Proposed Tutuka solar photovoltaic facility, Mpumalanga

Wetland Delineation and Functional Assessment

February 2015

Drafted by:

Limosella Consulting Pty Ltd

Reg No: 2014/023293/07

Email: antoinette@limosella.co.za

Cell: +27 83 4545 454

www.limosella.co.za

Prepared for:

Savannah Environmental (Pty) Ltd

1st Floor, Block 2, 5 Woodlands Drive Office Park

Woodmead

2191

Declaration of Independence

I, **Tracey Johnson**, 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 107 of 1998);
» 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 107 of 1998);
» 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; and
» 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.

Tracey Johnson Hydric Soils Specialist SACNASP Reg. No. No: 100006/4	28.02.2015 Date

I, **Robert Taylor**, 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 107 of 1998);
» 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 107 of 1998);
» 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.

Robert Taylor Ecologist/Botanist	28.02.2015 Date

Indemnity

This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as information available at the time of study. Therefore the author reserves the right to modify aspects of the report, including the recommendations, if and when new information may become available from on-going research or further work in this field, or pertaining to this investigation.

Although the author exercised due care and diligence in rendering services and preparing documents, she accepts no liability, and the client, by receiving this document, indemnifies the author against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by the author and by the use of this document.

Qualification of Specialists

Field work, GIS and report writing	Robert Taylor Ecologist/Botanist SACNASP Registration pending
Field work, data analysis and report writing assistance	Tracey Johnson Hydric soils specialist SACNASP Reg. No: 100006/4
Report writing assistance and review	Antoinette Bootsma Ecologist/Botanist/Wetland specialist SACNASP Reg. No. 400222-09

EXECUTIVE SUMMARY

Limosella Consulting (Pty) Ltd was appointed by Savannah Environmental (Pty) Ltd to conduct wetland and riparian delineations and functional assessments to inform the Environmental Authorization process for the development of the Tutuka solar photovoltaic (PV) facility in Mpumalanga. This facility is part of a series of proposed projects to harvest renewable energy to supplement the national power grid.

In accordance with EIA procedure all wetlands on or within 500m of the proposed sites have been delineated and wetland functional assessments conducted. The sites are located within the Soweto Highveld Grassland vegetation type near Standerton. Landscape setting suggested wetlands within the study area were likely to be seeps and/or unchannelled valley bottom wetlands.

Two wetlands, unchannelled valley-bottom wetlands, were located within the study area, as are very similar in there function, type and ecology they have been treated as one wetland for the purpose of the assessments.

The PES scores for the wetland is a D (→) (largely modified) - A large change in ecosystem processes and loss of natural habitat and biota has occurred. The wetland has been modified by several dams, roads and invasion of alien plants. The EIS score of 1.6 falls into a category characterised by moderate ecological importance and sensitivity. Wetlands in this category are considered to be ecologically important and sensitive on a provincial or local scale. According to the generic description of this class the biodiversity of these wetlands are not usually sensitive to flow and habitat modifications.

The wetlands encroach onto the western and eastern section of site alternative 1 and the southern section of site alternative 2. From a wetland function point of view, development should ideally be confined to the central portion of site alternative 1, or the northern portion of site alternative 2. It is important that the following mitigation measures be carefully implemented in order to prevent impacts to regional hydrology:

- The footprint of the development should not encroach onto wetland areas or their associated buffer zones. Boundaries of these sensitive areas should be clearly marked and access prevented
- A stormwater management system must ensure that the quality and quantity of stormwater resulting from the development (construction and operational phase) is the same as the stormwater characteristics prior to development.

Further general potential impacts of the construction as well as operational phase of the proposed solar PV facility include:

- **Clearing/removal of natural vegetation**. Even though development does not encroach onto the wetland areas or their buffer zones, clearing vegetation upland from wetlands may result in increased energy of surface flows resulting in erosion and sedimentation. Plants hold soils in place and trap sediments and attenuate water flow, functions that are lost when vegetation clearing occurs.
- **Mobilization of sediments**. Soil erosion could lead to increased sedimentation and turbidity downstream of the activity, which in turn reduces the water storage capacity thereof, smothers vegetation, and decreases oxygen concentration. If sedimentation is allowed to continue, wetlands will lose their function and likely become invaded by alien invasive plant species.
- **Exposure to erosion**. Removal of wetland vegetation, vegetation against slopes and compaction of soils, expose the resulting bare soils to erosion during rainfall events. Erosion removes the top soil layer, thereby preventing the successful establishment of indigenous vegetation on eroded soils. Eroded areas are likely to be colonised by alien invasive and pioneer plants, or in severe cases, no vegetation will establish causing high velocity runoff during rainfall events and continuous erosion. The occurrence of erosion resulting from the proposed activities should be closely monitored and addressed effectively.

It is important that these potential impacts be noted during the design phase of the project and that all care is taken to minimize these potential impacts. Mitigation measures should be carefully compiled and included into an Environmental Management Programme.

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1 INTRODUCTION

Limosella Consulting (Pty) Ltd was appointed by Savannah Environmental (Pty) Ltd to conduct wetland and riparian delineations and functional assessments to inform the Environmental Authorization process for the development of the Tutuka solar photovoltaic (PV) facility in accordance with the EIA Regulations (No. R. 385, Department of Environmental Affairs and Tourism, 21 April 2010) emanating from Part 5 of the National Environmental Management Act 1998 (Act No. 107 of 1998). The Tutuka solar PV facility is part of a series of proposed projects to harvest renewable energy to supplement the national power grid.

The proposed development of a 65.9MW Solar PV facility (or an alternative 24MW facility) includes the following infrastructure;

» Arrays of PV panels.
» Mounting structures to support the PV panels.
» Cabling between the project components.
» Inverters/transformer enclosures.
» An on-site substation or switching station.
» A power line to facilitate the connection of the solar energy facility to the existing substation/power line at the power station.
» Internal access roads.
» Buildings (which could include workshop area for maintenance and storage, and an on-site office).

Fieldwork was conducted on the 10th of February 2015.

1.1 Terms of Reference

The terms of reference for the study were as follows:
» Delineate the wetland areas;
» Classify the watercourse according to the system proposed in the national wetlands inventory if relevant,
» Undertake the functional assessment of wetlands areas within the area assessed;
» Discuss potential impacts and possible mitigation and management procedures relevant to the conservation of wetland areas on and near the site.

1.2 Assumptions and Limitations

» A detailed field study was conducted from a once off field trip and thus would not depict any seasonal variation in the wetland plant species composition and richness.

- Extensive disturbance in the soil, from activities such as ploughing or earthworks, may confound the determination of the wet- and up-land interface.
- Floodline calculation, groundwater and hydrological processes fall outside the scope of wetland and riparian delineation and functional assessments discussed in this report.
- The GPS used for wetland and riparian delineations is accurate to within five meters. Therefore, the wetland delineation plotted digitally may be offset by up to five meters to either side. Additional inaccuracies may arise from during the course of converting spatial data to final drawings. The scale at which maps and drawings are presented in the current report may become distorted should they be reproduced by for example photocopying and printing.
- All wetlands within 500m of construction activities should be identified as per the DWA Water Use Licence application regulations. In order to meet the timeframes and budget constraints for the project, wetlands within the study site will be delineated on a fine scale based on detailed soil and vegetation sampling. Wetlands that fall outside of these sites, but that fall within 500m of the proposed activities will be delineated based on desktop analysis of vegetation gradients visible from aerial imagery.

1.3 Definitions and Legal Framework

This section outlines the definitions, key legislative requirements and guiding principles of the wetland study and the Water Use Authorisation process.

The National Water Act, 1998 (Act No. 36 of 1998) [NWA] provides for constitutional water demands including pollution prevention, ecological and resource conservation and sustainable utilisation. In terms of this Act, all water resources are the property of the State and are regulated by the Department of Water Affairs (DWA). The NWA sets out a range of water use related principles that are to be applied by DWA when taking decisions that significantly affect a water resource. The NWA defines a water resource as including a watercourse, surface water, estuary or aquifer. A watercourse includes a river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake, pan or dam, into which or from which water flows; any collection of water that the Minister may declare to be a watercourse; and were relevant its beds and banks.

The NWA defines a wetland 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." In addition to water at or near the surface, other distinguishing indicators of wetlands include hydromorphic soils and vegetation adapted to or tolerant of saturated soils (DWA, 2005).

Riparian habitat often perform important ecological and hydrological functions, some similar to those performed by wetlands (DWA, 2005). Riparian habitat is also the accepted indicator used to delineate the extent of a river's footprint (DWAF, 2005). It is defined by the NWA as follows: "Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse, which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas".

Water uses for which authorisation must be obtained from DWA are indicated in Section 21 of the NWA. Section 21 (c) and (i) is applicable to any activity related to a wetland:
Section 21(c): Impeding or diverting the flow of water in a watercourse; and
Section 21(i): Altering the bed, banks, course or characteristics of a watercourse.

Authorisations related to wetlands are regulated by Government Notices R.1198 and R.1199 of 18 December 2009. GN 1198 and 1199 of 2009 grants General Authorisation (GA) for the above water uses on certain conditions:
GN R.1198: Any activity in a wetland for the rehabilitation of a wetland for conservation purposes.
GN R.1199: Any activity more than 500 m from the boundary of a wetland.

