*
gum grass	*Eragrostis gummiflua*
Small panicum	*Panicum ecklonii*
natal panicum	*Panicum natalense*
Natal Red Top	*Melinis repens*
Stink love grass	*Eragrostis cilianensis*
Dew grass	*Eragrostis obtusa*
Footpath love grass	*Eragrostis pseudosclerantha*
Lehmann's love grass	*Eragrostis lehmanniana*
Iron grass	*Aristida diffusa*
Purple three awn	*Aristida scabrivalvis*
Common wild oats	*Avena fatua*
annual blue grass	*Poa annua*
narrow curly leaf	*Eragrostis chloromelas*
weeping love grass	*Eragrostis curvula*
small buffalo grass	*Panicum colloratum*
Munnik fescue	*Festuca scabra*
spreading three awn	*Aristida congesta* subsp. *Barbicollis*
broom needle grass	*Triraphis andropogonoides*
tough love grass	*Eragrostis plana*
Catstail dropseed	*Sporobolus pyramidalis*
Olive dropseed	*Sporobolus centrifugus*
herringbone grass	*Pogonarthria squarrosa*
brown seed finger grass	*Digitaria diagonalis*
False love grass	*Bewsia biflora*
Goose grass	*Eleusine coracana*
Pinhole grass	*Bothriochloa insculpta*

Silver finger grass	*Digitaria argyrograpta*
Purple finger grass	*Digitaria tricholaenoides*
Black seed finger grass	*Digitaria ternata*
Crab finger grass	*Digitaria sanguinalis*
Feather top chloris	*Chloris virgata*
Black seed grass	*Alloteropsis semialata*
brown Rhodes grass	*Eustachys paspaloides*
Broad leaved bluestem	*Diheteropogon amplectens*
Broad leaved bluestem	*Diheteropogon filifolius*
Stab grass	*Andropogon schirensis*
Large silver andropogon	*Andropogon huillensis*
Giant turpentine grass	*Cymbopogon validus*
Red Autumn grass	*Schizachyrium sanguineum*
Giant spear grass	*Trachypogon spicatus*
Pincushion grass	*Microchloa cafra*
Perennial rye grass	*Lolium perenne*
Common bristle grass	*Setaria sphacelata*
Ratstail dropseed	*Sporobolus africanus*
Hairy trident grass	*Tristachya leucothrix*
Gongoni three awn	*Aristida junciformis*
common russet grass	*Loudetia simplex*
tite grass	*Eragrostis inamoena*
River grass	*Arundinella nepalensis*
jungle rice	*Echinochloa colona*
small rolling grass	*Trichoneura grandiglumis*
common finger grass	*Digitaria eriantha*
Couch grass	*Cynodon dactylon*
veld paspalum	*Paspalum scrobiculatum*
common signal grass	*Brachiaria brizantha*
Garden uruchloa	*Urucloa panicoides*
sweet signal grass	*Brachiaria eruciformis*
velvet signal grass	*Brachiaria serrata*
Snowflake grass	*Andropogon eucomus*
Swamp couch	*Hemarthria altissima*
Thunberg's Pennisetum	*Pennisetum thunbergii*
Riverbed grass	*Pennisetum macrourum*
Vlei bristle grass	*Setaria incrassata*
Stiburus	*Stiburus alopecuroides*
Cottonwool grass	*Imperata cylindrical*
Small oats grass	*Helictotrichon turgidulum*
Heartseed lovegrass	*Eragrostis capensis*
Rescue grass	*Bromus catharticus*
dropseed grass	*Sporobolus fimbriatus*
sweet grass	*Panicum schinzii*
Red dropseed	*Sporobolus festivus*
rolling grass	*Aristida bipartita*
Bronze love grass	*Eragrostis heteromera*
Common wild sorghum	*Sorghum bicolor*
Common reed	*Phragmites australis*
Couch panicum	*Panicum repens*
Bent grass	*Agrostis lachnantha*
Rice grass	*Leersa hexandra*

wireleaf daba grass	*Miscanthus junceus*
swamp grass	*Diplachne fusca*
Vasey grass	*Paspalum urvillei*
Hippo grass	*Ischaemum fasciculatum*
Turf grass	*Ischaemum afrum*
vlei bluestem	*Andropogon appendiculatus*
Rhodes grass	*Chloris gayana*
Water couch	*Paspalum distichum*
Dallis grass	*Paspalum dilatatum*
Nile grass	*Acroceras macrum*
Kikuyu	*Pennisetum clandestinum*

APPENDIX 3

LIST OF RECORDED GRASS SPECIES

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wireleaf daba grass	*Miscanthus junceus*
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Vasey grass	*Paspalum urvillei*
Hippo grass	*Ischaemum fasciculatum*
Turf grass	*Ischaemum afrum*
vlei bluestem	*Andropogon appendiculatus*
Rhodes grass	*Chloris gayana*
Water couch	*Paspalum distichum*
Dallis grass	*Paspalum dilatatum*
Nile grass	*Acroceras macrum*
Kikuyu	*Pennisetum clandestinum*

APPENDIX 4

LIST OF EXPECTED TREE SPECIES

Biological Name	**Common Name**
Aloe marlothii	Mountain Aloe
Cussonia paniculata	Highveld Cabbage Tree
Cussonia spicata	Common Cabbage Tree
Tarchonanthuscamphoratus	Wild Camphor Bush
Kiggelaria africana	Wild peach
Salix mucronata	Cape Willow
Solanum mauritianum	Bug tree
Solanum giganteum	Healing leaf tree
Gymnosporia buxifolia	Common spike thorn
Scolopia zeyheri	Thorn pear
Chrysanthemoides monilifera	Bush thick berry
Cassine transvaalensis	Transvaal saffron
Maytenus undata	Koko tree
Myrsine africana	Cape myrtle
Rhamnus rinoides	Dogwood
Salix babylonica	Weeping willow
Ilex mitis	Cape holly
Ehretia rigida	Puzzle bush
Diospyros lycioides	Blue bush
Diospyros whyteana	Bladder nut
Clutea pulchella	Common lightning bush
Protea caffra	Common sugarbush
Protea roupelliae	Sliver sugarbush
Ziziphus mucronata	Buffalo thorn
Grewia flava	Raisin bush
Grewia occidentalis	Cross berry
Celtis africana	White stinkwood
Buddleja salviifolia	Sagewood
Pavetta gardeniifolia	Common brides bush
Cassinopsis ilicifolia	Lemon thorn
Halleria lucida	Tree fuschia
Carissa bispinosa	Forest num-num
Buddleja saligna	False olive
Combretum molle	Velvet bushwillow
Euclea undulata	common guarrie
Olea europea subsp. Africana	Wild olive
Olinia emarginata	Mountain hard pear
Scutia myrtina	Cat thorn
Rhoicissus tridentata	Bushman grape
Rhus dentata	Nana berry
Rhus lancea	Karee
Rhus pyroides	Common wild currant
Leucosidea sericea	Oldwood
Heteromorpha trifoliata	Parsley tree
Acacia karroo	Sweet thorn

