FAUNAL, AVIFAUNAL, FLORAL AND WETLAND ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL IMPACT ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED SOLAR PHOTOVOLTAIC POWER PLANT WITH ASSOCIATED INFRASTRUCTURE AT THE ARNOT COAL FIRED POWER STATION, MPUMALANGA PROVINCE

Prepared for

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SECTION D

Wetland Assessment

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1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a faunal, avifaunal, floral and wetland ecological assessment as part of the environmental impact assessment process for the proposed solar photovoltaic power plant with associated infrastructure at the Arnot Coal Fired Power Station, Mpumalanga Province (hereafter referred to as "study area"). The study area is situated within the Arnot Power Station that is located in Arnot suburb in the Middelburg District in Mpumalanga.

1.2 Legislative Requirements

1.2.1 National Environmental Management Act, 1998

- The National Environmental Management Act (Act 107 of 1998) and the associated Regulations (Listing No R. 544, No R. 545 and R. 546) as amended, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment process or the Environmental Impact Assessment (EIA) process depending on the nature of the activity and scale of the impact.

1.2.2 National Water Act, 1998

- The National Water Act (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved.
- According to GN199 of the National Water Act all activities within 500m of a wetland must be authorised in terms of Section 21c and 21l of the National Water Act (Act 36 of 1998).
- No activity may therefore take place within a water course unless it is authorised by the Department of Water Affairs (DWA).
- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWA in terms of Section 21.

2 METHOD OF ASSESSMENT

2.1 Desktop Study

Wetland specific information resources taken into consideration during the desktop assessment of the study area included:

- National Freshwater Ecosystem Priority Areas (NFEPAs), 2011
  - NFEPA water management area (WMA)
  - NFEPA wetlands/ National wetlands map
  - Wetland and estuary FEPA
  - FEPA (sub)WMA % area
  - Sub water catchment area FEPAs
  - Water management area FEPAs
  - Fish sanctuaries
  - Wetland ecosystem types
- Mpumalanga Biobase (2002) were consulted to ascertain the general conservation importance of the study area.

2.2 Classification System for Wetlands and other Aquatic Ecosystems in South Africa

All wetland features encountered within the study area were assessed using the Classification System for Wetlands (hereafter referred to as the 'Classification System') and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis *et al*., 2013).

A summary of Levels 1 to 4 of the Classification System for Inland Systems are presented in Table 1 and 2 below.

Table 1: Classification structure for Inland Systems, up to Level 3.

WETLAND / AQUATIC ECOSYSTEM CONTEXT		
LEVEL 1: SYSTEM	**LEVEL 2: REGIONAL SETTING**	**LEVEL 3: LANDSCAPE UNIT**
Inland Systems	DWA Level 1 Ecoregions OR NFEPA WetVeg Groups OR Other special framework	Valley Floor
		Slope
		Plain
		Bench (Hilltop / Saddle / Shelf)

Table 2: Hydrogeomorphic (HGM) Units for Inland Systems, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River (Channel)	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional stream	Active channel
		Riparian zone
	Upper foothill rivers	Active channel
		Riparian zone
	Lower foothill rivers	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothill rivers	Active channel
		Riparian zone
	Upland floodplain rivers	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

2.3 Inland Systems

For the purposes of the Classification System, Inland Systems are defined as an aquatic ecosystem that have no existing connection to the ocean[1] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but which are inundated or saturated with water, either permanently or periodically.

It is important to bear in mind, however, that certain Inland Systems may have had a historical connection to the ocean, which in some cases may have been relatively recent.

2.3.1 Level 1: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the Classification System is that of DWA's Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland (Figure 1). DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

2.3.2 Level 2: NFEPA Wet Veg Groups

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups vegetation types across the country according to Biomes, which are then divided into Bioregions – composite spatial terrestrial units defined on the basis of similar biotic and physical features and processes at the regional scale (Mucina and Rutherford, 2006).

To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups, and it is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

[1] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

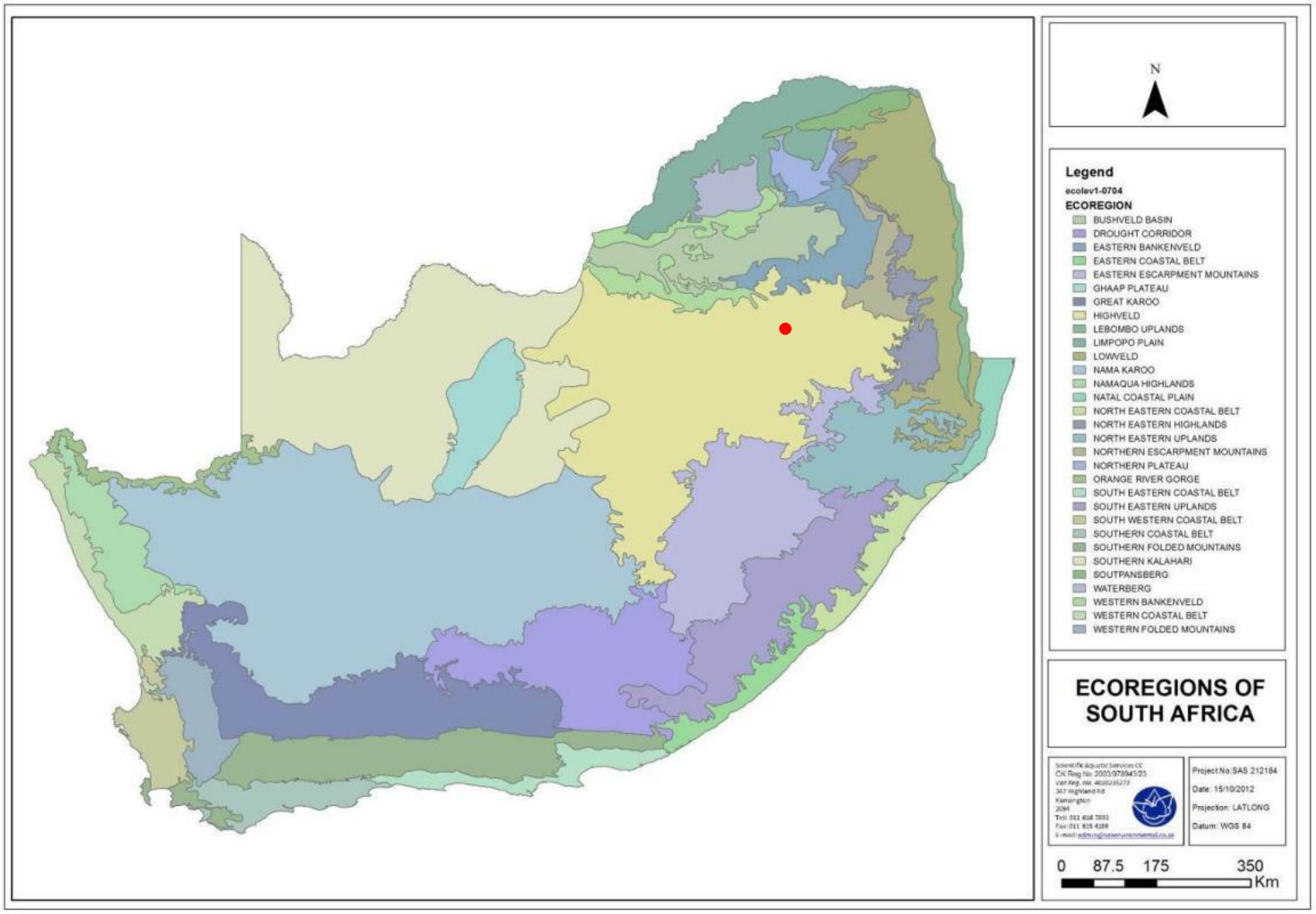

Figure 1: Map of Level 1 Aquatic Ecoregions of South Africa (approximate location of study area indicated in red)

At Level 3 of the Classification System for Inland Systems, a distinction is made between four Landscape Units (Table 1) on the basis of the landscape setting (i.e. topographical position) within which a Hydrogeomorphic (HGM) Unit is situated, as follows (Ollis *et al.,* 2013):

- **Slope:** an inclined stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.
- **Valley floor:** The base of a valley, situated between two distinct valley side-slopes.
- **Plain:** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.
- **Bench (hilltop/saddle/shelf):** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately perpendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

2.3.3 Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the Classification System (Table 2), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- **Channel (River):** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
- **Channelled valley-bottom wetland:** a valley-bottom wetland with a river channel running through it.
- **Unchannelled valley-bottom wetland:** a valley-bottom wetland without a river channel running through it.
- **Floodplain wetland:** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
- **Depression:** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- **Wetland Flat:** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat.

