MAREETSANE BATHO-BATHO SOLAR PV FACILITY
Wetland Assessment

SEF Reference No. 504744

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Declaration of Independence

I, **Willem Lubbe,** in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998);
- Have and will not have vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998);
- Will provide the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not;
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member;
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement; and
- Undertake to have my work peer reviewed on a regular basis by a competent specialist in the field of study for which I am registered.

___________________________	07 June 2013
Willem Lubbe *Cand. Sci. Nat.*	**Date**
Wetland specialist	
SACNASP Reg. No. 100064/08	

EXECUTIVE SUMMARY

Strategic Environmental Focus (Pty) Ltd, as independent environmental practitioners and ecological specialists, was appointed by Kgatelopele Private Equity and Venture Capital (Pty) Ltd to undertake a wetland delineation and functional assessment for the proposed 30MW Mareetsane Batho-Batho Solar PV Facility site and associated alternative powerline corridors in the North West Province, South Africa.

Three (3) alternative powerline routes are being considered. The wetland assessment covered a 400m corridor surrounding each powerline alternative, 200m on either side of the centre line, which will make provision for any ‘shifting’ of pylon positions at the final stages of the project.

The terms of reference for the current study were as follows:

- Delineate and classify wetland and riparian areas within the study area;
- Determine the Present Ecological State (PES) as well as the Ecological Importance and Sensitivity (EIS) of the identified wetlands within the study area; and
- Identify possible impacts and mitigation measures of proposed activities associated with wetlands within the study area.

The four main wetland indicators used during the wetland delineation process included the terrain unit indicator, soil wetness indicator, and the presence or absence of hydric soils and hydrophytes. Five hydro-geomorphic types were delineated within the study area and classified into thirty separate hydro-geomorphic units. These included valley-bottom wetlands without a channel, valley-bottom wetlands with a channel, hillslope seepage wetlands that were connected to a watercourse, hillslope seepage wetlands that were not connected to a watercourse, and depressions.

From a functional perspective, wetlands within the study area serve to improve habitat within and downstream of the study area through the provision of various ecosystem services, such as streamflow regulation, flood attenuation, groundwater recharge, nitrogen removal, phosphate removal, toxicant removal, particle assimilation and provision of natural resources including habitat for a variety of taxa. Each wetland’s ability to contribute to ecosystem services within the study area is further dependant on the particular wetland’s PES in relation to a benchmark or reference condition. Results of the Wet-Health Assessment indicated that the PES for wetlands within the study area ranged from being moderately modified with some loss of natural habitat, to being seriously modified with an extensive loss of natural habitat and associated functional attributes. An EIS assessment was undertaken to rank associated wetlands in terms of provision of goods and services or valuable ecosystem functions which benefit people, biodiversity support and ecological value, and reliance of subsistence users (especially basic human needs uses). The moderate to low EIS assigned to the various wetlands was attributed primarily to the loss of functionality as a result of land use practices, especially cultivation and grazing.

Based on the current and proposed activities and taking into consideration the present state of the wetlands and their associated functionality and biodiversity, several potential impacts on wetlands were identified. As a result, several measures are recommended to be

undertaken to limit impacts on the associated wetlands. From a wetland perspective, two alternative routes are recommended in order to effectively align powerline routes with existing linear infrastructure. The southern section of the Solar PV Facility should preferably not be developed unless a sensitive stormwater management could be developed that would ensure similar or improved site drainage and run-off characteristics to the receiving environment.

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1. INTRODUCTION

With South Africa being a contracting party to the Ramsar Convention on Wetlands, the South African government has taken a keen interest in the conservation, sustainable utilisation and rehabilitation of wetlands in South Africa. This aspect is also reflected in various pieces of legislation controlling development in and around wetlands and other water resources, of which the most prominent may be the National Water Act, 1998 (Act No. 36 of 1998) (NWA).

As South Africa is an arid country, with a mean annual rainfall of only 450mm in relation to the world average of 860mm (DWAF, 2003), water resources and the protection thereof becomes critical to ensure their sustainable utilisation. Wetlands perform various important functions related to water quality, flood attenuation, stream flow augmentation, erosion control, biodiversity, harvesting of natural resources, and others, highlighting their importance as an irreplaceable habitat type. Determining the location and extend of existing wetlands, as well as evaluating the full scope of their ecosystem services, form an essential part in striving towards sustainable development and protection of water resources.

1.1 Project Description

Strategic Environmental Focus (Pty) Ltd, as independent environmental practitioners and ecological specialists, was appointed by Kgatelopele Private Equity and Venture Capital (Pty) Ltd to undertake a wetland delineation and functional assessment for the proposed 30MW Mareetsane Batho-Batho Solar PV Facility site and associated powerline route/s in the North West Province, South Africa.

Three alternative powerline routes are being considered. The wetland assessment covered a 400m corridor surrounding each line alternative, 200m on either side of the centre line, which will make provision for any ‘shifting’ of pylon positions at the final stages of the project

1.2 Terms of Reference

The terms of reference for the current study were as follows:

- Delineate and classify wetland and riparian areas within the study area;
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- Identify possible impacts and mitigation measures of proposed activities associated with wetlands within the study area.

1.3 Assumptions and Limitations

In order to obtain definitive data regarding the biodiversity, hydrology and functioning of particular wetlands, studies should ideally be conducted over a number of seasons and over a number of years. The current study relied on information gained during a four day field survey conducted during a single season, desktop information for the area, information obtained from provincial conservation authorities, as well as professional judgement and experience. Delineations of wetlands were dependent on the extrapolation of data obtained during field surveys and from interpretation of orthophotos and other imagery. The potential for errors in delineating boundaries therefore exists as it would be impractical and expensive to verify each wetland boundary in totality. Further, the disturbed nature associated with historic land use practices throughout large sections of the study area made delineations of seepage areas difficult.

1.4 Methodology

The field surveys were undertaken on the 9th and the 10th of April and the 21st to the 23rd of May 2013. The wetland delineation was based on the legislatively required methodology as described by the Department of Water Affairs (2005). In order to gauge the PES of wetlands within the study area, a Level 2 Wet-Health assessment (Macfarlane *et al*., 2008) was applied in order to assign PES categories to identified wetlands. For a more comprehensive study approach and specific methodologies employed during the current study, see Appendix A.

2. BACKGROUND INFORMATION

2.1 Locality

The study area is located within the Ngaka Modiri Molema District Municipality in the North West Province, approximately 40 km south-west of the town of Mafikeng and falls under the jurisdiction of the Ratlou Local Municipality. The study area lies within Quarter Degree Grid Cell (QDGC) 2625AB between 26°07’03” – 26°14’16” South and 25°14’47” – 25°24’45” East (Figure 1).

2.2 Biophysical description

Climate

The region receives approximately 520 mm of rain per year, with rainfall occurring mainly in summer. The region receives the lowest rainfall in July and the highest in January. The average midday temperature ranges from 20°C in June and July to 35°C in December and January. The region is the coldest in June and July when the temperature drops to 2°C on average during the night. Frost occurs frequently in winter (Mucina & Rutherford, 2006)

Regional Vegetation

The study site is located within two biomes namely Grassland and Savanna. The Grassland Biome (Rutherford & Westfall, 1994) is characterized by high summer rainfall and dry winters. Frequent frost during the winter nights as well as marked diurnal temperature variations is unfavourable for tree growth resulting in the Grassland Biome consisting mainly of grasses and plants with perennial underground storage organs, such as bulbs and tubers. A large number of Rare and Threatened plant species in the summer rainfall regions of South Africa are restricted to high-rainfall grasslands, making this the vegetation type in most urgent need of conservation. Frost, fire and grazing within grasslands maintain the herbaceous grass and forb layer and prevent the establishment of thickets (Tainton, 1999). Fire is a natural disturbance caused by lightning, and natural fires (or controlled burning every 3 years or so) is therefore essential for maintaining the structure and biodiversity of this biome. However, if prevented due to activities such as agriculture and mining, thicket forming tree or alien species eventually dominate the natural vegetation and place an additional burden on already scarce resources such as water.

The Savanna Biome is the largest Biome in southern Africa, occupying over one-third of the surface area of South Africa (Mucina & Rutherford, 2006). It is characterised by a grassy ground layer and a distinct upper layer of woody plants. Where this upper layer is near the ground the vegetation may be referred to as Shrubveld, where it is dense, as Woodland, and the intermediate stages are locally known as Bushveld (Mucina & Rutherford, 2006).

Biomes are further divided into smaller units known as vegetation types and three of these vegetation types are recorded within the study area and includes Klerksdorp Thornveld (Grassland biome), Western Highveld Sandy Grassland (Grassland biome) as well as Mafikeng Bushveld (Savanna biome) (Figure 2).

Klerksdorp Thornveld is limited to the North-West Province and is characterized by flat plains or slightly undulating plains with dense *Acacia karroo* bush clumps in grassland. Important floral species in this vegetation type includes *Acacia karroo, A.caffra, Celtis africana, Searsia lancea, Ziziphus mucronata, Grewia flava, Gymnosporia buxifolia* and *Tarchonanthus camphorates* while the grass layer is dominated by species such as *Aristida congesta, Cynodon dactylon, Eragrostis lehmanniana, E.trichophora, Panicum coloratum, Themeda triandra, Brachiaria nigropedata* and *Diheteropogon contortus.* Herbaceous species include *Acalypha angustata, Berkheya onopordifolia, Helichrysum nudifolium, Hermannia lancifolia* and *Salvia radula*. This vegetation type is classified as Vulnerable according to Mucina & Rutherford (2006) with only 2% conserved in statutory reserves and private game parks.

Western Highveld Sandy Grassland is also limited to the North-West Province and consists of mostly flat plains with short, dry grassland while woody species occurs in bush clumps. Important grass species in this vegetation type includes *Anthephora pubescens, Aristida congesta, Eragrostis lehmanniana Pogonarthria squarrosa, Setaria sphacelata, Themeda triandra, Aristida adscensionis, Brachiaria serrata, Digitaria argyrograpta* and *Melinis nerviglumis.* The herbaceous layer is dominated by *Gazania krebsiana, Stachys spathulata, Barleria macrostegia, Chamaecrista mimosoides, Helichrysum callicomum, Hermannia depressa, Polygala hottentotta* and *Sida dregei.* This vegetation type is classified as Endangered with only a very small portion statutorily conserved in Baberspan Nature Reserve and more than 60% has been transformed mostly through agriculture (Mucina & Rutherford, 2006).