These regulations also stipulate that these water uses must the registered with the responsible authority. Any activity that is not related to the rehabilitation of a wetland and which takes place within 500 m of a wetland are excluded from a GA under either of these regulations. Wetlands situated within 500 m of proposed activities should be regarded as sensitive features potentially affected by the proposed development (GN 1199). Such an activity requires a Water Use Licence (WUL) from the relevant authority.

In addition to the above, the proponent must also comply with the provisions of the following relevant national legislation, conventions and regulations applicable to wetlands and riparian zones:

- Convention on Wetlands of International Importance - the Ramsar Convention and the South African Wetlands Conservation Programme (SAWCP).
- National Environmental Management Act, 1998 (Act No. 107 of 1998) [NEMA].
- National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004).
- National Environment Management Protected Areas Act, 2003 (Act No. 57 of 2003).
- Regulations GN R.543, R.544 and R.545 of 2010, promulgated under NEMA.
- Conservation of Agriculture Resources Act, 1983 (Act 43 of 1983).
- Regulations and Guidelines on Water Use under the NWA.
- South African Water Quality Guidelines under the NWA.
- Mineral and Petroleum Resources Development Act, 2002 (Act No. 287 of 2002).

1.4 Locality of the study site

The study sites are located around the Tutuka Power Station (S26° 46.5' E29° 21') in the Lekwa municipality, Mpumalanga, approximately 23 km northeast of Standerton. The sites consist of an alternative site 1 of 98.8 ha, abutting the southern section of the power station, and an alternative site 2 of 36 ha, immediately southeast of the power station (Fig. 1). The sites are on portions 4, 10, 11 and 12 of farm Pretorius Vley 374 IS.

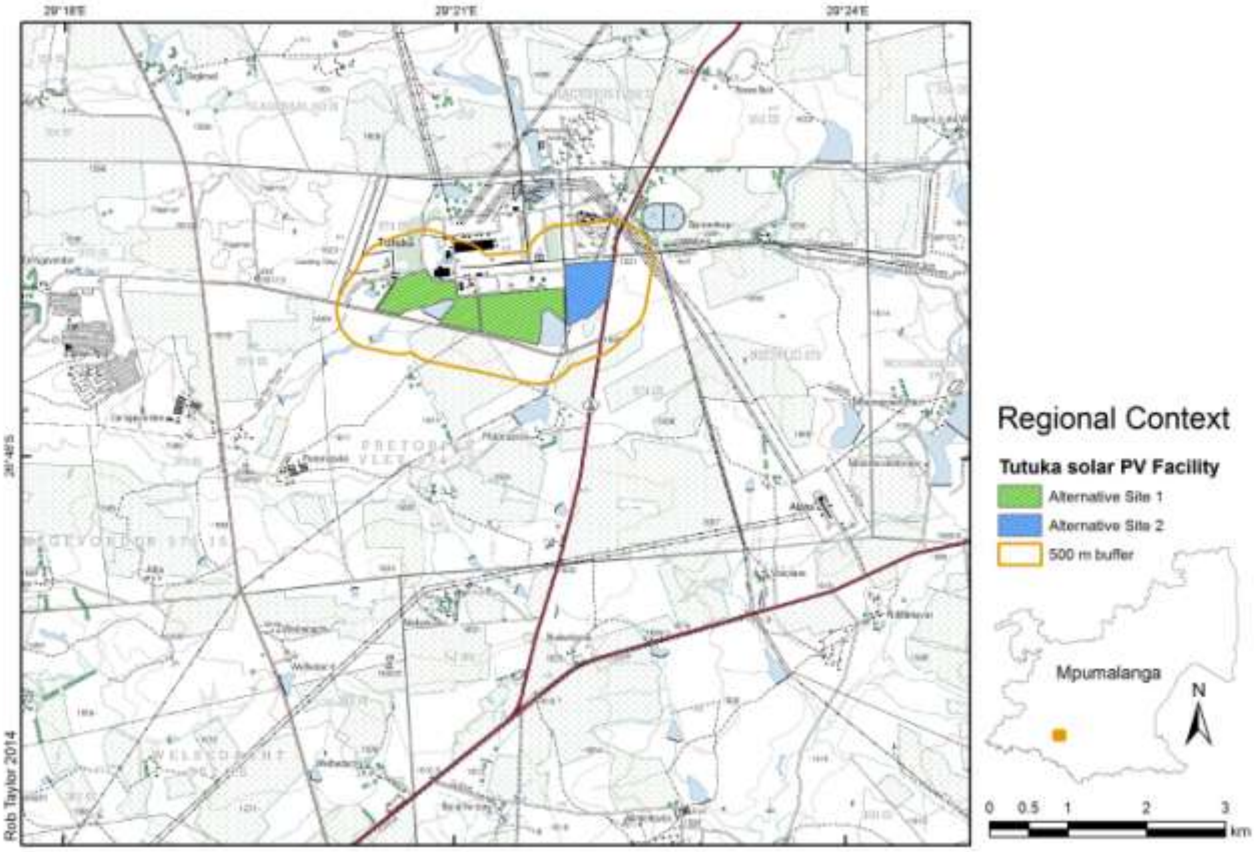


Figure 1: Regional context of the study sites (extracted from NGI 1:50 000 topo-cadastral maps)

1.5 Description of the Receiving Environment

A review of available literature and spatial data formed the basis of a characterisation of the biophysical environment in its theoretically undisturbed state and consequently an analysis of the degree of impact to the ecology of the study site in its current state.

1.5.1 Geology and Soils

The study site falls on Karoo dolerite. Soils are Vertisols, dark clay rich soils that form cracks upon desiccation with a very low erosion potential (Jones *et al.,* 2013). Water movement is limited through the soil and swelling and shrinking can be detrimental to foundations.

1.5.2 Regional Vegetation

The study sites fall within Soweto Highveld Grassland vegetation type (Mucina and Rutherford, 2006). In its undisturbed state this vegetation type is a short to medium-high densely tufted grassland, dominated by *Themeda triandra*. This vegetation type has been listed as endangered as only a small portion remains untransformed due to urban sprawl, mining activities and the building of dams. The relevant National Freshwater Ecosystem Priority Area (NFEPA) WetVeg Group is the Mesic Highveld Grassland Group 3 (Nel *et al.,* 2011).

1.5.3 Regional Hydrology

This relatively flat (~0.6% south facing slope) study area contains a cluster of NFEPA wetlands. Wetlands appear to form within the study sites draining into earthen dams located within the 500m buffer zone (Fig. 2). Inspection of aerial photos from 2012, provided by the office of the surveyor general, showed no obvious rivers or channelled waterways on or within 500m of the sites although furrows have been dug to drain water off the power station and onto the sites.

1.5.4 Quaternary Catchments

The study site falls within the quaternary catchment C11K. In this catchment the mean annual precipitation is lower than the potential evapotranspiration and as such any wetlands in this catchment would rely largely on regional hydrology for their source of water (water supplied by rainfall is unlikely to be enough to support these wetlands). These wetlands are sensitive to any changes in the volume and duration of the water supplied by regional hydrology.

2 METHODOLOGY

The delineation methodology documented in the "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008), the "Minimum Requirements for Biodiversity Assessments" (GDACE, 2009) and the "Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems" (Ollis *et al,* 2013) was followed throughout the field survey.

A hand held GPS was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and recent aerial imagery were used as reference material for the mapping of the preliminary wetland boundaries. These were converted to digital image backdrops and delineation boundaries were imposed accordingly after the field survey.

2.1 Wetland and Riparian Delineation

Wetlands were identified based on one or more of the following characteristic attributes (DWAF, 2005):

- The Terrain Unit Indicator;
- The presence of plants adapted to or tolerant of saturated soils (hydrophytes);
- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation; and
- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing within 50cm of the soil surface.

Wetlands were delineated up to the interface of the temporary wetland zone and the upland zone (Fig. 2). A recommended buffer will be added to the perimeter of the wetland to reduce impacts of construction on the wetlands.