- **Seep:** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the Classification System to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for "channel", "flat" and "valleyhead seep") is used, for example, in the tools developed as part of the Wetland Management Series including WET-Health (Macfarlane *et al.,* 2008) and WET-EcoServices (Kotze *et al.,* 2009).

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever changing landscape. The primary purpose of this assessment is to evaluate the ecophysical health of wetlands, and in so doing promote their conservation and wise management.

At Level 4B of the classification system, certain of the primary HGM Units can further be divided into sub-categories on the basis of longitudinal geomorphological zonation or localised landform, as follows:

- **Channels** (including their banks) are divided into six primary longitudinal zones and three zones associated with a rejuvenated longitudinal profile, according to the geomorphological zonation scheme of Rowntree & Wadeson (2000). The sub-categories are *Mountain Headwater Stream, Mountain Stream, Transitional River, Upper Foothill River, Lower Foothill River,* and *Lowland River* (i.e. the primary zones); and *Rejuvenated Bedrock Fall, Rejuvenated Foothill River,* and *Upland Floodplain River* (i.e. the zones associated with a rejuvenated long profile).
- **Channelled and unchannelled valley-bottom wetlands** are divided into '*valley-bottom flats'* and *'valley-bottom depressions'*.
- **Floodplain wetlands** are divided into *'floodplain depressions'* and *'floodplain flats'*.

2.4 Wetland Function Assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[2] The assessment of the ecosystem services supplied by the identified wetlands was conducted

[2] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999

according to the guidelines as described by Kotze *et al.* (2008). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

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

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 3: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied
<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

2.5 Index of Habitat Integrity (IHI)

To assess the PES of the wetland features, the IHI for South African floodplain and channelled valley bottom wetland types (Department of Water Affairs and Forestry Resource Quality Services, 2007) were used.

The WETLAND-IHI is a tool developed for use in the National Aquatic Ecosystem Health Monitoring Programme (NAEHMP), formerly known as the River Health Programme (RHP). The WETLAND-IHI has been developed to allow the NAEHMP to include floodplain and channelled valley bottom wetland types to be assessed. The output scores from the WETLAND-IHI model are presented in A-F ecological categories (table below), and provide a score of the PES of the habitat integrity of the wetland system being examined.

Table 4: Descriptions of the A-F ecological categories (after Kleynhans, 1996, 1999).

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

2.6 WET-Health

2.6.1 Level of Evaluation

Two levels of assessment are provided by WET-Health:

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution;
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

2.6.2 Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

2.6.3 Units of Assessment

Central to WET-Health is the characterisation of HGM Units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the Classification System for Wetlands and other Aquatic Ecosystems in Section 2.2.

2.6.4 Quantification of Present State of a Wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial *extent* of impact of individual activities and then separately assessing the *intensity* of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores and Present State categories are provided in Table 5.

Table 5: Impact scores and categories of Present State used by WET-Health for describing the integrity of wetlands.

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
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
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
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
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

2.6.5 Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (Table 6).

Table 6: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

2.6.6 Overall health of the wetland

Once all HGM Units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM Unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provides a summary of impacts, Present State, Trajectory of Change and Health for individual HGM Units and for the entire wetland.

2.7 Ecological Importance and Sensitivity (EIS) Method of assessment

The method used for the Ecological Importance and Sensitivity (EIS) determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to assign the EIS category as listed in Table 7 below:

Table 7: EIS Category definitions

EIS Category	Range of Mean	Recommended Ecological Management Class[3]
Very high 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.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate 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.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

2.8 Recommended Ecological Category

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure." [4]

The Recommended Ecological Category (REC) was determined based on the results obtained from the Wet-IHI, WET-Health calculations, reference conditions and Ecological Importance and Sensitivity (EIS) of the resource; followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland may receive the same category for the REC as the Present Ecological State (PES), if the wetland is deemed in good condition, and it must therefore remain in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the wetland feature.

[4] Department of Water Affairs and Forestry, South Africa Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999

Table 8: Description of REC classes.

Category	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

2.9 Wetland Delineation

For the purposes of this investigation, a wetland habitat is defined in the National Water Act (1998) as a land that is transitional between terrestrial and aquatic ecosystems 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 saturated soils.

The wetland zone delineation took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas" published by the DWA in February 2005. The foundation of the method is based on the fact that wetlands and riparian zones have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils;
- Vegetation adapted to saturated soils and
- The presence of alluvial soils in stream systems.

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

Riparian and wetland zones can be divided into three zones (DWAF, 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

3 GENERAL IMPORTANCE OF THE STUDY AREA

3.1 Ecoregions

When assessing the ecology of any area (aquatic or terrestrial), it is important to know which ecoregion the study area is located within. This knowledge allows for improved interpretation of data to be made, since reference information and representative species lists are often available on this level of assessment, which aids in guiding the assessment.

The study area falls within the Highveld Ecoregion and is located within the quaternary catchment B12B (Figure 2).

The main attributes of the Highveld Ecoregion, and the B12B quaternary catchment, are presented in Table 9 and Table 10 below:

Table 9: Main attributes of the Highveld Ecoregion (Kleynhans *et al,* 2005).

MAIN ATTRIBUTES	HIGHVELD
Terrain Morphology: Broad division (dominant types in bold) (Primary)	**Plains; Low Relief**; **Plains; Moderate Relief;** Lowlands; Hills and Mountains: Moderate and High Relief; Open Hills; Lowlands; Mountains: Moderate to High Relief; Closed Hills; Mountains: Moderate and High Relief (limited)
Vegetation types (dominant types in bold) (Primary)	Rocky Highveld Grassland; **Dry Sandy Highveld Grassland**; Dry Clay Highveld Grassland; **Moist Cool Highveld Grassland**; Moist Cold Highveld Grassland; North Eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Clay Highveld Grassland: Patches Afromontane Forest (very limited)
Altitude (m a.m.s.l) (modifying)	1100-2100, 2100-2300 (very limited)
MAP (mm) (Secondary)	400 to 1000
Coefficient of Variation (% of annual precipitation)	<20 to 35
Rainfall concentration index	45 to 65
Rainfall seasonality	Early to late summer
Mean annual temp. (°C)	12 to 20
Mean daily max. temp. (°C): February	20 to 32
Mean daily max. temp. (°C): July	14 to 22
Mean daily min. temp. (°C): February	10 to 18
Mean daily min temp. (°C): July	-2 to 4
Median annual simulated runoff (mm) for quaternary catchment	5 to >250

Table 10: Quaternary Catchments Information

Catchment	Resource	EIS	PESC	Quaternary catchment	DEMC
B12B	Klein Olifants	MODERATE	CLASS C	Class D (largely modified)	Moderately sensitive systems

B12B

According to the ecological importance classification for the quaternary catchment, the system can be classified as a *Moderately Sensitive* system, which, in its present state, can be considered a Class D (largely modified) stream.

The points below summarise the impacts on the aquatic resources in this quaternary catchment:

- Bed modification as a result of sedimentation has a moderate impact on the riverine resource;
- Moderate impacts have occurred as a result of flow modifications due to weirs, power stations and mines;
- There has been a low impact in the catchment as a result of introduction of instream biota with special mention of *Labeo umbratus;*
- A moderate impact from inundation is present within the catchment as a result of weirs;
- Erosion has created a moderate impact on river banks;
- Changes in the mid catchment have had a high impact on water quality in the catchment.

In terms of ecological functions, importance and sensitivity, the following points summarise the conditions in this catchment:

- The riverine systems in this catchment have a high diversity of habitat types including wetlands;
- The catchment has a moderate importance in terms of conservation areas and conservation of biodiversity;
- The riverine resources include various barb species which have a moderate intolerance to changes in flow and flow related water quality;
- The area has a moderate importance in terms of faunal migration;
- The area has no importance in terms of rare and endangered species conservation,
- The area is regarded of high importance as source of refugia for aquatic species;
- The catchment has a moderate sensitivity to changes in water quality;
- The catchment has a moderate sensitivity to water flow changes;
- The catchment has a moderate species/taxon richness;
- The catchment has no importance in terms of unique species conservation.