APPENDIX 5

LIST OF RECORDED TREE SPECIES

Common Name	**Biological Name**
Common spike thorn	*Gymnosporia buxifolia*
Thorn pear	*Scolopia zeyheri*
Weeping willow	*Salix babylonica*
Velvet bushwillow	*Combretum molle*
Karee	*Rhus lancea*
Sweet thorn	*Acacia karroo*

APPENDIX 6

LIST OF EXPECTED BIRD SPECIES

Roberts No.	Biological Name	Common Name
1	*Struthio camelus*	Ostrich
6	*Crested Podiceps cristatus*	Grebe Great
7	*Podiceps nigricollis*	Grebe Blacknecked
8	*Tachybaptus ruficollis*	Dabchick
55	*Phalacrocorax carbo*	Cormorant Whitebreasted
58	*Phalacrocorax africanus*	Cormorant Reed
60	*Anhinga rufa*	Darter
62	*Ardea cinerea*	Heron Grey
63	*Ardea melanocephala*	Heron Blackheaded
64	*Ardea goliath*	Heron Goliath
65	*Ardea purpurea*	Heron Purple
66	*Casmerodius albus*	Egret Great White
67	*Egretta garzetta*	Egret Little
68	*Mesophoyx intermedia*	Egret Yellowbilled
69	*Egretta ardesiaca*	Egret Black
71	*Bubulcus ibis*	Egret Cattle
72	*Ardeola ralloides*	Heron Squacco
74	*Butorides striatus*	Heron Greenbacked
76	*Nycticorax nycticorax*	Heron Blackcrowned Night
78	*Ixobrychus minutus*	Bittern Little
81	*Scopus umbretta*	Hamerkop
83	*Ciconia ciconia*	Stork White
84	*Ciconia nigra*	Stork Black
85	*Ciconia abdimii*	Stork Abdim's
89	*Leptoptilos crumeniferus*	Stork Marabou
90	*Mycteria ibis*	Stork Yellowbilled
91	*Threskiornis aethiopicus*	Ibis Sacred
92	*Geronticus calvus*	Ibis Southern Bald
93	*Plegadis falcinellus*	Ibis Glossy
94	*Bostrychia hagedash*	Ibis Hadeda
95	*Platalea alba*	Spoonbill African
96	*Phoenicopterus ruber*	Flamingo Greater
97	*Phoenicopterus minor*	Flamingo Lesser
99	*Dendrocygna viduata*	Duck Whitefaced
100	*Dendrocygna bicolor*	Duck Fulvous
101	*Thalassornis leuconotus*	Duck Whitebacked
102	*Alopochen aegyptiacus*	Goose Egyptian
103	*Tadorna cana*	Shelduck South African
104	*Anas undulata*	Duck Yellowbilled
105	*Anas sparsa*	Duck African Black
106	*Anas capensis*	Teal Cape
107	*Anas hottentota*	Teal Hottentot
108	*Anas erythrorhyncha*	Teal Redbilled
112	*Anas smithii*	Shoveller Cape
113	*Netta erythrophthalma*	Pochard Southern
114.1	*Anas platyrhynchos*	Mallard
115	*Sarkidiornis melanotos*	Duck Knobbilled
116	*Plectropterus gambensis*	Goose Spurwinged

117	*Oxyura maccoa*	Duck Maccoa
118	*Sagittarius serpentarius*	Secretarybird
122	*Gyps coprotheres*	Vulture Cape
126	*Milvus migrans*	Kite Black
126.1	*Milvus aegyptius*	Kite Yellowbilled
127	*Elanus caeruleus*	Kite Blackshouldered
128	*Aviceda cuculoides*	Hawk Cuckoo
130	*Pernis apivorus*	Buzzard Honey
131	*Aquila verreauxii*	Eagle Black
136	*Hieraaetus pennatus*	Eagle Booted
138	*Hieraaetus ayresii*	Eagle Ayres'
140	*Polemaetus bellicosus*	Eagle Martial
142	*Circaetus cinereus*	Eagle Brown Snake
143	*Circaetus pectoralis*	Eagle Blackbreasted Snake
148	*Haliaeetus vocifer*	Eagle African Fish
149	*Buteo buteo*	Buzzard Steppe
152	*Buteo rufofuscus*	Buzzard Jackal
156	*Accipiter ovampensis*	Sparrowhawk Ovambo
157	*Little Accipiter minullus*	Sparrowhawk
158	*Accipiter melanoleucus*	Sparrowhawk Black
159	*Accipiter badius*	Goshawk Little Banded
161	*Micronisus gabar*	Goshawk Gabar
164	*Circus aeruginosus*	Harrier Eurasian Marsh
165	*Circus ranivorus*	Harrier African Marsh
166	*Circus pygargus*	Harrier Montagu's
167	*Circus macrourus*	Harrier Pallid
168	*Circus maurus*	Harrier Black
169	*Polyboroides typus*	Gymnogene
170	*Pandion haliaetus*	Osprey
171	*Falco peregrinus*	Falcon Peregrine
172	*Falco biarmicus*	Falcon Lanner
173	*Falco subbuteo*	Falcon Northern Hobby
179	*Falco vespertinus*	Kestrel Western Redfooted
180	*Falco amurensis*	Kestrel Eastern Redfooted
181	*Falco tinnunculus*	Kestrel Rock
182	*Falco rupicoloides*	Kestrel Greater
183	*Falco naumanni*	Kestrel Lesser
188	*Francolinus coqui*	Francolin Coqui
189	*Francolinus sephaena*	Francolin Crested
192	*Francolinus levaillantii*	Francolin Redwing
193	*Francolinus levaillantoides*	Francolin Orange River
196	*Francolinus natalensis*	Francolin Natal
199	*Francolinus swainsonii*	Francolin Swainson's
200	*Coturnix coturnix*	Quail Common
201	*Coturnix delegorguei*	Quail Harlequin
203	*Numida meleagris*	Guineafowl Helmeted
205	*Turnix sylvatica*	Buttonquail Kurrichane
208	*Anthropoides paradiseus*	Crane Blue
210	*Rallus caerulescens*	Rail African
211	*Crex crex*	Corncrake
212	*Crex egregia*	Crake African
213	*Amaurornis flavirostris*	Crake Black

