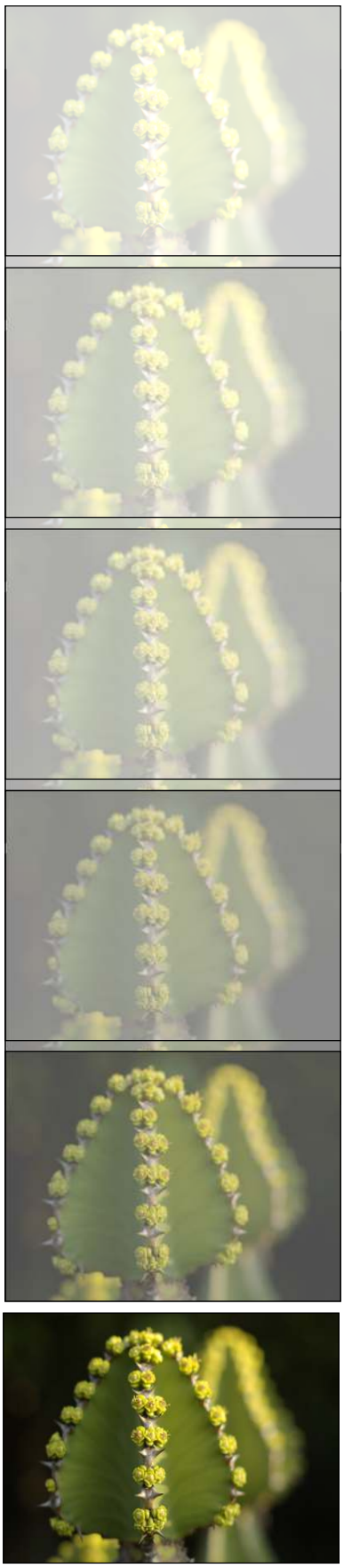

Client:

Environmental Impact Management Services (Pty) Ltd

Project:

Grootvlei PV

Ecological Assessment (Wetland and Vegetation) for the proposed PV station at Grootvlei Power Station

Date:

2013/03/06

Revision:

04

SPEC CC

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1 Introduction

Spatial Ecological Consulting CC (SPEC) was approached by Environmental Impact Management Services (Pty) Ltd (EIMS) to conduct an ecological assessment for the proposed PV Solar unit associated with the Grootvlei Power Station.

2 Legislative and policy framework

2.1 Constitution of South Africa (Act 108 of 1996)

The Constitution of South Africa (Act No. 108 of 1996) place a duty on the State and the citizens to protect the environment. Section 24 provides that:

"*Everyone has the right –*

(b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that

i)prevent pollution and ecological degradation;

ii) promote conservation; and

iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

2.2 National Environmental Management Act (Act 107 of 1998)

Section 2 of the National Environmental Management Act (NEMA) (Act no. 107 of 1998) lists the principles of the Act and includes the protection of sensitive and stressed ecosystems. The regulations for Environmental Impact Assessments (EIAs) are included under this act and are listed in regulations 543 to 547 of 18 June 2010.

2.3 National Environmental Management: Biodiversity Act (Act 10 of 2004)

The National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA) addresses amongst others:

- Biodiversity planning and monitoring;
- Protection of threatened or protected ecosystems;
- Protection of threatened or protected species;
- The control of alien species, invasive species and genetically modified organisms.

Species that are classified as threatened and/or protected are listed in Government Gazette 151 of February 2007 and the regulations are included in Government Gazette 152 of February 2007, with the most recent amendment in Government Notice 576 of July 2011.

Threatened ecosystems in need of protection are listed Government Notice 1002 of December 2011.

2.4 Conservation of Agricultural Resources Act (Act 43 of 1983)

The Conservation of Agricultural Resources Act includes control measures that apply to (Section 6):

- The cultivation of virgin soil;
- The protection and utilisation of vegetation;
- The grazing capacity of the veld;
- Control of weeds and invasive plants;
- The restoration and reclamation of eroded land and other disturbances to the land;
- The protection and restoration of wetlands.

2.5 Mpumalanga Nature Conservation Act (Act 10 of 1998)

The Mpumalanga Nature Conservation Act (Act No. 10 of 1998) relates to nature conservation in the province and provides for conservation concerns in the province. The act lists the protected and specially protected plants in the province and prohibits the picking, sale, export or removal of protected plants. The act also lists invader weeds, which must be controlled on site and may not be sold or donated.

2.6 The National Water Act (Act 36 of 1998)

The National Water Act mandates the Minister of Water Affairs and Forestry to ensure that water is *protected, used, developed, conserved, managed* and *controlled* in a sustainable and equitable manner for the benefit of all persons.

The Minister of Water Affairs and Forestry, supported by the Department of Water Affairs, acts as the public trustee of the nation's water resources. In doing so the Water Act must ensure that the nations' water resources are protected, used, developed, managed and controlled in a way that takes into account-

- meeting basic human needs both present and future;
- promoting equitable access and beneficial use
- facilitating social and economic development;
- protecting ecosystems and biodiversity; and
- reducing and preventing pollution and degradation.

This practically implies that there has to be enough water to meet the Ecological Reserve, this is the amount and quality of water that will maintain basic human needs and ecosystem services at a level that will be sustainable.

This is not currently the case and the degradation found in most catchments and river systems are such that the Ecological Reserve for a "largely natural" catchment cannot be met. A decision must be made wherein a desired level of ecosystem integrity, suited to the Ecological Importance and Ecological State of the system, the requirements of the inhabitants and the future basic needs of the inhabitants must be met. The catchments' water use is then managed to support this new goal. This new goal may be at, above or below the Present Ecological State, but preferably management must improve the environment that provides these ecosystem services. This implies that the Department of Water Affairs and Forestry may restrict stream flow reduction - and other activities that impact on the water quality and quantity and withdraw Water Use Licenses if it sees fit. It may also re-distribute these rights more equitably.

3 Location and study area description

3.1 Location

The Study area is located on or around the Grootvlei Power station, directly north of Grootvlei. Balfour is located to the north-east along the R51 and Villiers is located to the south-west. Four potential alternative sites were identified for the proposed Photo-voltaic plant around the Grootvlei power station, to the north, east, south-east and south-west. These four potential sites were assessed, and are discussed in detail. The broader study area and its surroundings were assessed to evaluate the ecological and hydrological drivers that act upon the ecosystems found on the four alternative sites. This assessment is not discussed separately from the four alternative sites in any detail. The R51 is very close to the site to the east and the N3 is present approximately 5km to the west (Figure 1).

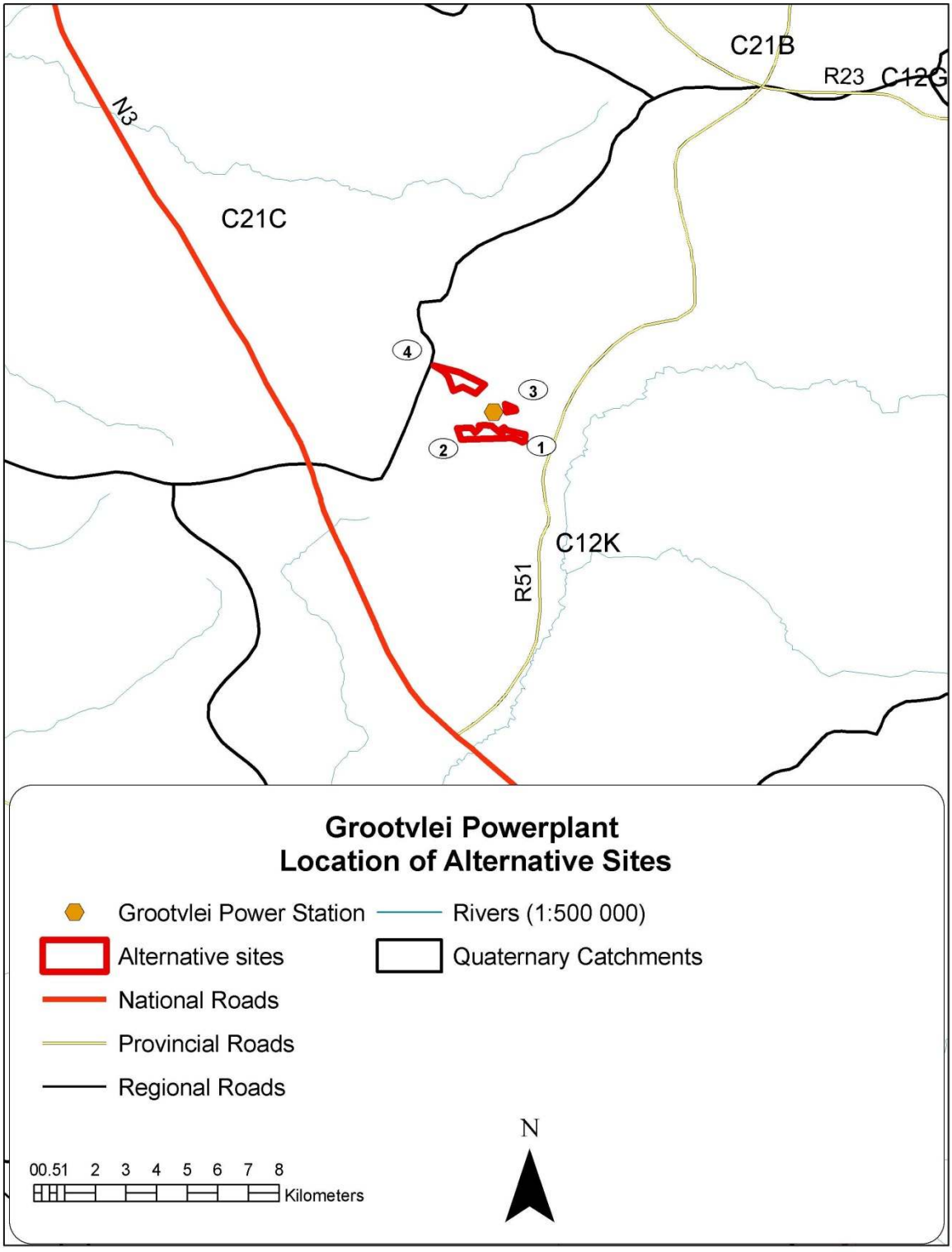

Figure 1. Study area location.

3.2 C-Plan

The Mpumalanga Biodiversity Conservation Plan (Mpumalanga C-Plan) (Ferrar & Lötter, 2007) was compiled to identify areas of conservation priority in Mpumalanga and to ensure that the biodiversity priorities in the province are met. The biodiversity in the province were classified into six

categories ranked according to their biodiversity and ecological priority and their contribution to ecological processes (Ferrar & Lötter, 2007):

1. "Protected areas - already protected and managed for conservation;
2. Irreplaceable areas - no other options available to meet targets–protection crucial;
3. Highly Significant areas - protection needed, very limited choice for meeting targets;
4. Important and Necessary areas - protection needed, greater choice in meeting targets;
5. Ecological Corridors – mixed natural and transformed areas, identified for long term connectivity and biological movement;
6. Areas of Least Concern – natural areas with most choices, including for development;
7. Areas with No Natural Habitat Remaining – transformed areas that make no contribution to meeting targets. "

3.2.1 Terrestrial biodiversity

According to the Mpumalanga C-Plan (Ferrar & Lötter, 2007) most of the Study area has no natural habitat remaining or is of "Least Concern". A small portion of the northern site alternative is indicated to be Important and Necessary (Figure 2).

According to the C-Plan all land uses are permitted in the "Least Concern" areas and areas where no natural habitat is remaining, although some restrictions may apply in the Least Concern areas. In the "Important & Necessary" area only conservation management, extensive game farming and extensive cattle farming is allowed with some limited rural recreational development. Some rural settlement can also be allowed with restrictions (Ferrar & Lötter, 2007).

3.2.2 Aquatic biodiversity subcatchments

The C-plan also indicates that all of the sites are located in a subcatchment that is highly significant for the maintenance of aquatic biodiversity (Figure 3).

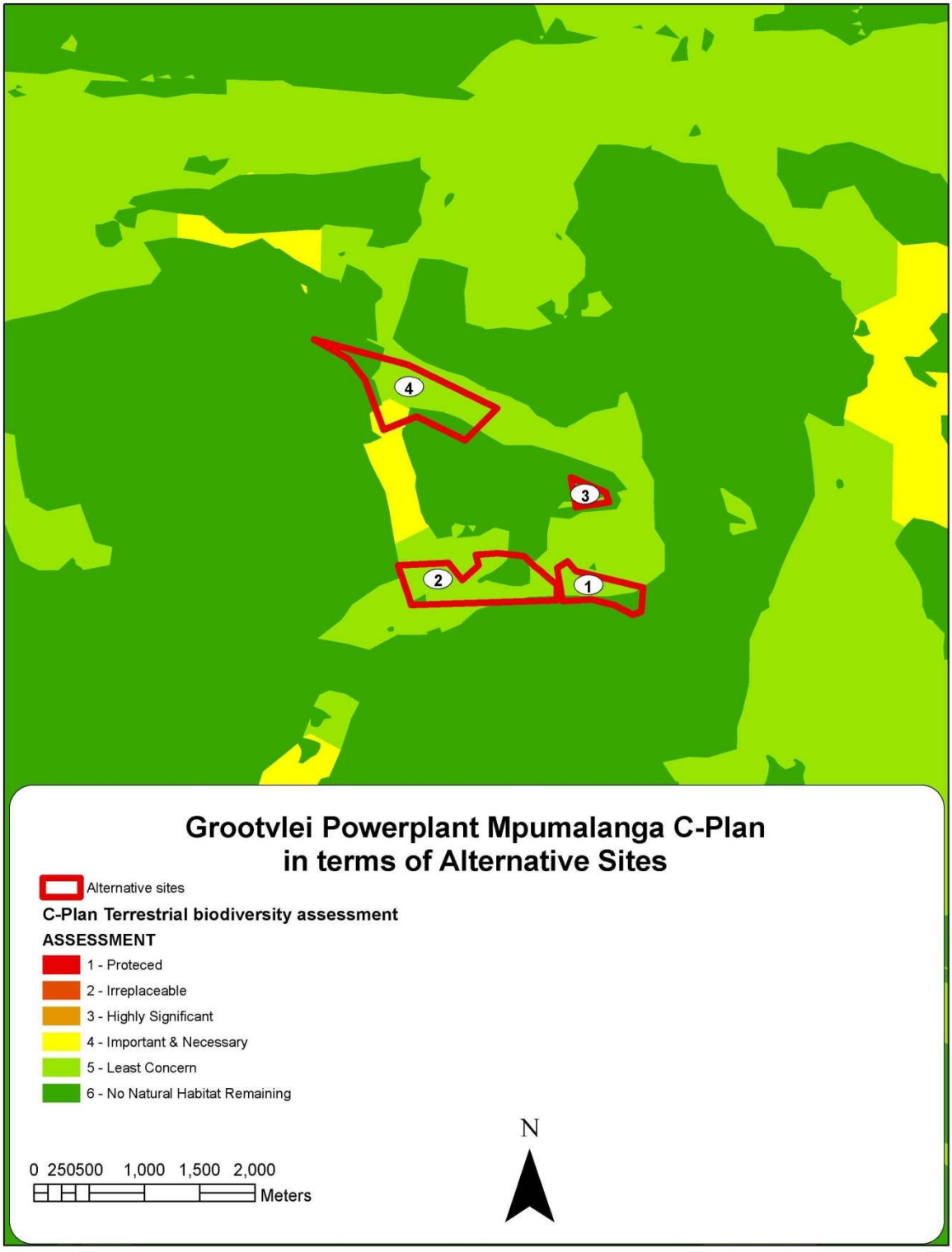

Figure 2. Terrestrial biodiversity assessment according to C-Plan.