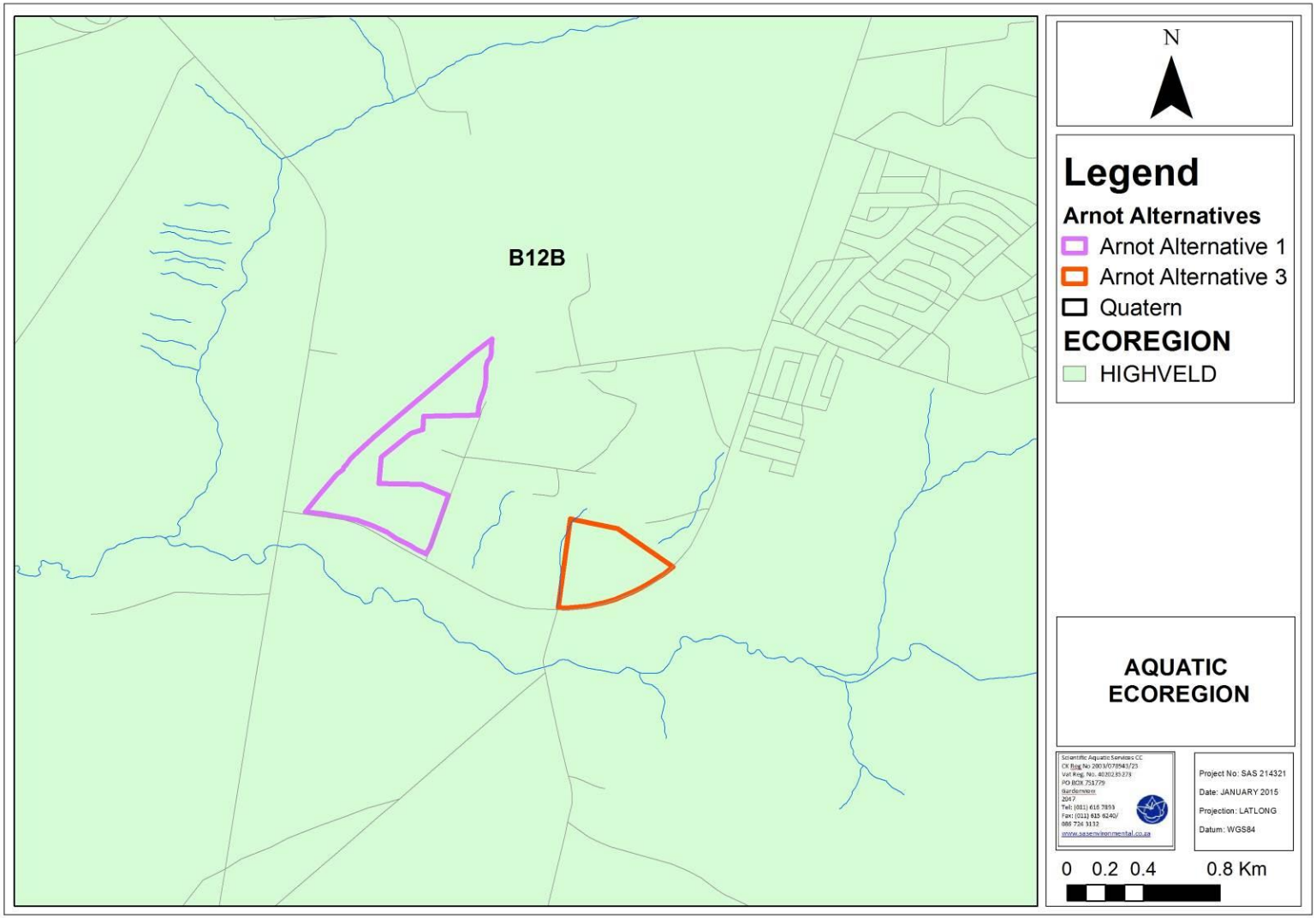

Figure 2: The Ecoregion and Quaternary Catchments applicable to the study area.

3.2 Importance according to the National Freshwater Ecosystems Priority Areas database (2011)

The SANBI Wetland Inventory (2006) NFEPA (2011), databases was consulted to define the aquatic ecology of the wetland or river systems close to or within the study area that may be of ecological importance. Aspects applicable to the study area and surroundings are discussed below:

- The study area falls within the Olifant Water Management Area (WMA). Each Water Management Area is divided into several sub-Water Management Areas (subWMA), where catchment or watershed is defined as a topographically defined area which is drained by a stream or river network. The Sub-Water management unit indicated for the study area is the Upper Olifant sub-WMA.
- The subWMA is not regarded important in terms of fish sanctuaries, rehabilitation or corridors.
- The subWMA is not considered important in terms of translocation and relocation zones for fish.
- The subWMA is not listed as a fish Freshwater Ecosystem Priority Area (FEPA).
- No FEPA Rivers were indicated by the NFEPA river database layer within the study area;
- No wetland features were indicated by the NFEPA wetland database layer within the study area, but there are NFEPA wetlands indicated within close proximity of the study area (Figure 3).

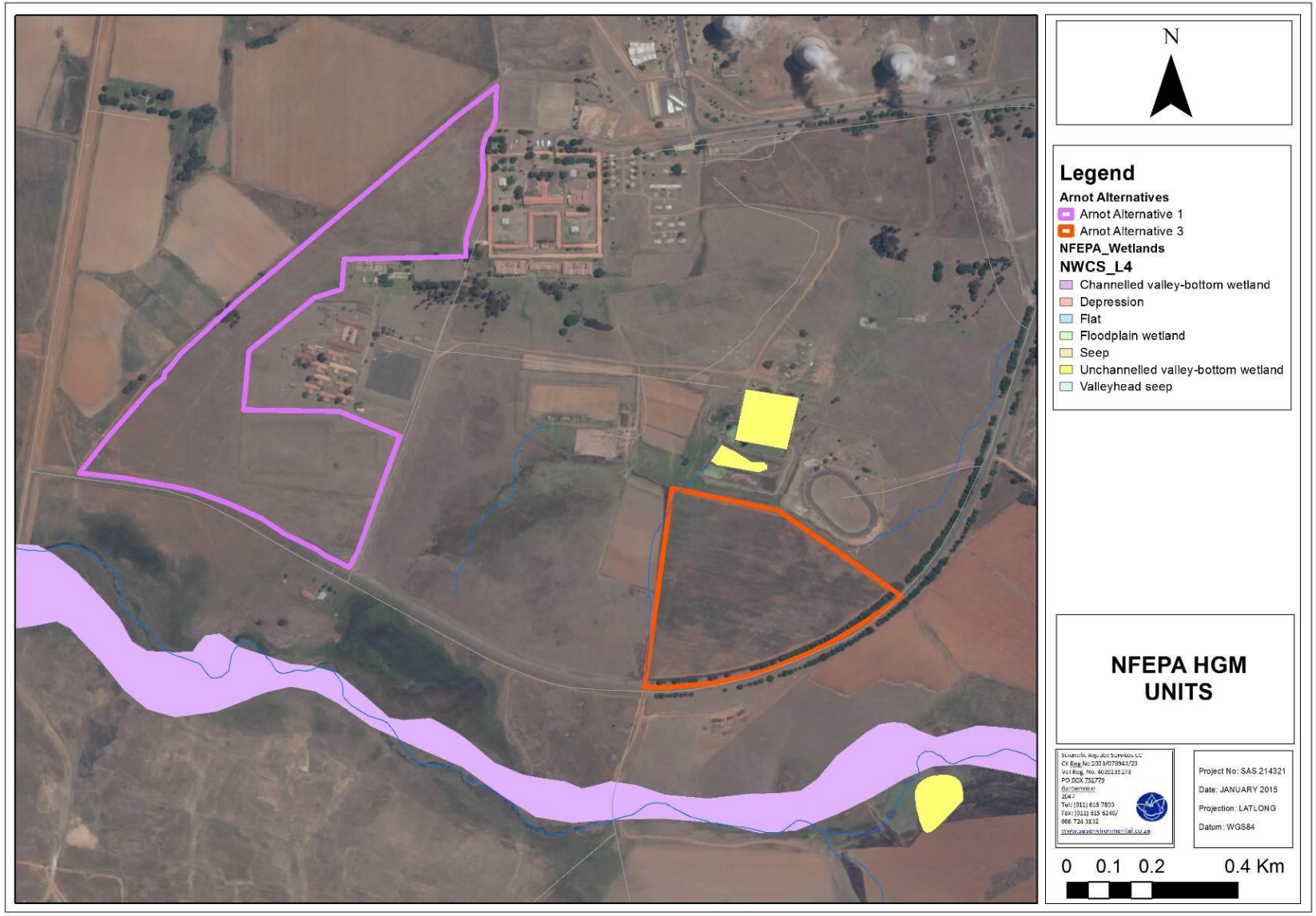

Figure 3: Map depicting HGM units of the NFEPA wetlands within and around the study area.