215	*Porzana pusilla*	Crake Baillon's
217	*Sarothrura rufa*	Flufftail Redchested
223	*Porphyrio porphyrio*	Gallinule Purple
226	*Gallinula chloropus*	Moorhen Common
228	*Fulica cristata*	Coot Redknobbed
231	*Neotis denhami*	Bustard Stanley's
233	*Eupodotis senegalensis*	Korhaan Whitebellied
234	*Eupodotis caerulescens*	Korhaan Blue
239.1	*Eupodotis afraoides*	Korhaan Whitewinged
240	*Actophilornis africanus*	Jacana African
242	*Rostratula benghalensis*	Snipe Painted
245	*Charadrius hiaticula*	Plover Ringed
247	*Charadrius pallidus*	Plover Chestnutbanded
248	*Charadrius pecuarius*	Plover Kittlitz's
249	*Charadrius tricollaris*	Plover Threebanded
255	*Vanellus coronatus*	Plover Crowned
258	*Vanellus armatus*	Plover Blacksmith
260	*Vanellus senegallus*	Plover Wattled
264	*Tringa hypoleucos*	Sandpiper Common
265	*Tringa ochropus*	Sandpiper Green
266	*Tringa glareola*	Sandpiper Wood
269	*Tringa stagnatilis*	Sandpiper Marsh
270	*Tringa nebularia*	Greenshank
272	*Calidris ferruginea*	Sandpiper Curlew
274	*Calidris minuta*	Stint Little
284	*Philomachus pugnax*	Ruff
286	*Gallinago nigripennis*	Snipe Ethiopian
287	*Limosa limosa*	Godwit Blacktailed
294	*Recurvirostra avosetta*	Avocet Pied
295	*Himantopus himantopus*	Stilt Blackwinged
297	*Burhinus capensis*	Dikkop Spotted
300	*Temminck's Cursorius temminckii*	Courser
305	*Glareola nordmanni*	Pratincole Blackwinged
313	*Larus fuscus*	Gull Lesser Blackbacked
315	*Larus cirrocephalus*	Gull Greyheaded
322	*Sterna caspia*	Tern Caspian
338	*Chlidonias hybridus*	Tern Whiskered
339	*Chlidonias leucopterus*	Tern Whitewinged
348	*Columba livia*	Pigeon Feral
349	*Columba guinea*	Pigeon Rock
350	*Columba arquatrix*	Pigeon Rameron
352	*Streptopelia semitorquata*	Dove Redeyed
354	*Streptopelia capicola*	Dove Cape Turtle
355	*Streptopelia senegalensis*	Dove Laughing
356	*Oena capensis*	Dove Namaqua
366	*Psittacula krameri*	Parakeet Roseringed
373	*Corythaixoides concolor*	Lourie Grey
374	*Cuculus canorus*	Cuckoo Eurasian
377	*Cuculus solitarius*	Cuckoo Redchested
378	*Cuculus clamosus*	Cuckoo Black
380	*Clamator glandarius*	Cuckoo Great Spotted

381	*Oxylophus levaillantii*	Cuckoo Striped
382	*Oxylophus jacobinus*	Cuckoo Jacobin
385	*Chrysococcyx klaas*	Cuckoo Klaas's
386	*Chrysococcyx caprius*	Cuckoo Diederik
391	*Centropus burchellii*	Coucal Burchell's
392	*Tyto alba*	Owl Barn
393	*Tyto capensis*	Owl Grass
395	*Asio capensis*	Owl Marsh
397	*Otus leucotis*	Owl Whitefaced
398	*Glaucidium perlatum*	Owl Pearlspotted
400	*Bubo capensis*	Owl Cape Eagle
401	*Bubo africanus*	Owl Spotted Eagle
402	*Bubo lacteus*	Owl Giant Eagle
404	*Caprimulgus europaeus*	Nightjar Eurasian
405	*Caprimulgus pectoralis*	Nightjar Fierynecked
406	*Caprimulgus rufigena*	Nightjar Rufouscheeked
408	*Caprimulgus tristigma*	Nightjar Freckled
411	*Apus apus*	Swift Eurasian
412	*Apus barbatus*	Swift Black
415	*Apus caffer*	Swift Whiterumped
416	*Apus horus*	Swift Horus
417	*Apus affinis*	Swift Little
418	*Tachymarptis melba*	Swift Alpine
421	*Cypsiurus parvus*	Swift Palm
424	*Colius striatus*	Mousebird Speckled
426	*Urocolius indicus*	Mousebird Redfaced
428	*Ceryle rudis*	Kingfisher Pied
429	*Megaceryle maxima*	Kingfisher Giant
430	*Alcedo semitorquata*	Kingfisher Halfcollared
431	*Alcedo cristata*	Kingfisher Malachite
433	*Halcyon senegalensis*	Kingfisher Woodland
435	*Halcyon albiventris*	Kingfisher Brownhooded
437	*Halcyon chelicuti*	Kingfisher Striped
438	*Merops apiaster*	Bee-eater Eurasian
443	*Merops bullockoides*	Bee-eater Whitefronted
444	*Merops pusillus*	Bee-eater Little
446	*Coracias garrulus*	Roller Eurasian
451	*Upupa africana*	Hoopoe African
452	*Phoeniculus purpureus*	Woodhoopoe Redbilled
464	*Lybius torquatus*	Barbet Blackcollared
465	*Tricholaema leucomelas*	Barbet Pied
470	*Pogoniulus chrysoconus*	Barbet Yellowfronted Tinker
473	*Trachyphonus vaillantii*	Barbet Crested
474	*Indicator indicator*	Honeyguide Greater
476	*Indicator minor*	Honeyguide Lesser
478	*Prodotiscus regulus*	Honeyguide Sharpbilled
486	*Dendropicos fuscescens*	Woodpecker Cardinal
487	*Thripias namaquus*	Woodpecker Bearded
489	*Jynx ruficollis*	Wryneck Redthroated
492	*Mirafra cheniana*	Lark Melodious
494	*Mirafra africana*	Lark Rufousnaped
495	*Mirafra apiata*	Lark Clapper