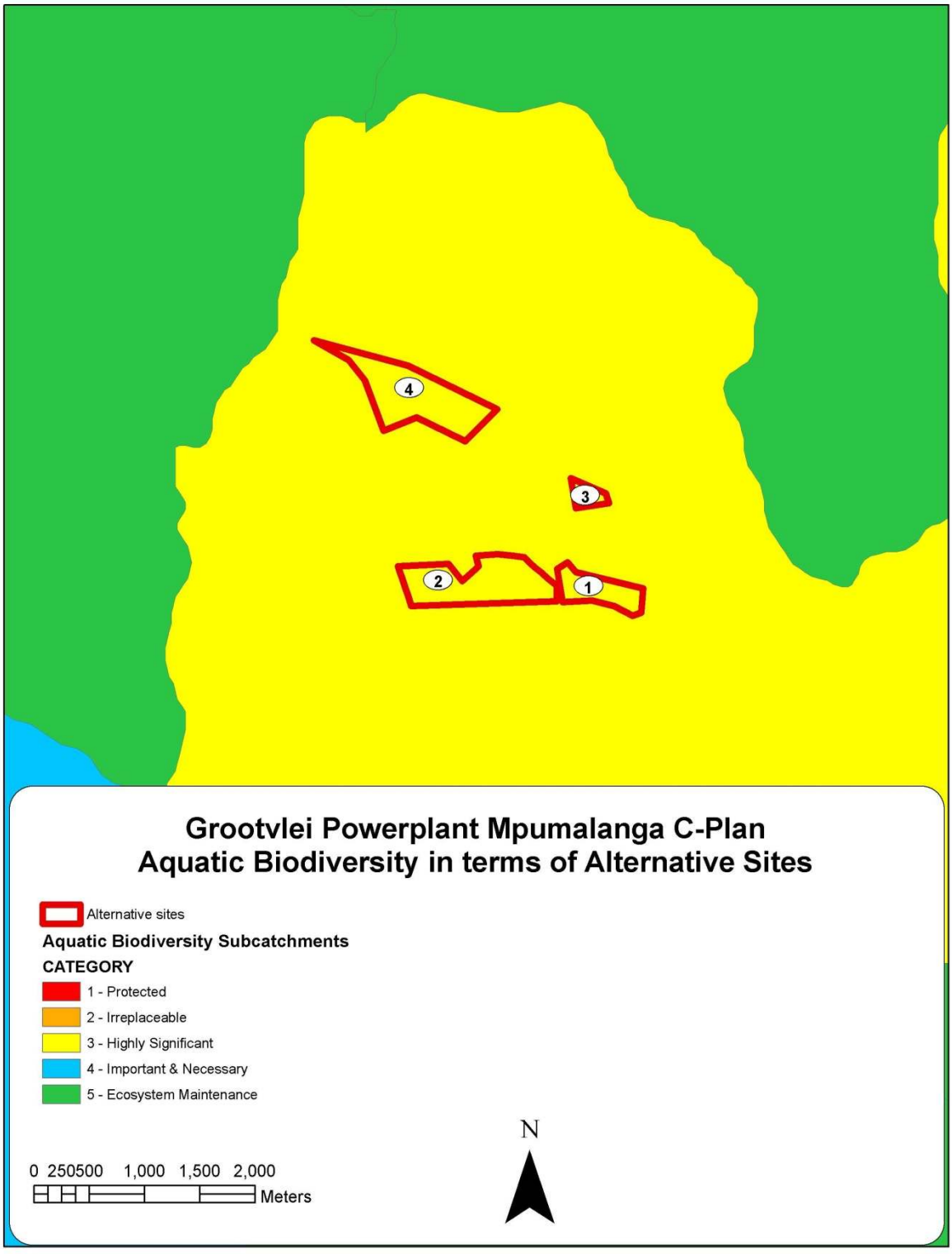

Figure 3. Aquatic biodiversity sub catchments according to C-Plan.

3.3 Water resources

The study area (Grootvlei Power station) is located in quaternary catchment C12K (**Figure 1. Study area location.)**. The study area slopes towards the east towards the Molspruit. The Molspruit flows towards the south-west and eventually enters the Vaal River. The power station is constructed at the

confluence of two wetland units, see **Figure 16. Current Wetland map around the Grootvlei power station**, one entering the site from the north-west and one from the south-west.

3.4 Vegetation types

The Soweto Highveld Grassland is present on the western portions of the study area (Figure 4) and falls within the Mesic Highveld Grassland Bioregion. This vegetation type has medium to high, dense tufted vegetation, dominated by *Themeda triandra* with several grasses such as *Elionurus muticus, Eragrostis racemosa, Tristachya leucotrix* and *Heteropogon contortis* also present (Mucina & Rutherford, 2006). The vegetation type is classified as Endangered in Mucina and Rutherford (2006) and as Vulnerable in the NEMBA list (2011).

Andesite Mountain Bushveld is present on the eastern portions of the study area and falls within the Central Bushveld Bioregion. This vegetation type is a medium-tall, dense thorny bushveld occurring at an altitude between 1350m and 1800m. The bushveld occurs on hill slopes in an undulating landscape and has a well-developed grass layer. The Andesite Mountain Bushveld is classified as Least Threatened, with 15% transformed. Impacts are mainly cultivation and urbanization. Erosion is mostly very low (Mucina & Rutherford, 2006). This vegetation type is not listed as threatened under NEMBA (2011).

3.5 Land cover

The four proposed alternative sites for the photovoltaic cells are located within the Grootvlei power station precinct and adjacent a residential community. The following land cover classes are included on the sites:

- Ash disposal facilities
- Historical agricultural fields
- Primary grassland
- Mechanical disturbance
- Infill (increased soil cover above natural ground level usually done to level construction site or to alter floodlines.)

It is clear from old aerial photographs that most of the land cover types were modified during the construction of the Grootvlei power station. Agricultural fields were however present over most of the sites when the aerial photographs were taken sometime between 1941 and 1945.

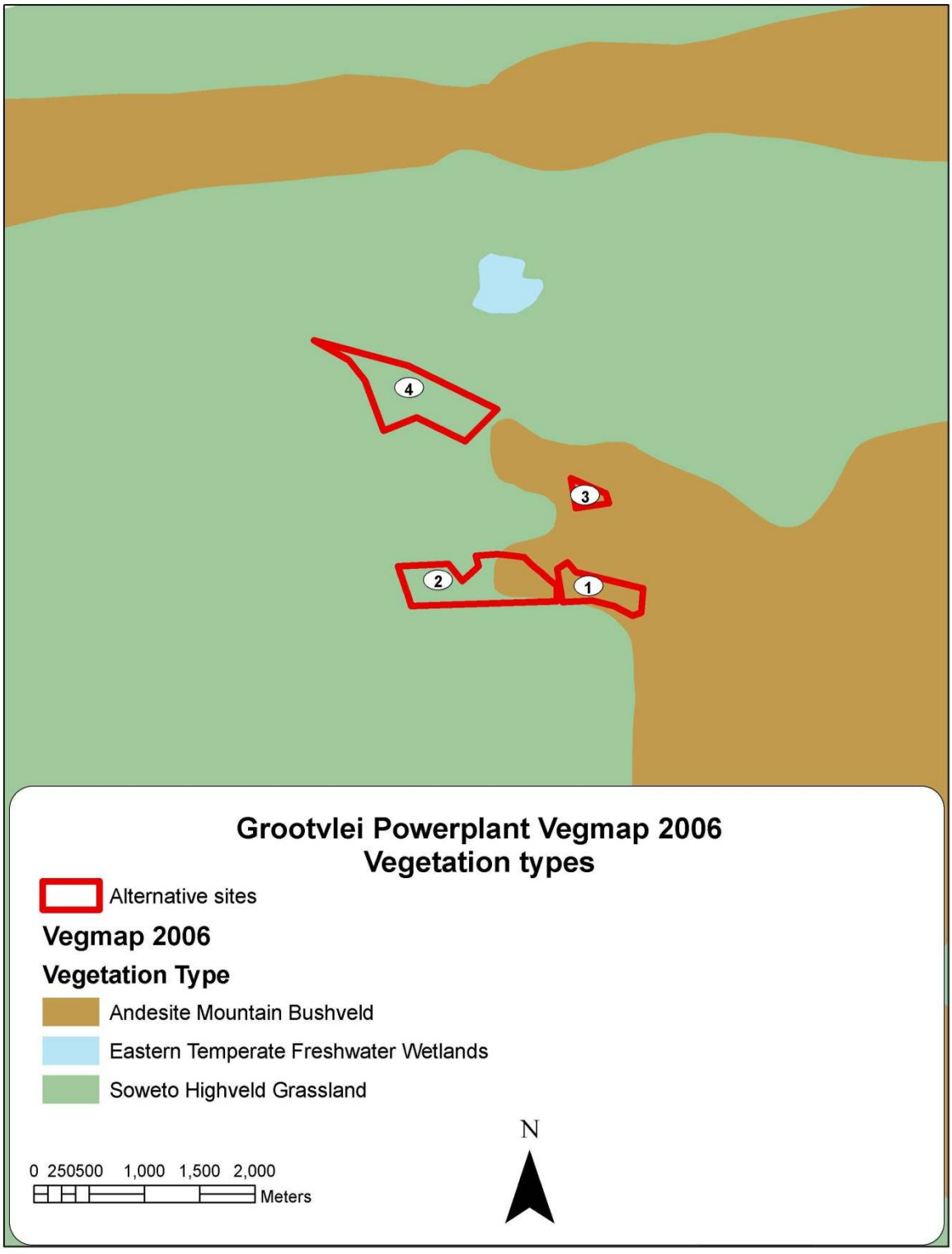

Figure 4. Vegetation types present on site according to Mucina & Rutherford (2006).

4 Methods

The site visit was conducted on 25-26 October 2012. During the site visit the soil was investigated in several places on the study area. Indicators of wetland conditions in the soil were noted. The vegetation present in each of the communities in each of the alternative sites was noted. After this

assessment the site selection process was followed to determine the preferred site based on the environmental conditions present on site.

A second site visit was conducted on 21 February 2013 to confirm and update the species composition at the selected site and to conduct an assessment for the proposed powerlines from the PV site to the power station. This includes determining the dominant plant species on site and confirming the wetland zones on site.

4.1 Desktop Delineation

Aerial photographs of the site was scrutinised prior to the site visit for an indication of the wetland boundaries. Due to the disturbance on site, the wetland boundaries are not clearly visible on remote imagery, but a general indication of the extent of the wetland could be obtained. These boundaries were confirmed on site.

The wetlands were compared with old aerial photographs of the site to determine changes in the wetland characteristics and boundaries. Aerial photography from between 1941 and 1945 was located and compared to the current situation. The Grootvlei power station had not been constructed at that time.

The accuracy of the resampled aerial photography and as a result the lines drawn for the wetland or vegetation delineation, is no better than 25m due to the reference used (1:50 000 topo maps– which is georeferenced by the Surveyor General to about 25m accuracy) for the 1941 and 2001 aerial photos. This implies that a line drawn by us can be 25m away from the actual boundary on the ground. It can be expected to be worse than this because there are small incremental errors that occur during resampling process and the digitizing process, whilst every endeavour is made to prevent this, these incremental errors are due to the constraints in human vision, dexterity and image quality.

4.2 Wetland Health

The Present Ecological State (PES) was calculated using the methods supplied by DWA Resource Quality Services. Wetland IHI Version 1.0. was used for the Channelled Valley bottom wetlands. This method is only valid for channelled valley bottom wetlands and floodplains

Table 1. PES classes and description (from DWAF 2007) indicating the interpretation of the mean scores to rate the PES category.

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.
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.

4.3 Ecological Importance and Sensitivity (EIS)

The EIS were calculated using the new draft DWA guidelines and model, as developed by Mark Rountree, but not yet published. Information was used from the SIBIS and VEGMAP products. A mean score between 0 and 4 is obtained, with 0 as the lowest and 4 as the highest score. No classification of the scores is given; the score is a linear score. These draft guidelines and model, was prescribed by the DWA, and is merely a more complete iteration of the previous Kleynhans model

4.4 Vegetation

Vegetation was subdivided into homogenous units, at a scale of better than 1:10000 and these homogenous units were surveyed for species composition and species of conservation importance. The site visit was conducted on 25 and 26 October 2012, and a follow-up site visit was conducted on 21 February 2013. During the first visit most of the four alternative sites' vegetation h was only 10 to 15cm high, with very few flowers or seeds. A large number of the species could therefore not be accurately identified, especially among the grass and sedge species. It is also possible that a number of forbs, especially bulbs, were not present yet. Very small seedlings could also not be identified. For this reason no cover-abundance was included for the species on the non-preferred alternatives. The second site visit was conducted in February 2013, to complete the vegetation assessment and to obtain a more complete species list for the preferred alternative site, with cover abundance values for the different vegetation units.