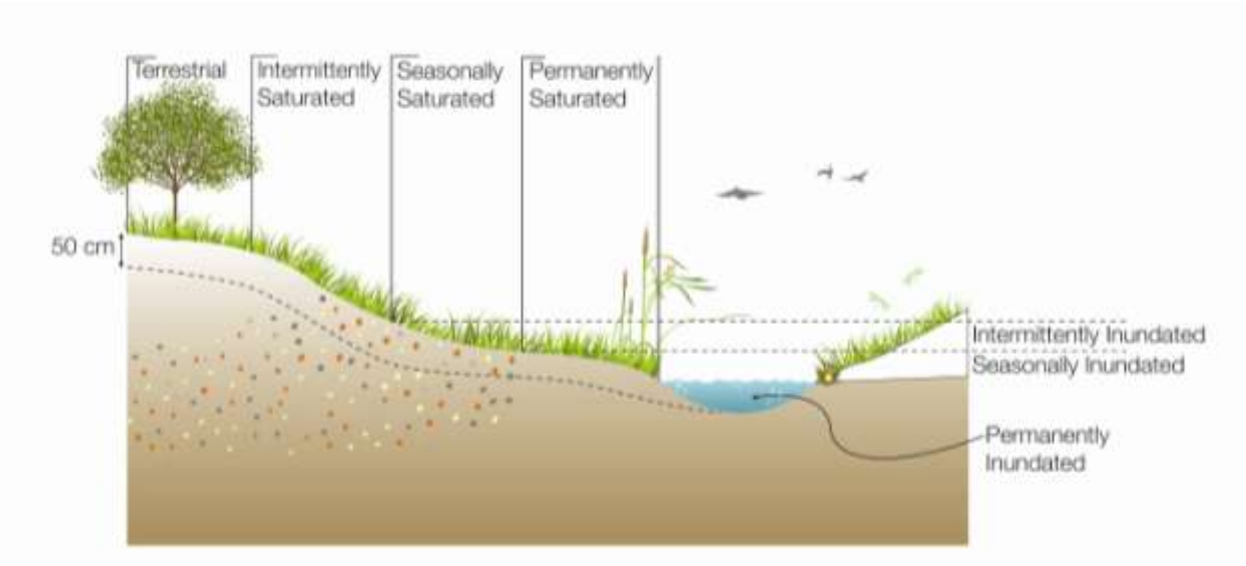


Figure 2. Typical Cross section of a wetland showing the temporary, seasonal, and permanent zones (Ollis, 2013)

Riparian habitat is classified as physical structure and the associated vegetation in areas adjacent to, or associated with a macro stream channel. This habitat can often be identified by its alluvial soils which are inundated or flooded with a frequency sufficient to support species composition and structure distinct from adjacent lands (National Water Act No 36 of 1998). Riparian habitat can be divided in to three distinct zones; marginal, lower, and upper zones (Fig. 3).

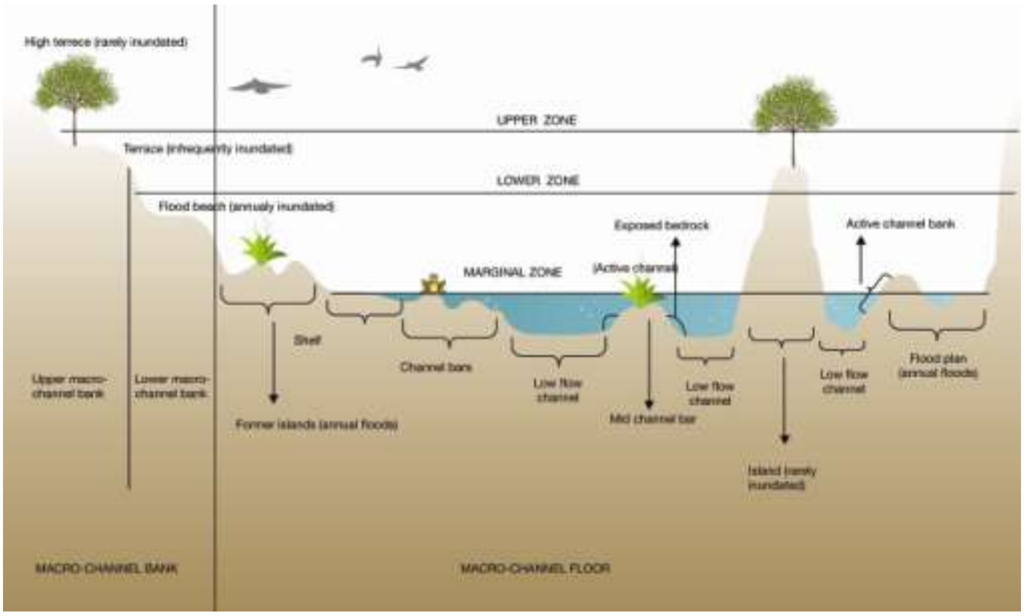


Figure 3. Schematic diagram illustrating the three riverine zones relative to geomorphic diversity (Kleynhans et al. 2007)

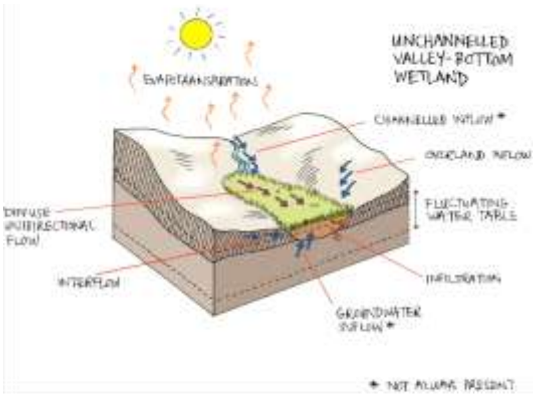
2.2 Wetland Classification and Delineation

The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification (SANBI, 2009). The current wetland study follows the same approach by classifying wetlands in terms of a functional unit in line with a level three category recognised in the classification system proposed in SANBI (2009). HGM units take into consideration factors that determine the nature of water movement into, through and out of the wetland system. In general HGM units encompass three key elements (Kotze *et al,* 2005):

- » 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);
- » Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
- » Hydrodynamics - This refers to how water moves through the wetland.

The wetland HGM types relevant to the study area are discussed below.

Table 1. Description of Hydrogeomorphic wetland type relevant to the study area

Hydro-geomorphic types (Ollis *et al,* 2013)	Description (Kotze *et al,* 2005)
Unchannelled Valley-bottom Wetlands 	Unchannelled Valley-bottom Wetlands are characterised by their location on valley floors, their absence of distinct channeled banks and prevalence of diffuse flows. These wetlands occur where a river loses its confinement (often brought ablout by a change in gradient) or at the downstream end of a seep.

2.3 Buffer Zones

A buffer zone is defined as a strip of land surrounding a wetland or riparian area in which activities are controlled or restricted (DWAF, 2005). A development has several impacts on the surrounding environment and on a wetland. The development changes habitats, the ecological environment, infiltration rate, amount of runoff and runoff intensity of the site, and therefore the water regime of the entire site. An increased volume of stormwater runoff, peak discharges, and frequency and severity of flooding is therefore often characteristic of transformed catchments. The buffer zone identified in this report serves to highlight an ecologically sensitive area in which activities should be conducted with this sensitivity in mind. Buffer zones have been shown to perform a wide range of functions and have therefore been widely proposed as a standard measure to protect water resources and their associated biodiversity. These include (i) maintaining basic hydrological processes; (ii) reducing impacts on water resources from upstream activities and adjoining land uses; (iii) providing habitat for various aspects of biodiversity. A brief description of each of the functions and associated services is outlined in Table 2 below.

Table 2. Generic functions of buffer zones relevant to the study site (adapted from Macfarlane et al, 2010)

Primary Role	Buffer Functions
Maintaining basic aquatic processes, services and values.	» Groundwater recharge: Seasonal flooding into wetland areas allows infiltration to the water table and replenishment of groundwater. This groundwater will often discharge during the dry season providing the base flow for streams, rivers, and wetlands.
Reducing impacts from upstream activities and adjoining land uses	» Sediment removal: Surface roughness provided by vegetation, or litter, reduces the velocity of overland flow, enhancing settling of particles. Buffer zones can therefore act as effective sediment traps, removing sediment from runoff water from adjoining lands thus reducing the sediment load of surface waters. » Removal of toxics: Buffer zones can remove toxic pollutants, such hydrocarbons that would otherwise affect the quality of water resources and thus their suitability for aquatic biota and for human use. » Nutrient removal: Wetland vegetation and vegetation in terrestrial buffer zones may significantly reduce the amount of nutrients (N & P), entering a water body reducing the potential for excessive outbreaks of microalgae that can have an adverse effect on both freshwater and estuarine environments. » Removal of pathogens: By slowing water contaminated with faecal material, buffer zones encourage deposition of pathogens, which soon die when exposed to the elements.

Despite limitations, buffer zones are well suited to perform functions such as sediment trapping, erosion control and nutrient retention which can significantly reduce the impact of activities taking place adjacent to water resources. Buffer zones are therefore proposed as a standard mitigation measure to reduce impacts of land uses / activities planned adjacent to water resources. These must however be considered in conjunction with other mitigation measures.

Local government policies require that protective buffer zones be calculated from the outer edge of the temporary zone of a wetland (KZN DAEA, 2002; CoCT, 2008; GDACE, 2009). This report suggests that a generic 30 m buffer zone be applied to the outer edge of the wetlands.

2.4 Wetland and Riparian Functionality and Integrity Assessments

In order to inform the water use licence application process, an analysis of wetland and riparian functionality and integrity must be undertaken. The hydrological, geomorphological and vegetation integrity was assessed for the wetlands in the study site to provide a Present Ecological Status (PES) score (Macfarlane *et al,* 2007)**,** and an Environmental Importance and Sensitivity category (EIS) (DWAF, 1999). The functional assessment methodologies presented below take into consideration recorded impacts in various ways to determine the scores attributed to each wetland.

2.4.1 Ecological Importance and Sensitivity

Ecological Importance and Sensitivity (EIS) relates to the importance of a wetland with regard to its ecological diversity and function, and its ability to resist or recover from disturbance. The Department of Water Affairs and Forestry (1999) provided a guideline for scoring a wetland's EIS using a series of determinants based on indigenous species and habitats found in the wetland. Each determinant is assessed on a scale of 0 to 4 (0 being not important and 4 having a very high importance. Each score needs to be substantiated and a confidence rating given. These scores are then used to determine the EIS status (Table 3). This classification allows or an appropriate ecological management class to be allocated to the wetland.