496	*Mirafra rufocinnamomea*	Lark Flappet
498	*Mirafra sabota*	Lark Sabota
500	*Mirafra curvirostris*	Lark Longbilled
506	*Chersomanes albofasciata*	Lark Spikeheeled
507	*Calandrella cinerea*	Lark Redcapped
508	*Spizocorys conirostris*	Lark Pinkbilled
509	*Spizocorys fringillaris*	Lark Botha's
515	*Eremopterix leucotis*	Finchlark Chestnutbacked
518	*Hirundo rustica*	Swallow Eurasian
520	*Hirundo albigularis*	Swallow Whitethroated
523	*Hirundo dimidiata*	Swallow Pearlbreasted
524	*Hirundo semirufa*	Swallow Redbreasted
526	*Hirundo cucullata*	Swallow Greater Striped
527	*Hirundo abyssinica*	Swallow Lesser Striped
528	*Hirundo spilodera*	Swallow South African Cliff
529	*Hirundo fuligula*	Martin Rock
530	*Delichon urbica*	Martin House
532	*Riparia riparia*	Martin Sand
533	*Riparia paludicola*	Martin Brownthroated
534	*Riparia cincta*	Martin Banded
541	*Dicrurus adsimilis*	Drongo Forktailed
545	*Oriolus larvatus*	Oriole Blackheaded
547	*Corvus capensis*	Crow Black
548	*Corvus albus*	Crow Pied
554	*Parus niger*	Tit Southern Black
560	*Turdoides jardineii*	Babbler Arrowmarked
568	*Pycnonotus barbatus*	Bulbul Blackeyed
576	*Turdus libonyanus*	Thrush Kurrichane
577	*Turdus olivaceus*	Thrush Olive
580	*Psophocichla litsitsirupa*	Thrush Groundscraper
581	*Monticola rupestris*	Rockthrush Cape
582	*Monticola explorator*	Rockthrush Sentinel
586	*Oenanthe monticola*	Chat Mountain
587	*Oenanthe pileata*	Wheatear Capped
589	*Cercomela familiaris*	Chat Familiar
593	*Thamnolaea cinnamomeiventris*	Chat Mocking
595	*Myrmecocichla formicivora*	Chat Anteating
596	*Saxicola torquata*	Stonechat
601	*Cossypha caffra*	Robin Cape
619	*Sylvia borin*	Warbler Garden
620	*Sylvia communis*	Whitethroat
621	*Parisoma subcaeruleum*	Titbabbler
625	*Hippolais icterina*	Warbler Icterine
628	*Acrocephalus arundinaceus*	Warbler Great Reed
631	*Acrocephalus baeticatus*	Warbler African Marsh
633	*Acrocephalus palustris*	Warbler Eurasian Marsh
634	*Acrocephalus schoenobaenus*	Warbler Eurasian Sedge
635	*Acrocephalus gracilirostris*	Warbler Cape Reed
637	*Chloropeta natalensis*	Warbler Yellow
638	*Bradypterus baboecala*	Warbler African Sedge

643	*Phylloscopus trochilus*	Warbler Willow
645	*Apalis thoracica*	Apalis Barthroated
651	*Sylvietta rufescens*	Crombec Longbilled
661	*Sphenoeacus afer*	Grassbird
664	*Cisticola juncidis*	Cisticola Fantailed
665	*Cisticola aridulus*	Cisticola Desert
666	*Cisticola textrix*	Cisticola Cloud
667	*Cisticola ayresii*	Cisticola Ayres'
670	*Cisticola lais*	Cisticola Wailing
672	*Cisticola chinianus*	Cisticola Rattling
677	*Cisticola tinniens*	Cisticola Levaillant's
679	*Cisticola aberrans*	Cisticola Lazy
681	*Cisticola fulvicapillus*	Neddicky
683	*Prinia subflava*	Prinia Tawnyflanked
685	*Prinia flavicans*	Prinia Blackchested
689	*Muscicapa striata*	Flycatcher Spotted
694	*Melaenornis pammelaina*	Flycatcher Black
695	*Bradornis mariquensis*	Flycatcher Marico
698	*Sigelus silens*	Flycatcher Fiscal
706	*Stenostira scita*	Flycatcher Fairy
710	*Terpsiphone viridis*	Flycatcher Paradise
711	*Motacilla aguimp*	Wagtail African Pied
713	*Motacilla capensis*	Wagtail Cape
714	*Motacilla flava*	Wagtail Yellow
716	*Anthus cinnamomeus*	Pipit Grassveld
717	*Anthus similis*	Pipit Longbilled
718	*Anthus leucophrys*	Pipit Plainbacked
719	*Anthus vaalensis*	Pipit Buffy
720	*Anthus lineiventris*	Pipit Striped
726	*Tmetothylacus tenellus*	Pipit Golden
727	*Macronyx capensis*	Longclaw Orangethroated
731	*Lanius minor*	Shrike Lesser Grey
732	*Lanius collaris*	Shrike Fiscal
733	*Lanius collurio*	Shrike Redbacked
735	*Corvinella melanoleuca*	Shrike Longtailed
736	*Laniarius ferrugineus*	Boubou Southern
739	*Laniarius atrococcineus*	Boubou Crimsonbreasted
743	*Tchagra australis*	Tchagra Threestreaked
744	*Tchagra senegala*	Tchagra Blackcrowned
746	*Telophorus zeylonus*	Bokmakierie
758	*Acridotheres tristis*	Myna Indian
759	*Spreo bicolor*	Starling Pied
760	*Creatophora cinerea*	Starling Wattled
761	*Cinnyricinclus leucogaster*	Starling Plumcoloured
764	*Lamprotornis nitens*	Starling Glossy
769	*Onychognathus morio*	Starling Redwinged
775	*Nectarinia famosa*	Sunbird Malachite
779	*Nectarinia mariquensis*	Sunbird Marico
785	*Nectarinia afra*	Sunbird Greater Doublecollared
787	*Nectarinia talatala*	Sunbird Whitebellied
792	*Nectarinia amethystina*	Sunbird Black