5 Results

5.1 Vegetation

The vegetation on site was divided into five vegetation groups with similar habitat. Vegetation communities could not be identified because the site was burned and cover-abundance values could not be allocated to the species. The broad vegetation groups discussed below include the relatively less, or more disturbed sites within a broad vegetation type, these are mapped, but not discussed as individual vegetation units. The vegetation types identified do not correspond with the indicated Mucina et al. classification (Andesite Mountain Bushveld), but rather the temperate eastern wetlands.

During the second site visit Braun-Blanquette cover abundance values were given to species observed on the preferred site and the area investigated for the powerline crossings.

5.1.1 Vegetation groups

5.1.1.1 Temporary wetlands

Figure 5. View of the temporary wetland zone in the southern wetland unit.

Temporary wetland zones area present on both sides of the wetlands running through the northern and south-western sites and on the northern portion of the south-eastern site. A number of species are present in the wetland, including indigenous and alien species. The temporary wetlands are dominated by grass species, which could not be identified correctly due to the burning and short vegetation present. A large number of forb species are present in the wetlands, including numerous pioneer species. This is an indication of disturbance in the wetland. Portions of the temporary wetlands were ploughed in the past, which will affect the vegetation composition. Unfortunately a clear distinction between different portions of the temporary zones is not clear, due to the burned vegetation. The portion of the temporary wetland located between the old railway line and the road, between sites 1 and 2, are very weedy, with a number of alien and invasive species. The temporary zone of the wetland associated with the northern site does, however, have larger species diversity and it appears that this section has fewer disturbances. From a vegetation point of view the wetland has a moderate sensitivity. Please see **Figure 6. Vegetation map of the alternative sites identified for the project** and **Table 2. Species observed in the various temporary wetland areas.**

Figure 6. Vegetation map of the alternative sites identified for the project

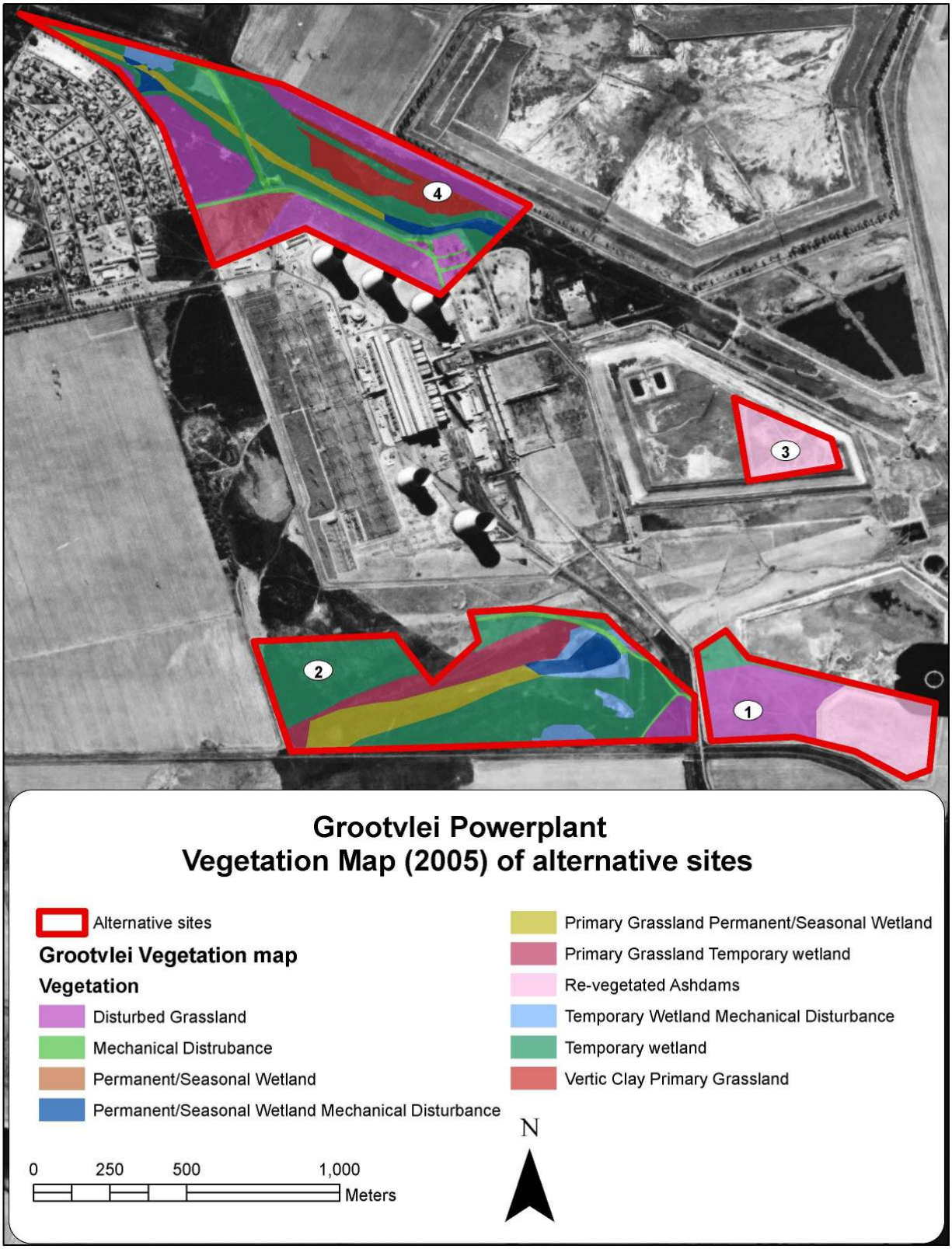

Table 2. Species observed in the various temporary wetland areas.

Species	SE wetland portion	SW wetland	N wetland area	Artificial wetland	Coal conveyor
Agrostis continuata	+	+		1	
Albuca sp		+	x		
Arctotis arctoides		+	x		
Aristida congesta	+				
Berkheya carlinopsis		+	x		
Berkheya radula	+	+			
Bidens bipinnata	2a				2a
Bidens pilosa				+	
Bromus catharticus				+	
Bulbine cf capitata			x		
cf Centella sp			x		
cf Ipomoea sp		+			
Chamaecrista mimosoides	+	+	x		
Chenopodium sp	+	3			+
Chloris virgata		+			
Cirsium vulgare	2a	1		2a	
Conyza cf canadensis	+			+	+
Conyza podocephala	+	+	x		+
Cortaderia selloana			x		
Cosmos bipinnata	1	2a		3	2a
Cuscuta campestris		+			
Cynodon dactylon	3	3		3	2a
Cyperaceae			x		
Cyperus esculentus				+	
Cyperus sp		+	x		
Datura stramonium					+
Eragrostis cf chloromelas			x		
Eragrostis curvula		3	x		
Eragrostis gummiflua		1	x		
Eragrostis plana	2a	+		2a	
Eucalyptus sp			x		
Euphorbia striata			x		
Falkia oblonga		+			
Gazania krebsiana		+			
Gomphrena celesioides		+			
Grasses			x		
Haplocarpa lyrata	+	+	x		
Haplocarpa scaposa			x		
Helichrysum nudifolia		+	x		
Helichrysum rugulosum			x		
Helichrysum sp	+				

Helychrysum rugulosum		+			
Hermannia coccocarpa			x		
Hermannia depressa			x	+	
Hyparrhenia hirta	1	2b	x		
Hypoxis cf hemerocallidea			x		
Hypoxis cf obtusa			x		
Hypoxis hemerocallidea		+	x		
Hypoxis rigidula		+			
Hypoxis sp			x		
Imperata cylindrica	+	+	x		
Jamesbritenia cf aurantiaca		+	x		
Juncus cf effusus		+			
Juncus sp	+				
Lactuca inerme				+	
Ledebouria cf cooperi			x		
Ledebouria cf stenophylla			x		
Ledebouria ovatifolia		+	x		
Melia azedarach			x		
Moraea sp			x		
Oenothera cf tetraptera			x		
Oenothera rosea	+	+	x	+	
Panicum maximum	+	+			2a
Paspalum dilatatum	2b	+		1	3
Paspalum distichum	+				
Persicaria lapathifolia		+			
Phragmites australis	+	+			
Pinus sp			x		
Plantago lanceolata	+	+			
Pseudognaphalium luteo-alba	+				
Rhynchosia totta		+			
Rumex crispus				+	
Schkuhria pinnata	+	+			
Senecio erubescens	+	+	x		
Senecio inornatus	2a	2a	x		1
Senecio sp		+	x		
Setaria sphacelata	2a	+	x		
Solanum panduriforme		+			
Sporobolus africana	2a	+			
Stoebe vulgare		+	x		
Tagetus minuta	2a	2a	x	+	2a
Tephrosia sp		+	x		
Themeda triandra		2a	x	1	
Thesium sp			x		
Typha capensis	+	+		3	1

Unidentified tree			x		
Urochloa mossambisensis					3
Verbena aristigera				+	
Verbena bonariense	+	+	x	2a	+
Verbena braziliense	+	+		+	+
Vernonia oligocephala		+			

5.1.1.2 Seasonal and permanent wetlands

Figure 7. Permanent wetness zone in the southern wetland unit in alternative 2, or the South Western site

Figure 8. Permanent wetness zone in the northern wetland unit in alternative 4, or the Northern site.

5.1.1.3 Permanent and seasonal wetlands

The seasonal and permanent wetness zones in the southern section of the wetland are mostly associated with the wetland channels and the lower-lying centreline of the wetland. The channels are mostly artificial and some sand mining in the centre of the wetland in the 1940s resulted in a depression in the wetland that remains wet for a prolonged period of time.

In the northern wetland unit the channels are partially natural, but mostly modified for development purposes. Erosion is also taking place in the channels, thereby contributing to the disturbance.

The vegetation is dominated by *Typha capensis*, with some *Phragmites australis*, *Cyperus spp* and *Juncus* species. Several grass and forb species are also present, including a number of alien and invasive species. The permanent and seasonal wetland zone between sites 1 and 2, located between the road and old railway line is very disturbed and weedy. Due to the short vegetation the identification of the plants was difficult and it is likely that several species were missed during the assessment. This list was however amended during the site visit in February 2013. From a vegetation point of view the wetland has a moderate sensitivity, however wetlands attract special protection from the NEMA and NWA and CARA. Please see **Figure 6. Vegetation map of the alternative sites identified for the project** and **Table 3. Species observed in the permanent wetland areas.**

Table 3. Species observed in the permanent wetland areas.

Species	SW area	N area	Artificial wetland	SE area
Albuca sp		x		
Asteraceae		x		

Berkheya radula	+	x		
Bidens bipinnata	+		+	3
Briophyta		x		
Canna cf indica		x		
cf Sesbania sp		x		
Chenopodium sp	3			1
Cirsium vulgare	+	x	+	1
Conyza podocephala		x		
Conyza sp		x		
Cosmos bipinnata	2b	x	+	2a
Crotalaria sp		x		
Cynodon dactylon	2a	x		2a
Cyperus congestus			2b	
Cyperus sp	+	x		
Epilobium hirsutum			+	
Eragrostis cf chloromelas		x		
Eragrostis curvula	+			
Eragrostis plana				1
Eucalyptus sp	+	x		
Felicia sp		x		
Flaveria bidentis				1
Fuirena sp		x		
Gazania krebsiana		x		
Gladiolus crassifolius		x		
Gomphocarpus burchelli		x		
Grasses	+	x		
Haplocarpa lyrata		x		
Hyparrhenia hirta		x		
Hyparrhenia tamba				1
Hypoxis cf argentea		x		
Imperata cylindrica		x		
Juncus cf punctorius		x		
Ledebouria ovatifolia		x		
Lotononis sp		x		
Medicago sativa		x		
Oenothera rosea	+	x		
Panicum maximum	+			
Paspalum dilatatum	2a	x		1
Pennisetum clandestinum		x		
Persicaria lapathifolia				1
Phragmites australis	2a	x	3	2a
Plantago lanceolata		x		
Rhynchosia totta	+			
Rumex crispus		x		
Salix babylonica	+	x		

Schoenoplectus/Eleocharis sp	+			
Senecio achilleifolius		x		
Senecio erubescens		x		
Senecio inornatus	+	x		
Senecio sp		x		
Sesbania punicea		x		
Setaria sphacelata		x		
Setaria sphacelata/nigrirostris		x		
Sporobolus africanus		x		
Sporobolus cf fimbriatus		x		
Sporobolus sp		x		
Tagetus minuta	1	x	+	2b
Themeda triandra		x		
Thesium sp		x		
Typha capensis	+	x	3	2a
Unidentified forb		x		
Verbena aristigera	+			
Verbena bonariense	2a	x	+	1
Verbena braziliense	+			
Vernonia sp		x		
Xanthium cf strumarium		x		

5.1.1.4 Artificial wetland

The proposed power lines cross an artificial wetland inside the power station fence. The artificial wetland is a result of an open stormwater drain crossing the area. A dam was also constructed in the artificial wetland. A leaking sewerage manhole is also present close to the stormwater outlet into the stormwater channel and also contributes some water to the system, although not a great amount. This will be fixed as soon as possible.

The vegetation in the artificial wetland is dominated by *Typha capensis, Verbena bonariense* and a few sedge species.

An artificial wetland is also present between the railway line and the road entering the power station directly to the east of the above mentioned artificial wetland. This portion of the wetland contains a number of permanent wetland species including *Typha capensis* and *Phragmites australis*.

Figure 9. Artificial wetland present inside the power station fence.

5.1.1.5 Re-vegetated ash disposal facilities

Figure 10. Thin topsoil layer and established vegetation on the ash disposal facility on the south-eastern alternative site (alternative 1).

Figure 11. Vegetation established on the ash disposal facility in the North Eastern alternative site (alternative 3).

Vegetation is established on both the old ash disposal facilities included in the assessment (Part of Alternative 1 or the South Eastern site, and the entire alternative 3 or North Eastern site). It appears

that the decommissioned ash disposal facilities are not effectively covered by a soil cover, as the layer of topsoil on the ash disposal facilities is very thin and missing in various places. This is especially evident on the ash disposal facility on the south-eastern alternative (alternative 1) site, where white patches of hardened ash is visible. Due to the hardening, shallow topsoil and uneven surface of the ash disposal facility water accumulates in places and results in wetland species being present in patches on the ash disposal facilities, most prominently the alternative 1 site. These areas should however not be viewed as wetlands. The vegetation on the ash disposal facilities has a high number of alien and invasive species present, especially on the eastern alternative site. This is a result of the relative age of vegetation establishment. From a vegetation point of view the ash disposal facilities are of low sensitivity. Please see **Figure 6. Vegetation map of the alternative sites identified for the project** and **Table 4. Vegetation observed on the re-vegetated ash disposal facilities.**

Table 4. Vegetation observed on the re-vegetated ash disposal facilities.