4 RESULTS

4.1 Wetland System Characterisation

The wetlands occurring within the study area have been classed into broad HGM units according to the classification system compiled by SANBI (Ollis *et al*., 2013), namely:

- Channelled valley bottom wetland; and
- Seepage wetland

The location of all the wetland features identified within the study area are conceptually presented in Figure 5. The 1:50 000 topographic maps also indicate a small drainage line intersecting the northern portion of Alternative 3 and another drainage line to the northeast. However, upon ground-truthing, no eveidence of these features was encountered.

Table 11: Classification system for wetland features identified within the study area.

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit
			HGM Type
Inland: An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	**Highveld Aquatic Ecoregion:** The study area falls within the Highveld Aquatic Ecoregion **WetVeg:** Mesic Highveld Grassland Group (Endangered) 4	**Valley floor:** The typically gently sloping, lowest surface of a valley	**Channelled valley bottom wetland:** A valley bottom wetland with a river channel running through it.
Inland: An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	**Highveld Aquatic Ecoregion:** The study area falls within the Highveld Aquatic Ecoregion **WetVeg:** Mesic Highveld Grassland Group 4 (Endangered)	**Slope:** An inclined stretch of ground typically located on the side of a mountain.	**Seep:** A wetland area located on gently to steeply sloping land and dominated by colluvial, unidirectional movement of water and material down-slope.

All wetland features have been affected by historical on-going agricultural activities and edge effects from the power station and adjacent roads such as stormwater runoff, resulting in inundation, augmentation of sediment deposition and vegetation clearing within the wetlands. The figure below presents typical views of the seepage and channelled valley bottom wetlands.

Figure 4: Representative photograph of the seepage wetland (top) and channeled valley bottom wetland (bottom).

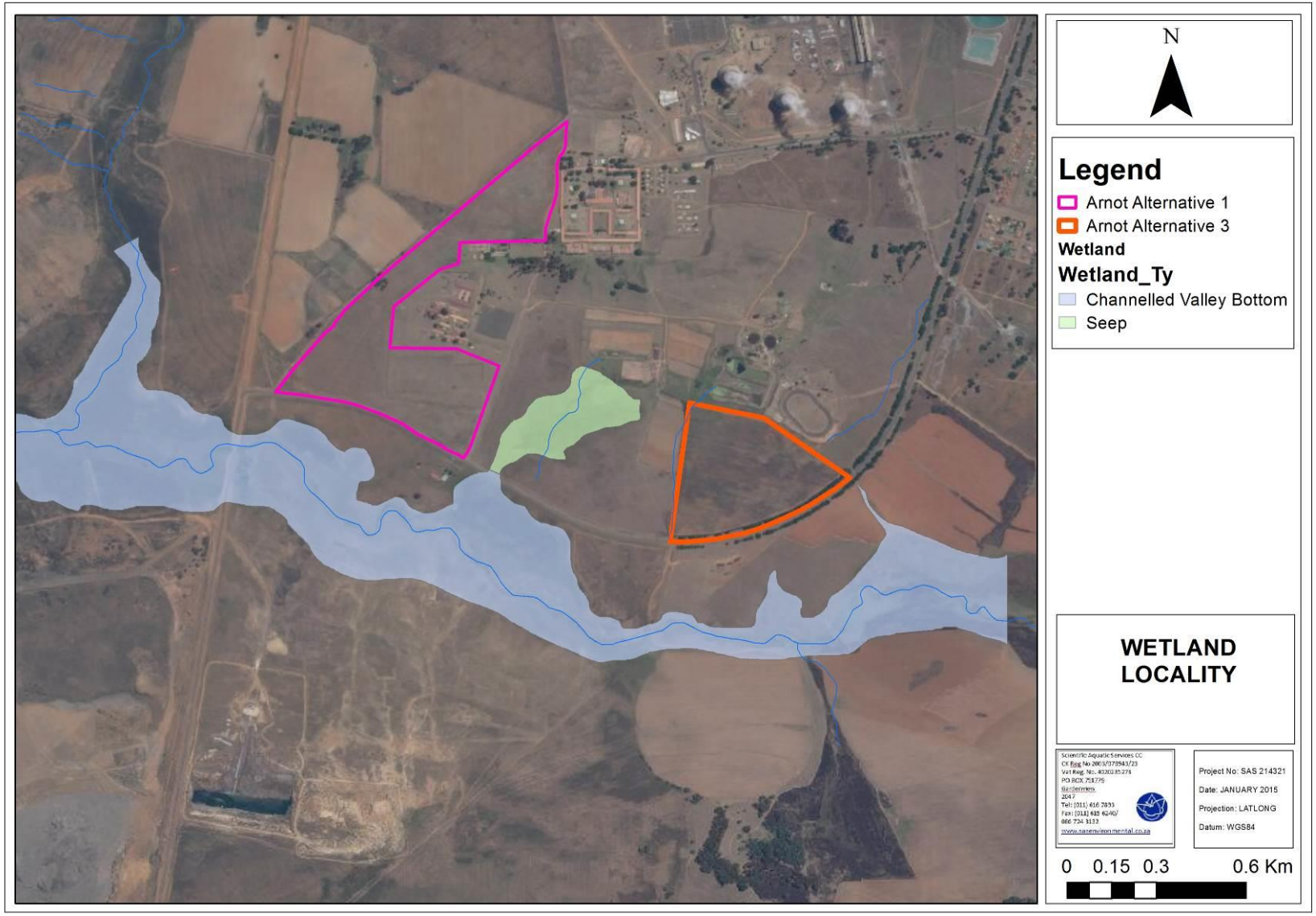

Figure 5: Map of the wetland features within the study area.

4.2 Wetland Function Assessment

Wetland function and service provision were assessed within the study area for all of the wetland systems. The average scores for the assessed systems are presented in the following table as well as the radar plot in the figure that follows the table.

Table 12: Wetland functions and service provision.

Ecosystem service	Wetland	
	Channelled Valley Bottom Wetland	Seepage Wetland
Flood attenuation	3.5	2.0
Streamflow regulation	3.2	1.8
Sediment trapping	3.3	2.0
Phosphate assimilation	3.3	2.1
Nitrate assimilation	3.3	2.1
Toxicant assimilation	2.1	2.1
Erosion control	3.0	1.8
Biodiversity maintenance	3.1	1.9
Carbon Storage	2.4	1.6
Water Supply	2.8	1.8
Harvestable resources	0.7	0.2
Cultivated foods	1.8	1.0
Cultural significance	0.0	0.0
Tourism and recreation	0.0	0.0
Education and research	0.0	0.0
SUM	**32.5**	**20.4**
Average score	**2.2**	**1.4**

In summary, the channelled valley bottom wetland obtained an overall ecological service provision score of 2.2, which places this wetland in a moderately high class, while the seepage wetland falls into a moderately low class of service provision due to the overall score of 1.4.

From the results of the assessment, it is evident that the channelled valley bottom wetland feature associated with the study area has moderately high levels of ecological function and service provision. This wetland feature is the most important in terms of flood attenuation, streamflow regulation and Phosphate, Nitrate and toxicant assimilation as it is situated in an agricultural area. Furthermore, this system also plays an important role in erosion control, carbon storage and biodiversity maintenance.

Furthermore, wetlands contribute to the maintenance of biodiversity through the provision of habitat and maintenance of natural processes (Kotze, *et. al.* 2008). The ‘vulnerable’ status of the Eastern Highveld Grassland vegetation type, and the ‘Critically Endangered’ status of

n the Mesic Highveld Grassland 4 WetVeg Group, contribute to the higher biodiversity maintenance weighting applied to the wetland system.