Table 3. EIS categories with an interpretation of median scores for biotic and habitat determinants. (DWAF, 1999)

Ecological Importance and Sensitivity Categories	Median score	EIS category
Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water in major rivers	>3 and <=4	Very High
Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers	>2 and <=3	High
Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers	>1 and <=2	Moderate
Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water in major rivers	>0 and <=1	Low

2.4.2 Present Ecological Status

WET-Health is a tool to assess the health of a wetland, where health is a measure of the deviation of a wetlands structure and function from its natural reference condition (Macfarlane *et al*, 2007). WET-Health separates wetlands into Hydrogeomorphic (HGM) units based on their landform and hydrological characteristics. Each HGM unit is analysed separately for changes three primary modules namely; hydrology (activities affecting water supply and timing as well as water distribution and retention within the wetland), geomorphology (presence of indicators of excessive sediment inputs and/or outputs), and vegetation (changes in vegetation composition and structure due to site transformation or disturbance). The magnitude of each impact is calculated from both the extent and the intensity of the activity. The impacts of all the activities in the HGM unit are combined to calculate the Present Ecological Status (PES) score for each module. This score provides an understanding of the current condition of the wetland (Table 4). A trajectory class is allocated to indicate the predicted change in wetland health over the next 5 years (Table 5).

Table 4. Health categories used by WET-Health for describing the integrity of wetlands (Macfarlane et al, 2007)

Description	Impact Score Range	PES Score	Summary
Unmodified, natural.	0-0.9	A	Very High
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B	High
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C	Moderate
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4-5.9	D	Moderate
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E	Low
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F	Very Low

Table 5. Trajectory class, change scores and symbols used to evaluate trajectory of change to wetland health (Macfarlane et al, 2007)

Change Class	Description	Symbol
Improve	Condition is likely to improve over the over the next 5 years	(↑)
Remain stable	Condition is likely to remain stable over the next 5 years	(→)
Slowly deteriorate	Condition is likely to deteriorate slightly over the next 5 years	(↓)
Rapidly deteriorate	Substantial deterioration of condition is expected over the next 5 years	(↓↓)

3 RESULTS

3.1 Land Use and Land Cover

The study site is bordered by the Tutuka power station in the north and farm land in the south (Fig. 4). The study sites have been largely modified by dams, large drains, scattered building rubble and alien plant infestations (Fig. 5). Gravel roads encompass the site on all sides. A large part of the site still hosts natural grassland and a diverse range of forbs, notably: a large colony of *Hypoxis rigidula* in the eastern wetland.

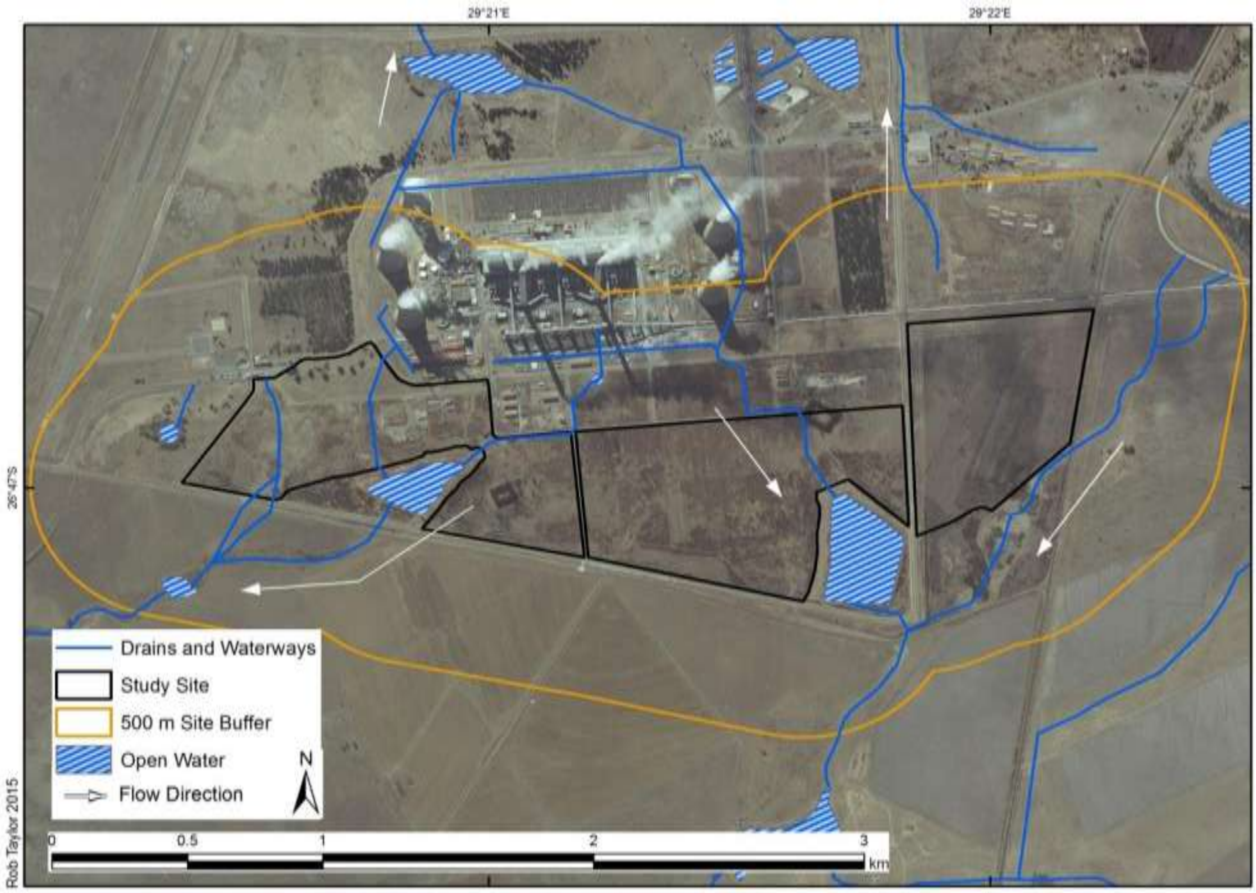


Figure 4. Local context of the study site relative to the Tutuka power station, with the waterways and drains, and direction of flow indicated.

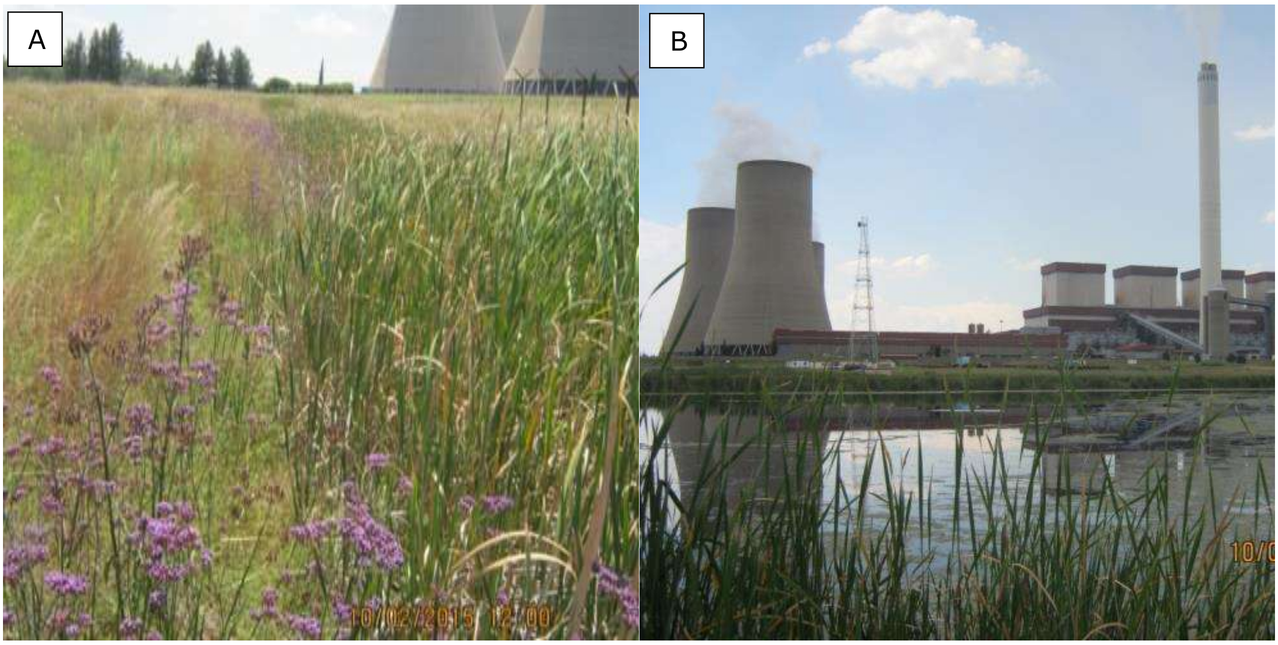


Figure 5. Some of the disturbances on the site included large drains and alien plants (*Verbena bonariensis* growing along a drain pictured in **A**) and dams (**B**).