Species	SE ash dam	N ash dam
Agave sisalana	+	x
Aristida congesta	+	
Arundo donax		x
Asparagus sp	+	
Bidens bipinnata	+	
Bidens sp		x
Chenopodium sp	1	
Cirsium vulgare		x
Conyza cf canadensis	2a	x
Conyza podocephala	+	
Conyza sp	+	
Cosmos bipinnata	1	x
Cymbopogon sp		x
Cynodon dactylon	1	x
Cyperus esculentus	+	x
Cyperus cf fastigiatus		x
Datura stramonium		x
Digitaria eriantha		x
Eragrostis curvula	2a	x
Eragrostis plana	1	
Eragrostis sp	+	
Crotalaria sphaerocarpa	+	
Felicia muricata	+	
Flaveria bidentis	2a	
Gomphocarpus sp		x
Haplocarpa sp	+	
Hyparrhenia hirta	2a	x
Imperata cylindrica	+	
Lipidium sp	+	x

Monsonia burkeana	+	
Oenothera rosea	+	x
Paspalum sp		x
Pennisetum clandestinum		x
Phragmites australis		x
Pinus sp		x
Pseudognaphalium luteo-alba	+	x
Rumex crispus	+	
Schkhuhria pinnata	3	x
Sporobolus africana	+	
Stoebe vulgare	+	
Tagetus minuta	2a	x
Tamarix sp		x
Themeda triandra	+	
Unidentified tree	+	x
Verbena aristigera	+	
Verbena bonariense	+	x
Verbena brasiliense	x	

5.1.1.6 Primary vertic clay grassland (Alternative 4)

Figure 12. View of primary vertic clay grassland on the northern alternative site.

This vegetation unit is a remainder of the primary grassland, present outside the wetland areas, that has never been ploughed. This is a fairly small vegetation unit, located between the wetland on its western, southern and eastern borders and cultivated fields and an ash disposal facility on the

northern boundary. Unfortunately, due to the veld that had burnt down and the short vegetation the grass species could not be identified and the dominant species could not be determined. *Albuca* sp and *Hypoxis* sp were very common in the grassland and *Asclepias cf eminens* were observed in the grassland and nowhere else. A number of forb species that are expected in primary grassland were observed in the grassland, as well as the invasive tree *Eucalyptus* sp. See **Table 5. Species observed in the primary clay grassland.** below for a species list

Table 5. Species observed in the primary clay grassland.

Species	Species
Albuca sp	*Hermannia ccoccocarpa*
Arctotis arctoides	*Hermannia depressa*
Asclepias cf eminens	*Hyparrhenia hirta*
Berkheya carlinopsis	*Hypoxis hemerocallidea*
cf Craterocapsa sp	*Ledebouria cf cooperi*
Conyza podocephala	*Ledebouria cf stenophylla*
Digitaria eriantha	*Ledebouria ovatifolia*
**Eucalyptus sp*	*Merremia tridentata*
Gazania krebsiana	*Pollichia campestris*
Geigeria burkei	*Stoebe vulgare*
Grasses	*Themeda triandra*
Haplocarpa lyrata	*Thesium sp*

* Alien species

5.1.1.7 Disturbed vegetation

Figure 13. Disturbed vegetation on the South Eastern site alternative 1.

In this instance disturbed vegetation includes secondary grassland, since most of the disturbed grassland has been altered to such an extent that it shows the same species composition as the secondary grassland. The difference however would be that there is no evidence of ploughing and wide-scale conversion of the specific site. We use secondary grassland in the description of the alternatives, where indeed there is evidence that the area was ploughed for a long period of time and that the vegetation community is a deflected climax. Most of the areas outside the wetlands have been ploughed in the past and large areas of infill are present as well. The portion of vegetation on the south-eastern alternative (1) site, outside the ash disposal facility, is affected by various disturbances. Ash is flowing, or used to flow from the top of the ash disposal facility into the area adjacent to the west of the disposal facility and can be seen and as a white deposit visible in the area of adjacent to the ash disposal facility. There are also several moisture spots against the walls of the ash disposal facility that indicates run-off from the ash disposal facility.

Severe soil disturbance is also present in the wetland, including some soil dumping, and a borrow pit is located on the south-western portion (alternative 2) of this site. The grassland vegetation on the site is therefore disturbed with several alien species, and *Stoebe vulgare, Hyparrhenia hirta* and *Cirsium vulgare* are dominant in different areas of the vegetation unit. Although a few wetland species were observed in the vegetation unit their occurrence is mostly associated with the channel next to the road on the northern portion of this site, next to the ash disposal facility. This section has a low to moderated sensitivity.

Disturbed grassland is also present on the south-eastern and north-western corners of the south-western alternative (alternative 1) site. This portion is dominated by grass species. A borrow pit is also located in this section, as well as some rubble dumping and an artificial canal. Numerous alien and invasive species are present in these grassland portions, as well as several forb species. Identified grass species include *Hyparrhenia hirta, Eragrostis chloromelas, Eragrostis plana* and *Setaria sphacelata*. This section has a low to moderate sensitivity.

Figure 14. Infill in the south-western alternative site (alternative 2).

Infill is present on several portions of the site, mostly under the Grootvlei power station and close to it, but also in a portion of the southern wetland unit on the south-western alternative site (alternative 2). Rubble is also present on the infill in the northern alternative site. The new portion of infill on the south-western alternative site have very large bare patches of soil and many weedy species, with only a few indigenous species, whereas the older portions of infill on the rest of the site has a greater diversity of plant species, including several indigenous grass and forb species. The area still has clear indications of disturbance. Please see Figure 6. Vegetation map of the alternative sites identified for the project and Table 6. Species present in the disturbed vegetation areas on site.

Table 6. Species present in the disturbed vegetation areas on site.

Species	Next to ash dam SE	SW outside wetland	SW Infill, dam wall	Infill and dumped rubble N	Powerline area outside wetand	Decom yard
Acacia karoo	+					
Agrostis continuata	+					
Albuca sp				x		
Alternanthera pungens					+	
Amaranthus hybridus			1			
Arctotis arctoides				x		
Argemone cf ochroleuca			+			
Aristida congesta	+					
Aristida transvalensis	2a					

Berkheya radula	+					
Bidens bipinnata	+		1			+
Bidens pilosa	+	x			+	
cf Sphenostylus angustifolia		x				
Chameacrista mimosoides	2a				+	
Chenopodium sp	1		3			+
Chloris gayana	+				1	
Cirsium vulgare	+	x	+	x		+
Conyza podocephala	+	x			+	+
Cosmos bipinnata	2b		2a		+	+
Crotalaria sphaerocarpa	+					
Cynodon dactylon	2b	x			2b	3
Cyperus esculentus			1			
Cyperus longus						+
Cyperus sp	+					
Datura stramonium	1		2a			+
Digitaria eriantha	+					
Eleusine coracana					1	
Eragrostis chloromelas	+	x			+	
Eragrostis curvula	1	x				
Eragrostis inaoena	+					
Eragrostis plana	+	x			+	
Euphorbia striata						
Felicia muricata	1					
Flaveria bidentis	+					
Gazania krebsiana	+	x				
Gomphrena celesioides					+	
Grasses		x		x		
Guilleminea densa					+	
Helichrysum nudifolium	+			x		
Helichrysum rugulosum	+	x			+	
Helichrysum sp		x				
Hermannia depressa		x				
Hyparrhenia hirta	2a	x		x	1	3
Hyparrhenia tamba				x		
Hypochoeris radicata					+	
Hypoxis hemerocallidea		x		x		
Hypoxis rigidula/albomarginatus		x				
Imperata cylindrica	+			x		
Ipomoea sp			+			
Ledebouria ovatifolia		x		x		
Mellilotis alba	+		+			
Monsonia burkeana					+	
Oenothera rosea	+	x				
Panicum maximum	2b					

Paspalum dilatatum	+		+		+	+
Paspalum distichum					+	
Pelargonium luridum		x				
Pennisetum clandestinum	+		1	x	2a	
Persicaria lapathifolia			+			
Phragmites australis	+		1			
Plantago lanceolata		x			+	
Pogonarthria squarrosa	+					
Pseudognaphalium luteo-alba	+	x				
Rhus lancea						+
Rhynchosia totta					+	+
Rumex crispus	+					
Schinus molle	+					
Schkhuhria pinnata	+		+		+	+
Senecio inornatus	+					+
Senecio sp	+					+
Setaria sphacelata	+	x				
Sonchus oleraceus					+	
Sporobolus africana	+					
Stoebe vulgare	+	x				
Tagetus minuta	2a	x	2a	x	+	
Tamarix sp	+					
Tephrosia sp		x				
Themeda triandra	+	x		x		
Tribulus terrestris					+	
Urochloa mossambisensis					1	
Vahlia capensis/Thesium sp		x				
Verbena aristigera					+	+
Verbena bonariense	+	x	+	x	+	+
Verbena braziliense	+					+
Vernonia cf natalensis		x				
Vernonia oligocephala		x		x		
Vernonia sp	+	x				
Xanthium spinosa			+			
Xanthium strumarium	+					

5.1.2 Invasive plant species

Invasive plant species are listed under the Conservation of Agricultural Resources Act (CARA) and under the Mpumalanga Nature Conservation Act (MNCA). These species are controlled under the acts.

According to CARA all category 1 species must be removed. Category 2 species may only remain if a permit has been obtained from the Department of Agriculture. If no permit has been obtained the

plants must be removed. Listed species may also not occur in a wetland or within 10m of a wetland. Please see **Table 7. Alien and Invasive species in the study area**

Name	Invasive species
Agave sisalana	CARA Category 2, MNCA
Argemone cf ochroleuca	CARA Category 1
Arundo donax	CARA Category 1, MNCA
Bidens pilosa	MNCA
Canna cf indica	CARA Category 1
Cirsium vulgare	CARA Category 1, MNCA
Cortaderia selloana	CARA Category 1
Cuscuta campestris	CARA Category 1, MNCA
Datura stramonium	CARA Category 1, MNCA
Eucalyptus sp	CARA Category 2, MNCA
Melia azedarach	CARA Category 1, MNCA
Pinus sp	CARA Category 2
Salix babylonica	CARA Category 2
Sesbania punicea	CARA Category 1, MNCA
Tamarix sp	CARA Category 3
Xanthium strumarium	CARA Category 1, MNCA

Table 7. Alien and Invasive species in the study area

5.1.3 Medicinal plant species

Several medicinal plant species are present in South Africa and are still used for medicinal purposes by various communities. It is therefore necessary to note what species may be of medicinal value on site. Please see Table 8. Medicinal plant species recorded on site.

Table 8. Medicinal plant species recorded on site.

Name	Medicinal
Acacia karoo	The bark and leaves are used for diarrhoea and dysentry. The bark, leaves and gum are used for colds, conjuctivitis and haemorrhage, while the gum is also used for oral thrush.
*cf *Centella sp*	Used to treat leprosy wounds and cancer. Also used for general wound treatment, fever, syphilis and as a diuretic and purgative. Also used for venous and lymphatic vessel insufficiency.
**Datura stramonium*	Mainly used to reduce pain and asthma. Also as a poultice for rheumatism pain, gout, boils, abscesses and woulds. It is also used to treat toothache, tonsillitis and sore throat and to relieve asthma or bronchitis and to treat motion sickness and to treat Parkinsonism and visceral spasms.

Gomphocarpus sp	Some species of *Gomphocarpus* including *G. fruticos, G physocarpa* and *G. crispa* are used for headache and tuberculoses. The plants are also used for strengthen the body and to relieve stomach ache and other pain. It is also used as a diuretic, purgative and emetic, or to treat asthma, typhus fever and for cough.
Helichrysum nudifolia	Several *Helichrysum* species are used for medicinal purposes including treatment of coughs, colds, fever, infections, headache, menstrual pain and wound dressings.
Helichrysum rugulosum	Several *Helichrysum* species are used for medicinal purposes including treatment of coughs, colds, fever, infections, headache, menstrual pain and wound dressings.
Helichrysum sp	Several *Helichrysum* species are used for medicinal purposes including treatment of coughs, colds, fever, infections, headache, menstrual pain and wound dressings.
Hypoxis hemerocallidea	The plant is used to treat dizziness, bladder disorders, insanity, as a tonic for weak children and to treat burns. It is also used for treat testicular tumours prostate hypertrophy, urinary infections and for prostate problems.
Pelargonium luridum	Used to treat diarrhoea and dysentry.
Typha capensis	The rhizomes are used during pregnancy for easy labour and for veneral diseases, dysmennorhoea, diarrhoea, dysentry and increased libido. It is also used to increase circulation and fertility.
Vernonia oligocephala	Used to treat abdominal pain, colic, rheumatism, dysentry, ulcerative colitis and diabetes.

5.2 Wetland

5.2.1 Hydrogeomorphic and general description of wetland

The wetlands on site are channelled valley bottom wetlands with seepage zones on the sides. The wetlands have a fairly low slope, and are located in a slightly undulating terrain. The Grootvlei power station was constructed at the confluence of the two wetland sections and is constructed on infill. The infill took place into the wetland and the ash disposal facilities and other infrastructure of the power station was constructed on the wetland. The wetlands are therefore also crossed by several roads and the channels in the wetlands were modified. Erosion is taking place in some portions of the wetland due to the disturbances present in the wetland. The delineation (**Figure 15. Historical Wetland map around the Grootvlei power station**) based on the 1941 aerial photographs seems fairly clear, however it must be said that since it cannot be verified, and because soil moisture indicators do change over time, especially following pro-longed disturbance, a lesser confidence

must be given to this than to a current delineation. (**Figure 16. Current Wetland map around the Grootvlei power station**)

5.2.2 Wetland delineation

The delineation is done from the perspective of the sensitivity of the wetland to the proposed impact; as such we grouped the permanent and seasonal wetlands together, as they are more sensitive to the proposed impact than the temporary zone. Furthermore the permanent and seasonal zones are more closely associated in structure and vegetation than to the temporary zone.