The seepage wetland feature within the study area obtained a moderately low score in terms of ecological function and service provision, and has been subjected to more transformation than the valley bottom wetland. This wetland feature is most important in terms of Phosphate, Nitrate and Toxicant assimilation as well as being important in terms of carbon storage, biodiversity maintenance and water supply. The results obtained were mainly due to the fact that the wetland feature is situated in an agricultural area and have been subjected to grazing, maize cultivation and topographic alteration.

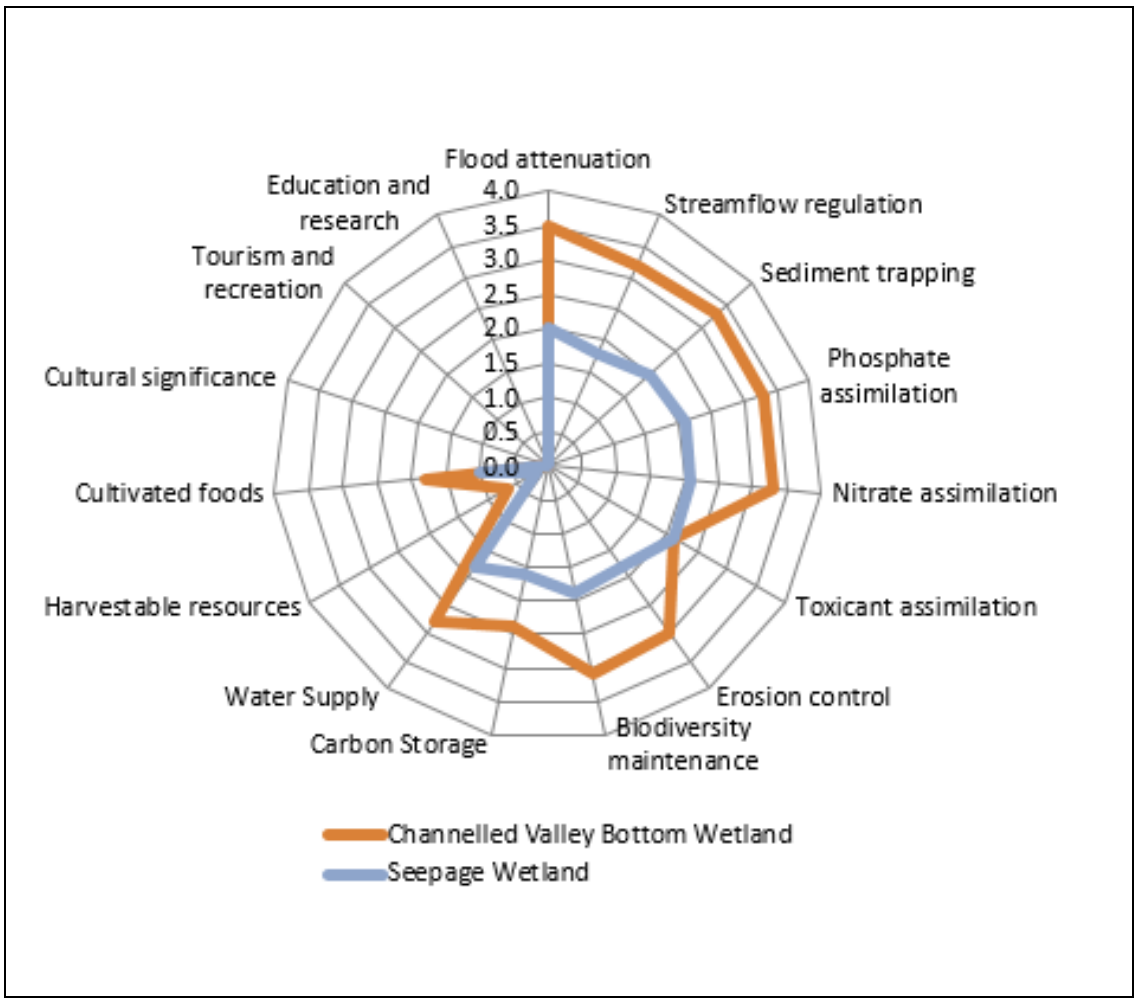

Figure 6: Radar plot of wetland services provided.

4.3 WET-Health Assessment

Three modules were assessed namely hydrology, geomorphology and vegetation. Each HGM unit was assessed separately, after which the sum of the individual area weighted scores for each HGM unit was taken as the final score of each module considered

representative of the wetland feature as a whole. A summary of the results is provided in the tables below.

Table 13: Summary of the overall health of the seepage wetland feature based on impact score and change score.

Hydrology		Geomorphology		Vegetation	
Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
C	→	C	↓	C	↓

The present hydrological state of the seepage wetland falls within Category C (Moderately modified). Erosion and changes in runoff intensity is considered moderate within the wetland system, as a result the calculated a score falls within the present geomorphic Category C (Moderately modified) with a possibility of the system deteriorating slightly in future. The present vegetation state is considered to fall within Category C (Moderately modified). Vegetation composition has been moderately altered but introduced alien and/or ruderal species are still clearly less abundant than characteristic indigenous wetland species, with marginal deterioration of vegetation likely due to edge effects associated with the power station and roads in the area.

Vegetation obtained the lowest score of the three modules assessed and is also considered the most likely to deteriorate in the next five years. Main sources of change considered within the vegetation module include grazing, old abandoned lands and edge effects associated with surrounding roads.

The overall score for the wetland system that aggregates the scores for the three modules, namely hydrology, geomorphology and vegetation, was calculated using the formula[5] as provided by the Wet-Health methodology. The overall score calculated was 2.1, falling within the PES category C (Moderately modified). The PES was then used as a benchmark for the identification of an appropriate category for the REC (section below).

4.4 Index of Habitat Integrity (IHI)

To assess the PES of the channelled valley bottom wetland feature, the protocol "*Index of Habitat Integrity (IHI) for South African floodplain and channelled valley bottom wetland types"* (Department of Water Affairs and Forestry Resource Quality Services, 2007) were used.

[5] ((Hydrology score) x 3 + (geomorphology score) x2 + (vegetation score) x 2))/ 7 = PES

The results for the criteria and attributes used for the calculation of the IHI are presented in the tables below.

Table 14: The overall PES score of the channelled valley bottom wetland feature.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	**Weighting**	**Score**	***Confidence Rating***	**PES Category**
DRIVING PROCESSES:		**100**	**2.2**		
Hydrology	1	100	2.0	*3.1*	**C/D**
Geomorphology	2	80	2.4	*3.7*	**D**
Water Quality	3	30	2.2	*4.5*	**D**
WETLAND LANDUSE ACTIVITIES:		**80**	**1.5**	***4.1***	
Vegetation Alteration Score	1	100	1.5	*4.1*	**C**
Weighting needs to consider the sensitivity of the type of wetland *(e.g.: nutrient poor wetlands will be more sensitive to nutrient loading)*					
OVERALL SCORE:			**1.9**	***Confidence Rating***	
	PES %		**62.4**		
	PES Category:		**C**	***3.9***	

The average score calculated for the channelled valley bottom wetland feature with the use of the IHI, indicates that the feature falls within PES Category C: moderately modified. The wetland feature is located within an area dominated by agricultural activities and livestock grazing. As a result, deviations in water quality are expected to be high. The major impacts noted within the feature are related to alien floral invasion, impoundments traversing the valley bottom wetlands and isolated eroded areas, dominated by bank erosion.

The largest impairment to wetland integrity has occurred as a result of hydrological changes to the system along with changes to geomorphological structure and function of the system, while impacts on water quality were also considered to be a significant driver of change in the system.

4.5 Ecological Importance and Sensitivity (EIS)

The EIS assessment was applied to the wetland features in order to ascertain the level of importance and ecological sensitivity. The results of this assessment are presented in the table below.

Table 15: The overall EIS score of the wetland features associated with the study area.