Mafikeng Bushveld is located in the savanna biome and occurs in the North-West Province, west of Mafikeng and south of the Botswana border. The vegetation consists of a well-developed tree layer with dense stands of *Terminalia sericea, Acacia luederitzii* and *A.erioloba* while the shrub layer consists of *Acacia karroo, A.hebeclada, A.mellifera, Dichrostachys cinerea, Grewia flava, Grewia retinervis* and *Ziziphus mucronata*. The grass layer is dominated by *Anthephora pubescens, Cymbopogon pospischilii, Digitaria eriantha, Eragrostis lehmanniana, E.pallens, Aristida congesta, Cynodon dactylon* and various *Eragrostis* spp. This vegetation type is classified as Vulnerable with nothing conserved in statutory conservation areas; however, a small area is conserved in Mmabatho Recreational Area (Mucina & Rutherford, 2006).

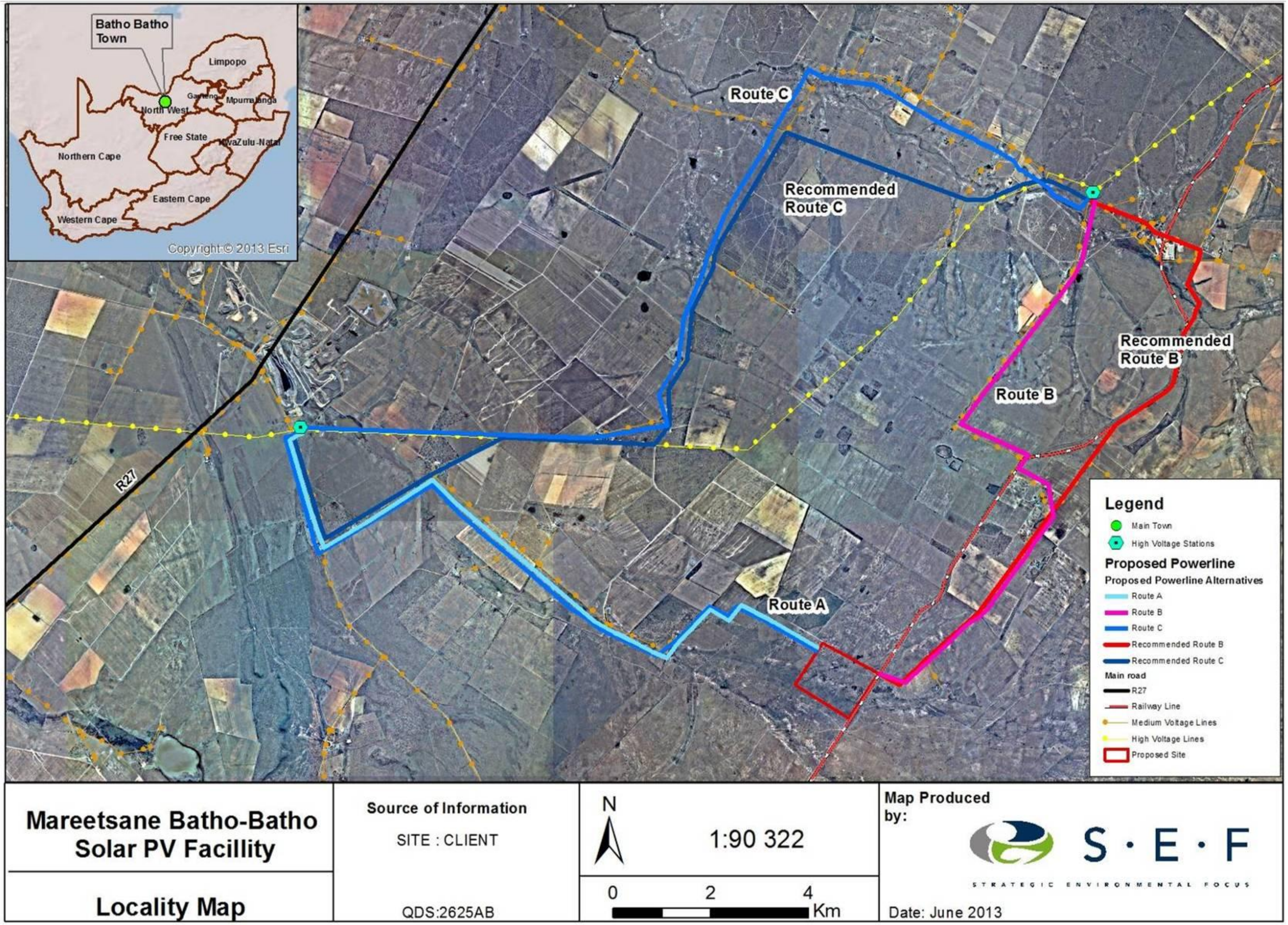


Figure 1: Locality map of the study area.

2.3 National Freshwater Ecosystem Priority Areas Status

The National Freshwater Ecosystem Priority Areas (NFEPA) project is a project currently underway, and represents a multi-partner project between the Council for Scientific and Industrial Research (CSIR), South African National Biodiversity Institute (SANBI), Water Research Commission (WRC), Department of Water Affairs (DWA), Department of Environmental Affairs (DEA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). More specifically, the NFEPA project aims to:

- Identify Freshwater Ecosystem Priority Areas (hereafter referred to as 'FEPAs') to meet national biodiversity goals for freshwater ecosystems; and
- Develop a basis for enabling effective implementation of measures to protect FEPAs, including free-flowing rivers.

The project further aims to maximize synergies and alignment with other national level initiatives such as the National Biodiversity Assessment (NBA) and the Cross-Sector Policy Objectives for Inland Water Conservation.

Based on current outputs of the NFEPA project, no NFEPA wetland areas or wetland clusters were identified within the study area. Further, wetlands on site fall within the Eastern Kalahari Bushveld Group 1 and Dry Highveld Grassland Group 5, NFEPA WetVeg Groups (Ollis *et al*,. 2013). Both identified NFEPA WetVeg Groups are classified as being of Least Concern.

2.4 Biodiversity Corridors and Critically Important Areas

The North-West Province Biodiversity Conservation Assessment Technical Report (North-West Department of Agriculture, Conservation, Environment and Rural Development, 2009) outlines a provincial-level biodiversity corridor network with an aim to retain the connectivity between all geographic areas with minimal financial cost and maximum biodiversity preservation. These corridors are interconnected areas through the landscape that were identified as important for conservation through a series of systematic biodiversity assessments.

Biodiversity Nodes were also identified through a systematic process to coincide with areas where important or intact biodiversity remains, however, unlike Biodiversity Corridors, these nodes are isolated from each other. These areas were often identified as the last remaining areas for the proclamation of reserves and may contribute significantly to biodiversity conservation goals. These areas have been identified as areas that are still intact and contain one of the last remaining areas of Western Highveld Sandy Grassland.

Core Biodiversity Corridors traverse the southern portion of the study area with a portion of the solar facility site as well as Powerline Alternative Route A and portions of Powerline Alternative Route C located within the 1500m buffer of this Biodiversity Corridor. The remainder of the solar facility site as well as the southern portion of Powerline Alternative Route B are located within the 3000m and 5000m buffer (Figure 3).

Hyperdiversity is a measure of the areas of overlap in which the highest diversity of fauna occurs in the province. Critically Important Areas are areas where threatened ecosystems which are vulnerable to transformation and should be prioritised for conservation. Several patches of Critically Important Areas, which are highly sensitive hyperdiversity areas, occur within the study area, many of which appear to be associated with riverine and wetland areas (Figure 4). No areas of high or medium-high hyperdiversity hot spots seem to occur within the proposed solar facility site itself.