5.2.2.1 Vegetation

The temporary zone, and possibly the seasonal zone, of the wetland were ploughed in the past. But the vegetation seems to have recovered since. The wetland vegetation contains a number of grass species, as well as *Typha capensis*, *Phragmites australis* and several indicators of wetland conditions. In general the channels and canals have more wetland vegetation and the temporary zone less, as expected. The wetland boundaries correspond to the wetland vegetation.

5.2.2.2 Topography

The wetlands are located on the lower lying areas of the site in the valley bottom position. This is the area where wetlands are expected to occur and the wetland area therefore corresponds well to the topography of the site as well.

5.2.2.3 Soil

In general the soil in the wetland is a brown sandy clay soil going to grey with depth, with some red, yellow and black mottles. The mottles start at different depths depending on the wetland zone. The temporary zone of the wetland has more sand, and the disturbance in the soil is also greater, since this portion of the wetland has been ploughed in the past. The ploughing took place long enough in the past that signs of wetland are again evident in the soil. The soil in the channels has a high organic content and is a good indication of wetness for most of the year. The ploughing in the temporary zone of the wetland renders it difficult to indicate the exact boundary of the wetland.

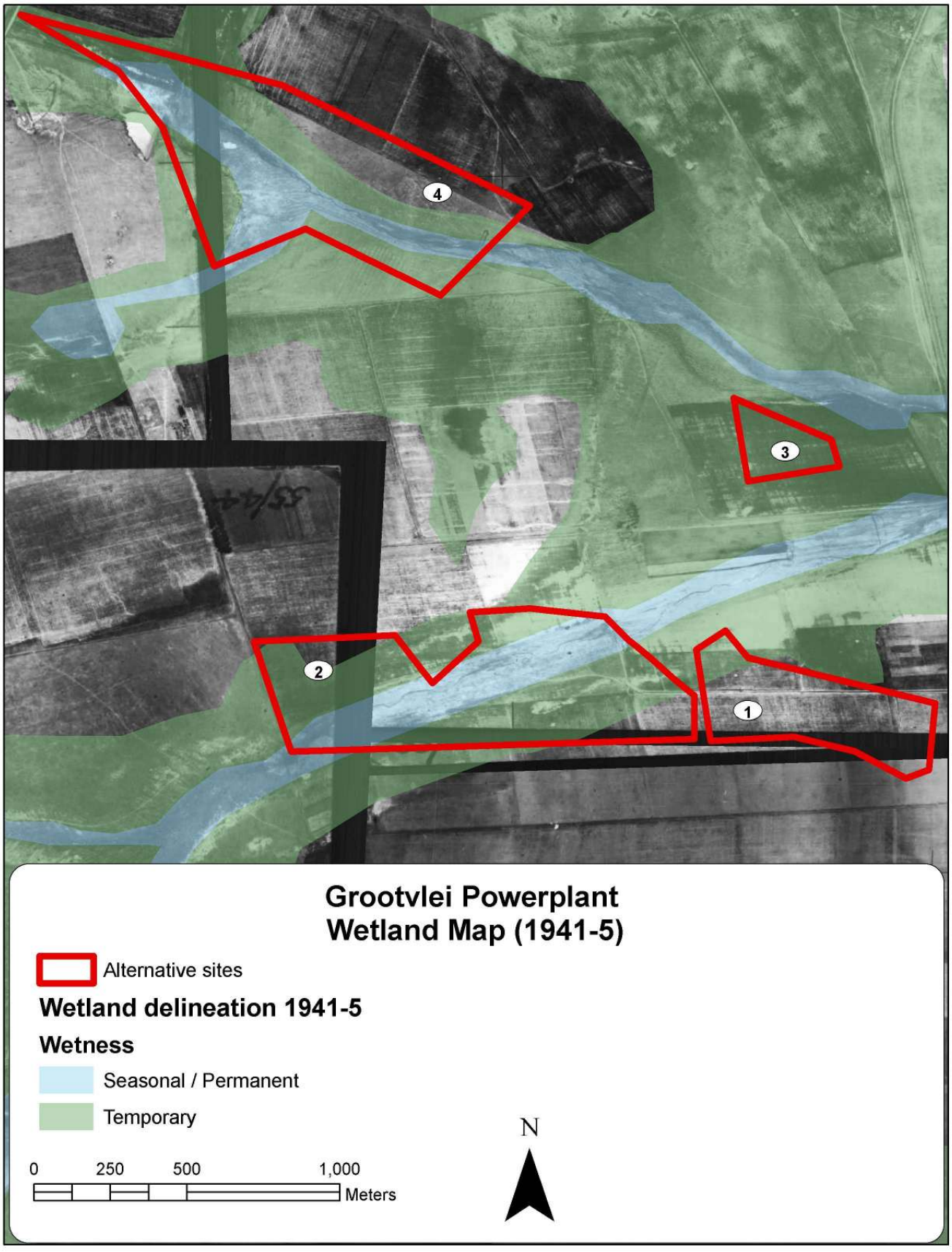

Figure 15. Historical Wetland map around the Grootvlei power station

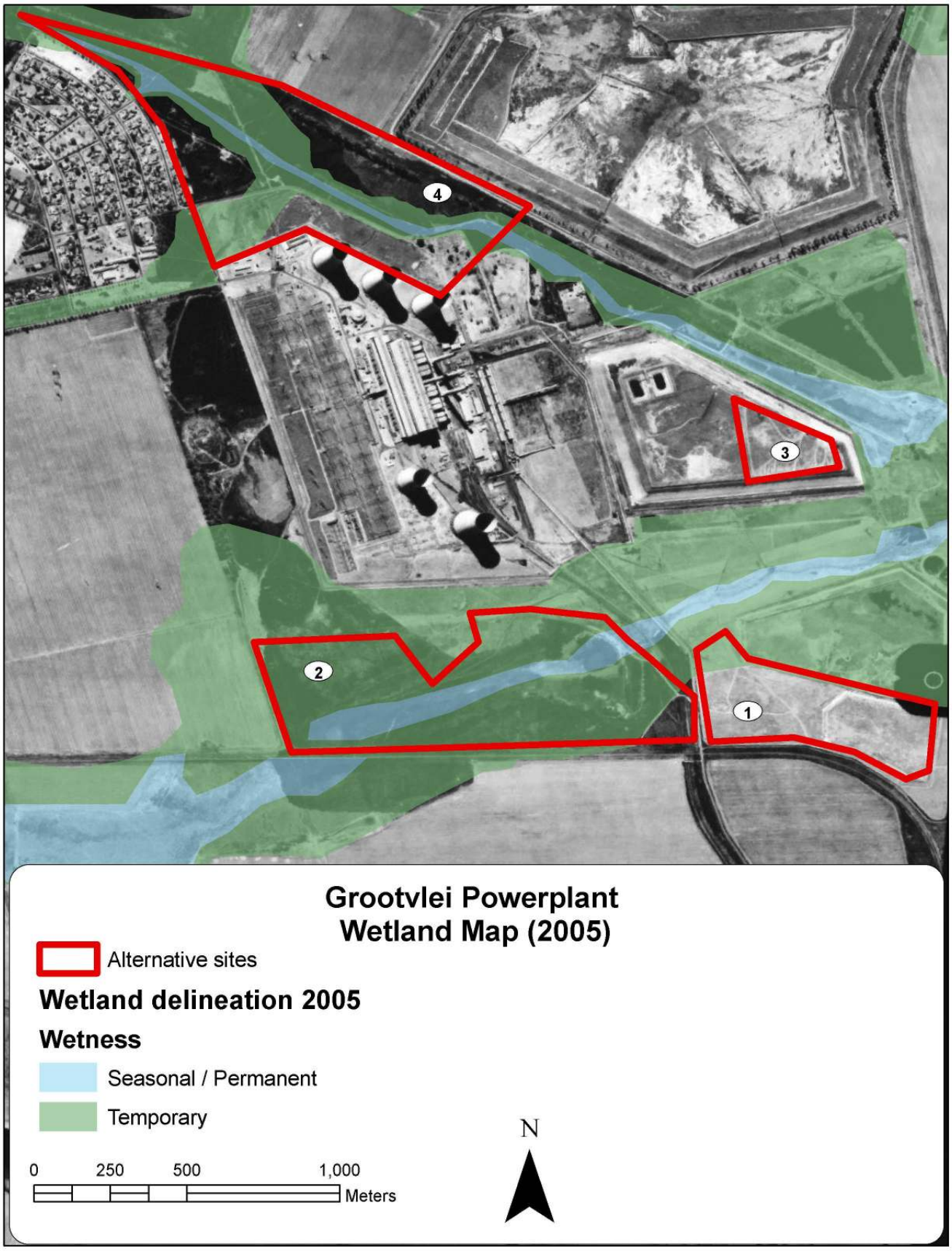

Figure 16. Current Wetland map around the Grootvlei power station

Figure 17. Soil in the permanent and seasonal zone of the wetland of Grootvlei Power Station

Figure 18. Soil in the temporary zone of the wetland of Grootvlei Power Station

5.2.2.4 Conclusion

It is clear from the vegetation, soil and topography that wetlands are present on the study area and affect all the alternative sites to a varying degree. Several impacts are however present in the

wetland and this affects all three of the wetland indicators (Soil moisture indicators, vegetation indicators and topographic indicators). It is therefore difficult to indicate the exact boundary of the wetland, but SPEC is confident that the indicated boundaries indicate the current extent of the wetland. The previous extent of the wetlands according to old (1941-1945) aerial photography is also indicated on the historical wetland map.

5.2.3 Present Ecological State

5.2.3.1 Northern portion wetland

This wetland is a channelled valley bottom wetland, with seepage zones. Large portions of the seepage zone have been destroyed by development, the power station and an ash disposal facility. Infill is present in the wetland. Although a portion of the wetland channel is natural most of the wetland channel has been rerouted and/or deepened for the development. The Northern wetland which impacts site 4, or the Northern Site, is calculated as a C/D which means it is moderately to largely modified in terms of the biota, hydrology geomorphology and functioning, a split rating indicates that there are certain aspects that are still in a relatively better class, in this case geomorphology. Refer to

Table 9. Wetland PES score for the wetland on the northern portion of the site.

Hydrological – The above changes had a large impact on the hydrology of the wetland and high flows are therefore more channelled and less dispersed than under normal conditions. The increase in impermeable surface and loss of seepage zones also resulted in a higher flow during floods and a longer dry period in between.

Geomorphology – The topography of the wetland is changed by the various impacts on the wetland, especially the infill and changes to the wetland channel. Some erosion is also taking place in the wetland and contributes to the changes to the geomorphology of the wetland. The most significant change is the canalisation of the southern tributary of the wetland, with very deeply incised erosion adjacent to the power station.

Figure 19. Erosion in the channel of the northern wetland unit. (Alternative 4)

Water Quality – The power station and ash disposal facilities are located within the historical extent of the wetland. Concrete channels were constructed around the ash disposal facilities to collect seepage water from the ash disposal facilities, but it is expected that some pollution will enter the wetland from time to time. Ash has a high alkalinity and any leachate from the ash disposal facility entering the wetland is therefore likely to increase the pH in the wetland.

Vegetation – Although the vegetation over most of the wetland unit was burned and only about 5-15cm high during the site visit it is clear that both indigenous and alien species is present in the wetland. The dominant species appears to be indigenous species, such as *Typha capensis, Phragmites australis* and indigenous grass species. A number of invasive species are also present in the wetland or adjacent to the wetland. This includes *Eucalyptus* sp which may cause a lowering of

the water table. Portions of the vegetation in the wetland unit have also been destroyed or significantly altered by the infill in the wetland and historical ploughing.

Table 9. Wetland PES score for the wetland on the northern portion of the site.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**2.1**		
Hydrology	1	100	2.6	3.4	D
Geomorphology	2	80	1.8	2.5	C
Water Quality	3	30	1.9	2.9	C/D
WETLAND LANDUSE ACTIVITIES:		**80**	**1.8**	**4.7**	
Vegetation Alteration Score	1	100	1.8	4.7	C
OVERALL WETLAND SCORE			2.0	*2.1*	**C/D**

5.2.3.2 Southern portion wetland

Farm dams are located in the southern wetland unit, outside the precinct upstream of the proposed site alternative 2, several roads and a railway cross the wetland. Some infill is present in the wetland for the ash disposal facility and power station, as well as the roads and railway line. Although the wetland is a channelled valley bottom wetland the wetland upstream of the site is unchannelled and the channel should start approximately at the railway crossing.

At some stage in the past the natural wetland channel has been changed and an artificial, straighter wetland channel was constructed from the culverts under the railway line on the southern boundary of the south-western alternative site to the culverts under the road on the eastern boundary of this site. It appears that the natural channel was closed, either through mechanical means, or by silting up. The levee constructed adjacent to the artificial channel to assist with canalisation of the water has since been breached and some water therefore enters the lower-lying area previously occupied by the natural wetland channel. Several other artificial channels are present on the south-western alternative site, as well as an old broken farm dam wall. This Southern wetland's PES is calculated as a C, Moderately modified. It almost encompasses alternative 2 and borders on alternative 1. (**Table 10. Wetland PES score for the wetland on the southern portion of the site.)**

Hydrological – The artificial canals, roads, railway and farm dams in the wetland causes significant changes in the hydrology of the wetland, including the flow patterns and intensity. The dams, road and railway crossings cause retention of water in portions of the wetland, while the canals cause less dispersed water flow. The section of the wetland downstream of the south-western alternative site still have a fairly natural channel, but flow in this area is also affected by the ash disposal facilities and the road crossings.

Geomorphology – Several changes to the topography of the wetland took place, including artificial canals, changes to the natural channel and infill for the road, railway and ash disposal facilities. It appears that excavation also took place in the wetland in the past and a deeper, wetter portion is now present in the wetland.

Figure 20. Broken farm dam wall and road crossing in the southern wetland unit. (Alternative 2)

Water Quality – The power station and ash dam are located on the wetland. Concrete channels were constructed around the ash dams to collect seepage water from the ash disposal facilities, but it is expected that some pollution will enter the wetland from time to time. Ash has a high alkalinity and any dispersal of ash from the ash disposal facility entering the wetland is therefore likely to increase the pH in the wetland.