3.1.1 Soil Indicators

Soils were used extensively for delineating the wetlands on site. Wetland soil types found on site included: Katspruit (Orthic A /G horizon), Glenrosa (Othic A / Lithocutanic B), Rensberg (Vertic A / G horizon). Signs of wetness that were used to delineate the wetland boundary included red and yellow mottles and soft and hard plinthic nodules (Fig. 6).

Figure 6. Examples of some of the wetland indicators found in the soil. Red mottles, haematite, (**A**) and yellow mottles, goethite, (**B**) form under fluctuating water table where the iron accumulates during redox. Soft plinthic showing a goethite nodule (**C**) - formed over many years of a fluctuating water table and an accumulation of iron and manganese mottles.

3.1.2 Vegetation Indicators

Wetland plants were an important indicator for the delineation process. *Typha capensis* (Bulrush) and *Phragmites australis* were found in ponding water, while a community of wetland species indicated the extent of the permanent, seasonal and temporary zones. Some common obligate and facultative wetland species used to delineate the wetlands were: *Paspalum dilatatum, Agrostis lachnantha*, *Sorghum bicolor, Imperata cylindrica, Andropogon eucomus* (Snowflake grass), *Cyperus denudatus, Cyperus congestus, Juncus effuses* and *Verbena bonariensis.* Several of these species are shown in Figure 7. For the most part wetland plant community correlated with the soils except for where disturbance had altered the plant community.

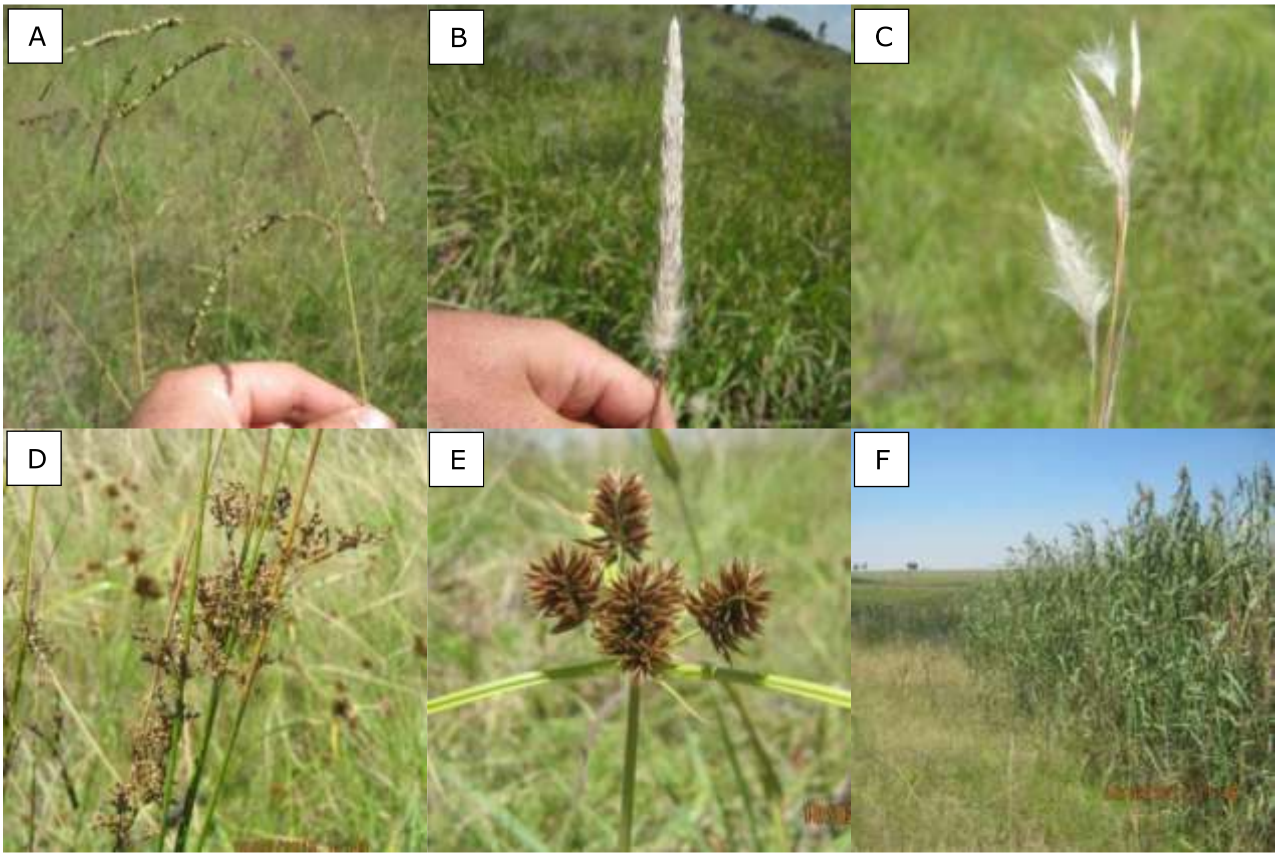


Figure 7. Examples of some wetland indicator species found. **A:** *Paspalum dilatatum* – facultative wetland species, **B:** *Imperata cylindrica* – obligate wetland species, **C:** *Andropogon eucomus* (Snowflake grass) – obligate wetland species, **D:** *Juncus effusus* – obligate wetland species, **E:** *Cyperus congestus* – facultative wetland species, **F:** *Phragmites australis* – obligate wetland species.

3.2 Wetland Classification and Delineation

Two wetlands were delineated on the study site both being unchannelled valley-bottom wetlands. Figure 9 shows the delineated wetlands together with the 30m wetland buffers. 25.5ha of wetland is located on the alternative site 1 and 4.12ha of wetland on the alternative site 2.

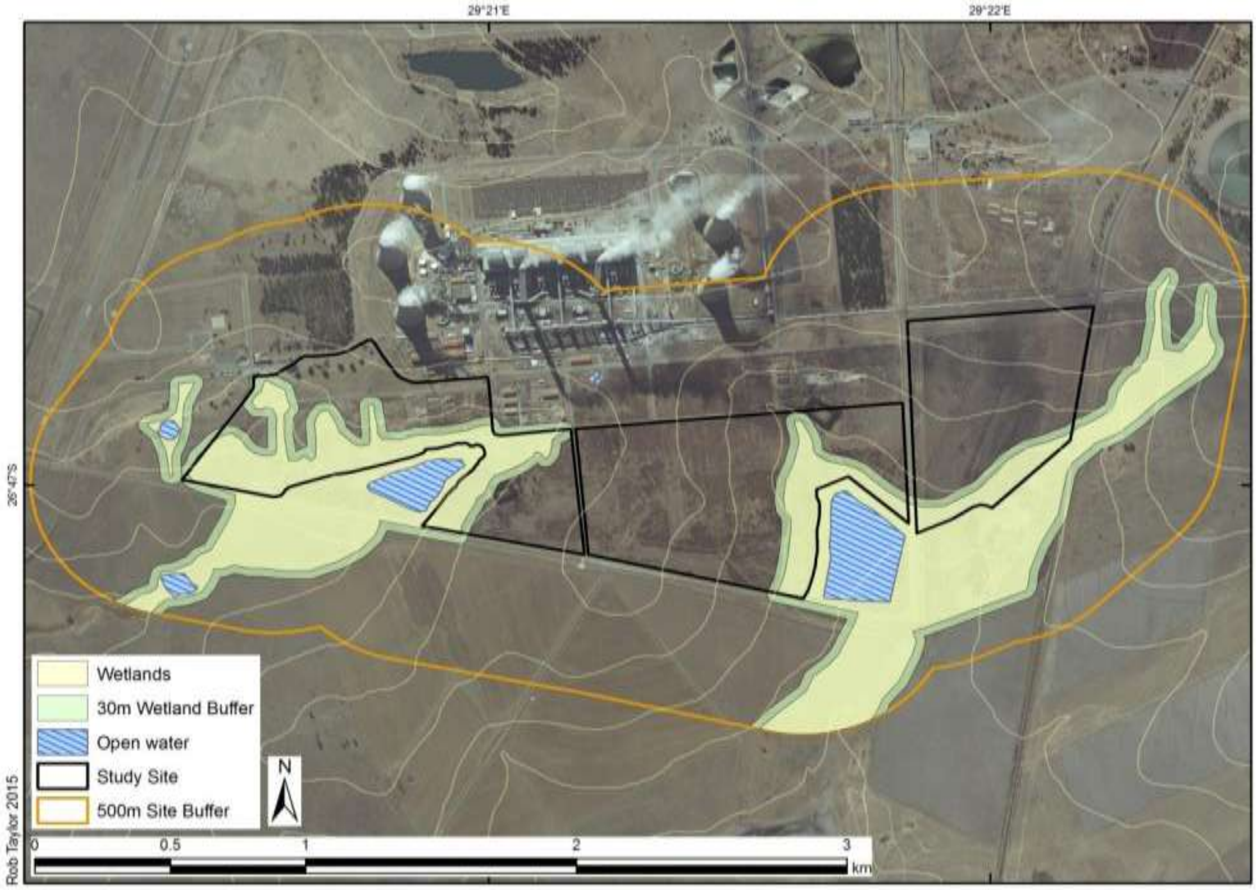


Figure 8. The wetlands and wetland buffers on the study site. All wetlands within a 500m buffer of the construction are prescribed by the DWA as relevant to the Water Use Licence application process.

