GEOMORPHOLOGICAL ASSESSMENT OF THE PROPOSED WIND ENERGY FACILITY AND ASSOCIATED INFRASTRUCTURE ON THE WEST COAST (MATZIKAMA LOCAL MUNICIPALITY AND WESTERN CAPE MUNICIPAL AREA 1)

Specialist Study prepared for SAVANNAH ENVIRONMENTAL (PTY) LTD

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Front cover: A view north along the coastline from a point south of the study area.

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ACRONYMS, ABBREVIATIONS AND DEFINITIONS
Article 3.1 (*sensu* Ramsar Convention on Wetlands)
"Contracting Parties "*shall formulate and implement their planning so as to promote the conservation of the wetlands included in the List, and as far as possible the wise use of wetlands in their territory*"".(Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/).
DWAF
Department of Water Affairs and Forestry
Indigenous
"Indigenous" for the purposes of this report refers to all biological organisms that occurred naturally within the study area prior to 1800.
Natural properties of an ecosystem (*sensu* Convention on Wetlands)
Defined in Handbook 1 as the "*…physical, biological or chemical components, such as soil, water, plants, animals and nutrients, and the interactions between them*". (Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/)
NEMA
National Environmental Management Act (Act 107 of 1998) and associated regulations.
NWA
National Water Act (Act 36 of 1998) and associated regulations.
Ramsar Convention on Wetlands
"The Convention on Wetlands (Ramsar, Iran, 1971) is an intergovernmental treaty whose mission is "the conservation and wise use of all wetlands through local, regional and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world". As of March 2004, 138 nations have joined the Convention as Contracting Parties, and more than 1300 wetlands around the world, covering almost 120 million hectares, have been designated for inclusion in the Ramsar List of Wetlands of International Importance." (Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/). South Africa is a Contracting Party to the Convention.
Sustainable Utilization (*sensu* Convention on Wetlands)
Defined in Handbook 1 as the "*human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations*". (Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/).
Wise Use (*sensu* Convention on Wetlands)
Defined in Handbook 1 (citing the third meeting of the Conference of Contracting Parties (Regina, Canada, 27 May to 5 June 1987) as "*the wise use of wetlands is their sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem*".(Ramsar Convention Secretariat. 2004. Ramsar handbooks for the wise use of wetlands. 2nd Edition. Handbook 1. Ramsar Convention Secretariat, Gland, Switzerland.) (see http://www.ramsar.org/)

1. INTRODUCTION

Savannah Environmental (Pty) Ltd have been appointed by Eskom to co-ordinate an environmental impact assessment of a proposed wind energy facility and associated infrastructure, to be located north of the Olifants River mouth. As part of the assessment process, Savannah Environmental (Pty) Ltd subcontracted the author to provide a geomorphological assessment of the areas potentially impacted by the proposed development. As a specialist study, this report addresses the Terms of Reference listed in the scoping study report for the geomorphological component of the assessment process. The most important outcomes of this report are the identification of geomorphologically sensitive areas that require consideration during the planning / design of the proposed project and the assessment of issues and impacts associated with the proposed development. The key components of this report are listed below.

- A description of the Regional Geomorphological Setting.
- A map indicating landforms sensitive to development.
- An assessment of Present Geomorphological State of the potentially affected environment.
- An assessment of the potential significance of project related impacts.
- An Environmental Impact Statement.

1.1. Experience of the Author

The author has majors in Botany (UPE), Entomology (Rhodes), Geography (UPE) and Geology (UPE) and honours degrees in Geology (UPE) and Geography (Rhodes). He subsequently obtained an MSc (Geography) (with distinction) and PhD (Entomology) from Rhodes University. Prior to working as a consultant, the author was a member of the Wetlands Group in the Institute for Water Research at Rhodes University. He has participated in earth and/or biological science related field work within Botswana, Malawi, Mozambique, Namibia (lower Orange River), South Africa, Zimbabwe and the southern oceans. A selection of his geomorphological experience is listed below.

- MSc thesis entitled "*The Morphology and Sedimentology of Two Unconsolidated Quaternary Debris Slope Deposits in the Alexandria District, Cape Province*".
- Paper: Lewis, C.A. and Illgner, P.M. 2001. Late Quaternary glaciation in southern Africa: moraine ridges and glacial deposits at Mount Enterprise in the Drakensberg of the Eastern Cape Province, South Africa. Journal of Quaternary Science, 16, 4, 365-374.
- Paper: Rosen, D.Z., Lewis, C.A., Illgner, P.M. 1999. Palaeoclimatic and archaeological implications of organic-rich sediments at Tiffindell Ski Resort,

near Rhodes, Eastern Cape Province, South Africa. Transactions of the Royal Society of South Africa, 54, 2, 311-321.