Vegetation – The vegetation in the portion of the southern wetland unit present on site has burned and species identification is therefore difficult. It appears however that the vegetation composition is similar to the vegetation condition downstream and upstream of the site. Large portion of the vegetation in the wetland has been modified or destroyed by the infill activities and dams in the wetland. The wetland also contains various alien species, including a number of invasive plants. At present the impact from the invasive species are fairly small.

Table 10. Wetland PES score for the wetland on the southern portion of the site.

OVERALL PRESENT ECOLOGICAL STATE (PES) SCORE					
	Ranking	Weighting	Score	*Confidence Rating*	PES Category
DRIVING PROCESSES:		**100**	**2.1**		
Hydrology	1	100	1.9	3.2	C
Geomorphology	2	80	1.8	3.0	C
Water Quality	3	30	1.7	4.1	C
WETLAND LANDUSE ACTIVITIES:		**80**	**1.6**	**3.4**	
Vegetation Alteration Score	1	100	1.6	3.4	C
OVERALL WETLAND SCORE			1.7	*1.5*	**C**

5.2.4 Ecological Importance and Sensitivity

The EIS is a broader index, and is used to gauge the value of larger systems; therefore the two wetland units are evaluated as one wetland has an Ecological Importance and Sensitivity (EIS) score of 1.3. This is a value between 0 and 4, with 0 being very low and 4 very high. The wetland therefore has a moderate EIS score.

5.2.5 Conservation Importance

Although the wetlands on site have several disturbances the sub-catchment is indicated to be Highly Significant. The wetlands are therefore part of a highly significant aquatic system. In addition all wetlands are considered to be of conservation importance. The wetlands on site can therefore be considered to be of high conservation importance.

6 Buffers

A buffer is an area of land (next to a sensitive feature or ecosystem) designated as such and used to 'dilute' impacts from adjacent developments and activities in order to protect or preserve the sensitive feature or ecosystem. The size of the buffer zone is determined by the extent and magnitude of the impact from the adjacent activities or development and the sensitivity of the feature to be protected. Different buffer zones have been proposed for the protection of wetlands and rivers in South Africa, mostly ranging between 30m and 100m.

In the light of the variability in impacts originating from the variation activities relating to the proposed photovoltaic plant, a buffer zone of 30m is recommended around the wetland areas for any infrastructure that includes an increase in hard surfaces on the ground, and clearing of vegetation and other potentially eroding surfaces. For any activities that do not require hard surfaces, or additional bare soil, we propose a 10m buffer, because the activities such as these will not materially affect the wetland drivers, especially in this case where the wetland has been moderately to largely modified.

7 Sensitivity and conservation importance

The sensitivity map of the site was compiled according to the following categories:

a) **No-Go:** These areas are of such value that no development should take place in this system. This includes areas of primary vegetation, which is protected on a regional or national level as areas that is irreplaceable or areas that are incompatible with the proposed land use. Permanent and seasonal wetlands are included herein for the range of impacts expected by the proposed development.

b) **High**: Good vegetation cover exists, with no severe impacts noted and little problem plant or weed species, for instance a low percentage of plants associated with overgrazing and / or mechanical disturbance, as well as a healthy looking A-horizon (which means good organic content). No or slight management intervention or land use is required to return vegetation to pristine condition. Vegetation that is a good representation of a threatened vegetation type is also included in this category, even if a few alien and invasive species are

present. Temporary wetlands are included here for the range of impacts expected by the proposed development

c) **Moderate**: Signs of overgrazing, some shift in species composition, some degree of soil degradation. Management Intervention is required, but may also recover if natural processes occur and the impact is removed.

d) **Low**: Extensive soil erosion, plant cover dominated by noxious and / or grazing resistant species. Somewhat diverted climax plant communities. Will not recover without serious management intervention, if ever. This also includes areas with very low plant species diversity such as cultivated pastures.

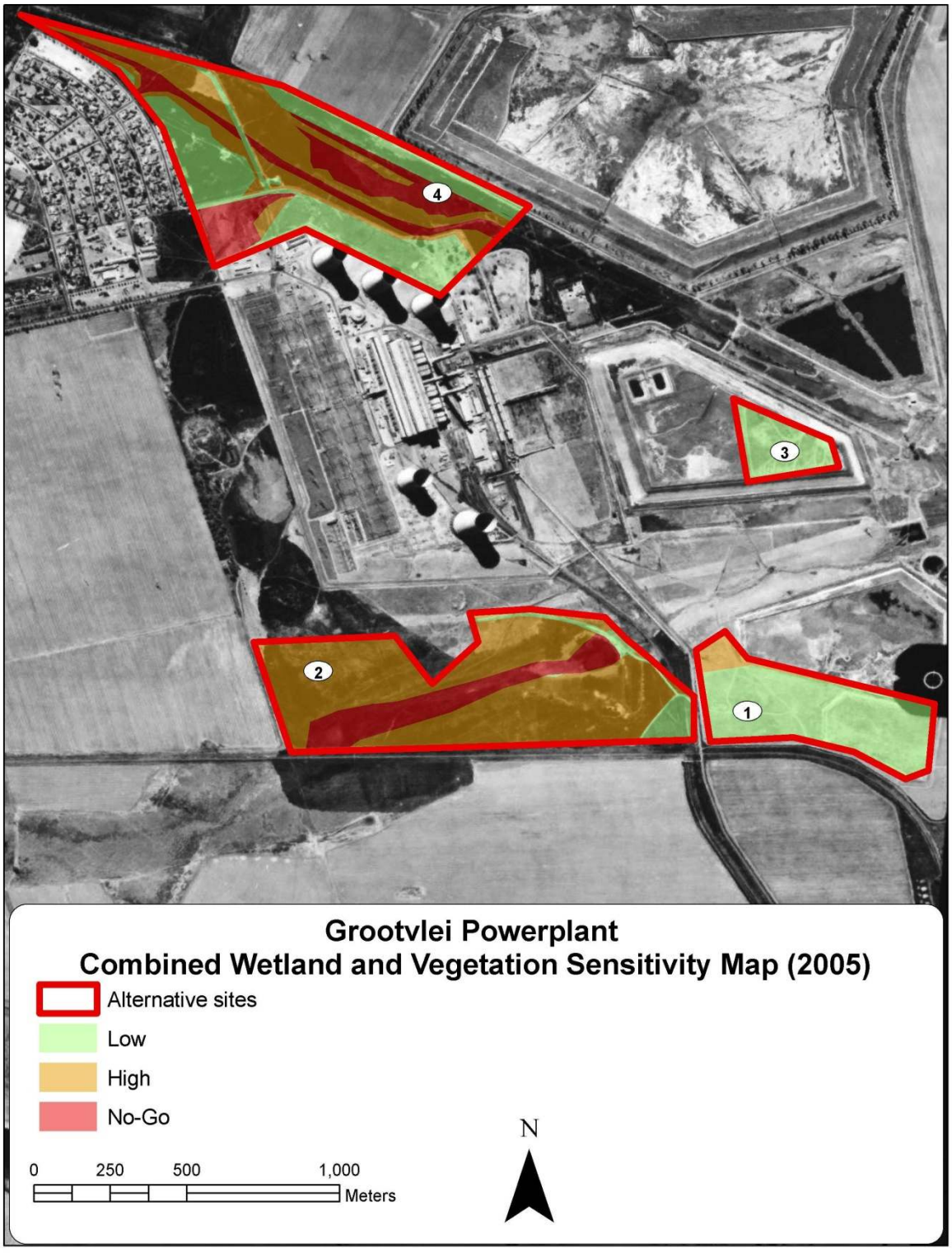

Figure 21. Combined Vegetation and Wetland Sensitivity map of the alternative sites at Grootvlei Power Station

8 Site Selection:

This site selection is made from an ecological point of view, and includes the recommendations from the fauna study, the wetland study and the vegetation study and a detailed land cover assessment through extensive use of historical aerial photographs and historical wetland delineations. This analysis relied partly on the basis of an incomplete (as it relates to plant species identification, due to seasonal constraints) field survey. This limitation was overcome by a follow-up site visit. The preferred alternative was revisited and confirmed to be the best location from an ecological point of view and the vegetation report was updated to reflect this survey. The powerline route alternatives were also subjected to a complete vegetation survey. We consider this approach effective in determining the preferred site from an ecological point of view. Please note all areas noted below are in relation to ecological condition only, it does not include buffers and are limited by the accuracy constraints noted in the method discussion.

8.1 North-Western site (Alternative 4)

The North-western site is located on what was predominantly a wetland in the 1940's; it consists of two areas of primary grassland, which contains food plant species for the threatened butterfly *Aloeides dentata*. The site is however not connected to other such sites and the species was not found on the site. The rest of the North western site has been impacted by historical ploughing, infill during the construction phase of the powerplant, erosion and mechanical disturbance such as clay mining, road construction, and altering the location of the wetland channel during the construction of the powerplant. The areas suitable for the photo-voltaic plant are the secondary grassland (that has been infilled) to the south of the wetland channel are approximately 10.5 ha in size divided roughly in two. These two sites are not large enough and will create a disjointed plant which will lead to inefficiencies.

8.2 North-Eastern site (Alternative 3)

This site is a re-vegetated ash disposal facility and as such is suitable for the proposed development. It is however small (approximately 4.8 ha) and as such will in all likelihood not be suitable.

8.3 South-Western Site (Alternative 2)

The South-Western site straddles the channelled valley bottom wetland to the south of the site, with some primary vegetation in the channel areas. The disturbance levels are very high with borrow pits, historical ploughing, historical erosion, dams and roads impacting the site, however the wetland still functions to a large extent. The site is therefore less suitable for the proposed development. Parts of (secondary vegetation and secondary vegetation in the temporary wetland zone) the site may be explored for development of the site provided the process mentioned in the site selection preamble is followed. It will remain difficult to receive authorisation in spite of the fact that we believe the impacts may be readily mitigated. Suitable area from an ecological point of view is approximately 1.4ha.

8.4 South-Eastern Site (Alternative 1) (Preferred site)

The recommended site from an ecological point of view consists of secondary grassland, which is predominantly not wetland, and a portion of re-vegetated ash disposal facility. The soil cover on the ash disposal facility is between zero and 0.3m thick.

The South-East site has the following benefits from an ecological point of view:

1. It is predominantly not a wetland.
2. It is secondary grassland, and therefore biodiversity constraints are fairly low.
3. It is large enough (14.5 ha) and can accommodate the plant in a single area, increasing footprint efficacy.
4. The soil is fairly sandy and drainage will not be impacted significantly due to the hard-surfaces of the PV panels.
5. It has significant impacts already on it, mostly the
    a. Ash disposal facility
    b. Historical ploughing
    c. A boundary road is already present and should not add significantly more impacts during construction and operation.
6. The power line can follow existing disturbances across the adjacent wetland habitat.

We therefore propose that this site is the most suitable site from an ecological perspective.

8.5 Power lines

The power line options were conceptually designed by the ecological specialists as feasible from an ecological and biodiversity point within the context of the site using basic guidelines from the engineers. The engineering team chose the preferred route from these options, which coincided with the ecologically preferred route, with minor amendments. These minor amendments do not affect the sensitivity of the route.

Table 11. Possible power line route options.

Route option	Comments
A	Shortest route, straight pylons can be placed outside permanent and seasonal zones, but route does not follow existing disturbances
B	second shortest route, no big direction changes in route, pylons can be placed outside permanent and seasonal zones at existing disturbances, route does not follow existing disturbances
C	Third shortest route, significant direction changes in route, pylons outside permanent and seasonal zones at existing disturbances, route follows existing disturbances
D	Longest route, significant direction changes in route, pylons outside permanent and seasonal zones at existing disturbances, route follows existing disturbances, may affect wetlands in plant area that are not delineated,
F	Current preferred route based on ecological, engineering and construction concerns, the most important factor involving the ready access for the construction vehicles on a pre-existing road, and no other significant drawbacks.

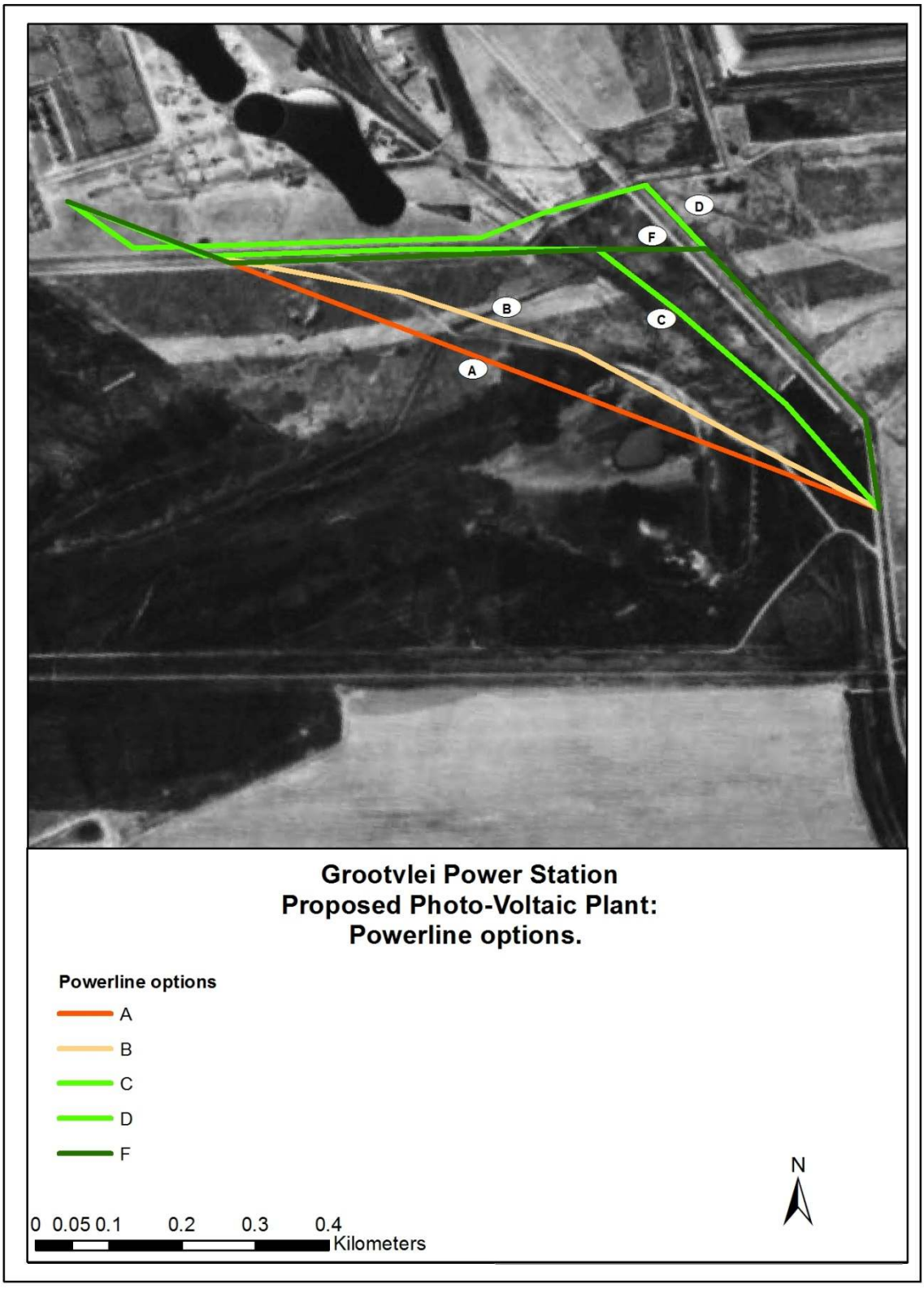

Figure 22. Power line route options on site.