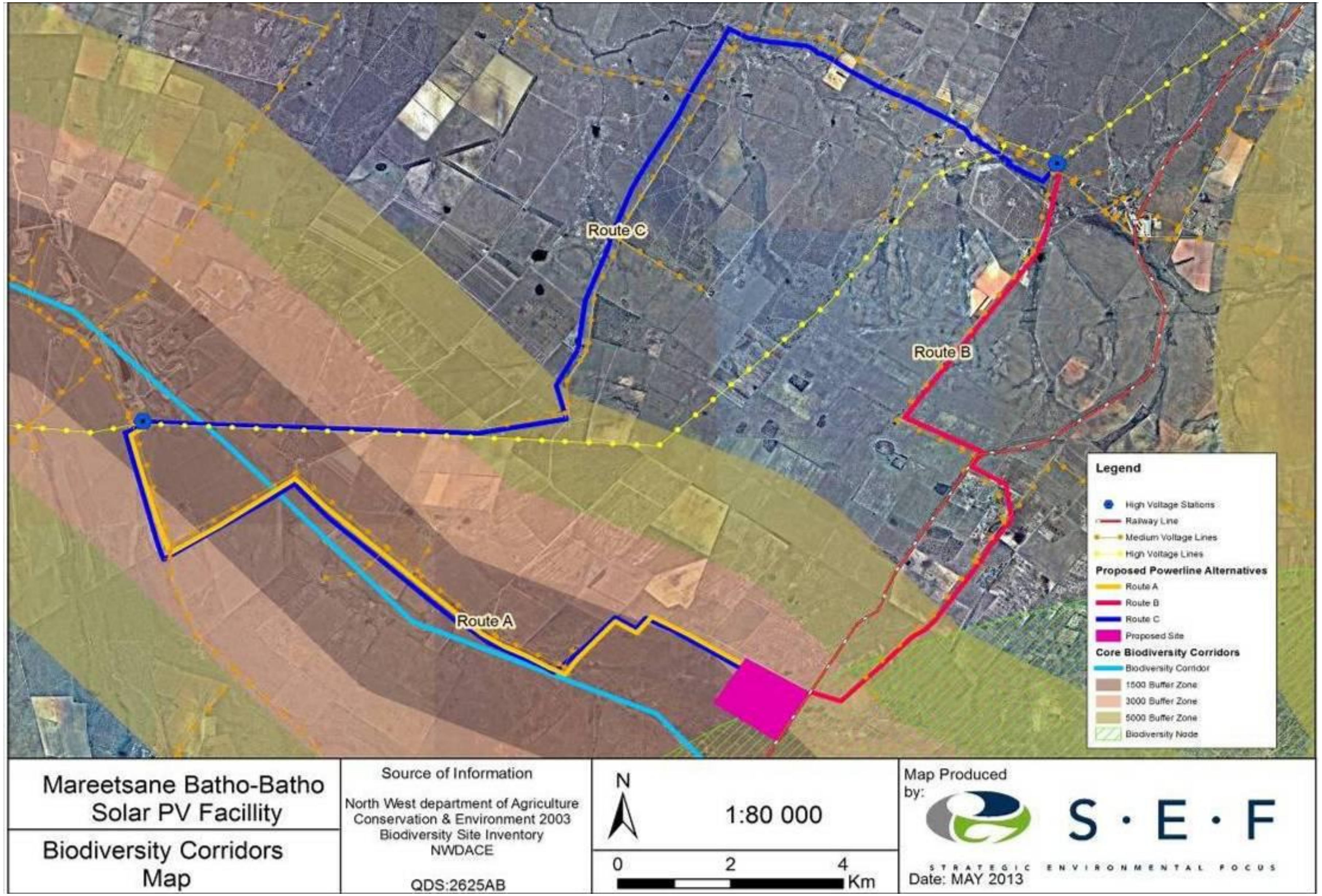


Figure 2: Biodiversity corridors within the study area

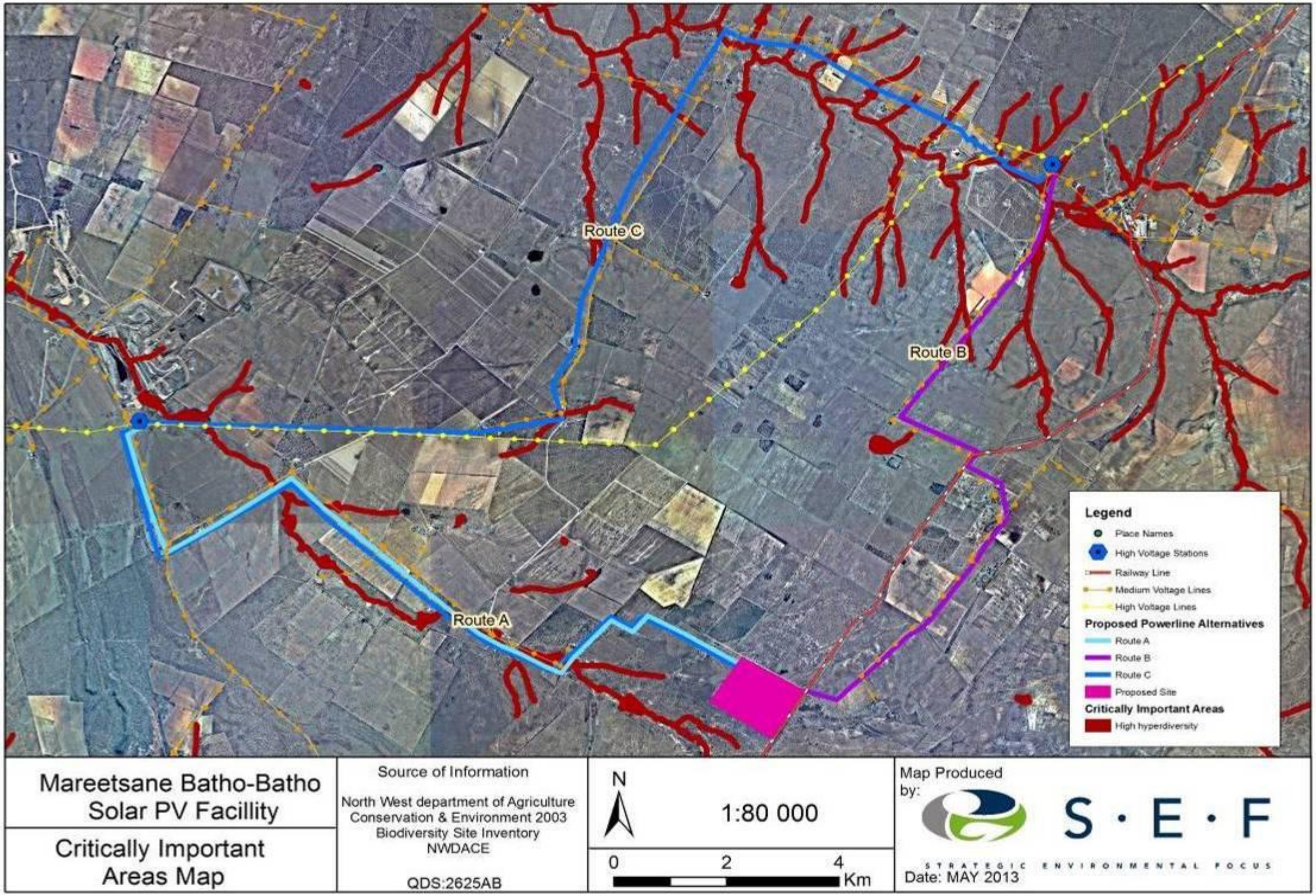


Figure 3: Critically important areas within the study area

3. RESULTS

3.1 Wetland soils

According to DWAF (2005), the permanent zone of a wetland will always have either Champagne, Katspruit, Willowbrook or Rensburg soil forms present, as defined by the Soil Classification Working Group (1991). The seasonal and temporary zones of the wetlands will have one or more of the following soil forms present (signs of wetness incorporated at the form level): Kroonstad, Longlands, Wasbank, Lamotte, Estcourt, Klapmuts, Vilafontes, Kinkelbos, Cartref, Fernwood, Westleigh, Dresden, Avalon, Glencoe, Pinedene, Bainsvlei, Bloemdal, Witfontein, Sepane, Tukulu, Montagu. Alternatively, the seasonal and temporary zones will have one or more of the following soil forms present (signs of wetness incorporated at the family level): Inhoek, Tsitsikamma, Houwhoek, Molopo, Kimberley, Jonkersberg, Groenkop, Etosha, Addo, Brandvlei, Glenrosa, Dundee (DWAF, 2005).

The surveyed area comprised a wide variety of soils including, oxidic duplex, plinthic, calcic, and hydromorphic soils. Oxidic soils primarily consisted of well drained apedal Clovelly soils (representing a typical recharge soil within the study area's cantena) occurring on relatively flat and gently sloping land within the solar plant site and along the proposed powerline routes. Duplex Valsrivier and Sepane soil forms were also identified on site, and constituted approximately half of the solar plant footprint. Plinthic soils including Longlands, Westleigh, and Katspruit soil forms were identified on landscape depressions and along drainage lines within the solar plant site and along the proposed Powerline Option Route C. Hydric soil present within the study area included Longlands, Katspruit, Westleigh, Sepane, Cartef, Fernwood, Kroonstad and Pinedene. The more clayey and organic rich Katspruit soil forms were characteristic of the valley-bottom wetlands while the more sandy Pinedene, Longlands and Westleigh soil forms were especially associated with the hillslope seepage wetlands.

Soil erosion within the survey area is primarily attributed to poor vegetation management with injudicious grazing, reducing vegetation cover which in turn increases soil and organic matter removal through water and wind erosion. Soils with an E horizon including Fernwood, Longlands, Cartref, and Kroonstad soil forms are highly susceptible to erosion due to the loose leached nature of the E horizon and their topographic position. This is attributable to the intermittent saturation with water and subsequent lateral discharge of water through the A and E horizons during wet conditions (SEF, 2013).

For an area to be considered a wetland, redoximorphic features must be present within the upper 500mm of the soil profile (Collins, 2005). Redoximorphic features are the result of the reduction, translocation and oxidation (precipitation) of iron and manganese oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Only once soils within 500mm of the surface display these redoximorphic features can the soils be considered to be hydric (wetland) soils. Redoximorphic features typically occur in three types (Collins, 2005):

- **A reduced matrix** - i.e. an *in situ* low chroma (soil colour), resulting from the absence of $Fe^{3}+$ ions which are characterised by "grey" colours of the soil matrix (Photograph 1).

- **Redox depletions** - the "grey" (low chroma) bodies within the soil where Fe- Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur.
- **Redox concentrations** - Accumulation of iron and manganese oxides (also called mottles). These can occur as:
    - Concretions - harder, regular shaped bodies;
    - Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours; and,
    - Pore linings – zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognized as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres.

According to the DWAF (2005), soil wetness indicators (i.e. identification of redoximorphic features) are the most important indicator of wetland occurrence due to the fact that soil wetness indicators remain in wetland soils, even if they are degraded or desiccated. All augured soil samples within delineated wetland areas represented sufficient redoximorphic reactions to be classified as hydric soils, with brown, black and orange mottles as well as rhizospheres particularly evident.

3.2 Wetland Vegetation

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act, 1998 (Act No. 36 of 1998) (NWA). Using vegetation as a primary wetland indicator however, requires undisturbed conditions (DWAF, 2005). A cautionary approach must be taken as vegetation alone cannot be used to delineate a wetland, as several species, while common in wetlands, can occur extensively outside of wetlands. When examining plants within a wetland, a distinction between hydrophilic (vegetation adapted to life in saturated conditions) and upland species must be kept in mind. There is typically a well-defined 'wetness' gradient that occurs from the centre of a wetland to its edge that is characterized by a change in species composition between hydrophilic plants that dominate within the wetland to upland species that dominate on the edges of, and outside of the wetland (DWAF, 2005). It is important to identify the vegetative indicators which determine the three wetness zones (temporary, seasonal and permanent) which characterize wetlands. Each zone is characterized by different plant species which are uniquely suited to the soil wetness within that zone.