796	*Zosterops pallidus*	White-eye Cape
799	*Plocepasser mahali*	Sparrowweaver Whitebrowed
801	*Passer domesticus*	Sparrow House
803	*Passer melanurus*	Sparrow Cape
804	*Greyheaded Passer diffusus*	Sparrow Southern
805	*Petronia superciliaris*	Sparrow Yellowthroated
807	*Amblyospiza albifrons*	Weaver Thickbilled
811	*Ploceus cucullatus*	Weaver Spottedbacked
813	*Ploceus capensis*	Weaver Cape
814	*Ploceus velatus*	Weaver Masked
820	*Anomalospiza imberbis*	Finch Cuckoofinch
821	*Quelea quelea*	Quelea Redbilled
824	*Euplectes orix*	Bishop Red
826	*Euplectes afer*	Bishop Golden
827	*Euplectes capensis*	Widow Yellowrumped
828	*Euplectes axillaris*	Widow Redshouldered
829	*Euplectes albonotatus*	Widow Whitewinged
831	*Euplectes ardens*	Widow Redcollared
832	*Euplectes progne*	Widow Longtailed
834	*Pytilia melba*	Finch Melba
840	*Lagonosticta rubricata*	Firefinch Bluebilled
842	*Lagonosticta senegala*	Firefinch Redbilled
846	*Estrilda astrild*	Waxbill Common
847	*Estrilda erythronotos*	Waxbill Blackcheeked
852	*Ortygospiza atricollis*	Finch Quail
854	*Sporaeginthus subflavus*	Waxbill Orangebreasted
855	*Amadina fasciata*	Finch Cutthroat
856	*Amadina erythrocephala*	Finch Redheaded
857	*Spermestes cucullatus*	Mannikin Bronze
860	*Vidua macroura*	Whydah Pintailed
862	*Vidua paradisaea*	Whydah Paradise
864	*Vidua funerea*	Widowfinch Black
867	*Vidua chalybeata*	Widowfinch Steelblue
869	*Serinus mozambicus*	Canary Yelloweyed
870	*Serinus atrogularis*	Canary Blackthroated
872	*Serinus canicollis*	Canary Cape
878	*Serinus flaviventris*	Canary Yellow
881	*Serinus gularis*	Canary Streakyheaded
884	*Emberiza flaviventris*	Bunting Goldenbreasted
885	*Emberiza capensis*	Bunting Cape
886	*Emberiza tahapisi*	Bunting Rock
887	*Emberiza impetuani*	Bunting Larklike

APPENDIX 7

LIST OF RECORDED BIRD SPECIES

Roberts No.	Common Name	Biological Name
58	Cormorant Reed	*Phalacrocorax africanus*
60	Darter	*Anhinga rufa*
62	Heron Grey	*Ardea cinerea*
66	Egret Great White	*Casmerodius albus*
71	Egret Cattle	*Bubulcus ibis*
81	Hamerkop	*Scopus umbretta*
91	Ibis Sacred	*Threskiornis aethiopicus*
93	Ibis Glossy	*Plegadis falcinellus*
94	Ibis Hadeda	*Bostrychia hagedash*
95	Spoonbill African	*Platalea alba*
102	Goose Egyptian	*Alopochen aegyptiacus*
127	Kite Blackshouldered	*Elanus caeruleus*
193	Francolin Orange River	*Francolinus levaillantoides*
196	Francolin Natal	*Francolinus natalensis*
199	Francolin Swainson's	*Francolinus swainsonii*
200	Quail Common	*Coturnix coturnix*
203	Guineafowl Helmeted	*Numida meleagris*
208	Crane Blue	*Anthropoides paradiseus*
233	Korhaan Whitebellied	*Eupodotis senegalensis*
234	Korhaan Blue	*Eupodotis caerulescens*
242	Snipe Painted	*Rostratula benghalensis*
248	Plover Kittlitz's	*Charadrius pecuarius*
255	Plover Crowned	*Vanellus coronatus*
258	Plover Blacksmith	*Vanellus armatus*
260	Plover Wattled	*Vanellus senegallus*
284	Ruff	*Philomachus pugnax*
286	Snipe Ethiopian	*Gallinago nigripennis*
297	Dikkop Spotted	*Burhinus capensis*
300	Courser Temminck's	*Cursorius temminckii*
349	Pigeon Rock	*Columba guinea*
354	Dove Cape Turtle	*Streptopelia capicola*
355	Dove Laughing	*Streptopelia senegalensis*
356	Dove Namaqua	*Oena capensis*
393	Owl Grass	*Tyto capensis*
428	Kingfisher Pied	*Ceryle rudis*
451	Hoopoe African	*Upupa africana*
494	Lark Rufousnaped	*Mirafra africana*
495	Lark Clapper	*Mirafra apiata*
496	Lark Flappet	*Mirafra rufocinnamomea*
498	Lark Sabota	*Mirafra sabota*
500	Lark Longbilled	*Mirafra curvirostris*
506	Lark Spikeheeled	*Chersomanes albofasciata*
507	Lark Redcapped	*Calandrella cinerea*
526	Swallow Greater Striped	*Hirundo cucullata*
527	Swallow Lesser Striped	*Hirundo abyssinica*
548	Crow Pied	*Corvus albus*
568	Bulbul Blackeyed	*Pycnonotus barbatus*
586	Chat Mountain	*Oenanthe monticola*
587	Wheatear Capped	*Oenanthe pileata*

589	Chat Familiar	*Cercomela familiaris*
595	Chat Anteating	*Myrmecocichla formicivora*
664	Cisticola Fantailed	*Cisticola juncidis*
665	Cisticola Desert	*Cisticola aridulus*
677	Cisticola Levaillant's	*Cisticola tinniens*
681	Neddicky	*Cisticola fulvicapillus*
698	Flycatcher Fiscal	*Sigelus silens*
713	Wagtail Cape	*Motacilla capensis*
727	Longclaw Orangethroated	*Macronyx capensis*
731	Shrike Lesser Grey	*Lanius minor*
732	Shrike Fiscal	*Lanius collaris*
746	Bokmakierie	*Telophorus zeylonus*
759	Starling Pied	*Spreo bicolor*
760	Starling Wattled	*Creatophora cinerea*
803	Sparrow Cape	*Passer melanurus*
814	Weaver Masked	*Ploceus velatus*
824	Bishop Red	*Euplectes orix*
826	Bishop Golden	*Euplectes afer*
828	Widow Redshouldered	*Euplectes axillaris*
829	Widow Whitewinged	*Euplectes albonotatus*
846	Waxbill Common	*Estrilda astrild*
847	Waxbill Blackcheeked	*Estrilda erythronotos*
862	Whydah Paradise	*Vidua paradisaea*
870	Canary Blackthroated	*Serinus atrogularis*