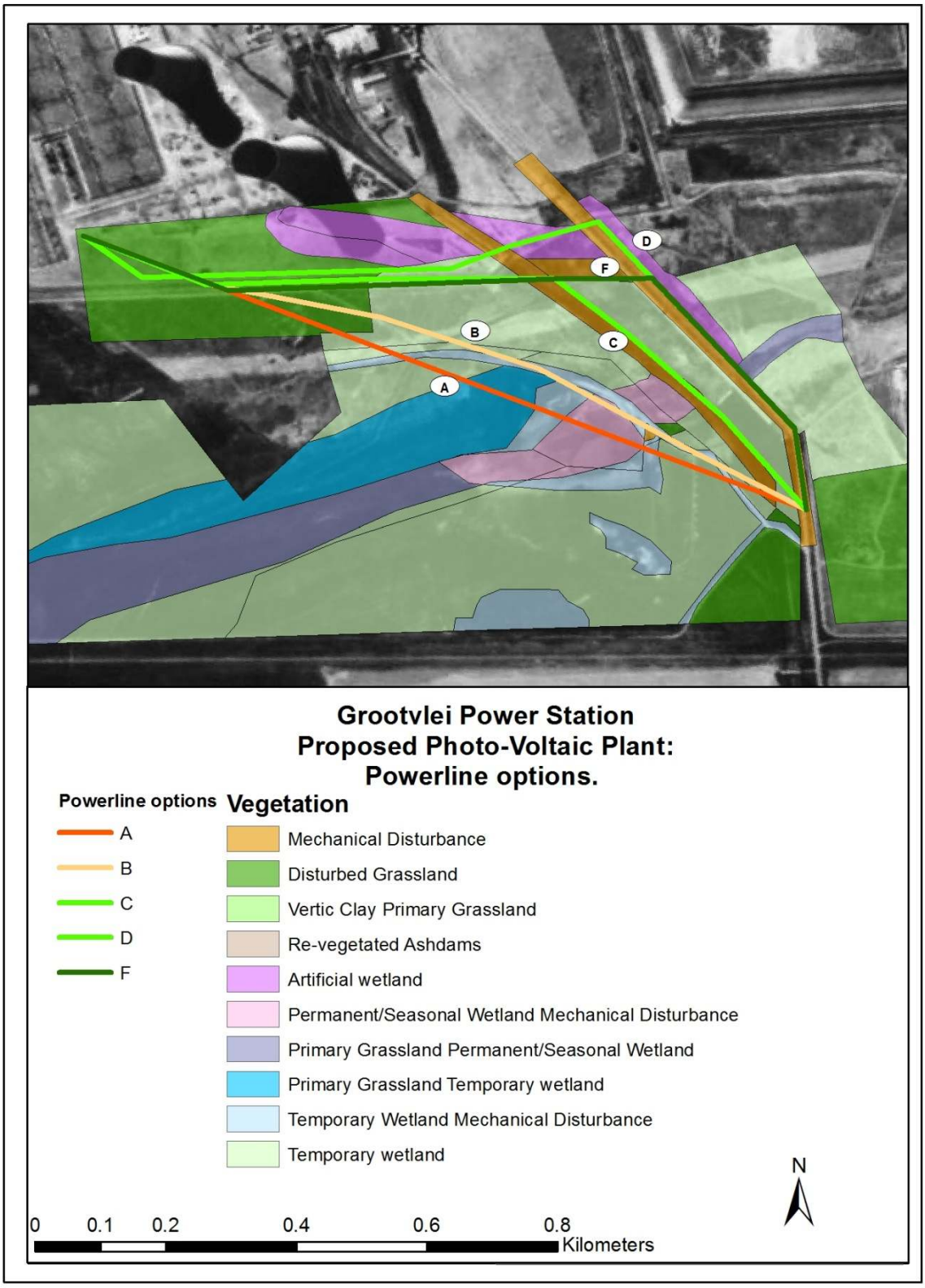

Figure 23. Vegetation and wetlands along the power line route options.

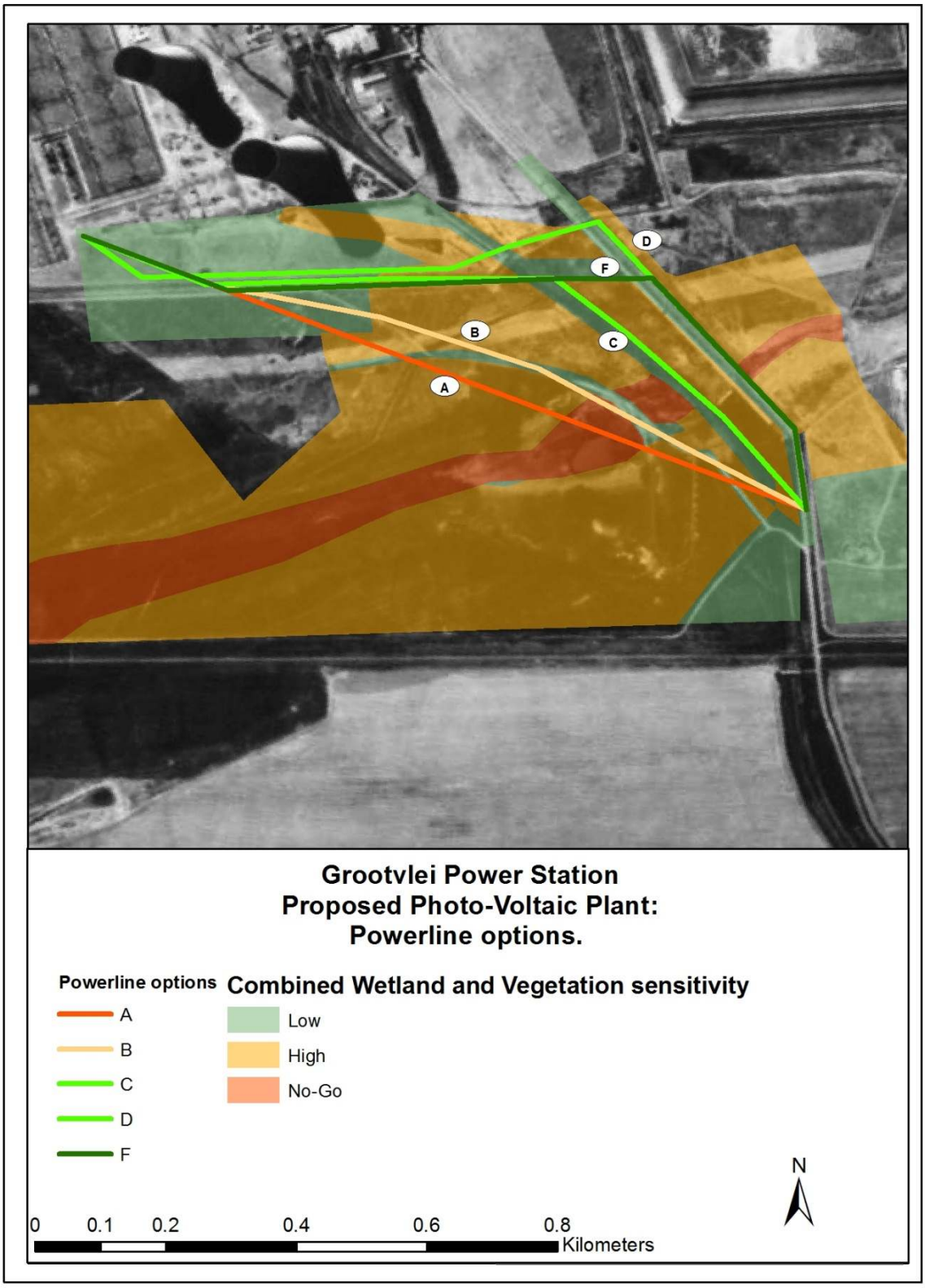

Figure 24. Sensitivity along the power line route options.

To keep environmental impact as small as possible and due to the large wetland zone the power lines should be kept to areas of existing disturbance as far as possible. The old disused railway, the road into Grootvlei power station and the old disused conveyor belt are all existing disturbances. A smaller road is present in site 2 and represents a disturbance that can be utilised. Although a wetland section is present between the old railway and the conveyor next to the road the wetland is very disturbed. The wetland is very weedy and imported soil from the disturbances is present in the wetland. This route would be preferred from an environmental point of view, but any power line route staying close to existing disturbance would be acceptable.

The proposed route F will intersect the wetland at the following points:

Route option	Description	Long	Lat
F	Wetland Start N - S	28.49946814	-26.7745567
F	Permanent Zone Start N - S	28.50455127	-26.7756749
F	Wetland End N - S	28.50536554	-26.776579
F	Permanent Zone End N - S	28.50474676	-26.7758814

The other potential routes will intersect the wetland at the following points:

Route option	Description	Long	Lat
A	Wetland Start N - S	28.49909577	-26.77521278
A	Permanent Zone Start N - S	28.50217315	-26.77637913
A	Permanent Zone End N - S	28.50325582	-26.77678948
A	Wetland End N - S	28.5053738	-26.77759221
B	Wetland Start N - S	28.49951398	-26.77496642
B	Permanent Zone Start N - S	28.50253237	-26.77608483
B	Permanent Zone End N - S	28.50302031	-26.77634687
B	Wetland End N - S	28.50536531	-26.77758899
C	Wetland Start N - S	28.49953654	-26.77446557
C	Wetland End N - S	28.50535692	-26.77746439
D	Wetland Start N - S	28.4997924	-26.77433928
D	Permanent Zone Start N - S	28.50107968	-26.77413892
D	Permanent Zone End N - S	28.50475141	-26.77588636
D	Wetland End N - S	28.50536561	-26.77657942

In terms of the engineering requirement of the power line the following is applicable.

1. The pylons should be as far as possible apart to limit disturbance in the wetland.
2. Excavation activities in the wetland must be kept as small and as shallow as possible.
3. An optimal balance between these requirements must be reached to keep the disturbance in the wetland as small as possible.

In summary option C and D was combined into option F for the following reasons:

1. Follows the most significant pre-existing impacts.

2. It represents the straightest (shortest) route through the wettest parts of the wetland, allowing some scope for ecologically sound pylon placement.
3. It contains a road along which the contractor might gain access to the majority of the site, avoiding the need for wetland crossings in natural permanently wet zones
4. It is not significantly more expensive than the least cost route.

It must be noted that the ecological sensitivities would be equally well served by any alignment between route C and F, as the level of infill and disturbance in between these routes are of such a nature that the impacts are negligible (the permanent/seasonal zone has largely disappeared at the current ground level) provided normal mitigation measures are in place.

Please view **Figure 23. Vegetation and wetlands along the power line route options.** and **Figure 24. Sensitivity along the power line route options.** Refer to **Addendum E – Photos of the powerline routes** for the photos along the routes. Please note, the no-go areas represent no-go for the pylon placement, not the route it-self.

9 Impacts and Recommendations

9.1 Impact Description

This impact statement is based on two meetings and various e-mail conversations, without the preliminary designs, and as such may require amendment once the preliminary designs are available. It is majorly based on the preferred site noted above, although most of the measures will apply equally to other sites

9.1.1 Post commissioning state:

The site will have a security fence with a boundary dirt road / firebreak. A transformer station will be located near the North Eastern corner of the site, it is of unknown size; it will require a concrete foundation slab and most likely additional security fencing. The photovoltaic panels are on 24/48 panel arrays that are mounted on single or multiple columns, these columns require very small foundations (0.5m by 0.7m) or none at all depending on the founding conditions. In the case where no foundations are needed, the columns may be either a screw type or a straight pole. The photovoltaic panels are at a minimum height; above the vegetation on the site (in this case the grass and other herbaceous species are below 1.5m. Fire is excluded from the site, and vegetation is kept under control through grazing, usually sheep. Cables are laid in fairly shallow, narrow trenches that are backfilled in a fairly short period of time. A tracking, or fixed panel array may be installed, the tracking system uses electric motors housed in the base of the columns or poles, this system will require the larger foundations stated above (0.5m by 0.7m). A six or eleven kVA powerline will be routed from the transformer to the South Western corner of the site. No trees or high shrubs will be allowed to grow on the site.

9.1.2 Construction Process

Fairly heavy vehicles will carry equipment to the site on tar and dirt roads. The raw material and equipment will be placed on an open piece of land, such as the preferred site. The material will be moved by mechanical means across the site.

The site of the transformer will be graded, excavated and filled with concrete as a foundation and slab, a fence will be erected and the transformer will be installed.

The columns / poles for the PV- arrays are either driven or screwed into the ground with a trailer mounted jackhammer / auger. In some cases small foundations of approximately 0.5m by 0.7m are dug and filled with concrete. No general vegetation clearing will be done, although vegetation may be mowed prior to installation. Walking and driving on the site may lead to paths forming in the vegetation.

Trenches for the cables are dug with a small trenching machine and is backfilled after the cables are laid. The trenches are narrow and approximately 0.3m to 0.5m deep

A boundary road and security fence will be constructed; it may however be possible to use the current boundary roads and fences, with small upgrades.