In general, the study area has undergone a high level of transformation with dryland crop cultivation as the dominant land-use with grazing applied in especially the wetland habitats. Areas within valley-bottom wetlands with permanent and seasonal zonation and associated high water tables contained hydrophylic plants, such as *Typha capensis*, *Phragmites* sp., *Juncus* sp., *Schoenoplectus* sp. and *Cyperus* sp.. The temporary wetland areas consisted of a mixture of facultative wetland and terrestrial species such as *Imperata cylindrical, Searsia lancea, Setaria* sp.*, Thermeda triandra, Eragrostis plana, Eragrostis gummiflua*, *Aristida* sp.*, Andropogan* sp.*, Setaria sphacelata, Hyparrenhia* sp., *Monopsis decipiens* and *Nidorella anomala*. The vegetation associated with several hillslope seepage wetlands as well as the channelled valley-bottom wetland was impacted on through overgrazing, resulting in encroachment by the indigenous *Tarchonanthus camphorates. Melia azedarach*, an alien vegetation species, was recorded within the drainage lines and channelled valley bottom wetland.

3.3 Delineated Wetland Areas

According to the NWA 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 land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

Wetlands typically occur on the interface between aquatic and terrestrial habitats and therefore display a gradient of wetness – from permanent, to seasonal, to temporary zones of wetness - which is represented in their plant species composition, as well as their soil characteristics. It is important to take cognisance of the fact that not all wetlands have visible surface water. An area which has a high water table just below the surface of the soil is as much a wetland as a pan that only contains water for a few weeks during the year.

Hydrophytes and hydric soils are subsequently used as the two main wetland indicators. The presence of these two indicators is indicative of an area that has sufficient saturation to classify the area as a wetland. The soil form indicator examines soil forms as defined by the Soil Classification Working Group. Typically soil forms associated with prolonged and frequent saturation by water, where present, is a sign of wetland occurrence (DWAF, 2005). The Soil Classification Working Group has identified various soil types that typically occur within the different zones found within a wetland, i.e. a permanent, seasonal and temporary zone. Terrain unit refers to the land unit in which the wetland is found. Wetlands can occur across all terrain units from the crest to valley bottom. Many wetlands occur within valley bottoms, but wetlands are not exclusively found within depressions. Terrain unit is a useful indicator in assessing the hydro-geomorphic form of the wetland.

In practice all four indicators should be used in any wetland assessment / delineation exercise, the presence of redoximorphic features being most important, with the other indicators being confirmatory. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland and to delineate the boundary of a wetland. According to the DWAF delineation guidelines, the more wetland indicators that are present, the higher the confidence of the delineation. In assessing whether an area is a wetland, the boundary of a wetland or a non- wetland area should be considered to be the point where indicators are no longer present.

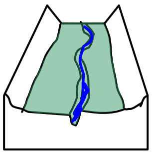
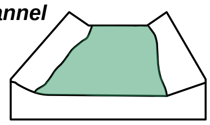
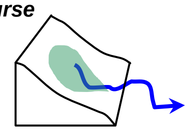
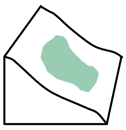
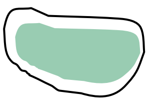
Five hydro-geomorphic (HGM) types were delineated within the study area and classified into thirty separate HGM units within the study area. These included valley-bottom wetlands without a channel, valley-bottom wetlands with a channel, hillslope seepage wetlands that were connected to a watercourse, hillslope seepage wetlands that were not connected to a watercourse and depression. The thirty HGM units identified during the current assessment are presented graphically in Figure 4.

HGM units encompass three key elements (Kotze *et al.*, 2005):

(1) Geomorphic setting. This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment);
(2) Water source. There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
(3) Hydrodynamics, which refers to how water moves through the wetland.

Table 1 describes the characteristics that form the basis for the classification of the HGM units in the study area.

Table 1: Wetland hydro-geomorphic types typically supporting inland wetlands in South Africa (adapted from Kotze *et al*, 2005)

Hydro-geomorphic types	**Description**	**Source of water maintaining the wetland[1]**	
		Surface	**Sub-surface**
Valley bottom with a channel 	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 	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.	***	*/ ***
Hillslope seepage feeding a watercourse 	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 not feeding a watercourse 	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 (includes Pans) 	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.	*/ ***	*/ ***

[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings

Water source:	*	Contribution usually small
	***	Contribution usually large
	*/ ***	Contribution may be small or important depending on the local circumstances

 Wetland

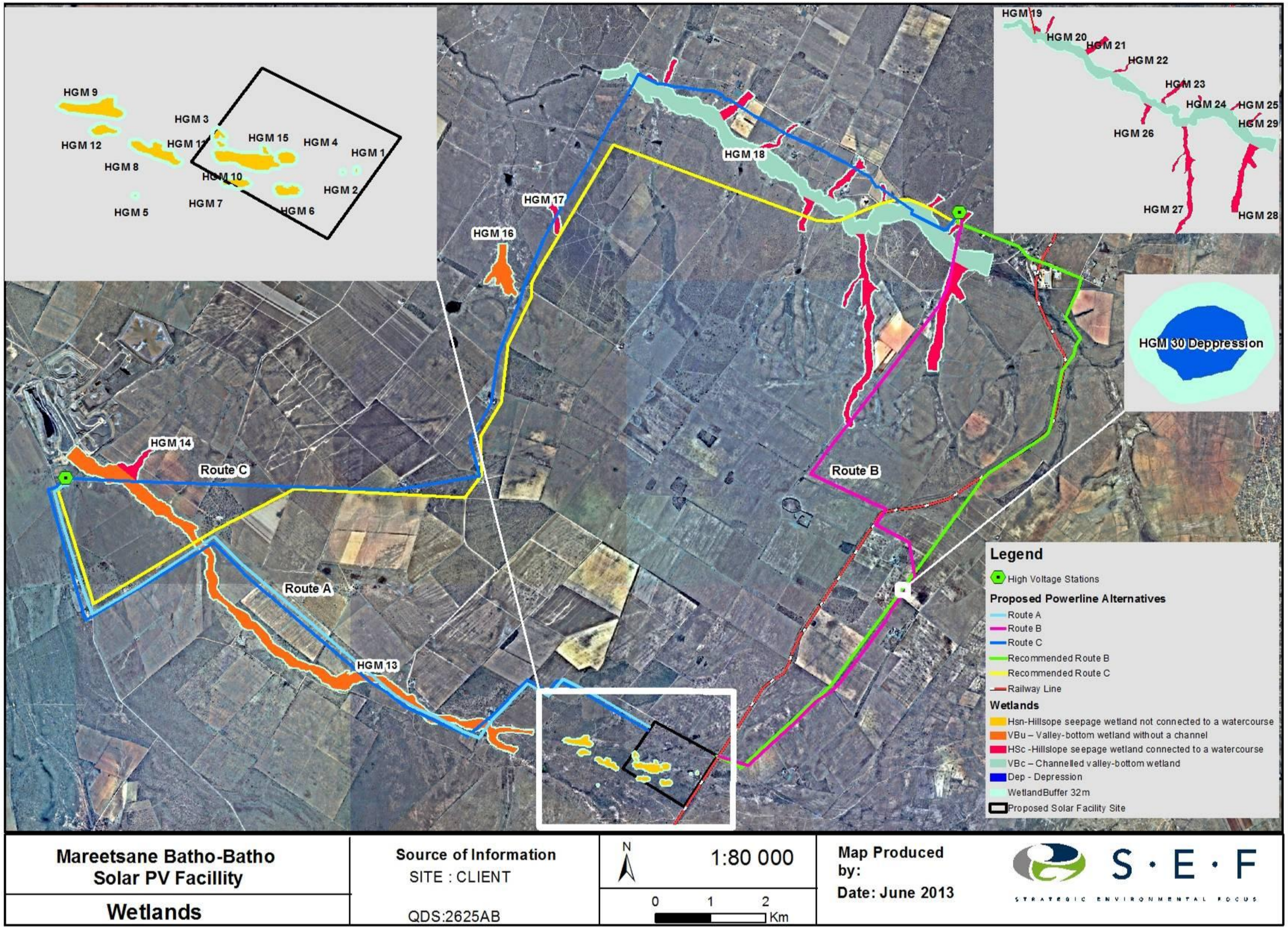


Figure 4: Delineated wetland areas within the study area.

4. FUNCTIONAL ASSESSMENT

Wetlands within the study area serve to improve habitat within and potentially downstream of the study area through the provision of various ecosystem services. Many of these functional benefits therefore contribute directly or indirectly to increase biodiversity within the study area as well as downstream of the study area through provision and maintenance of appropriate habitat and associated ecological processes (Table 2).

Table 2: Potential wetland services and functions in study area

Function	Aspect
Water balance	Stream flow regulation
	Flood attenuation
	Groundwater recharge
Water purification	Nitrogen removal
	Phosphate removal
	Toxicant removal
	Water quality
Sediment trapping	Particle assimilation
Harvesting of natural resources	Reeds, Hunting, etc.
Livestock usage	Water for livestock
	Grazing for livestock
Crop farming	Irrigation

Hydro-geomorphic units are inherently associated with hydrological characteristics related to their form, structure and particularly their position in the landscape. This, together with the biotic and abiotic character (or biophysical environment) of wetlands in the study area, means that these wetlands are able to contribute better to some ecosystem services than to others (Kotze *et al.,* 2005) (Table 3).

Each wetland's ability to contribute to ecosystem services within the study area is further dependant on the particular wetland's Present Ecological State (PES) in relation to a benchmark or reference condition. Present Ecological State scores were assigned for various wetlands within the study area using Wet-Health Level 2 assessment. Through the use of a scoring system, the perceived departure of elements of each particular system from the "natural-state" was determined. The following elements were considered in the assessment:

- Hydrologic: Flow modification (has the flow, rates, volume of run-off or the periodicity changed);
- Geomorphic (Canalisation, impounding, topographic alteration and modification of key drivers); and
- Biota (Changes in species composition and richness, Invasive plant encroachment, over utilization of biota and land-use modification).