APPENDIX 8

LIST OF EXPECTED MAMMAL SPECIES

Biological Name	**Common Name**
Chrysopalax villosus	Rough haired Golden Mole
Amblysomus hottentotus	Hottentot Golden Mole
Elephantulus myurus	Rock Elephant Shrew
Myosorex varius	Forest Shrew
Crocidura mariquensis	Swamp Musk Shrew
Crocidura cyanea	Reddish-grey Musk Shrew
Crocidura hirta	Lesser Red Musk Shrew
Nycteris thebiaca	Egyptian Slit-faced Bat
Rhinolophus clivosus	Geoffreys Horseshoe Bat
Miniopterus schreibersii	Schriebers Long-fingered Bat
Eptesicus capensis	Cape serotine Bat
Myotis tricolor	Temmincks Hairy Bat
Tadarida aegyptica	Egyptian Free-taled Bat
Lepus saxatilis	Scrub Hare
Graphiurus murinus	Woodland Dormouse
Graphiurus parvus	Lesser Savanna Dormouse
Cryptomus hottentotus	Common Molerat
Hystrix africaeaustralis	Porcupine
Dendromus melatonis	Grey Climbing Mouse
Dendromus mystacalis	Chestnut Climbing Mouse
Tatera leucogaster	Bushveld Gerbil
Tatera brantsii	Highveld Gerbil
Aethomys namaquensis	Namaqua Rock Mouse
Aethomys chrysophilus	Red Veld Rat
Dasymys incomtus	Water Rat
Rhabdomys pumilio	Striped Mouse
Mus minutoides	Pygmy mouse
Mus musculus	House mouse
Thallomys paeduculus	Tree mouse
Mastomys coucha/natalensis	(Natal) Multimammate Mouse
Rattus rattus	House Rat
Otomys angoniensis	Angoni Vlei Rat
Otomys irroratus	Vlei Rat
Aonyx capensis	Cape Clawless Otter
Lutra maculicollis	Spotted-necked Otter
Poecilogale albinucha	Striped Weasel
Ictonyx striatus	Striped Polecat
Galerella sanguinea	Slender Mongoose
Atilax paludinosus	Water Mongoose
Ichneumia albicauda	White-tailed Mongoose
Cynictis penicillata	Yellow Mongoose
Genetta genetta	Small-spotted Genett
Genetta tigrina	Large-spotted Genett
Felis lybica	African Wild Cat
Procavia capensis	Rock Dassie (Hyrax)

APPENDIX 9

LIST OF RECORDED MAMMAL SPECIES

Common Name	Biological Name
Hottentot Golden Mole	*Amblysomus hottentotus*
Scrub Hare	*Lepus saxatilis*
Woodland Dormouse	*Graphiurus murinus*
Porcupine	*Hystrix africaeaustralis*
Striped Mouse	*Rhabdomys pumilio*
Vlei Rat	*Otomys irroratus*
Cape Clawless Otter	*Aonyx capensis*
Spotted-necked Otter	*Lutra maculicollis*
White-tailed Mongoose	*Ichneumia albicauda*
Yellow Mongoose	*Cynictis penicillata*

APPENDIX 10

LIST OF EXPECTED AMPHIBIAN SPECIES

Common Name	**Biological Name**
Common Platanna	*Xenopis laevis*
Bubblin Kassina	*Kassina senegalensis*
Giant Bullfrog	*Pyxicephalus adspersus*
Tremelo Sand Frog	*Tomopterna cryptotis*
Natal Sand Frog	*Tomopterna natalensis*
Raucous Toad	*Bufo rangeri*
Guttural Toad	*Bufo gutturalis*
Red Toad	*Schismaderma carens*
Striped River Frog	*Strongylopus fasciatus*
Common River Frog	*Afrana angolensis*
Common Caco	*Cacosternum boettgeri*
Snoring Puddle Frog	*Phrynobatrachus natalensis*

APPENDIX 11

LIST OF RECORDED AMPHIBIAN SPECIES

Common Name	Biological Name
Guttural Toad	*Bufo gutturalis*
Striped River Frog	*Strongylopus fasciatus*
Common River Frog	*Afrana angolensis*
Common Caco	*Cacosternum boettgeri*

APPENDIX 12

LIST OF EXPECTED REPTILE SPECIES

Common Name	Biological Name
Marsh Terrapin	*Pelomedusa subrufa*
Bibrons Blind Snake	*Typhlops bibronii*
Delalandes Blinde Snake	*Typhlops lalandei*
Cape Thread Snake	*Leptotyplops conjunctus*
Peters Thread Snake	*Leptotyplops scutifrons*
Common Brown Water Snake	*Lycodonomorphus rufulus*
Brown House Snake	*Lamprophis fuliginosus*
Aurora house Snake	*Lamprophis aurora*
Cape Wolf Snake	*Lycophidion capense*
Common Slug Eater	*Duberria lutrix*
Mole Snake	*Pseudaspis cana*
Rhombic Skaapsteker	*Psammophylaxrhombeatus*
Montane Grass Snake	*Psamorphis crucifer*
Cape Centipede Eater	*Aparallactus lunulatus*
Spotted Harlequin Snake	*Homoroselaps lecteus*
Striped Herlequin Snake	*Homoroselaps dorsalis*
Green Water Snake	*Philothanus hoplogaster*
Natal Green Snake	*Philothanus natalensis*
Rhombic Egg Eater	*Dasypeltis scabra*
Herald Snake	*Crotaphopeltis hotamboeia*
Sundevalls Garter Snake	*Elapsoidea sundevallii*
Rinkhals	*Hemachatus haemachatus*
Rhombic Night Adder	*Causus rhombeatus*
Puffadder	*Bitis arietans*
Cape Skink	*Mabuya capensis*
Striped Skink	*Mabuya striata*
Variable Skink	*Mabuya varia*
Yellow-throated Plate Lizard	*Gerrhosaurus flavigularis*
Transvaal Grass Lizard	*Chammaesaura aenea*
Transvaal Girdled Lizard	*Cordylus tropidosternum*
Rock Monitor	*Varanus exanthematicus*
Nile Monitor	*Varanus niloticus*
Rock Agama	*Agama aculeata*
Cape Gecko	*Pachydactylus capensis*

APPENDIX 13

LIST OF RECORDED REPTILE SPECIES

Common Name	**Biological Name**
Puffadder	*Bitis arietans*
Cape Skink	*Mabuya capensis*
Striped Skink	*Mabuya striata*
Rock Agama	*Agama aculeata*