Determinant	Score	Confidence	Score	Confidence
Wetland system	**Channelled Valley Bottom Wetland**		**Seepage Wetland**	
PRIMARY DETERMINANTS				
1. Rare & Endangered Species	1	4	1	3
2. Populations of Unique Species	1	4	1	3
3. Species/taxon Richness	2	4	1	3
4. Diversity of Habitat Types or Features	2	4	1	4
5 Migration route/breeding and feeding site for wetland / aquatic species	3	4	1	4
6. PES as determined by WET-Health / IHI assessment	3	4	2	4
7. Importance in terms of function and service provision	3	4	2	4
MODIFYING DETERMINANTS				
8. Protected Status according to NFEPA Wetveg	3	4	3	4
9. Ecological Integrity	3	4	2	4
TOTAL	**21**		**14**	
MEAN	**2.3**		**1.6**	
OVERALL EIS	**B**		**C**	

The score achieved for the EIS assessment places the channelled valley bottom wetland within Category B (The biodiversity of these wetlands may be sensitive to flow and habitat modifications). The wetland feature was important in terms of IHI functionality and a diversity of wetland habitat type for wetland species. The seepage wetland feature falls within Category C (Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale.). This wetland feature did not score a high importance in terms of diversity, habitat and wetland function. However, due to the high score value (critical value) of the wetland vegetation group according to the NFEPA protection stated, this increased the overall score and value of the EIS of the wetland feature.

4.6 Recommended Ecological Category (REC)

All results obtained from the sections above were used in the determination of the appropriate REC for each feature. The results obtained from the assessment of the channelled valley bottom wetland indicate moderately high levels of ecological service provision. Vegetation transformation is considered more significant due to ongoing grazing in combination with aspects such as construction of earth dams and roads that resulted in loss of vegetation in the vicinity of the disturbed areas. The results from the assessment of the seepage wetland feature indicate intermediate levels of ecological service provision, with moderate impacts on hydrology and geomorphology observed. Vegetation transformation is

considered significant due to historical agriculture and edge effects from the surrounding roads and power station.

The results of the wetland function assessment and IHI assessment, together with the results of the EIS assessment, were used to inform the REC, which is deemed to be a Class B (largely natural with few modifications) for the channeled valley bottom wetland, while for the seepage wetland a Class C (moderately modified) category is recommended.

4.7 Wetland Vegetation

During the assessment, the various wetland vegetation components were identified. Dominant species were characterised as either wetland or terrestrial species, and were then further categorised as temporary, seasonal and permanent zone species. This characterisation is presented in the table below, and includes the terrestrial species identified near the wetland zones. Diversity and abundance of the terrestrial, temporary and seasonal zone floral species were considered uniform throughout the site with no discernible difference noted between the channelled valley bottom and the seepage wetland.

Table 16: Dominant floral species identified during the wetland delineation.

Terrestrial zone	Temporary / Seasonal Zone	Permanent Zone
Hyparrhenia hirta	**Verbena bonariensis*	*Mariscus congestus*
Eragrostis curvula	*Sporobolus africanus*	*Imperata cylindrica*
Eragrostis chloromelas	*Juncus effusus*	*Kylinga alba*
Harpochloa falx	*Schoenoplectus corymbosus*	*Cyperus rupestris*
**Asclepias fruticosa*	*Imperata cylindrica*	*Typha capensis*
Cymbopogon plurinodis	*Helichrysum* species	*Juncus effusus*
**Cosmos bipinnata*	*Habenaria nyikana*	*Schoenoplectus corymbosus*
**Conyza bonariensis*	*Eragrostis plana*	*Phragmites australis*
Eragrostis plana		*Leersia hexandra*

4.8 Wetland Delineation and Sensitivity Mapping

It should be noted that not all indicators were collectively employed in all wetland features, since they were individually characterised by different indicators. During the assessment, the following indicators were used:

- Terrain units were used to determine in which parts of the landscape the wetland features are most likely to occur.

- The soil form indicator was used to determine the presence of soils that are associated with prolonged and frequent saturation, as well as variation in the depth of the saturated soil zone within 50cm of the soil surface. This indicator was used to identify gleyed soils where the soil is a greyish/greenish/bluish colour due to the leaching out of iron. Whilst mottling was not extensive, it was present in the temporary zone. These factors were utilised to aid in determining the location of the wetland zones and their boundaries.
- The vegetation indicator was used in the identification of the wetland boundary through the identification of the distribution of both facultative and obligate wetland vegetation associated with soils that are frequently saturated. Changes in vegetation density and levels of greening were also considered during the delineation process. This indicator was very useful in identifying the boundary of the temporary zone.
- Surface water was not present in all wetland features, however, it was noted and taken into consideration in areas where it was observed.

The wetlands are considered to be sensitive, as they provide faunal and floral habitat in an area characterised by transformation due to agriculture and also provide migratory corridors for faunal species. The National Environmental Management Act (Act 107 of 1998) stipulates that no activity can take place within 32m of a wetland without the relevant authorisation. In addition, the National Water Act (Act 36 of 1998) states that no diversion, alteration of bed and banks or impeding of flow in watercourses (which includes wetlands) may occur without obtaining a water use licence authorising the proponent to do so. Furthermore, General Notice (GN) 1199 as published in the Government Gazette 32805 of 2009 as it relates to the NWA, 1998 (Act 36 of 1998) states that any activities occurring within 500m of watercourses must be authorised by the DWS.

After consideration of findings during the wetland assessment, a suitable buffer zone was considered for the proposed development. A 32m buffer was prescribed and all non-essential activities should be situated outside of wetland areas and the development footprint and activity footprint in the wetland and associated buffer should be prevented as far as possible. This buffer zone is deemed sufficient to maintain the Present Ecological State, limit any further impact that the proposed development could have and ultimately support the REC. A 500m buffer around the wetlands is also indicated in the figure below in terms of GN1199.

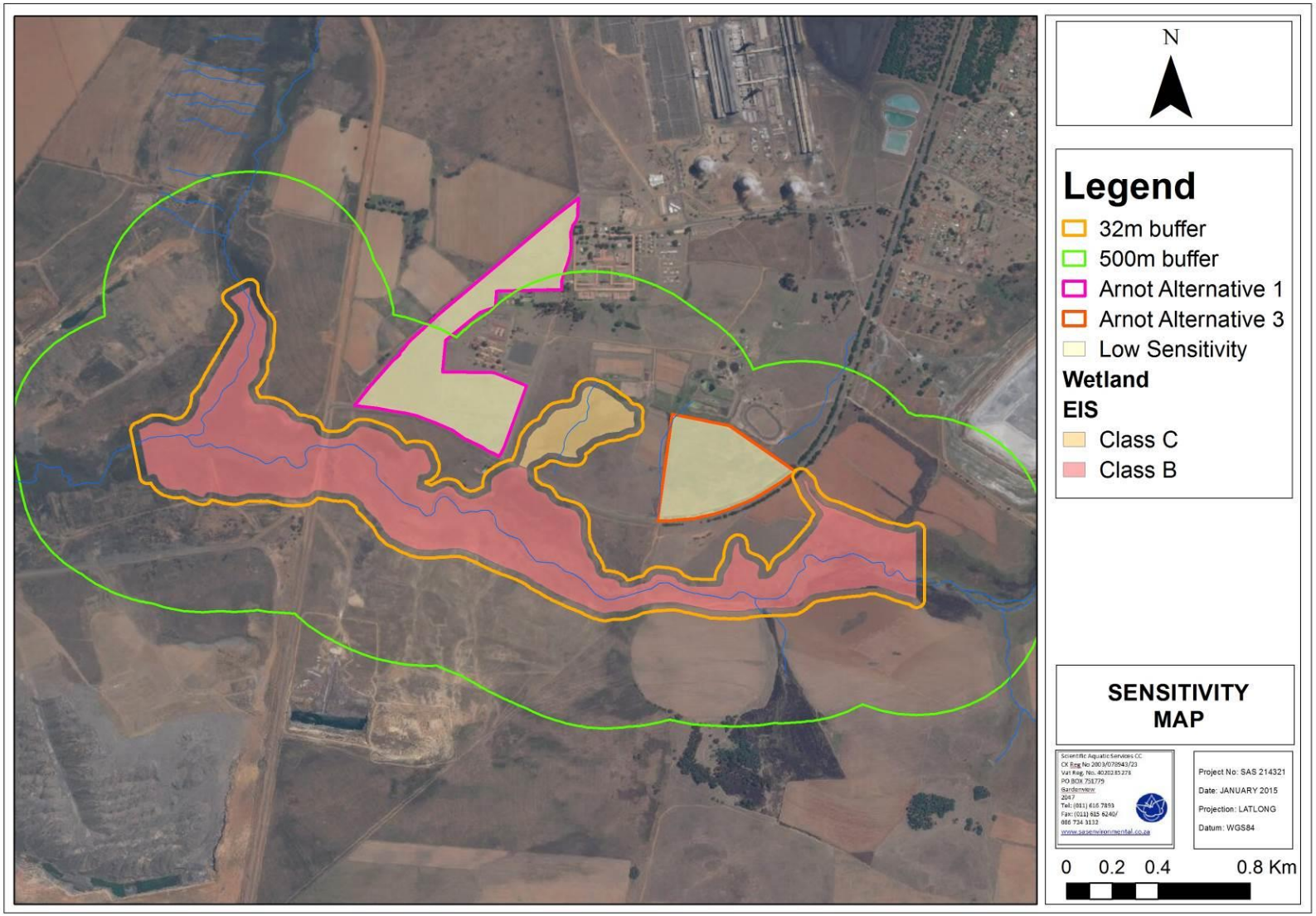

Figure 7: Wetland sensitivity mapping with associated buffers.