Table 3: Preliminary rating of the hydrological benefits likely to be provided by a wetland given its particular hydro-geomorphic type (Kotze *et al*., 2005)

WETLAND HYDRO-GEOMORPHIC TYPE	HYDROLOGICAL BENEFITS POTENTIALLY PROVIDED BY THE WETLAND							
	Flood attenuation		Stream flow regulation	Erosion control	Enhancement of water quality			
	Early wet season	Late wet season			Sediment trapping	Phos-phates	Nitrates	Toxicants[2]
Valley bottom - channelled	+	0	0	++	+	+	+	+
Valley bottom - unchannelled	+	+	+?	++	++	+	+	++
Hillslope seepage feeding a stream channel	+	0	+	++	0	0	++	++
Hillslope seepage not feeding a stream	+	0	0	++	0	0	++	+
Pan/ Depression	+	+	0	0	0	0	+	+

[2]Toxicants are taken to include heavy metals and biocides

Rating: 0 Benefit unlikely to be provided to any significant extent
\+ Benefit likely to be present at least to some degree
++ Benefit very likely to be present (and often supplied to a high level)

The scores obtained in the PES assessment places the specific wetland unit in one of six categories (Table 4) and results displayed (Table 5) in Figure 5.

Table 4: Interpretation of scores for determining present ecological status (Kleynhans 1999)

Rating of Present Ecological State Category (PES Category)
CATEGORY A Score: 0-0.9; Unmodified, or approximates natural condition.
CATEGORY B Score: 1-1.9; Largely natural with few modifications, but with some loss of natural habitats.
CATEGORY C Score: 2 – 3.9; Moderately modified, but with some loss of natural habitats.
CATEGORY D Score: 4 – 5.9; Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E Score: 6 -7.9; Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F Score: 8 - 10; Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

Table 5: Results for individual HGM unit's present ecological status category

HGM unit	Wetland type	Hydrology	Geomorphology	Vegetation	PES category
1	Isolated hillslope seepage	5.0	5.3	5.6	D (5.2)
2	Isolated hillslope seepage	5.8	5.9	6.1	D (5.9)
3	Isolated hillslope seepage	5.1	5.1	5.3	D (5.1)
4	Isolated hillslope seepage	4.5	4.2	3.8	D (4.2)
5	Isolated hillslope seepage	5.3	5.4	6.3	D (5.6)
6	Isolated hillslope seepage	5.0	5.2	5.8	D (5.2)
7	Isolated hillslope seepage	5.0	5.4	5.5	D (5.2)
8	Isolated hillslope seepage	5.5	5.1	5.7	D (5.4)
9	Isolated hillslope seepage	5.5	5.2	5.8	D (5.5)
10	Isolated hillslope seepage	5.3	5.4	5.8	D (5.4)
11	Isolated hillslope seepage	5.1	5.1	5.3	D (5.1)
12	Isolated hillslope seepage	5.0	5.4	5.5	D (5.2)
13	Unchannelled valley bottom	3.5	3.2	4.4	C (3.7)
14	Hillslope seepage connected to a watercourse	6.2	6.2	6.4	E (6.3)
15	Isolated hillslope seepage	5.8	5.9	6.1	D (5.9)
16	Unchannelled valley bottom	6.1	6.0	6.0	E (6.0)
17	Hillslope seepage connected to a watercourse	5.5	5.2	5.8	D (5.5)
18	Channelled valley bottom	3.9	3.7	4.0	C (3.9)
19	Hillslope seepage connected to a watercourse	5.1	5.1	5.3	D (5.1)
20	Hillslope seepage connected to a watercourse	4.5	4.2	3.8	D (4.2)
21	Hillslope seepage connected to a watercourse	5.1	5.1	5.3	D (5.1)
22	Hillslope seepage connected to a watercourse	4.5	4.0	4.0	D (4.2)
23	Hillslope seepage connected to a watercourse	4.5	4.2	3.8	D (4.2)
24	Hillslope seepage connected to a watercourse	5.0	5.2	5.8	D (5.2)
25	Hillslope seepage connected to a watercourse	5.5	5.2	5.8	D (5.5)
26	Hillslope seepage connected to a watercourse	5.1	5.1	5.3	D (5.1)
27	Hillslope seepage connected to a watercourse	4.5	4.0	4.0	D (4.21)
28	Hillslope seepage connected to a watercourse	5.0	5.3	5.6	D (5.2)
29	Hillslope seepage connected to a watercourse	5.3	5.4	6.3	D (5.6)
30	Depression	4.5	4.2	3.8	D (4.2)

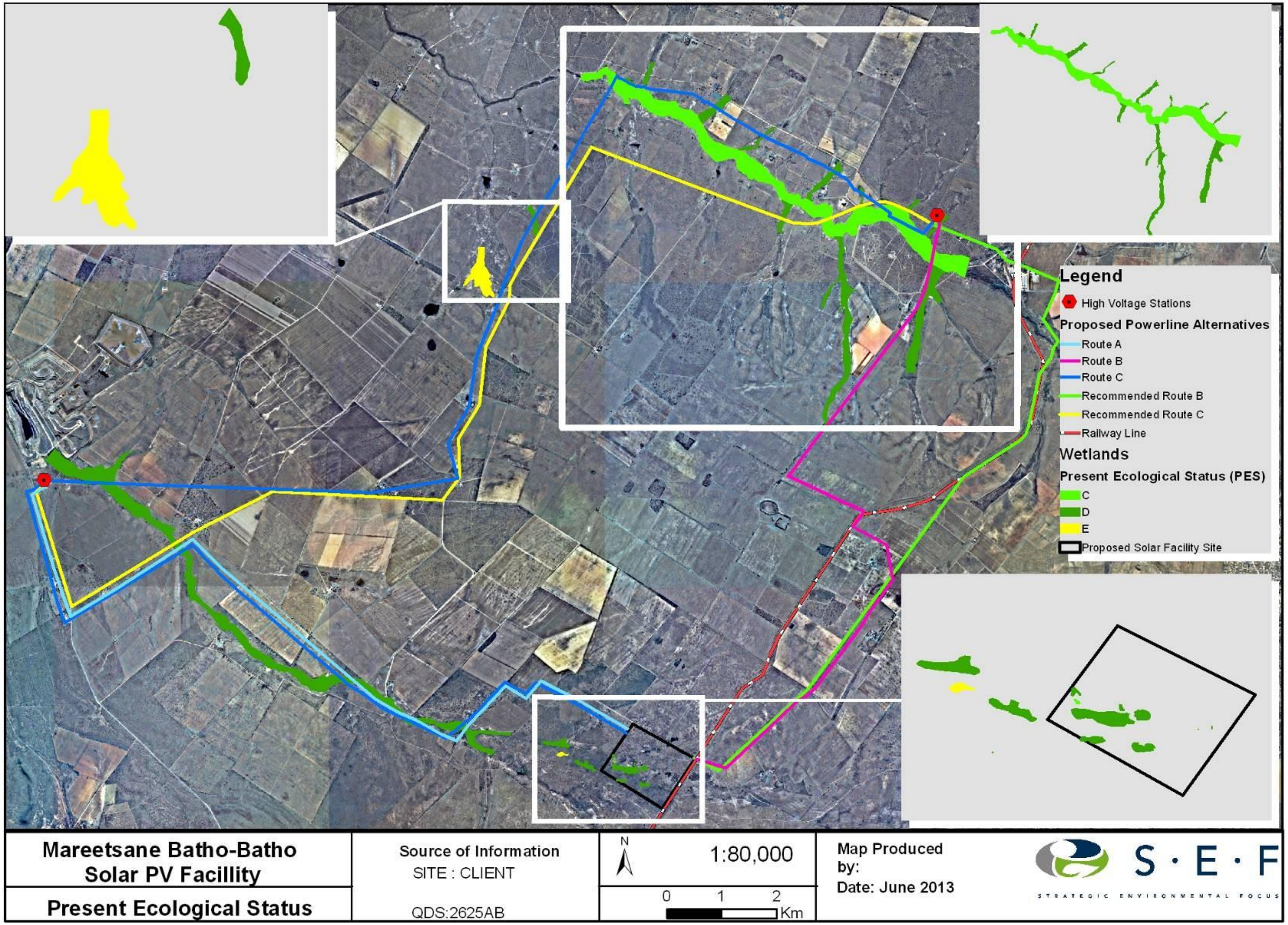


Figure 5: PES results for wetlands within the study area

4.1 Present Ecological State for HGM 1, HGM 2, HGM 3, HGM 4, HGM 5, HGM 6, HGM 7, HGM 8, HGM 9, HGM 10, HGM 11, HGM 12 and HGM 15

HGM 1 to HGM 12 was discussed as a group due to their similar PES, which was a result of the similar impacts and landscape settings that they occupy. These isolated hillslope seepage wetlands represent the extreme valley head of an unchannelled valley-bottom wetland on a very low slope. Changes to the hydrological and geomorphologic characteristics of these wetlands could largely be attributed to cattle tracks and severe historic overgrazing regimes within the wetlands and their associated catchment which reduced surface roughness and increased run-off. Vegetation composition has therefore been altered substantially, not only within the wetlands catchment, but also in the wetlands themselves as evident by the high indigenous encroachment of several *Acacia* species as well as *Tarchonanthus camphorates*. The increased run-off combined with reduced surface run-off was evident in several locations where a considerable portion of the soil's A horizon has been removed through sheet erosion processes. The above mentioned HGM units were therefore considered to be largely modified (PES category D)

4.2 Present Ecological State for HGM 13

HGM 13 was delineated as an unchannelled valley-bottom wetland with a relatively large catchment. The hydrology and geomorphology of this particular wetland was perceived to be largely intact (PES category C) with only a couple of farm dams constructed within its course. The largest impact within the unchannelled valley-bottom wetland was historic overgrazing practices within the wetland itself as well as its catchment. The wetland is transected by a few dirt roads with some channel development in a number of segments as a result of overgrazing, associated changes in species composition and reduced surface roughness within the wetland and its catchment. A segment of the wetland downstream and outside of the study area has been completely destroyed through opencast mining activities (this impact was not considered as part of the current assessment).