APPENDIX 14

SERVICES SCORES FOR WETLAND UNITS

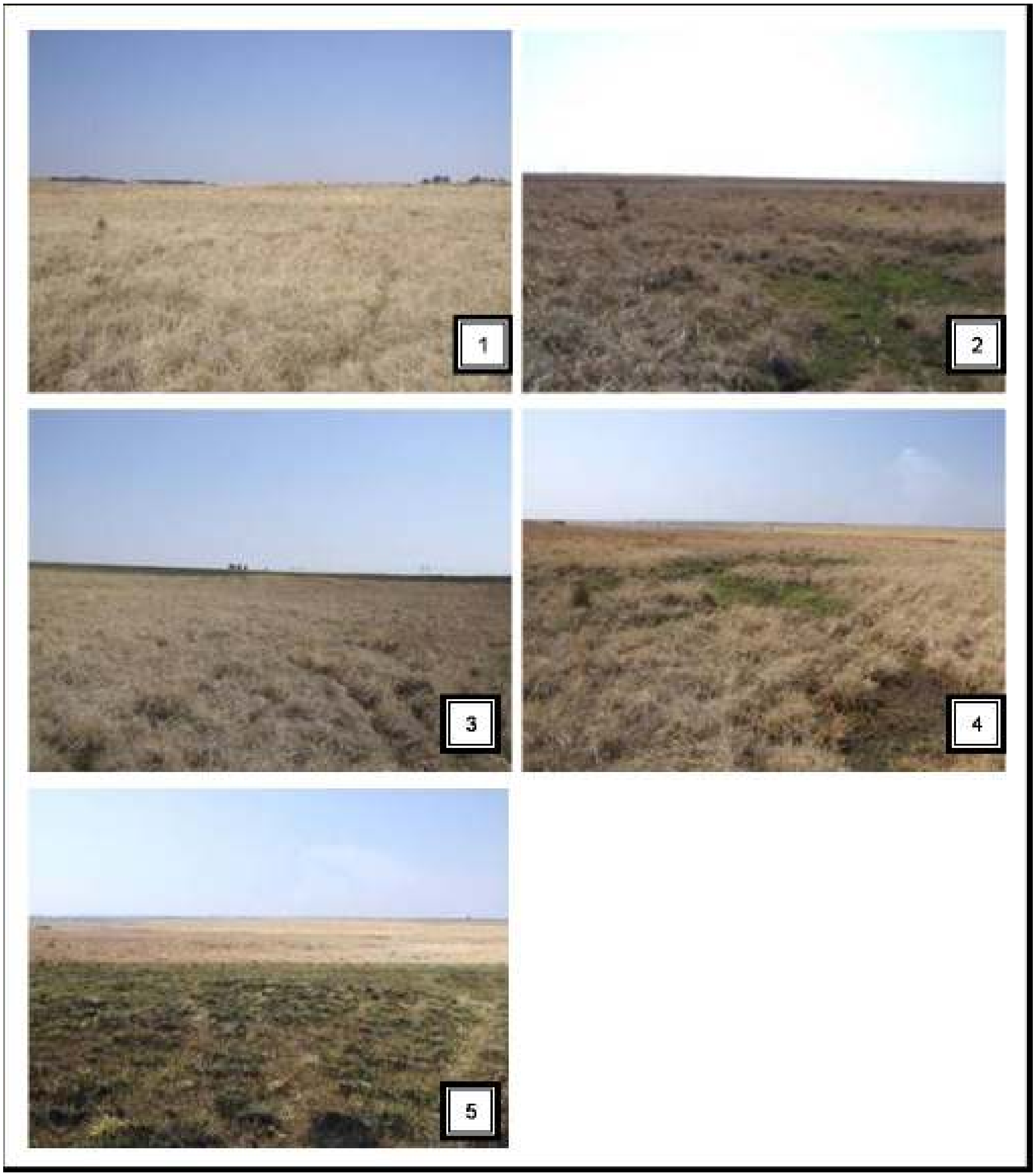
	YFP1		YVB1		YCHSW1		YVBC1		YVBC2		YHSW8	
Servives	Score	Confidence	**Score**	**Confidence**	**Score**	**Confidence**	**Score**	**Confidence**	**Score**	**Confidence**	**Score**	**Confidence**
Flood attenuation	1.8	2.8	1.4	2.7	1.8	2.7	2.1	2.9	1.8	2.9	1.4	3.0
Streamflow regulation	2.5	3.2	2.2	3.0	2.3	3.2	2.5	3.2	2.3	3.2	2.7	3.2
Sediment trapping	3.0	3.0	2.9	2.9	2.0	3.0	3.2	3.0	2.5	3.3	2.5	2.8
Phospahte trapping	2.2	2.5	2.2	3.1	2.3	3.0	2.9	3.2	3.0	3.4	2.7	2.9
Nitrate removal	1.7	2.5	2.8	2.3	2.5	3.0	1.7	3.2	2.8	3.2	3.5	3.0
Toxicant removal	2.1	2.9	2.3	2.7	2.0	3.0	2.4	3.2	2.7	3.2	2.9	2.9
Erosion control	2.2	2.7	2.5	2.4	2.1	2.7	2.1	3.1	2.0	3.0	2.1	2.9
Carbon storage	1.7	2.7	1.0	2.3	1.7	3.0	1.3	3.0	1.7	3.0	2.3	3.0
Maintenance of biodiversity	1.8	2.8	1.8	2.7	2.8	3.2	4.0	3.2	1.9	3.2	2.4	3.0
Water supply for human use	1.4	3.2	1.2	2.8	0.9	2.0	2.8	3.5	1.6	3.0	1.4	3.0
Natural resources	2.0	3.6	2.2	3.4	0.8	3.6	1.6	3.2	1.2	3.4	0.6	3.4
Cultivated foods	1.0	3.6	1.4	3.2	0.8	2.4	1.4	3.4	1.2	3.0	0.6	3.0
Cultural significance	0.0	3.0	0.0	3.0	0.0	3.0	0.0	3.8	0.0	3.3	0.0	3.0
Tourism and recreation	1.0	2.4	0.9	2.6	0.6	3.4	2.7	3.4	0.6	3.0	0.6	3.0
Education and research	1.5	3.3	1.5	3.3	1.0	3.0	2.0	3.5	1.5	3.3	1.3	3.3
Threats	3.0	3.0	3.0	2.0	3.0	3.0	3.0	4.0	3.0	3.0	3.0	3.0
Opportunities	2.0	3.0	1.0	2.0	0.0	3.0	3.0	4.0	2.0	3.0	2.0	3.0

	YHSW5		**XD1**		**XVBC1**		**XHS1**		**XVB1**		**XVB2**	
Servives	**Score**	**Confidenc e**	**Score**	**Confidenc e**	**Score**	**Confidenc e**	**Score**	**Confidenc e**	**Score**	**Confidenc e**	**Score**	**Confidenc e**
Flood attenuation	1.8	2.9	2.3	1.8	1.8	2.5	2.2	2.8	1.8	3.0	1.9	2.9
Streamflow regulation	2.5	3.2	2.0	3.0	2.2	3.2	2.0	3.0	2.7	3.2	2.0	3.0
Sediment trapping	2.2	2.8	2.2	2.8	2.8	3.0	3.2	2.9	2.9	3.0	2.2	3.0
Phospahte trapping	2.1	2.9	2.6	2.8	2.4	3.0	2.6	3.0	2.1	3.0	2.1	2.8