9.1.3 Power lines

From the transformer on site the power will be transported to a transformer or relay station at the power station. Power lines will therefore be constructed from the site to the power station. The design of the power line has not been confirmed yet. It is however fairly certain that a 6.6kV power line will be used. Steel or wood pylons may be used. The interval between wood poles will be 30-40 m and the interval between steel pylons would be between 80 and 250m. If steel pylons are used it will probably be a steel monopole with supports.

9.2 Mitigation measures

The mitigation measures noted below are based on a broad overview of the proposal and may change with additional information.

9.2.1 Management Concerns

General aspects that need to be managed in the context of the preferred alternative site 1; these aspects can be managed so that no significant residual impact remains.

4. The boundary of the wetland is on the Northern portion of the site, and must be excluded from the development.
5. The wetland boundary is directly adjacent the site along the northern edge.
6. The current access roads are dirt-roads which cross the temporary zone of the wetland in some cases.
7. Fire will be excluded from the site once the site is established, because of the risk to the photovoltaic panels and infrastructure
8. There are several small individual trees of Acacia karroo, these will be removed from the site.
9. There are some Stoebe vulgaris or Seriphium plumosum on the site and as such this may lead to encroachment if the grass sward is not frequently rejuvenated. This would cause degradation of the site from an ecological point of view; it would also increase management effort and increase the risk of fire.

9.2.2 Potentially negative aspects related to the preferred alternative

Alternative Site 1 has some negative aspects associated with the use of the old ash disposal facility. These negative aspects can be managed in such a way that the residual impact is negligible. The following issues will need to be managed.

1. The infrastructure will be settled into the “ashcrete”, possibly mobilizing the solidified ash for a short period of time.
2. The trenches cut in the “ashcrete” will throw ash-dust into the air and liberate it into the environment.
3. It is possible that the alkaline ash may be corrosive to some parts of the infrastructure.
4. The construction phase will disrupt the existing soil cover on the ash disposal facility. It is very thin and likely not resilient.
5. Connections of cables or trenches off the ash disposal facility may lead to dispersal of the ash into the neighbouring environment.
6. Dispersed “ashcrete” is found to the west of the ash disposal facility, which may impact construction, and points to the risk outlined above.

9.2.3 Mitigation of PV site

The following site specific mitigation measures must be included in the EMP to reduce the impact the proposed development will have on the site.

1. The development must use existing access roads.
2. The roads on the site must not be upgraded, with the exception of the use of a course gravel layer on the waterlogged portions of the road, to the North of the proposed site.
3. The development must upgrade the existing fences to the south of the proposed site where possible, instead of building new fences.
4. The Ash disposal facility soil cover must be re-established after construction, as it will likely not be very resilient to mechanical disturbance.
5. The soil cover may need to be thicker than it is currently to store water and remove the water off the Ash disposal facility. This is called a “Store and Release Cover”.
6. All trenches for cables etc. draining off the ash disposal facility must be sealed in some way to avoid seepage of the ash onto the adjacent sites.
7. Stability of the “ashcrete” especially under inundation periods must be assured, as instability may cause additional pollution downstream.
8. The grassland needs to be re-juvenated by fire, prior to the construction. If fire is not acceptable mowing or high-intensity grazing is a suitable substitute. Thereafter it will require grazing in the early summer, potentially with some molasses or salt lick additions to stimulate grazing. If, in spite of this, encroachment by *Seriphium plumosum* takes place, mechanical and or chemical control needs to be done, as fire is not a viable alternative and *Seriphium plumosum* is prone to hot fires when dry and occurring at high densities.
9. The trenches for the electrical cables need to be kept as narrow as possible, and reinstated very quickly in order to facilitate rehabilitation. Typically no more than a calendar week open trench time.
10. The substation / transformer must be located outside of a 30m buffer from the edge of the wetland.
11. Any additional soil clearing must be done outside of a 30m buffer from the edge of the wetland.
12. Any permeable fencing (wire /palisades) must be put outside a 10m buffer from the edge of the wetland
13. Any non-permeable fencing (walls) must be placed outside a 30m buffer of the wetland.

14. No vegetation clearing or surface levelling on the site (except for the transformer substation), beyond mowing or burning the site prior to construction.
15. Prevent concrete spillage from leaving the substation site.

9.2.4 Mitigation of power lines

- Pylons
    - Minimise the amount of pylons in the wetland as far as possible.
    - A number of pylons will be necessary in the wetland and should be placed in the temporary wetland zone, not the seasonal or permanent wetland zones.
    - Excavation must be kept to the minimum area possible.
    - Construction activities close to and in the wetland should preferably take place in the dry season.
    - Route selection – if altered - must use existing disturbances and stay as close to them as possible, as was done here.
- Vehicle crossing
    - Crossing of the wetland should take place in the dry season.
    - If at all possible, use the existing road and not a new crossing.
    - If the wetland cannot be crossed by using the existing road, use bog mats for the vehicle crossing over the wetland.
        - Bogmats must be installed on top of existing vegetation, and the topsoil must NOT be stripped and stored separately. During the short timeframe of this impact, this will result in less damage than stripping the topsoil and replacing it at a later stage.
        - As an alternative a soil bridge laid on top of a geotextile mat can be used, with provisions made for flow in the existing artificial channel. The topsoil under the soil bridge must not be stripped and stored separately. This soil bridge must be removed immediately once the crossing is removed and before the rainy season starts to avoid sedimentation in the wetland.
    - The wetland must be clearly indicated on site and all non-essential vehicle movement kept out of the wetland.
    - Caterpillar tracked vehicles are preferred due to the lower pressure exerted on the soil, turning and driving back and forth is not advised. **These measures are what we expect based on our understanding of the construction process; this will be updated and amended along with the contractor's method statement once a preferred contractor is identified.**

9.2.5 General Mitigation measures

- Erosion control measures and sediment traps must be present in all areas of bare soil to prevent sediment from washing into the wetland and causing sedimentation in the wetland.
- All bare areas must be revegetated as soon as possible and the area monitored for erosion at least 1 year of completion of construction.
- Soil conservation measures must be in place in all areas likely to erode.
- Compacted soil must be ripped in at right angles to the slope. This must be restricted to compacted areas and kept as small as possible.

9.3 Invasive species:

- Several species listed as alien invasive species are present on greater site.
- Under the Conservation of Agricultural Resources Act landowners are responsible for the invasive species on their properties.
- No invasive species may be present within 20m of a wetland and must be removed.
- Removal must take place in an appropriate manner.

10 Conclusion

This study can be judged sufficient to select the most ecologically suitable site and adequately describe the likely impacts on the site and the proposed mitigation measures, some improvements can be made with more information. There is agreement between the fauna, flora and wetland surveys on the preferred site and the power line has been placed in the most ecologically suitable position. Option C

The expected impacts can be mitigated or avoided to a large extent on the preferred site and power line option, and as such we have no hesitation to recommend the proposed development on the recommended alternative (alternative site1, on the south eastern part of the power station precinct) with the associated power lines.

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Addendum A – PES calculation for the southern wetland unit

Addendum B – PES calculation for the northern wetland unit

Addendum C – EIS calculation for the wetland

ECOLOGICAL IMPORTANCE AND SENSITIVITY	Score (0-4)	*Confidence (1-5)*	Motivation
Biodiversity support	**0.67**	*3.67*	
Presence of Red Data species	**1.00**	*3.00*	No Red Data species were observed but a RD butterfly have habitat on site
Populations of unique species	**-**	*4.00*	
Migration/breeding/feeding sites	**1.00**	*4.00*	
Landscape scale	**0.60**	*3.40*	
Protection status of the wetland	**-**	*5.00*	Public area, with several disturbances, including rubble dumping and infill
Protection status of the vegetation type	**1.00**	*3.00*	Portions of the wetland are in a vulnerable vegetation type.
Regional context of the ecological integrity	**1.00**	*3.00*	The wetland is fairly disturbed but in an important subcatchment
Size and rareity of the wetland type/s present	**1.00**	*3.00*	Several channelled valley bottom wetlands are present in the catchment
Diversity of habitat types	**-**	*3.00*	The wetland is disturbed, not much diversity is present
Sensitivity of the wetland	**1.33**	*3.00*	
Sensitivity to changes in floods	2.00	*3.00*	Valley bottom wetlands are normally sensitive to change in floods
Sensitivity to changes in low flows/dry season	1.00	*3.00*	The wetland is already fairly channelized, but maintains some sensitivity to low flows
Sensitivity to changes in water quality	1.00	*3.00*	The wetland receives pollution and has lost some sensitivity to changes in water quality
ECOLOGICAL IMPORTANCE & SENSITIVITY	**1.3**	*3.4*	

Addendum D – Species list of the sites

Name	Invasive species	Protected
Acacia karoo		
**Acer sp*		
**Agave sisalana*	CARA Category 2, MNCA	
Albuca sp		
Arctotis arctoides		
**Argemone cf ochroleuca*	CARA Category 1	
Aristida congesta		
**Arundo donax*	CARA Category 1, MNCA	
Asclepias cf eminens		
Asparagus sp		
Asteraceae		
Berkheya carlinopsis		
Berkheya radula		
**Bidens bipinnata*		
**Bidens pilosa*	MNCA	
**Bidens sp*		
Briophyta		
Bulbine cf capitata		
**Canna cf indica*	CARA Category 1	
*cf *Centella sp*		
Chamaecrista mimosoides		
**Cirsium vulgare*	CARA Category 1, MNCA	
**Conyza cf canadensis*		
Conyza podocephala		
**Conyza sp*		
**Cortaderia selloana*	CARA Category 1	
**Cosmos bipinnata*		
cf Craterocapsa sp		
Crotalaria sp		
**Cuscuta campestris*	CARA Category 1, MNCA	
Cymbopogon sp		
Cynodon dactylon		
Cynodon dactylon/Brachiara		
Cyperaceae		
Cyperus cf esculentus		
Cyperus cf fastigiatus		
Cyperus esculentus		
Cyperus sp		
cf Dactyloctenium sp		
**Datura stramonium*	CARA Category 1, MNCA	
Digitaria eriantha		
Eragrostis chloromelas		

Eragrostis curvula		
Eragrostis gummiflua		
Eragrostis plana		
Eragrostis sp		
**Eucalyptus sp*	CARA Category 2, MNCA	
Euphorbia striata		
Fabaceae, Medicago sp?		
Falkia oblonga		
Felicia muricata		
Felicia sp		
**Flaveria bidentis*		
Fuirena sp		
Gazania krebsiana		
Geigeria burkei		
Gladiolus crassifolius		MNCA Protected
Gomphocarpus sp		
Grasses		
Haplocarpa lyrata		
Haplocarpa scaposa		
Haplocarpa sp		
Helichrysum nudifolia		
Helichrysum rugulosum		
Helichrysum sp		
Hermannia coccocarpa		
Hermannia depressa		
Hyparrhenia hirta		
Hyparrhenia tamba		
Hypoxis cf argentea		
Hypoxis cf hemerocallidea		
Hypoxis cf obtusa		
Hypoxis hemerocallidea		
Hypoxis rigidula/albomarginatus		
Hypoxis sp		
Imperata cylindrica		
Indigophera/Cleome/Sesbania sp		
Ipomoea sp		
Jamesbritenia cf aurantiaca		
Juncus cf effusus		
Juncus cf punctorius		
Juncus sp		
Ledebouria cf cooperi		
Ledebouria cf stenophylla		
Ledebouria ovatifolia		
cf Lipidium sp		
Lotononis sp		

**Medicago sativa*		
**Melia azedarach*	CARA Category 1, MNCA	
Merremia tridentata		
Moraea cf thomsonii		
Unidentified tree		
**Oenothera cf tetraptera*		
**Oenothera rosea*		
**Paspalum sp*		
Pelargonium luridum		
**Pennisetum clandestinum*		
Phragmites australis		
**Pinus sp*	CARA Category 2	
**Plantago lanceolata*		
Unidentified forb		
Pogonarthria squarrosa		
Pollichia campestris		
**Pseudognaphalium luteo-alba*		
**Rumex crispus*		
Rumex sp		
**Salix babylonica*	CARA Category 2	
**Schinus molle*		
**Schkhuhria pinnata*		
Schoenoplectus/Eleocharis sp		
Senecio achilleifolius		
Senecio erubescens		
Senecio inornatus/inaequidens		
Senecio sp		
**Sesbania punicea*	CARA Category 1, MNCA	
*cf *Sesbania sp*		
Setaria sphacelata		
Setaria sphacelata/nigrirostris		
cf Sphenostylus angustifolia		
Sporobolus africana		
Sporobolus cf fimbriatus		
Sporobolus sp		
Stoebe vulgare		
**Tagetus minuta*		
**Tamarix sp*	CARA Category 3	
Tephrosia sp		
Tephrosia/Indigophera		
Themeda triandra		
Thesium sp		
Typha capensis		
Unidentified sedge		
Vahlia capensis/Thesium		

**Verbena bonariense*		
**Verbena brasiliense*		
Vernonia cf natalensis		
Vernonia oligocephala		
Vernonia sp		
**Xanthium strumarium*	CARA Category 1, MNCA	

Addendum E – Photos of the powerline routes

Route F

Routes C, D and F, inside the power station fence, close to the relay station, looking from east to west.

Routes C, D and F, inside the power station fence, close to the relay station, looking from west to east.

Route D & F, at the road crossing of F, looking in a southern direction in the temporary wetland zone.

Route D & F at the permanent wetland crossing, looking in a southern direction.

Route D & F looking in a northern direction in the temporary wetland zone.

Route D & F looking in a northern direction from the edge of the temporary wetland zone.

Alternative routes

Route A on site alternative 2 looking in a north-western direction from the edge of the temporary wetland zone.

Route A at the permanent wetland crossing.

Route A at the mechanical disturbance next to the permanent zone.

Route A on site alternative 2 looking in a south-eastern direction in the temporary wetland zone.

Route A on site alternative 2 looking in a south-eastern direction from the edge of the temporary wetland zone.

Route B looking in a northern direction at the edge of the temporary wetland on site alternative 2.

Route B looking in a north-western direction in the temporary wetland zone.

Route B in the temporary wetland looking in a north-western direction.

Route B in the temporary wetland looking in a north-western direction.

Route C next to the railway line, looking in the northern direction.

Alternative D, between dam and road. Looking in southern direction, close to turn to the west.