- Paper: Lewis, C.A. and Illgner, P.M. 1998. Fluvial conditions during the Holocene as evidenced by alluvial sediments from above Howison's Poort, near Grahamstown, South Africa. Transactions of the Royal Society of South Africa, 53, 1, 53-67.
- Book Chapter: Illgner, P.M. 1996. Ch.4. Coastal features. In C.A. Lewis [Ed], The Geomorphology of the Eastern Cape: South Africa, Grocott & Sherry Publishers, Grahamstown, South Africa, p.52-70.
- Conference: Haigh, E.H. and Illgner, P.M. 2002. Rehabilitation of a small upper catchment seep/wetland of the Kowie River in the Eastern Cape Province, South Africa. Poster presentation, SASAQS Conference, Bloemfontein, July 2002.
- Consulting Report: Illgner, P.M. and Anderson, C.R. 2007. Desktop geomorphological assessment of a site selected for the location of a stormwater outfall - Coega Industrial Development Zone (for Mzizi Msutu and Associates).
- Consulting Report: Dollar, E.S.J. and Illgner, P.M. 2006. Geomorphological Assessment of proposed weirs on the Orange and Vaal rivers (for Bohlweki Environmental (Pty) Ltd).
- Consulting Report: Illgner, P.M., Rynhoud, M.S., Rynhoud, M. and Holland, H. 2006. A Geological and Geomorphological Assessment of the proposed Mercury-Ferrum-Garona Transmission line (for Bohlweki Environmental (Pty) Ltd).
- Consulting Report: Illgner, P.M. 2005. Geological and Geomorphological Overview of the Mbotyi Area (for Coastal and Environmental Services).

1.2. Disclaimer

This report considers landforms, their associated geomorphological processes and the potential impacts of the project on these features and processes. The report does not consider the potential impact of the landscape on the project, unless it relates to the siting of infrastructure or to sediment transport. The report does not consider geotechnical aspects of the environment, the impact of climatic conditions on the weathering of infrastructure, the agricultural potential of soils or substrate associations between biota and landforms and/or the former and geomorphological processes.

2. ASSUMPTIONS AND LIMITATIONS

2.1. Assumptions

This study assumes that any potential impacts on the environment associated with the proposed development will be avoided, mitigated or offset in order for the proposed project to conform with the definition of wise use provided in the section on "Acronyms, Abbreviations and Definitions" above. Although this definition relates specifically to wetlands it is also more broadly applicable to all aspects of the natural environment and hence has been adopted for use in this report. The study assumes that the term "Study Area" is synonymous with "Affected Environment", unless otherwise indicated.

2.2. Limitations

This report has been predominantly based on a desktop assessment of the environment and two site visits (1st: 7-8 March 2007: 2nd: 8-9 October 2007) and conversations with K. Jodas and J. Thomas of Savannah Environmental (Pty) Ltd. The site visit included walkabouts at various sites within the landscape in the vicinity of the study area, accompanied by inter alia Ian Smit (representing Eskom) (first site visit only), the aforementioned individuals (first site visit only) and Hansie Visser, owner of Skaapvlei (second visit only). No sediment sampling was carried out for later analysis, while some potential wetlands were not visited by the author.

3. LOCATION OF THE STUDY AREA

The location of the area selected for the siting of the wind turbines and the proposed alternative power line route alignments have been indicated in Figure 1. A summary of information pertaining to the location of the study area has been summarized in Table 1 below.

Table 1. A summary of aspects relating to the planning and biophysical environment for the study area.

LOCATION OF THE STUDY AREA	NOTES
1:50 000 Topographical Map	3118AC and 3118CA
Geographic Location of the Northern Extremity of the Study Area	31.4764°S 18.1520°E.
Spatial Extent of the Study Area (excluding route of the distribution line to the Koekenaap Substation**)**	3760 ha
Temperature Regime	Temperature Range[1] (period unknown) at Brand se Baai = -8.3°C to 46.3°C (Couto et al. 2006).
Rainfall Regime	Mean Annual Precipitation = 115.63 mm (based on data for the quaternary catchment F60E). Mean Annual Precipitation[2] at Brand se Baai (1994-2004) = 147 mm (Couto et al. 2006). Vredendal = 144 mm[2] (Draft Scoping Report, Savannah Environmental (Pty) Ltd).
Potential Evaporation	Estimated Mean Annual Evaporation[3] at Brand se Baai = 1750 mm (Couto et al. 2006). Vredendal - 1748 mm[3] (Symons Tank) and 2182 mm[3] (A Pan) (Draft Scoping Report, Savannah Environmental (Pty) Ltd).
Wind	At the De Punt Meterological Station (ESKOM) the prevailing wind is from the SSW, followed (in order of decreasing frequency) by winds from the S, WNW, ENE, WSW, NNW, W, SSE and E, with winds seldom blowing from the N, NNE and ESE (the latter three not necessarily listed in order of decreasing