Nitrate removal	3.3	3.2	1.2	3.0	1.8	3.0	2.5	2.8	3.0	3.0	1.8	2.8
Toxicant removal	2.5	2.9	1.6	2.8	1.9	3.0	2.7	2.8	2.8	3.0	2.2	2.8
Erosion control	2.4	3.0	1.8	2.1	2.1	3.0	1.6	3.1	2.4	3.0	2.3	3.0
Carbon storage	2.7	3.0	0.0	3.0	1.0	3.0	0.7	3.0	2.3	3.0	1.3	2.7
Maintenance of biodiversity	3.5	3.0	1.3	3.0	1.3	3.0	0.5	3.1	2.2	3.0	1.6	3.0
Water supply for human use	1.6	3.0	0.3	3.0	2.0	3.0	2.0	3.2	1.4	3.0	1.0	2.8
Natural resources	0.6	3.0	0.6	3.0	1.4	3.0	0.8	3.8	0.8	3.0	0.4	2.8
Cultivated foods	0.0	3.0	0.2	3.0	1.2	3.0	1.4	3.0	0.8	3.2	1.0	3.0
Cultural significance	0.0	3.0	0.0	3.0	0.0	3.0	0.0	3.0	0.0	3.0	0.0	3.0
Tourism and recreation	0.3	3.2	0.4	3.0	1.4	3.0	0.0	4.0	0.7	3.0	0.4	3.0
Education and research	1.0	3.0	0.0	3.0	0.8	3.0	0.3	3.5	1.0	3.0	1.0	3.0
Threats	3.0	3.0	3.0	3.0	4.0	3.0	4.0	4.0	3.0	3.0	3.0	3.0
Opportunities	1.0	3.0	1.0	3.0	3.0	3.0	0.0	4.0	3.0	3.0	1.0	3.0

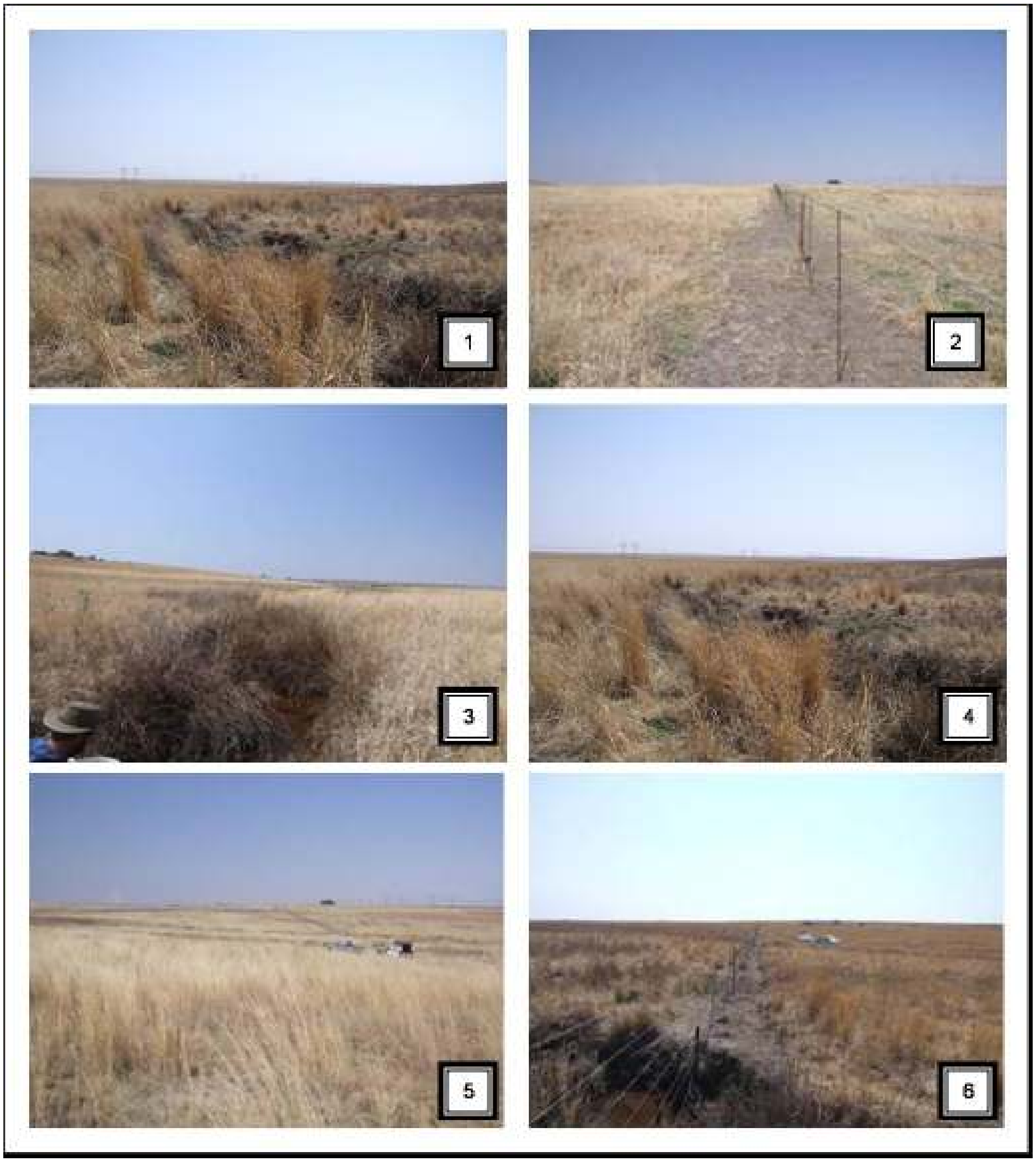
APPENDIX 15

SAMPLE SITE PHOTOGRAPHS



Site XHFSAD: 1) Left hand bank, 2) Right hand bank, 3) Upstream, 4) Downstream, 5) Valley.

Site XKFSDS: 1) Left hand bank, 2) Right hand bank, 3) Upstream, 4) Downstream.



Site XKFSCSAD: 1) Left hand bank, 2) Right hand bank, 3) Upstream, 4) Downstream, 5) Valley, 6) Transverse.

Site XPSPAN: 1) Left hand bank, 2) Right hand bank.

Site XKFSPS: 1) Upstream, 2) Downstream, 3) Valley, 4) Transverse.

Site XKSDS: 1) Left hand bank, 2) Right hand bank, 3) Upstream, 4) Downstream, 5) Valley,

Site YKSUS: 1) Left hand bank, 2) Right hand bank, 3) Upstream, 4) Downstream, 5) Valley, 6) Transverse,

Site YKWRDS: 1) Left hand bank, 2) Right hand bank, 3) Upstream, 4) Downstream, 5) Valley, 6) Transverse.

Site YWRUS: 1) Left hand bank, 2) Right hand bank, 3) Upstream, 4) Downstream.

APPENDIX 16

ESKOM KENDAL WETLAND DELINEATION SOIL SURVEY

VILJOEN & ASSOCIATES