4.3 Present Ecological State for HGM 14

HGM 14, a hillslope seepage connected to HGM 13 was considered to be highly modified (PES category E) from a hydrological and geomorphological perspective through intensive agriculture practices. The majority of the wetland and its catchment has been completely transformed through repeated dryland crop production. Very little natural vegetation remains in the catchment and the wetland was dominated by annual crops with associated low basal cover. Currently a raised berm separates HGM 14 form HGM 13 which effectively acts as a farm dam.

4.4 Present Ecological State for HGM 16

HGM 16, an unchannelled valley-bottom wetland, was considered to be highly modified (PES category E) from a hydrological and geomorphological perspective. The majority of the wetland and its catchment are slowly recovering from historic farming activities as evident by the colonisation of the area by indigenous vegetation species composition. Several small erosion channels are still present as a result of past anthropogenic activities.

4.5 Present Ecological State for HGM 17

HGM 17 was delineated as a small hillslope seepage connected to HGM 16. The small seepage with a relatively small catchment was weakly developed with only Pinedene soils representing hydric conditions. The hydrology and geomorphology of this particular wetland was perceived to be largely modified as a result of over grazing and associated erosion processes.

4.6 Present Ecological State for HGM 18

HGM 18, a channelled valley-bottom wetland, commonly referred to as the Mareetsane river had the largest catchment of the study area. The hydrology and geomorphology of this particular wetland was perceived to be moderately modified as a result of agricultural activities, including dry-land crop cultivation, farm dams and several roads transecting the wetland and its catchment. Overgrazing within this HGM unit was evident by the dominance of *Tarchonanthus camphorates.* The largely modified nature of the supporting hillslope seepage and reduced basal cover within the catchment was likely to have caused some channel straightening within the valley-bottom wetland, although sinuosity was still relatively high for the main channel.

4.7 Present Ecological State for HGM 19, HGM 20, HGM 21, HGM 22, HGM 23, HGM 24, HGM 25, HGM 26, HGM 27, HGM 28 and HGM 29

HGM 19 to HGM 29 was a series of hillslope seepage wetlands connected to HGM 18. Most of these seepages had small to medium size catchments with similar PES (PES category D). Some channel incision has occurred in a few localities, a likely result of overgrazing regimes and a number of roads transecting the wetlands. Vegetation composition has also been altered as a result of grazing regimes which has led to a reduced basal cover and increased run-off during precipitation events.

4.8 Present Ecological State for HGM 30

HGM 30 was delineated as a depression wetland with a relatively small catchment. Although Wet-health assessments are not ideally suited for depression wetlands, the hydrology and geomorphology of this particular wetland was perceived to be largely modified as a result of a dirt road transecting the depression as well as exposure to heavy grazing regimes.

5. ECOLOGICAL IMPORTANCE AND SENSITIVITY

All wetlands, rivers, their flood zones and their riparian areas are protected by law and no development is allowed to negatively impact on rivers and river vegetation. The vegetation in and around rivers and drainage lines play an important role in water catchments, assimilation of phosphates, nitrates and toxins as well as flood attenuation. Quality, quantity and sustainability of water resources are fully dependent on good land management practices within the catchment. All flood lines, riparian zones and wetlands along with corresponding buffer zones must be designated as sensitive.

The Ecological Importance and Sensitivity (EIS) assessment was undertaken to rank water resources in terms of:

- Provision of goods and service or valuable ecosystem functions which benefit people;
- biodiversity support and ecological value; and
- Reliance of subsistence users (especially basic human needs uses).

Water resources which have high values for one or more of these criteria may thus be prioritised and managed with greater care due to their ecological importance (for instance, due to biodiversity support for endangered species), hydrological functional importance (where water resources provide critical functions upon which people may be dependent, such as water quality improvement) or their role in providing direct human benefits (Rountree, 2010). Degradation of wetlands through impacts in catchments or in wetlands themselves is resulting in the reduction and loss of their functional effectiveness and ability to deliver ecosystem services or benefits to humans and the environment (Kotze *et al.,* 2008). EIS score results for each of the HGM units are listed in Table 6.

Table 6: EIS scores for wetland units

Wetland Complex	Parameter	Rating (0 -4)	Confidence (1 – 5)
HGM 1, HGM 2, HGM 3, HGM 4, HGM 5, HGM 6, HGM 7, HGM 8, HGM 9, HGM 10, HGM 11, HGM 12 and HGM 15 (Isolated Hillslope seepage)	Ecological Importance & Sensitivity	Low (1.33)	2.53
	Hydrological / Functional Importance	Low (1.87)	2.00
	Direct Human Benefits	Low (1.00)	2.50
HGM 13 (Unchannelled valley-bottom)	Ecological Importance & Sensitivity	Moderate (2.00)	2.42
	Hydrological / Functional Importance	Low (1.75)	2.25
	Direct Human Benefits	Moderate (2.33)	2.50
HGM 14 (Connected Hillslope seepage)	Ecological Importance & Sensitivity	Low (1.33)	2.42
	Hydrological / Functional Importance	Low (1.80)	2.25
	Direct Human Benefits	Low (1.00)	2.50
HGM 16 (Unchannelled valley-bottom)	Ecological Importance & Sensitivity	Low (1.00)	2.42
	Hydrological / Functional Importance	Low (1.73)	2.75
	Direct Human Benefits	Low (1.00)	2.50
HGM 17 (Connected Hillslope seepage)	Ecological Importance & Sensitivity	Low (1.00)	2.42
	Hydrological / Functional Importance	Low (1.93)	2.75
	Direct Human Benefits	Low (1.00)	2.50
HGM 18 (Channelled valley-bottom)	Ecological Importance & Sensitivity	Moderate (2.50)	2.42
	Hydrological / Functional Importance	Moderate (2.33)	2.85

	Direct Human Benefits	Moderate (2.50)	2.00
HGM 19, HGM 20, HGM 21, HGM 22, HGM 23, HGM 24, HGM 25, HGM 26, HGM 27, HGM 28 and HGM 29	Ecological Importance & Sensitivity	Moderate (2.00)	2.53
	Hydrological / Functional Importance	Low (1.33)	2.85
	Direct Human Benefits	Low (1.00)	2.00
HGM 30 (Depression)	Ecological Importance & Sensitivity	Low (2.00)	2.48
	Hydrological / Functional Importance	Low (1.73)	2.85
	Direct Human Benefits	Low (1.00)	2.00

The low to moderate EIS assigned to most of the HGM units can be attributed to the disturbed nature of the wetlands in the study area and the resultant low potential for species of conservation concern. Farming practices within all of the assessed wetlands catchments and cultivation taking place within some of the wetlands themselves had a moderate to serious impact on most of the wetlands' ability to perform certain hydrological benefits, reducing the wetlands ecological importance. HGM 18 represented the most intact and functional wetland system within the study area and scored moderately in terms of EIS, followed by HGM 13 which is also a valley bottom wetland system. Direct human benefits were associated with cattle grazing and the cultivation of crops within wetland areas.

6. IMPACT ASSESSMENT AND MITIGATION

Any development in a natural system will impact on the surrounding environment, usually in a negative way. The purpose of this phase of the project was therefore to identify and assess the significance of the impacts likely to arise during the construction, operational and closure phases of the proposed project, and provide a short description of the mitigation required so as to limit the impact of the proposed activity on the natural environment.

6.1 Assessment Criteria

The environmental impacts are assessed with mitigation measures (WMM) and without mitigation measures (WOMM) and the results presented in impact tables which summarise the assessment. Mitigation and management actions are also recommended with the aim of enhancing positive impacts and minimising negative impacts.

In order to assess these impacts, the proposed development has been divided into two project phases, namely the construction and operation phase. The criteria against which these activities were assessed are discussed below.

<u>*Nature of the Impact*</u>

This is an appraisal of the type of effect the project would have on the environment. This description includes what would be affected and how and whether the impact is expected to be positive or negative.

Extent of the Impact

A description of whether the impact will be local (extending only as far as the servitude), limited to the study area and its immediate surroundings, regional, or on a national scale.

Duration of the Impact

This provides an indication of whether the lifespan of the impact would be short term (0-5 years), medium term (6-10 years), long term (>10 years) or permanent.

Intensity

This indicates the degree to which the impact would change the conditions or quality of the environment. This was qualified as low, medium or high.

Probability of Occurrence

This describes the probability of the impact actually occurring. This is rated as improbable (low likelihood), probable (distinct possibility), highly probable (most likely) or definite (impact will occur regardless of any prevention measures).

Degree of Confidence

This describes the degree of confidence for the predicted impact based on the available information and level of knowledge and expertise. It has been divided into low, medium or high.

6.2 Impact Assessment

The possible impacts of the proposed project on the delineated wetlands within the study area during the various phases are presented below. Table 7 and Table 8 list a summary of the possible risks that could occur within the construction phase and the operational phase respectively. In determining the applicability of measures to be undertaken to limit impacts on the associated wetlands, it is recommended that the environmental impact hierarchy to be adhered to should follow:

- Avoidance of impact – the design and route planning of the new powerline and power plant site must first take into consideration the environmental sensitivities of the site and undertake to avoid impacts wherever possible.
- Minimisation of impact – where impacts to the wetland are unavoidable, the route design and infrastructure design must be undertaken in such a way as to minimise the impacts associated with their activities; and
- Mitigation of impact – once all possible impacts have been avoided and minimised as far as possible, the remaining significant impacts must be mitigated on site. This can be undertaken through control measures during construction and maintenance of the powerline and plant site, and through effective rehabilitation measures.
- Off-set mitigation – where avoidance, minimisation and mitigation measures fail or are not possible, an appropriate off-set approach should be followed.

Table 7: Primary impacts arising during construction phase relating to the associated wetland ecosystems

Possible impact	Source of impact
Sedimentation of wetlands	Runoff from construction activities and clearing of natural and secondary vegetation
Destruction of wetland habitat and associated loss of wetland functionality	Destruction of hydric soils and hydrophytic vegetation
Changes to surface and sub-surface flow regimes	Excavations of pits / trenches, channelling as a result of large machinery, removal and disturbances to vegetation.