3.3 Wetland Functional Assessment

The two wetlands in the study site are very similar in there function, type and ecology. They merge shortly downstream of the study area and as such they will be treated as one wetland for the purpose of these assessments.

3.3.1 Present Ecological Status (PES)

A major impact on this wetland has been the construction of earthen dams. These dams have flooded large parts of the wetland and are impeding low flows. Several roads also impede the flow of water.

Several large drains drain areas of infrastructure and hardened surfaces from the power station, increasing storm water peak flows. Additional drains drain some of the wetlands extracting water to outside of the study site.

The disturbance has led to an invasion of alien plants. Unless actively controlled, the area and density of alien plants will increase in future years.

The combined PES score for all the wetlands on site is a D (→) - largely modified - A large change in ecosystem processes and loss of natural habitat and biota has occurred. The condition of this wetland is expected to remain in a steady state over a five year timeframe (Macfarlane *et al*, 2007). The scores are summarised in the tables below (Table 6 & Table 7):

Table 6. Summary of hydrology, geomorphology and vegetation health assessment for the wetlands on the study site (Macfarlane *et al,* 2009).

Wetland Unit		Hydrology		Geomorphology		Vegetation	
		Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Unchannelled valley-bottom		6.5	0	2	0	3.66	-1
PES Category and Projected Trajectory		**E**	**→**	**C**	**→**	**C**	**↓**

Table 7. Combined PES score for the all the wetlands on site (Macfarlane *et al,* 2009).

	Impact Score	Category	Change score	Change Symbol	Health class
Overall Health Score for the Entire Wetland	**4.4**	**D**	**-0.33**	**→**	**D (→)**

3.3.2 Ecological Importance and Sensitivity (EIS)

An EIS score of 1.67 was calculated for the wetlands, placing them in the moderate importance and sensitivity category. Wetlands in this category are considered to be ecologically important and sensitive on a provincial or local scale (DWAF, 1999). The wetlands have been modified and as such no important or sensitive biota were found.

3.4 Impacts

This section discusses the impacts to the wetland expected to arise with the construction of a Solar PV facility.

The solar PV facility will have several impacts on the surrounding environment and wetland. The earth works, construction and operation of the facility will change habitats and the ecological environment, infiltration rates, amount of runoff and runoff intensity of storm-water, and therefore the hydrological regime of the site.

Potential impacts to be taken into account include:

- Loss and disturbance of wetland habitat and fringe vegetation.
- Introduction and spread of alien invasive vegetation.
- Changes in the amount of sediment entering the system.
- Changes in water quality due to toxic contaminants and increased nutrient levels entering the system.
- Changes in water flow regime due to the alteration of surface characteristics.

These impacts and are assessed as recommended by the guidelines supplied by Savannah Environmental (Pty) Ltd. This impact evaluation will assess and rate the extent, magnitude, duration and significance of each potential impact together with possible mitigation measures.

3.4.1 *Loss and disturbance of wetlands and wetland fringe habitat*

Nature: Loss and disturbance of wetland habitat and fringe vegetation due to direct development on the wetland as well as changes in management, fire regime and habitat fragmentation.		
	Without mitigation	With mitigation
Extent	Moderate (3)	Low (1)
Duration	Permanent (5)	Permanent (5)
Magnitude	Very high (10)	Slight (4)
Probability	Highly probable (4)	Improbable (2)
Significance	72 (High)	20 (Low)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes

Can impacts be mitigated?	Yes	

Mitigation:

- » The development footprint should be designed around current wetland and wetland buffers.
- » Where wetlands will be lost to the development footprint, those wetlands that are least disturbed and show near natural conditions and functionality should be given priority for conservation.
- » Where wetlands are lost, compensation should be made to protect the remaining wetlands and their catchments, increase their buffers and rehabilitate their condition and functionality.

Cumulative impacts:

Any loss of wetlands will add to the overall loss of wetlands in the region.

Residual impacts:

Once lost it is unlikely that a wetland can be rehabilitated to its original state and functionality.

3.4.2 *The introduction and spread of alien invasive species*

Nature:

Introduction and spread of alien invasive vegetation due to both opportunistic invasions after disturbance and the introduction of seed in building materials and on vehicles. Invasions of alien plants can impact on hydrology, by reducing the quantity of water entering a wetland, and outcompete natural vegetation, decreasing the natural biodiversity. Once in a system alien invasive plants can spread through the catchment.

	Without mitigation	**With mitigation**
Extent	Medium (3)	Low (1)
Duration	Permanent (5)	Medium-term (3)
Magnitude	Moderate (6)	Small (0)
Probability	Highly probable (4)	Improbable (2)
Significance	56 (Medium)	8 (Low)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	No
Can impacts be mitigated?	Yes	

Mitigation:

- » Weed control
- » Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area and returning it where possible afterwards.
- » Rehabilitate or revegetate disturbed areas
- » Monitor the establishment of alien invasive species within the areas affected by the

construction and maintenance and take immediate corrective action where invasive species are observed to establish.
Cumulative impacts: If allowed to seed before control measures are implemented alien plans can easily colonise and impact on downstream users. Alien plants can form dense thickets which replace indigenous wetland habitats and their natural flow regime. This will result in a loss of wetland species and wetland functioning.
Residual impacts: After clearing of invasive plants their seeds may remain dormant in the soil for many years and will require extensive follow-up control measures.

3.4.3 *Changes in the amount of sediment entering the system*

Nature:
Changes in the amount of sediment entering the system due to earthworks and soil disturbance as well as the removal of natural vegetation. This could result in sedimentation of the wetland and increase the turbidity of the water.

	Without mitigation	With mitigation
Extent	Moderate (3)	Low (1)
Duration	Permanent (5)	Medium-term (3)
Magnitude	Moderate (6)	Slight (4)
Probability	Very probable (4)	Improbable (2)
Significance	56 (Moderate)	16 (Low)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	

Mitigation:

» Formalise access roads and make use of existing roads and tracks where feasible, rather than creating new routes through naturally vegetated areas.

» Retain vegetation and soil in position for as long as possible, removing it immediately ahead of construction / earthworks in that area.

» A vegetation rehabilitation plan should be implemented. Grassland can be removed as sods and stored within transformed vegetation. The sods must preferably be removed during the winter months and be replanted by latest springtime. The sods should not be stacked on top of each other or within sensitive environs. Once construction is completed, these sods should be used to rehabilitate the disturbed areas from where they have been removed. In the absence of timely rainfall, the sods should be watered well after planting and at least twice more over the next 2 weeks.

» Remove only the vegetation where essential for construction and do not allow any disturbance to the adjoining natural vegetation cover. » Cordon off areas that are under rehabilitation as no-go areas using danger tape and steel droppers. If necessary, these areas should be fenced off to prevent vehicular, pedestrian and livestock access. » Protect all areas susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and work areas. » Runoff from roads must be managed to avoid erosion and pollution problems. » Source-directed controls » Maintain buffer zones to trap sediments
Cumulative impacts: Additional sediments would lead to increase turbidity downstream which will put additional stress on aquatic life and loss of sensitive biota. Also loss of wetland habitat is expected in the case of sedimentation as open permanent wet areas may become silted up. Downstream dams and weirs will face a reduction in capacity due to sedimentation.
Residual impacts: Once sensitive biota are lost from a system it can take many years to recolonize.

3.4.4 *Changes in water quality*

Nature:
Changes in water quality due to toxic contaminants and changes in nutrients is largely caused by discharge of solvents and other industrial chemicals, leakage of fuel/oil from vehicles and the disposal of sewage. This could result in the loss of sensitive biota in the wetlands and a reduction in wetland function.

	Without mitigation	With mitigation
Extent	Moderate (3)	Low (1)
Duration	Medium-term (3)	Medium-term (3)
Magnitude	Moderate (6)	Minor (2)
Probability	Highly probable (4)	Improbable (2)
Significance	48 (Moderate)	12 (Low)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	

Mitigation:
» After construction, the land must be cleared of rubbish, surplus materials, and equipment, and all parts of the land shall be left in a condition as close as possible to that prior to use.
» Ensure that maintenance work does not take place haphazardly, but, according to a fixed

plan, from one area to the other.
- Maintenance of construction vehicles
- Control of waste discharges
- Guidelines for implementing Clean Technologies
- Maintenance of buffer zones to trap sediments with associated toxins
- All potentially polluting and hazardous substances used and stored on site should be stored in clearly demarcated areas away from storm water.

Cumulative impacts:
The addition of toxic contaminants will impact on downstream ecosystems resulting in the loss of sensitive biota. Bioaccumulation of toxins in the food chain can be harmful especially to predators higher up in the food chain. Nitrification can lead to algal blooms that reduce the oxygen levels in the water causing anaerobic conditions.

Residual impacts:
Once sensitive biota are lost from a system it can take many years to recolonize. Once in the system it may take many years for some toxins to be eradicated.

3.4.5 *Changes in water flow regime due to the alteration of surface characteristics*

Nature:
Changes in water flow regime due to the alteration of surface characteristics (the compaction of soil, the removal of vegetation, surface water redirection and infrastructure) is likely to increased peak flows and decrease flood attenuation. Increased storm water discharge could result soil erosion.