[1] Assumed to refer to extreme values for the entire record.
[2] Assumed to refer to mean annual value.
[3] Assumed to refer to mean annual value.

LOCATION OF THE STUDY AREA	NOTES
	frequency) (Draft Scoping Report, Savannah Environmental (Pty) Ltd). The maximum wind velocity (mean for a duration of 3 seconds) recorded at De Punt was 180 km/h (50 m/s). The corresponding maximum mean for a duration of 10 minutes at De Punt was 114 km/h (40 m/s) (Draft Scoping Report, Savannah Environmental (Pty) Ltd). Vredendal = 6.5 m/s (Draft Scoping Report, Savannah Environmental (Pty) Ltd)[4].
Quaternary Catchment	F60E, with the exception of a small area of c. 1.3 ha at the southermost extremity of the study area, which lies within E33H.
Geomorphic Province	Namib
Vegetation Type (sensu Mucina & Rutherford 2006)	Namaqualand Sand Fynbos (Least Threatened) (Fynbos Biome) and Namaqualand Strandveld (Least Threatened) (Succulent Karoo Biome). Erosion within the Namaqualand Sand Fynbos and Namaqualand Strandveld is reputed to be very low on both accounts.
Administrative Area	Vredendal Magisterial District; Matzikama Local Municipality and Western Cape Municipal Area 1 (WCMA01), West Coast District Municipality
Affected Properties (listed in alphabetical order**)**	Gravewaterkop 158 Portion 5, Olifants River Settlement Portion 617, Olifants River Settlement Portion 620
SITE VISIT	**NOTES**
Directions to the site for the location of the wind turbines (Wind Farm)	Proceed north from Lutzville on the R363 towards Koekenaap. At 31.5210°S 18.2885°E turn off the R363 onto an unpaved road and proceed westwards towards the coast via Kommandokraal (entrance = 31.5084°S 18.2133°E). This unpaved road enters the study area at 31.5045°S 18.1441°E and exits it immediately east of Skaapvlei, at 31.4914°S 18.0819°E.

[4] Assumed to refer to mean annual value.