Table 8: Primary impacts arising during operation phase relating to the associated wetland ecosystems

Possible impact	Source of impact
Destruction of wetland habitat and associated loss of wetland functionality	Maintenance crews working in wetlands

6.3 Impact Assessment: Construction Phase

6.3.1 Sedimentation of watercourses/ wetlands

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Local	Short	Medium	Medium Probability	Medium	Low	High

Description of Impact

The clearing of natural vegetation and the stripping of topsoil and sub-soils for placing pylons, solar panels and substations will potentially result in increased runoff of sediment from the site into watercourses associated with the study area. Several soil types associated with wetlands are particularly susceptible to soil erosion due to the presence of an E-horizon. The high soil erodibility within parts of the study area motivates for good catchment principles to be applied in order to mitigate any potential impacts that could result due to the proposed development.

Mitigation Measures Solar PV Facility site

- The layout and placement of solar panels, substations and other associated infrastructure should take cognisance of the delineated wetland boundaries. The northern section of the solar site are more readily developable compared to the southern section of the site which contains wetlands as well as diffused drainage lines which conveys stormwater from the east to the west towards HGM 13, Figure 6. The layout design should therefore place infrastructure as far from wetland boundaries as possible, but as a minimum, a 32m buffer should be applied to all

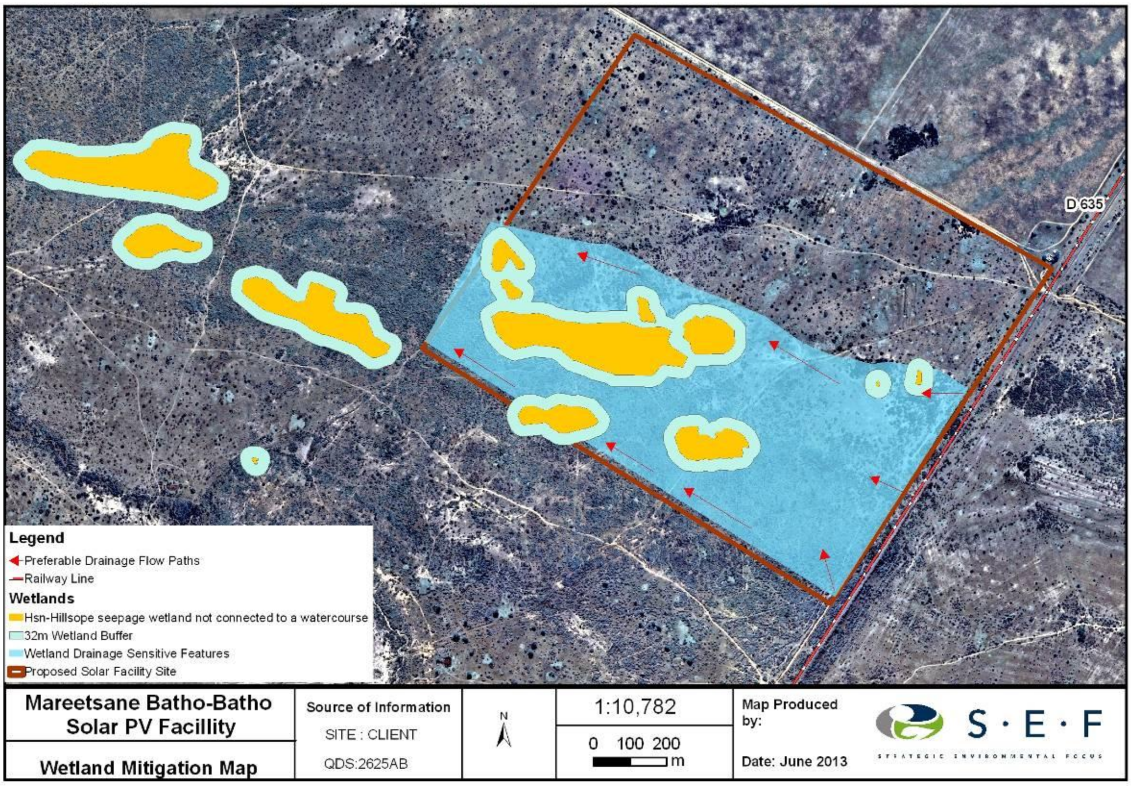


Figure 6: Sensitivities associated with the southern portion of the solar site.

wetlands and serve as a no go areas as a minimum. Further, development of the site should not cause negative changes to the hydrology of the wetlands. Uprooting trees and shrubs within especially the southern section of the solar site could expose the soils to accelerated erosion processes as this area forms a preferential flow path for stormwater. The southern section should preferably not be developed unless a sensitive stormwater management could be developed that would ensure similar or improved site drainage and run-off characteristics to the receiving environment. As a minimum stormwater design will have to include:

- Increased surface roughness across the entire site through increased basal cover;
- Attenuation facilities e.g. attenuation swales; and
- Diffuse water release infrastructure.

- Linear infrastructure including access roads within the Solar PV Facility site should take cognisance of drainage patterns and incorporate sensitive stormwater management principles to avoid concentrating flow paths which could initiate erosion processes
- Good catchment management principles including appropriate stormwater planning need to be applied within the proposed Solar PV Facility site. Vegetation basal cover should be increased through removing grazing pressure and introducing an indigenous and appropriate seeding program. A reduced grazing regime and successful re-establishment of a good basal cover are essential and are likely to result in a positive effect on wetlands through increased surface roughness within the wetlands themselves as well as their associated catchments.
- A wetland monitoring program must be in place to pro-actively detect threats to wetlands before it can cause damage through an adaptive management approach, e.g. the initiation of new concentrated drainage pathways and erosion processes as a

result of new access roads etc. It is recommended that a wetland specialist (preferential) or ecologist have at least three visit during the construction process and bi-annual visits for the first 5 years after construction is completed. The wetland specialist needs to ensure that no negative impacts on wetlands have occurred or that processes have been initiated that could harm wetlands in the future, e.g. preferential flow paths or erosion.

Mitigation Measures Powerline Routes

- From a wetland perspective, recommended route A and recommended route B, Figure 1, should be utilised as it follows existing linear developments within the study area. Wetland areas should be crossed perpendicularly with pylons placed outside of the wetlands habitat (preferably also avoiding a 32m wetland buffer), especially the valley-bottom wetlands. If necessitated, pylons could be placed within certain hillslope seepage wetlands where further on site studies and mitigation measures are confirmed by a wetland specialist.
- Develop soil management measures for the route and substation construction sites which will prevent runoff of sediment into the associated watercourses, e.g. scheduling the construction phase during low rainfall periods, installing soil curtains and use of swales to capture run-off water and settle suspended materials etc.
- Usually substations and associated infrastructure are bedded with gravel which is a good medium to curtail excessive precipitation run-off. However, if the proposed development is to include several hardened surfaces which could increase peak flows received by wetlands, attenuation facilities should be designed which diffusely releases water. Further, wetland rehabilitation in the vicinity of such infrastructure is then also highly recommended.
- A wetland monitoring program must be in place to pro-actively detect threats to wetlands before it can cause damage through an adaptive management approach, e.g. the initiation of new concentrated drainage pathways and erosion processes as a result of new access roads etc. It is recommended that a wetland specialist (preferential) or ecologist have at least one visit during the construction process and three visit after construction is completed. The wetland specialist needs to ensure that no negative impacts on wetlands have occurred or that processes have been initiated that could harm wetlands in the future, e.g. preferential flow paths or erosion.

6.3.2 Destruction of wetland habitat and associated loss of wetland functionality

Extent	**Duration**	**Intensity**	**Probability of occurrence**	**Significance**		**Confidence**
				WOMM	WMM	
Local	Short	High	Medium Probability	Medium	Low	High

<u>Description of Impact</u>

The footprint of new infrastructure and construction activities could infringe or destroy wetland habitat and associated biota through removal of hydrophytic vegetation and or hydric soils. Activities are also likely to negatively affect supporting hydrological sources of wetlands.

Mitigation Measures

- Avoid construction activities in wetlands as far as possible through proper planning, demarcation and appropriate environmental awareness training. Appropriate wetland buffer zones (minimum of 32m from the outer edge of wetlands) and no-go areas must be assigned in particular to valley-bottom wetlands.
- All construction staff must be informed of the need to be vigilant against any practice that will have a harmful effect on wetlands e.g. Do not take short-cuts through valley bottoms (wetlands) but use existing road infrastructure.
- Any proclaimed weed or alien species that germinate during the construction period shall be cleared as per the recommendation of the vegetation assessment (SEF, 2013).
- Caution must be taken to ensure building materials are not dumped or stored within the delineated wetland zones
- Emergency plans must be in place in case of spillages into wetland systems.
- Littering and contamination of water sources during construction must be mitigated by effective construction camp management.
- All construction materials including fuels and oil should be stored in a demarcated area that is contained within a bunded impermeable surface to avoid spread of any contamination (outside of wetlands or wetland buffer zones).
- Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area, in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase.

6.3.3 Changes to surface and sub-surface flow regimes of wetlands

Extent	**Duration**	**Intensity**	**Probability of occurrence**	**Significance**		**Confidence**
				WOMM	WMM	
Local	Short	Med	High Probability	Medium	Low	High

Description of Impact

Linear construction activities, excavations, removal and disturbances to vegetation could create preferential flow paths and/or cut off existing flow paths on the surface as well as sub-surface. Hydrology is an important driver of wetlands and changes thereto could have various negative impacts on wetlands and their associated functionality.

Mitigation Measures

- Avoid construction activities in wetlands or preferential hydrological pathways supporting wetlands through proper planning, appropriate design and minimising the construction footprint as per previous impacts discussed.
- Soils should be replaced in the same order as removed.

- Where it is absolutely necessary for the use of machinery, limit the footprint of impact to a minimum through appropriate planning, e.g. keeping turning circles outside of the wetland. Where vehicle tracks have formed rehabilitate immediately by levelling (where possible by hand)
- Re-vegetation of the affected areas should be done as priority.