	Without mitigation	With mitigation
Extent	Moderate (3)	Low (1)
Duration	Permanent (5)	Medium-term (3)
Magnitude	Moderate (6)	Slight (4)
Probability	Very probable (4)	Improbable (2)
Significance	56 (Moderate)	16 (Low)
Status	Negative	Negative
Reversibility	Low	Low
Irreplaceable loss of resources?	Yes	Yes
Can impacts be mitigated?	Yes	

Mitigation:
- Maintain buffer zones to retard storm water.
- Stormwater should be managed and stormwater discharge points must be suitably protected against erosion

Cumulative impacts:
Increase stromwater will affect downstream users who are dependent on their topsoil and

grass cover for agriculture. A reduced infiltration of water into the soil may reduce low flows that sustain wetlands during dry periods.
Residual impacts: Once topsoil is lost it is hard to replace and revegetate. The disturbance caused by erosion will create a window of opportunity for alien invasive plants to colonise.

4 CONCLUSION

Two unchannelled valley-bottom wetlands are located on the study site. The wetlands have been impacted upon by earthen dams and a network of roads which impede low flows. A network of drains drain direct storm flows off the power station and other hardened surfaces into the wetlands increasing peak flows. Alien plants are spreading through the wetland and outcompeting natural vegetation and reducing flows into the wetlands.

Overall the wetlands on site were largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred. The ecological importance and sensitivity suggests that wetlands in this category are considered to be ecologically important and sensitive on a provincial or local scale. It was recommended that a 30m buffer is set to protect wetland functionality.

The wetlands encroach onto the western section of site alternative 1 and the southern section of site alternative 2. From a wetland function point of view, development should ideally be confined to the central portion of site alternative 1, or the northern portion of site alternative 2. It is important that the following mitigation measures be carefully implemented in order to prevent impacts to regional hydrology:

» The footprint of the development should not encroach onto wetland areas or their associated buffer zones. Boundaries of these sensitive areas should be clearly marked and access prevented
» A stormwater management system must ensure that the quality and quantity of stormwater resulting from the development (construction and operational phase) is the same as the stormwater characteristics prior to development.

Further general potential impacts of the construction as well as operational phase of the proposed solar PV facility include:

» **Clearing/removal of natural vegetation**. Even though development does not encroach onto the wetland areas or their buffer zones, clearing vegetation upland from wetlands may result in increased energy of surface flows resulting in erosion and sedimentation. Plants hold soils in place and trap sediments and attenuate water flow, functions that are lost when vegetation clearing occurs.

- **Mobilization of sediments**. Soil erosion could lead to increased sedimentation and turbidity downstream of the activity, which in turn reduces the water storage capacity thereof, smothers vegetation, and decreases oxygen concentration. If sedimentation is allowed to continue, wetlands will lose their function and likely become invaded by alien invasive plant species.
- **Exposure to erosion**. Removal of wetland vegetation, vegetation against slopes and compaction of soils, expose the resulting bare soils to erosion during rainfall events. Erosion removes the top soil layer, thereby preventing the successful establishment of indigenous vegetation on eroded soils. Eroded areas are likely to be colonised by alien invasive and pioneer plants, or in severe cases, no vegetation will establish causing high velocity runoff during rainfall events and continuous erosion. The occurrence of erosion resulting from the proposed activities should be closely monitored and addressed effectively.

It is important that these potential impacts be noted during the design phase of the project and that all care is taken to minimize these potential impacts. Mitigation measures should be carefully compiled and included into an Environmental Management Programme.

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Appendix A: Points sampled on the study site.

Sample	Lat	Long	Terrain unit	Vegetation	Soil type	Soil wetness	Notes
1	-26.781200	29.345570	3	*Typha capensis, *Cirsium vulgare, *Verbena bonariensis, Cyperus congestus, Sporobolus africanus, Eragrostis curvula, Hyperrhenia hirta, *Paspalum dilatatum, *Tagetes minuta*	**Glenrosa 2220** (Orthic A / Lithocutanic B)	Grey A-low bunk density, possibly ash. Redox morphology at 20 cm (gleyed, signs of wetness, goethite). Saprolite (lithocutanic) at 25 cm. A horizon(bleached)/ Lithocutanic B	Seasonal/ Peramnent Wetland (disturbed, exposed rock)
2	-26.781200	29.345260	3	**Cirsium vulgare, *Tagetes minuta, *Bidens pilosa, *Bromus catharticus, Hyperrhenia hirta*	**Mispah** (Orthic A / Hard rock)	No signsof wetness. Orthic/ hard rock	Dryland (higher than last point)
3	-26.781250	29.344870	3 (4)	**Paspalum dilatatum, *Verbena bonariensis, Cyperus congestus*	**Mispah** (Orthic A / Hard rock) / **Katspruit** (Orthic A / G horizon)	Orthic/ Hard rock. Orthic/ Pedocutanic (signs of wetness at 5 cm). Haematite mottles, structure.	Temporary wetland (lower than last point)
4	-26.781390	29.344300		**Verbena bonariensis, *Cirsium vulgare*			Drain
5	-26.781390	29.344220		*Eragrostis curvula* (dominant), *Eragrostis plana, Aristida junciformis*		No soil point	Upland
6	-26.781560	29.343240		*Aristida difusa, Eragrostis plana*		No soil point	Upland
7	-26.781540	29.343230		Imperata cylindrica, *Verbena bonariensis		No soil point (Carbonate nodules at surface)	Interface
8	-26.781590	29.343020		Andropogon eucomus, Eragrostis plana	**Glenrosa** (Othic A / Lithocutanic B)	None	Upland (Boundary)
9	-26.782150	29.341880		*Paspalum dilatatum, Cyperus congestus	**Katspruit** (Orthic A / G horizon)	Mottles at 10 cm, clayey. Orthic or Melanic/ Grey colours, geothite mottles, few haemathite mottles.	Wetland (within a few meters of boundary)
10	-26.782140	29.341350		**Verbena bonariensis,*Paspalum dilatatum, Eragrostis curvula, Hyperrhenia tamba, *Cosmos bipinnatus, Xysmalobium undulatum*		No soil point	Wetland (Boundary-vegetation)
11	-26.781940	29.346040	4	**Cosmos bipinnatus, *Verbena bonariensis, *Paspalum dilatatum,*		No soil point	Wetland (close to interface)
12	-26.783280	29.349880	3	**Cosmos bipinnatus, Themeda triandra, *Bidens pilosa, Cyperus denudatus*		Signs of wetness within 5 cm, faint small haematite mottles	Temporary wetland

13	-26.782970	29.350600	3	**Cosmos bipinnatus, Agrostis lachnantha *Paspalum dilatatum*	**Mispah** (Orthic A / Hard rock)	Orthic/ Hard rock	Dryland
14	-26.786600	29.360200		*Agrostis lachnantha, *Paspalum dilatatum, *Cosmos bipinnatus*		Dark A/ G horizon. Man-made, coal and ash present. Redox features noted. Structured. Human interference	Wetland (artificial- near pipe)
15	-26.782450	29.351130	3	*Typha capensis, Cyperus congestus, Andropogon eucomus, Juncus effusus*		Not observed	Artificial wetland (permanently wet)
16	-26.782120	29.351670	3	**Paspalum dilatatum, Cyperus congestus, *Bromus catharticus, Hyperrhenia hirta, *Verbena bonariensis, *Bidens pilosa*		Not observed	Interface (vegetation change)
17	-26.782320	29.351970	3	*Cyperus congestus, *Paspalum dilatatum, *Verbena bonariensis*		Not observed	Wetland (boundary)
18	-26.780010	29.355390	1	Typha capensis		Roadside seepage	Wetland (probably artificial due to road)
19	-26.783060	29.362980	3(5)	*Cosmos bipinnatus, themeda triandra, Hypoxis rigidula (not wetland species)	**Rensberg** (Vertic A / G horizon) or **Arcadia** (Vertic A / unspecified)	Vertic, grey colours, small red dots (could be quartz particles)	Not wetland plants, Soils possibly wetland
20	-26.783380	29.362800	3(5)	Setaria sphacelata, *Cosmos bipinnatus, Themeda triandra, Eragrostis plana	**Rensberg** (Vertic A / G horizon)	Vertic, signs of wetness at 20 cm, haemathite mottles.	Permanent wetland (Boundary)
21	-26.786600	29.360200	3(5)	*Paspalum dilatatum, *Cosmos bipinnatus, *Verbena officinalis, Themeda triandra	**Rensberg** (Vertic A / G horizon)	Vertic/ G. Signs of wetness present.	Permanent wetland
22	-26.786350	29.359900	3	*Cosmos bipinnatus, Eragrostis plana, Setaria sphacelata, Panicum sp.	**Rensberg** (Vertic A / G horizon)	Vertic/ G. Slight grey colour variation. Very few Fe colours, possibly quartz particles. Lime	Soils: wetland, Plants: Dryland (Boundary)
23	-26.786180	29.357900	2	*Cosmos bipinnatus, Eragrostis capensis, Eregrostis plana, Themeda triandra, Aristida diffusa, Brachiaria serrata	**Arcadia** (Vertic A / Unspecified)	Not observed	Dryland
24	-26.782590	29.367970	5	*Cosmos bipinnatus, Hyperrhenia hirta, Sorghum bicolor, *Paspalum dilatatum,	**Katspruit** (Orthic A / G horizon)	Orthic/ G, grey colours. Signs of wetness at 20 cm	Seasonal wetland
25	-26.782180	29.367790		Aristida diffusa, Eragrostis plana, *Verbena officinalis, Hyperrhenia tamba	**Katspruit** (Orthic A / G horizon)	Orthic/ G, grey colours.	Plants: Dryland, Soils: Wetland