5 IMPACT ASSESSMENT

5.1 Impact Identification and Assessments

The tables below serve to summarise the significance of perceived impacts on the wetland ecology and biodiversity of the study area. Summaries for all potential pre-construction, construction and operational impacts are provided in Section 5.5. The tables presents the impact assessment according to the method described in Section A.

This section also indicates the required mitigatory measures required to minimise any perceived impacts on the wetland ecology of the receiving environment. In addition the tables present an assessment of the significance of the impacts taking into consideration the available mitigatory measures assuming that they are fully implemented.

Latent and general everyday impacts which may impact on the wetland ecology and biodiversity, will include any activities which take place within the study area that may impact on the receiving wetland environment. These measures are highlighted below and are relevant for all sensitive wetland areas identified in this report:

- All construction activities should be located outside of the 32m wetland buffer.
- All laydown areas and material stockpiles should be located outside of the 32m wetland buffer.
- No fires whatsoever should be allowed during construction.
- Appropriate sanitary facilities must be provided during construction and all waste removed to an appropriate waste facility.
- All soils compacted as a result of construction activities should be ripped and profiled.
- Special attention should be paid to alien and invasive species within disturbed areas. Alien and invasive vegetation control should take place throughout all development phases to prevent loss of faunal and floral habitat.
- To prevent the erosion of top soils, management measures may include berms, soil traps, hessian curtains and storm water diversion away from disturbed areas susceptible to erosion.
- No dumping of waste should take place. If any spills occur, they should be immediately cleaned up.
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced to prevent the ingress of hydrocarbons into the topsoil.

- Ensure that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. Regularly inspect all vehicles for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.

5.2 Impacts on Wetland Habitat and Ecological Structure

Activities and aspects register

Pre-Construction	Construction	Operational
Inadequate design of infrastructure leading to changes to wetland habitat	Site clearing and the removal of wetland vegetation	Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management
	Compaction of soils due to construction activities	Continuous introduction and proliferation of alien plant species and further transformation of natural habitat
	Site clearing and the disturbance of soils	
	Movement of construction vehicles as well as access road construction within wetland zones	
	Dumping waste and construction material within the wetland	
	Dumping of material leading to alien plant species proliferation	

Since wetland areas provide potential habitat and migratory connectivity for faunal species as well as the potential to host a higher diversity of floral species, they are considered to be of significant importance in the maintenance of biodiversity and habitat provision. Development activities could result in fragmentation of wetland habitat or even loss of this sensitive habitat altogether. Development activities expected to most likely be the cause of loss of wetland habitat and ecological structure include encroachment of infrastructure or dumping of construction waste materials into the wetland areas. However, ineffective rehabilitation may also lead to excessive erosion and the loss of wetland soils which in turn will lead to reduced wetland habitat availability and suitability for both faunal and floral species.

As the proposed infrastructure is situated outside of any wetland areas, any significant impacts are unlikely, and with implementation of mitigation measures the impact significance may be reduced to low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	3	2	2	2	7	6	42 (Low)
Operational phase	2	3	2	2	2	5	6	30 (Low)

Essential mitigation measures for construction phase:

- Limit the footprint area of the construction activities to what is absolutely essential in order to minimise environmental damage. Construction vehicles must use existing roads where possible.
- During construction all building materials should be kept out of the wetland areas as well as the 32m buffer;
- In any areas where disturbance of banks or wetland vegetation occurs, bank and bed profile should be re-instated in such a way as reinstate predevelopment habitat conditions
- All waste and remaining building materials should be removed from site on completion of the project;
- No vehicles should be allowed to indiscriminately drive through the wetland areas or within the 32m buffer;
- The duration in which soils are exposed during construction activities should remain as short as possible;
- Concurrent rehabilitation is to take place as far as possible and footprint areas should be minimised as far as possible;
- Monitor all disturbed areas for erosion and incision.
- Continually maintain access roads leading to towers during maintenance activities in order to prevent erosion.
- Avoid unnecessary site clearing/vegetation clearing between photovoltaic panels as far as possible.
- During maintenance activities, vehicles must only be driven on existing, maintained access roads and not drive indiscriminately through natural areas.

Recommended mitigation measures for construction phase:

- As far as possible, all construction activities should occur in the low flow season, during the drier winter months.

Essential mitigation measures for operational phase:

- Any area where active erosion is observed must be immediately rehabilitated in such a way as to ensure that the hydrology of the area is re-instated to conditions which are as natural as possible.
- Implement alien vegetation control program within wetland areas.
- Monitor the wetlands for erosion and incision.

Recommended mitigation measures for operational phase:

N/A

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	2	2	2	6	6	36 (Low)
Operational phase	1	3	1	1	1	4	3	12 (Very-low)

Probable latent impacts

- Small permanent change in wetland habitat.
- Proliferation of alien and weed species in disturbed areas will lead to altered vegetation communities within the wetland areas.

5.3 Changes to Wetland Ecological and Sociocultural Service Provision

Activities and aspects register

Pre-Construction	Construction	Operational
Inadequate design of the proposed layout leading to erosion and sedimentation of the wetland features	Site clearing and further removal of vegetation impacting on ecological and sociocultural service provision capabilities of the wetlands	Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management
	Contaminating wetland soils and water, further deteriorating the water quality within the wetlands	Increased water runoff into wetland areas due to un-vegetated areas not rehabilitated after construction
	Movement of construction vehicles within the wetlands	
	Dumping of construction material into the wetlands	
	Inability to support biodiversity as a result of changes to increased sedimentation and alteration of natural hydrological regimes	
	Alteration of natural hydrological regime, impacting on flood attenuation and streamflow regulation capabilities	

The proposed development activities may result in the loss of ecoservices and function from wetland resources such as stream flow regulation, sediment trapping, nutrient cycling and toxicant assimilation abilities. Furthermore, impacts may result in a decrease in the ability of the feature to support biodiversity as a result of clearance of vegetation, increased sedimentation and alteration of natural hydrological regimes. Therefore, the socio-cultural services provided by the different wetlands may be either lost or decreased if the impact is not effectively mitigated. Furthermore, if left unmitigated, impacts on service provision and function would be permanent. However, as the proposed infrastructure is situated outside of any wetland areas, any significant impacts are unlikely, and with implementation of mitigation measures the impact significance may be reduced to very low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	4	3	2	2	2	7	6	42 (Low)
Operational phase	2	3	2	2	2	5	6	30 (Low)

Essential mitigation measures for construction phase:

- Limit the footprint area of the construction activities to what is absolutely essential in order to minimise environmental damage. Construction vehicles must use existing roads where possible.
- During construction all building materials should be kept out of the wetland areas as well as the 32m buffer;
- In any areas where disturbance of banks or wetland vegetation occurs, bank and bed profile should be re-instated in such a way as reinstate predevelopment habitat conditions
- All waste and remaining building materials should be removed from site on completion of the project;
- No vehicles should be allowed to indiscriminately drive through the wetland areas or within the 32m buffer;
- The duration in which soils are exposed during construction activities should remain as short as possible;
- Concurrent rehabilitation is to take place as far as possible and footprint areas should be minimised as far as possible;
- Monitor all disturbed areas for erosion and incision.
- Continually maintain access roads leading to towers during maintenance activities in order to prevent erosion.
- Avoid unnecessary site clearing/vegetation clearing between photovoltaic panels as far as possible.
- During maintenance activities, vehicles must only be driven on existing, maintained access roads and not drive indiscriminately through natural areas.

Recommended mitigation measures for construction phase:

- As far as possible, all construction activities should occur in the low flow season, during the drier winter months.