6.4 Impact Assessment: Operational Phase

6.4.1 Destruction of wetland habitat and associated loss of wetland functionality

Extent	Duration	Intensity	Probability of occurrence	Significance		Confidence
				WOMM	WMM	
Local	Short	Medium	Low Probability	Low	Low	High

Description of Impact

Maintenance activities are likely to have a lower impact than construction activities, except for worst case scenarios where sections of the powerline might have to be reconstructed. Wetland habitat could be impacted on or be destroyed through maintenance operations e.g. through removal of hydrophytic vegetation and or hydric soils.

Mitigation Measures

- Mitigation measures for worst case scenarios would be the same as for the construction phase

7. CONCLUSION

The four main wetland indicators used during the wetland delineation process included the terrain unit indicator, soil wetness indicator, and the presence or absence of hydric soils and hydrophytes. Five hydro-geomorphic types were delineated within the study area and classified into thirty separate hydro-geomorphic (HGM) units within the study area. These included valley-bottom wetlands without a channel, valley-bottom wetlands with a channel, hillslope seepage wetlands that were connected to a watercourse, hillslope seepage wetlands that were not connected to a watercourse and depressions.

From a functional perspective, wetlands within the study area serve to improve habitat within and downstream of the study area through the provision of various ecosystem services such as streamflow regulation, flood attenuation, groundwater recharge, nitrogen removal, phosphate removal, toxicant removal, particle assimilation and provision of natural resources including habitat for a variety of taxa. Each wetland's ability to contribute to ecosystem services within the study area is further dependant on the particular wetland's Present Ecological State in relation to a benchmark or reference condition. Results of the Wet-health assessment indicated that the Present Ecological State for wetlands within the study area ranged from being moderately modified with some loss of natural habitat to being seriously modified with an extensive loss of natural habitat and associated functional attributes. An Ecological Importance and Sensitivity (EIS) assessment was undertaken to rank associated wetlands in terms of provision of goods and service or valuable ecosystem functions which benefit people, biodiversity support and ecological value, and reliance of subsistence users (especially basic human needs uses). The moderate to low Ecological Importance and Sensitivity assigned to the various wetlands was attributed primarily to the loss of functionality as a result of land use practices, especially cultivation and grazing.

Based on the current and proposed activities and taking into consideration the present state of the wetlands and their associated functionality and biodiversity, several potential impacts on wetlands were identified. As a result, several measures are recommended to be undertaken to limit impacts on the associated wetlands. From a wetland perspective, two alternative routes are recommended in order to effectively align powerline routes with existing linear infrastructure. The southern section of the Solar PV Facility should preferably not be developed unless a sensitive stormwater management could be developed that would ensure similar or improved site drainage and run-off characteristics to the receiving environment.

GLOSSARY

Alien species	Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity.
Biodiversity	Biodiversity is the variability among living organisms from all sources including inter alia terrestrial, marine and other aquatic ecosystems and ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
Biome	A major biotic unit consisting of plant and animal communities having similarities in form and environmental conditions, but not including the abiotic portion of the environment.
Buffer zone	A collar of land that filters edge effects.
Conservation	The management of the biosphere so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations. The wise use of natural resources to prevent loss of ecosystems function and integrity.
Critically Endangered	A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.
Ecosystem	Organisms together with their abiotic environment, forming an interacting system, inhabiting an identifiable space.
Ecological Corridors	Corridors are roadways of natural habitat providing connectivity of various patches of native habitats along or through which faunal species may travel without any obstructions where other solutions are not feasible.
Edge effect	Inappropriate influences from surrounding activities, which physically degrade habitat, endanger resident biota and reduce the functional size of remnant fragments including, for example, the effects of invasive plant and animal species, physical damage and soil compaction caused through trampling and harvesting, abiotic habitat alterations and pollution.
Endangered	A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.
Exotic species	Plant taxa in a given area, whose presence there, is due to the intentional or accidental introduction as a result of human activity
Fauna	The animal life of a region.
Flora	The plant life of a region.
Forb	A herbaceous plant other than grasses.
Habitat	Type of environment in which plants and animals live.
Indigenous	Any species of plant, shrub or tree that occurs naturally in South Africa.

Invasive species	Naturalised alien plants that have the ability to reproduce, often in large numbers. Aggressive invaders can spread and invade large areas.
Outlier	An observation that is numerically distant from the rest of the data
Primary vegetation	Vegetation state before any disturbances such as cultivation, overgrazing or soil removal
Threatened	Species that have naturally small populations, and species which have been reduced to small (often unsustainable) population by man's activities.
Red data	A list of species, fauna and flora that require environmental protection. Based on the IUCN definitions.
Species diversity	A measure of the number and relative abundance of species.
Species richness	The number of species in an area or habitat.
Vulnerable	A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

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APPENDIX A

Wetland delineation methodology

The report incorporated a desktop study, as well as a field survey, with a site visit conducted during January 2013. Additional data sources that were incorporated into the investigation for further reliability included:

- Google Earth images;
- 1:50 000 cadastral maps; and
- ortho-rectified aerial photographs.

Identified wetland areas were marked digitally using GIS (changes in vegetation composition within wetlands as compared to surrounding non-wetland vegetation show up as a different hue on the orthophotos, thus allowing the identification of wetland areas). These were converted to digital image backdrops and delineation lines and boundaries were imposed accordingly after the field surveys.

The wetland delineation methodology used was the same as the one set out by the Department of Water affairs and Forestry (DWAF, 2005) document "*A Practical field procedure for the identification and delineation of wetlands and riparian areas"*. The Department of Water affairs and Forestry (DWAF) wetland delineation guide makes use of indirect indicators of prolonged saturation by water, namely wetland plants (hydrophytes) and (hydromorphic) soils. The presence of these two indicators is indicative of an area that has sufficient saturation to classify the area as a wetland. Hydrophytes were recorded during the site visit and hydromorphic soils in the top 0.5 m of the profile were identified by taking cored soil samples with a bucket soil auger and Dutch clay auger (photographs of the soils were taken). Each auger point was marked with a handheld Global Positioning System (GPS) device. All cored samples were analysed for signs of wetness that indicate wetland associated conditions. Areas denuded of primary vegetation often corresponded to areas that have been tilled, making vegetation and soil profiles poor wetland indicators.

Following the field survey, the data was submitted to a GIS program for compilation of the map sets. Subsequently the field survey and desktop survey data were combined within a single project report.

In order to gauge the Present Ecological State of various wetlands within the study area, a level 1 and level 2 Wet-health assessment was applied in order to assign PES categories to certain wetlands. Wet-Health (Macfarlane *et al., 2*009) is a tool which guides the rapid assessment of a wetland's environmental condition based on a site visit. This involves scoring a number of attributes connected to the geomorphology, hydrology and vegetation, and devising an overall score which gives a rating of environmental condition. Wet-Health is useful when making decisions regarding wetland rehabilitation, as it identifies whether the wetland is beyond repair, whether rehabilitation would be beneficial, or whether intervention is unnecessary, as the wetland's functionality is still intact. Through this method, the cause of any wetland degradation is also identified, and this facilitates effective remediation of wetland damage.

There is wide scope for the application of Wet-Health as it can also be used in assessing the Present Ecological State of wetlands and thereby assist in determining the Ecological

Reserve as laid out under the National Water Act. Wet-Health offers two levels of assessment, one more rapid than the other. For the assessments, an impact and indicator system is used. The wetland is first categorized into the different hydrogeomorphic (HGM) units and their associated catchments, and these are then assessed individually in terms of their hydrological, geomorphologic and vegetation health by examining the extent, intensity and magnitude of impacts, of activities such as grazing or draining. The extent of the impact is measured by estimating the proportion the wetland that is affected. The intensity of the impact is determined by looking at the amount of alteration that occurs in the wetland due to various activities. The magnitude is then calculated as the combination of the intensity and the extent of the impact and is translated into an impact score. This is rated on a scale of 1 to 10, which can be translated into six health classes (A to F – compatible with the ecostatus categories used by DWAF, Table 12). Threats to the wetland and its overall vulnerability can also be assessed and expressed as a likely Trajectory of Change.

Determination of Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze *et al*. (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2010). An example of the scoring sheet is attached as Table 13. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 14.

Table 4: Interpretation of scores for determining present ecological status (Kleynhans 1999)

Rating of Present Ecological State Category (PES Category)
CATEGORY A Score: 0-0.9; Unmodified, or approximates natural condition.
CATEGORY B Score: 1-1.9; Largely natural with few modifications, but with some loss of natural habitats.
CATEGORY C Score: 2 – 3.9; Moderately modified, but with some loss of natural habitats.
CATEGORY D Score: 4 – 5.9; Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
OUTSIDE GENERAL ACCEPTABLE RANGE
CATEGORY E Score: 6 -7.9; Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
CATEGORY F Score: 8 - 10; Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

*: If any of the attributes are rated <2, then the lowest rating for the attribute should be taken as indicative of the PES category and not the mean

Table 5: Example of scoring sheet for Ecological Importance and sensitivity

ECOLOGICAL IMPORTANCE AND SENSITIVITY:			
Ecological Importance	Score (0-4)	*Confidence (1-5)*	**Motivation**
Biodiversity support			
Presence of Red Data species			
Populations of unique species			
Migration/breeding/feeding sites			
Landscape scale			
Protection status of the wetland			
Protection status of the vegetation type			
Regional context of the ecological integrity			
Size and rareity of the wetland type/s present			
Diversity of habitat types			
Sensitivity of the wetland			
Sensitivity to changes in floods			
Sensitivity to changes in low flows/dry season			
Sensitivity to changes in water quality			
ECOLOGICAL IMPORTANCE & SENSITIVITY			

Table 6: Category of score for the Ecological Importance and Sensitivity

Rating	Explanation
Very low (0-1)	Rarely sensitive to changes in water quality/hydrological regime.
Low (1-1.9)	One or a few elements sensitive to changes in water quality/hydrological regime.
Moderate (2-2.9)	Some elements sensitive to changes in water quality/hydrological regime.
High (3-3.5)	Many elements sensitive to changes in water quality/ hydrological regime.
Very high (+3.5)	Very many elements sensitive to changes in water quality/ hydrological regime.