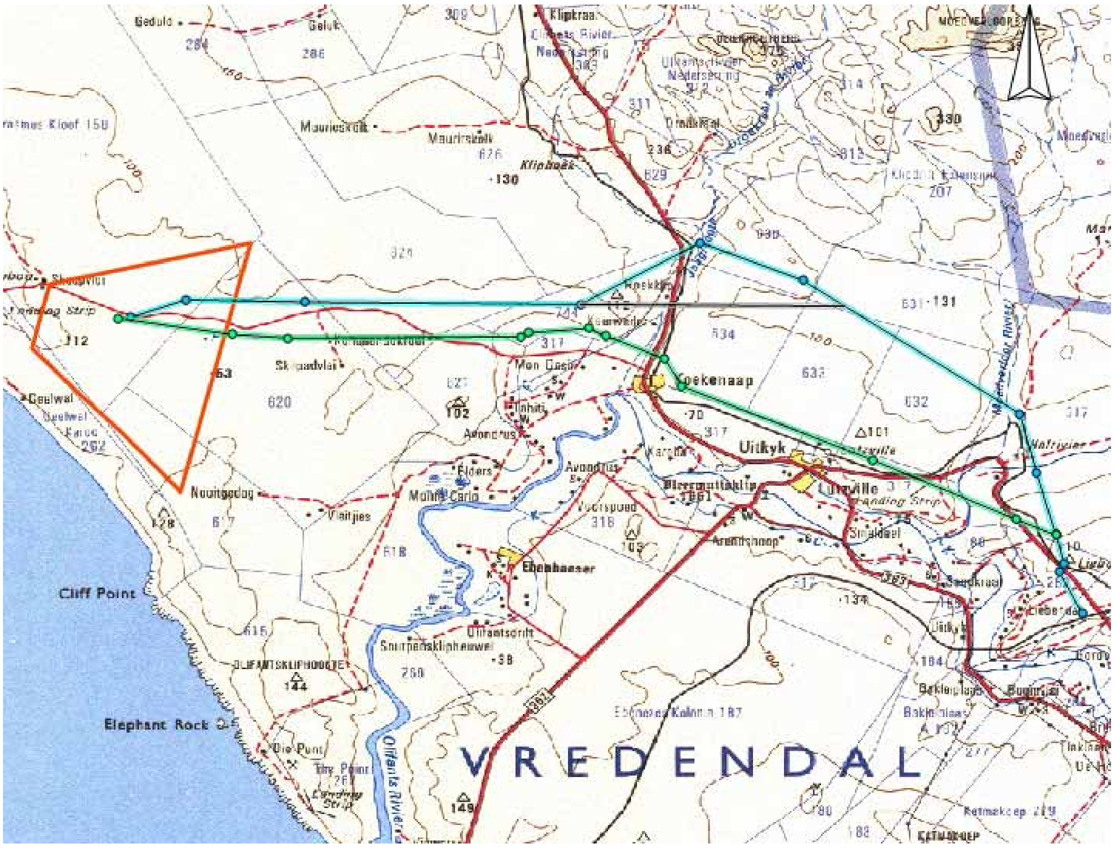

Figure 1. A view of the area selected for the siting of the wind turbines and the alternative route alignments. Red line = Encloses area selected for the siting of the turbines (i.e. Wind Energy Facility). Blue corridor (200 m wide) = alternative 1. Grey corridor (200 m wide) = alternative 1a. Green corridor (200 m wide) = alternative 2.

4. PROJECT DESCRIPTION

A description of the project has been summarized in Table 2 below.

Table 2. A summary of key aspects of the proposed project.

INFRASTRUCTURE	NOTES
Buildings	
Location(s)	An office and visitors centre is proposed to be constructed at the entrance to the wind energy facility.
Dimensions	c. 150 m^2
Other	No other structures buildings are expected to be constructed.
Issues/Impacts that may affect planning	1. Rainfall runoff from a sealed surface (e.g. roof). 2. Undercutting of the building by wind erosion and subsequent subsidence. 3. Sandblasting of mortar and plaster by wind transported sand.
Turbines	
Location(s)	The provisional location of the turbines has been indicated in Figure 2.
Dimensions	Concrete Base ≈ 20 m X 20 m X 2 m deep/turbine, Hub Height ≈ 80 m, Rotor Blades ≈ 3 X 45 m (diameter = 90 m).
Other	The turbines may be located approximately 2 km (i.e. first row) inland, within 4 rows parallel to each other as indicated in Figure 2.
Issues/Impacts that may affect planning	1. Possible preferential removal of sediment adjacent to foundation slabs by overland flow. 2. Undercutting of the concrete plinth by wind erosion and subsequent subsidence. 3. Sandblasting of concrete and steel tower by wind transported sand.

INFRASTRUCTURE	NOTES
Substation	
Location(s)	To be centrally located between rows 2 and 3 of the wind turbines,, with underground cables connecting each turbine to the substation.
Dimensions	Approximately 80 m X 80 m.
Other	
Issues/Impacts that may affect planning	1. Possible preferential removal of sediment adjacent to foundation slabs by overland flow. 2. Undercutting of the concrete plinths by wind erosion and subsequent subsidence. 3. Sandblasting of concrete and steel substation components by wind transported sand.
Power Lines	
Location(s)	Alternative alignments as indicated in Figure 1. The distribution line will have to link the substation on site to the national grid (viz. Juno Substation).
Dimensions	Current planning corridor = 200 m. Approximate width of servitude = 32 m.
Other	Voltage = 132 kV.
Issues/Impacts that may affect planning	1. Removal of sediment adjacent to the towers by fluvial processes. 2. Winnowing of sediment adjacent to the towers by wind erosion and subsequent subsidence. 3. Sandblasting of concrete and steel by wind transported sand.
Roads	
Location(s)	The existing access road to site will be used, with internal roads to be orientated inter alia along each row of turbines..
Dimensions	Internal Access Road(s): Width = 6 m, Longitudinal Slope < 8^{o}, Lateral Slope < 2^{o}, Axle Weight/m^2 = 15 t, Turning Radius = 25 m. A compacted area with a width of 12 m to 13 m will be associated with the route to be used by the crane.
Other	Access roads down the length of each row of turbines and to the substation between rows 2 and 3.