26	-26.781800	29.367810	3	*Hyperrhenia tamba* - dominant		Light orthic A/ Vertic/ Pedocutanic. Variation in grey, black, brown. Haemathite spots- very small (possibly quarts)	Dryland
27	-26.782580	29.343580					Dryland
28	-26.782550	29.344040					Dryland
29	-26.782390	29.343920		Phragmites australis			Wetland

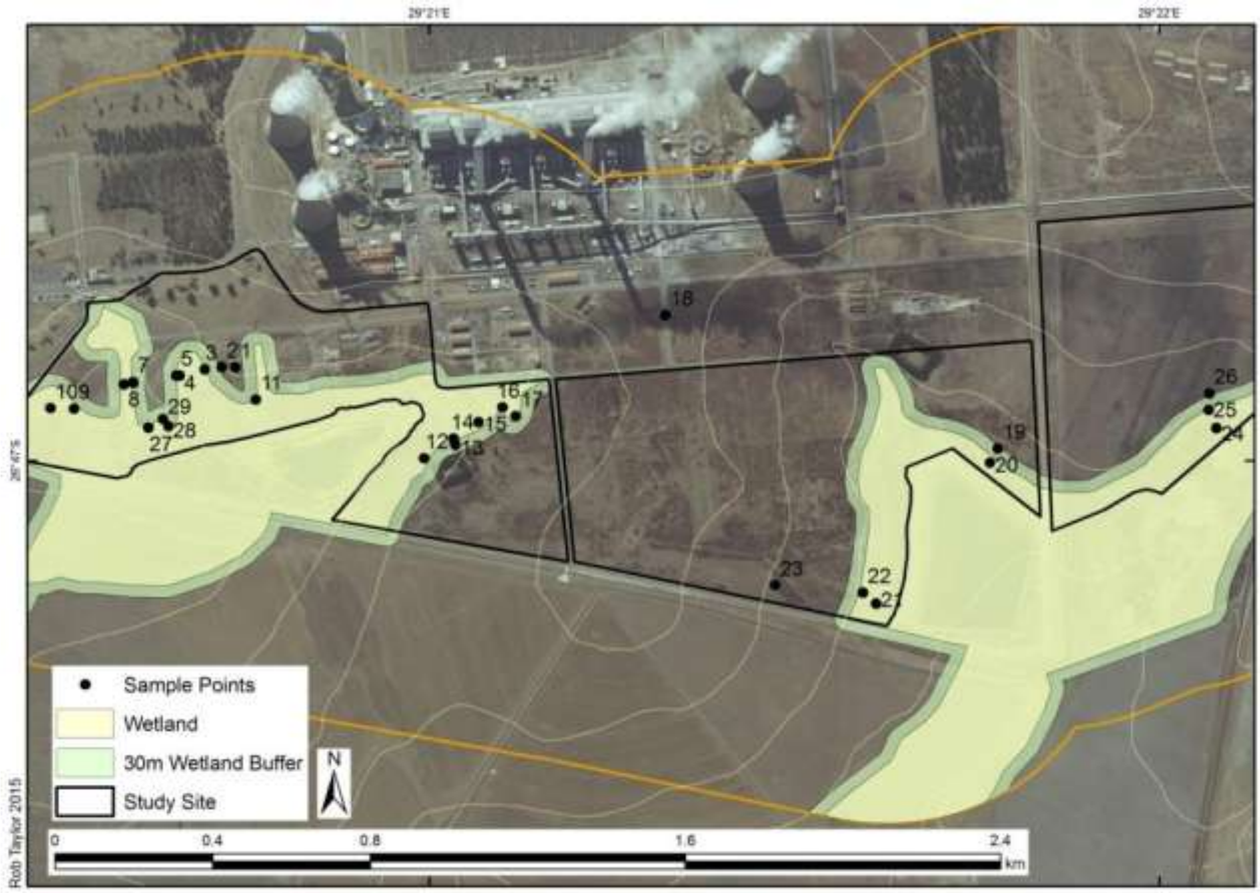

Figure 9. The location of sample points listed in Appendix A.

Appendix B: Summary of PES for the wetland in the study site

Tutuka - combined wetlands **Unchannelled Valley-bottom** **Vulnerability factor: 1**

Hydrological Assessment

			Dominant impacts	Extent (%)	Intensity	Magnitude of impact	Comments
Catchment Impacts	Change in quantity of inflows	Reduced flows	alien plants	30	-5	-1.5	stands of alien plants
		Increased flows	None	0	0	0	
		Overall change in quantity				**-1.5**	
	Alteration of floodpeaks	Reduced floodpeaks	None			0	
		Increased floodpeaks	Hardened surfaces			6	A large area of hardened surfaces draining into wetlands
		Overall change in floodpeaks				**6**	
	Overall score of catchment impacts					**2.5**	

		Dominant impacts	Extent (%)	Intensity	Magnitude of impact	Comments
Onsite Impacts	Impact of canalization on the distribution and retention of water	Drains	50	0.42	0.21	Large drains canalise the wetland
	Stream channel modification	None	0	0	0	
	Impact of impeding features (upstream)	Dams	50	5	2.5	Dam through wetland impending flow
	Impact of impeding features (downstream)	Dams	30	3.2	0.96	Low flows interrupted due to limited flows through dams
	Impact of altered surface roughness	None	0	0	0	
	Impact of direct water loss	Alien plants	30	4.8	1.44	Several gum trees (Eucalyptus sp.), and dense stands of Bidens pilosa, and Cosmos bipinnatus
	Impact of recent deposition/excavation		0	0	0	
	Overall score of on-site activities				**5.11**	

Hydrology Impact Score	**6.5**	
Heath Category	**E**	Very largely modified some natural features still exist.
Anticipated trajectory of change	**→**	

Geomorphology Assessment

	Extent (%)	Intensity	Magnitude of impact	Comments
Impacts of changes in runoff characteristics	50	4	2	modification due to increased floodpeaks
Erosional features	0	0	0.00	
Depositional features	0	0	0	
Loss of organic sediment	0	0	0	

Geomorphology Impact Score	**2.00**	
Heath Category	**C**	Moderatly modified
Anticipated trajectory of change	**→**	

Vegetation Assessment

Disturbance	Extent (%)	Intensity	Magnitude of impact	Comments
Deep flooding	10	10	1	Dams
Shallow flooding	4	4	0.16	
Dense Alien vegetation patches.	30	8	2.4	Dense stands of Bidens pilosa, and Cosmos bipinnatus.
Minimal human disturbances	5	2	0.1	Disturbance from construction, small scale dumping of waste (rubble, wire/cables), coating of coal dust.

Geomorphology Impact Score	**3.66**	
Heath Category	**C**	Moderatly Modified
Anticipated trajectory of change	**↓**	

Appendix C: Summary of EIS

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*	**Motivation**	**Scoring Guideline**
Biodiversity support	**1.67**	**3.33**		
Presence of Red Data species	1	*4*	No rare or endangered species found.	*Endangered or rare Red Data species presence*
Populations of unique species	2	*4*	A large population of Hypoxis rigidula	*Uncommonly large populations of wetland species*
Migration/breeding/feeding sites	2	*2*	Duck nests found, possibly other species	*Importance of the unit for migration, breeding site and/or a feeding.*
Landscape scale	**1.60**	**4.00**		
Protection status of the wetland	1	*4*	Protected under broad national legislation (National Water Act)	*National (4), Provincial, private (3), municipal (1 or 2), public area (0-1)*
Protection status of the vegetation type	2	*4*	Soweto highveld grassland is listed as endangered.	*SANBI guidance on the protection sutatus of the surrounding vegetation*
Regional context of the ecological integrity	2	*4*	regionally important	*Assessment of the PES (habitat integrity), especially in light of regional utilisation*
Size and rareity of the wetland type/s present	2	*4*	Not rare, moderate size	*Identification and rareity assessment of the wetland types*
Diversity of habitat types	1	*4*	Low diversity	*Assessment of the variety of wetland types present within a site.*
Sensitivity of the wetland	**1.67**	**4.00**		
Sensitivity to changes in floods	2	*4*	valley bottom	*floodplains at 4; valley bottoms 2 or 3; pans and seeps 0 or 1.*
Sensitivity to changes in low flows/dry season	2	*4*	Unchanneled valley bottom but damed	*Unchannelled VB's probably most sensitive*
Sensitivity to changes in water quality	1	*4*	Low sensitivity - No sensive species	*Esp naturally low nutrient waters - lower nutrients likely to be more sensitive*
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1.67**	**4.00**	Moderate Importance and sensitivity to flow and habitat modifications.	