Essential mitigation measures for operational phase:

- Any area where active erosion is observed must be immediately rehabilitated in such a way as to ensure that the hydrology of the area is re-instated to conditions which are as natural as possible.
- Implement alien vegetation control program within wetland areas.
- Monitor the wetlands for erosion and incision.

Recommended mitigation measures for operational phase:

N/A

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	1	3	1	1	1	4	3	12 (Very-low)
Operational phase	1	3	1	1	1	4	3	12 (Very-low)

Probable latent impacts

- A small reduction in biodiversity support.

5.4 Impacts on Wetland Hydrological Function and Sediment Balance

Activities and aspect register

Pre-Construction	Construction	Operational
Poor planning with regards to the placement of infrastructure within the wetland that could result in change of the hydrological regime	Site clearing and the removal of vegetation leading to increased runoff volumes and velocity.	Insufficient aftercare and maintenance leading to on-going erosion and increased sedimentation of wetlands
	Earthworks in the vicinity of the wetland leading to increased runoff and altered runoff patterns	
	Construction within wetlands altering base flow patterns and water velocities	
	Sediment deposition and stream bed scouring	

During construction, site clearing and the removal of vegetation may result in an increase in runoff from disturbed areas and an increase in the erosion and incision within the wetland. An increase in runoff from disturbed areas may also alter flow patterns and may result in the inundation of the features. In addition, sediment deposition as a result of the disturbance of soils and increased sediment runoff during the construction of the powerlines may result in an impact on the sediment balance of the features.

Operational activities such as vegetation clearing for maintenance purposes, if left unmitigated are likely to result in a long term negative impact on the wetland features.

However, as the proposed infrastructure is situated outside of any wetland areas, any significant impacts are unlikely, and with implementation of mitigation measures the impact significance may be reduced to very low levels.

Unmanaged	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	3	3	3	2	2	6	7	42 (Low)
Operational phase	2	3	2	2	2	5	6	30 (Low)

Essential mitigation measures for construction phase:

- Limit the footprint area of the construction activities to what is absolutely essential in order to minimise environmental damage. Construction vehicles must use existing roads where possible.
- During construction all building materials should be kept out of the wetland areas as well as the 32m buffer;
- In any areas where disturbance of banks or wetland vegetation occurs, bank and bed profile should be re-instated in such a way as reinstate predevelopment habitat conditions
- All waste and remaining building materials should be removed from site on completion of the project;
- No vehicles should be allowed to indiscriminately drive through the wetland areas or within the 32m buffer;
- The duration in which soils are exposed during construction activities should remain as short as possible;
- Concurrent rehabilitation is to take place as far as possible and footprint areas should be minimised as far as possible;
- Monitor all disturbed areas for erosion and incision.
- Continually maintain access roads leading to towers during maintenance activities in order to prevent erosion.
- Avoid unnecessary site clearing/vegetation clearing between photovoltaic panels as far as possible.
- During maintenance activities, vehicles must only be driven on existing, maintained access roads and not drive indiscriminately through natural areas.

Recommended mitigation measures for construction phase:

- As far as possible, all construction activities should occur in the low flow season, during the drier winter months.

Essential mitigation measures for operational phase:

- Avoid unnecessary site clearing/vegetation clearing between photovoltaic panels as far as possible.
- Any area where active erosion is observed must be immediately rehabilitated in such a way as to ensure that the hydrology of the area is re-instated to conditions which are as natural as possible.
- Implement alien vegetation control program within wetland areas.
- Monitor the wetlands for erosion and incision.

Recommended mitigation measures for operational phase:

N/A

Managed	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Construction phase	2	3	2	1	1	5	4	20 (Very-low)
Operational phase	1	3	1	1	1	4	3	15 (Very-low)

Probable latent impacts:

- Sedimentation of the wetland areas may occur if exposed areas are not effectively rehabilitated.

5.5 Impact Assessment Conclusion

Based on the above assessment it is evident that there are three possible impacts that may have an effect on the overall integrity of the system. The table below summarises the findings indicating the significance of the impacts before mitigation takes place as well as the significance of the impacts if appropriate management and mitigation takes place.

Table 17: Summary of the wetland impact assessment

Construction phase		
Impact	**Unmanaged**	**Managed**
1: Impact on the loss of wetland habitat and ecological structure	Low	Low
2: Impact on the changes to wetland ecological service provision	Low	Very-Low
3: Impact on wetland hydrological function and sediment balance	Low	Very-Low
Operational phase		
Impact	**Unmanaged**	**Managed**
1: Impact on the loss of wetland habitat and ecological structure	Low	Very-Low
2: Impact on the changes to wetland ecological service provision	Low	Very-Low
3: Impact on wetland hydrological function and sediment balance	Low	Very-Low

From the table it is evident that for the duration of the construction phase, the impact on wetland habitat and ecological wetland ecological service provision and wetland hydrological function and sediment balance is considered to be of low significance prior to mitigation, however should mitigation measures be implemented the impact will be reduced to very low levels.

For the duration of the operational phase, the impact on wetland habitat and ecological structure as well as the impact on wetland hydrological function and sediment balance are considered to be low level impacts, prior to mitigation. However, if mitigation is implemented impacts will be reduced to very-low significance impacts.

5.6 Analysis of Alternatives

Considering the results of the above assessments, the wetland sensitivities and the locality of the proposed alternatives, no significant difference in impact on wetland resources is anticipated for any of the footprint alternatives associated with the proposed photovoltaic plants. However, Alternative 1 is anticipated to have the least significant impact on wetland resources associated with the study area, and as such is supported from a wetland ecological perspective.

6 RECOMMENDATIONS

After conclusion of this wetland assessment, it is the opinion of the ecologists that the proposed activities be considered favourably, provided that the mitigation measures as outlined in this report are adhered to, along with the following:

Construction and operational footprint

- Limit the footprint area of the construction activities to what is absolutely essential in order to minimise environmental damage. Construction vehicles must use existing roads where possible.
- Limit vegetation clearance during the operational phase to the absolute minimum to avoid increased silt loads and runoff velocities and volumes which may affect the hydrology of downstream wetland areas.
- During construction all building materials should be kept out of the wetland areas as well as the associated buffer zones;
- Keep all demarcated sensitive zones outside of the construction area off limits during the construction and rehabilitation phases of the development.
- Appropriate sanitary facilities must be provided during the construction phase and all waste removed to an appropriate waste facility.

Vehicle access

- All construction footprint areas should remain as small as possible and should not encroach onto surrounding more sensitive wetland areas. It must be ensured that these areas are off-limits to construction vehicles and personnel as far as possible.
- In the event of a breakdown, maintenance of vehicles must take place with care and the recollection of spillage should be practiced near the surface area to prevent ingress of hydrocarbons into topsoil.
- It must be ensured that all hazardous storage containers and storage areas comply with the relevant SABS standards to prevent leakage. All vehicles must be regularly inspected for leaks. Re-fuelling must take place on a sealed surface area to prevent ingress of hydrocarbons into topsoil.
- All spills should be immediately cleaned up and treated accordingly.

Alien plant species

- Proliferation of alien and invasive species is expected within any disturbed areas. These species should be eradicated and controlled to prevent their spread beyond the linear development. Alien plant seed dispersal within the top layers of the soil

within footprint areas, that will have an impact on future rehabilitation, has to be controlled.

- Removal of the alien and weed species encountered on the property must take place in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). Removal of species should take place throughout the construction, operational, and rehabilitation/ maintenance phases.
- Species specific and area specific eradication recommendations:
  - Care should be taken with the choice of herbicide to ensure that no additional impact and loss of indigenous plant species occurs due to the herbicide used.
  - Footprint areas should be kept as small as possible when removing alien plant species.
  - No vehicles should be allowed to drive through designated sensitive areas during the eradication of alien and weed species.

Soils

- All soils compacted as a result of construction activities falling outside of project footprint areas should be ripped and profiled. Special attention should be paid to alien and invasive control within these areas. Alien and invasive vegetation control should take place throughout all construction and rehabilitation phases to prevent loss of floral habitat.
- Monitor all systems for erosion and incision.

Rehabilitation

- Upon rehabilitation, reseeding of indigenous grasses should be implemented in all impacted areas and strategic planting of grassland species should take place.
- As much vegetation growth as possible should be promoted surrounding the photovoltaic structures in order to protect soils. In this regard special mention is made of the need to use indigenous vegetation species where hydroseeding, wetland and rehabilitation planting (where applicable) are to be implemented.

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