INFRASTRUCTURE	NOTES
Issues/Impacts that may affect planning	1. Accelerated fluvial erosion within drainage ditches adjacent to the roads. 2. Removal of fine sediment from the road surface by wind. 3. Compaction of surficial sediments due to loading associated with vehicle traffic.
DISTURBANCES	**NOTES**
Excavations	Foundation related excavations will be required during the construction phase.
Issues/Impacts that may affect planning	1. Modification of a landform/feature of Special Scientific Interest. 2. Exposure of a stratgraphic profile within a landform that is of Special Scientific Interest.
Stockpiles and Temporary Storage	It is assumed that during the construction phase areas will be required for the stockpile of sediment (e.g. removed from excavations and potentially brought in for construction purposes) and the temporary storage of building materials (e.g. laydown areas for turbine components). An area of 40 m X 40 m will be required at each turbine as a temporary laydown area and for location of the crane pad.
Issues/Impacts that may affect planning	1. Increase in the availability of sediment easily remobilised by wind (e.g. dust blown from stockpiled sediment or from areas denuded of vegetation). 2. Modification of a landform/feature of Special Scientific Interest. 3. Modification of the surface for the construction of roads and the positioning of a crane at each turbine site.

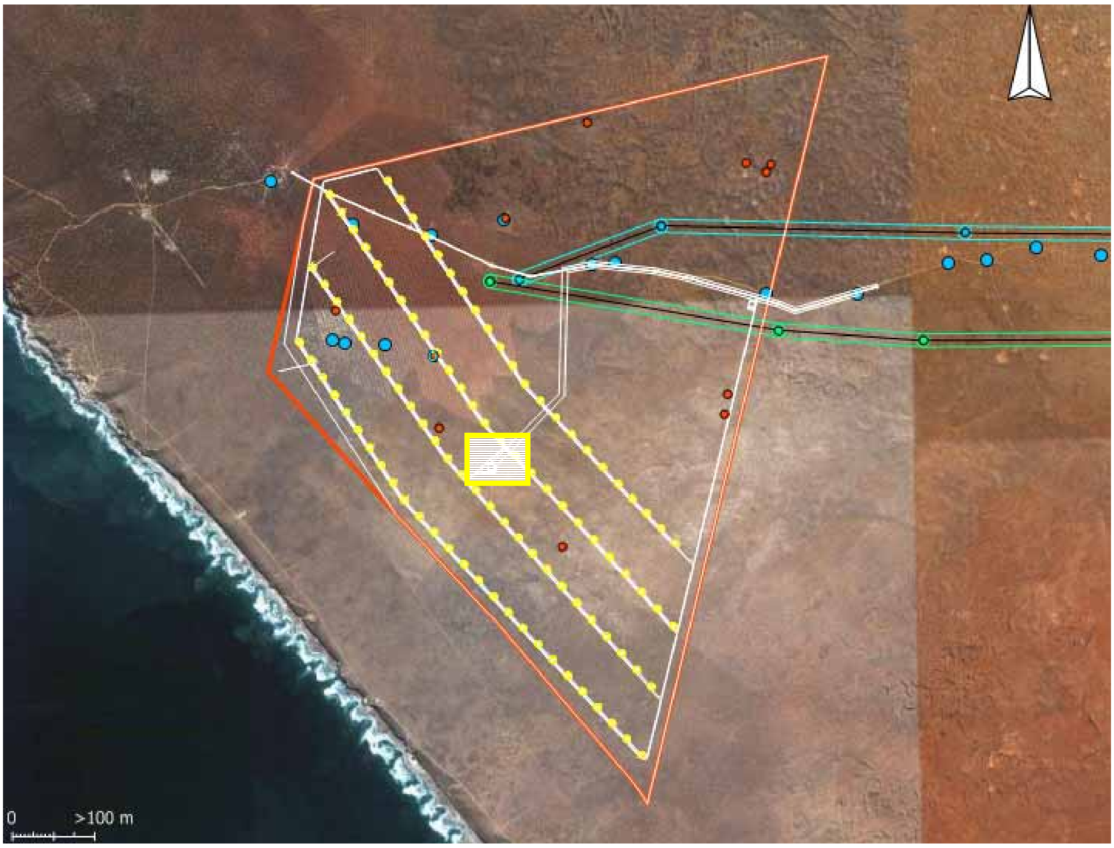

Figure 2. The provisional location of the wind turbines on site. The red line encloses the area selected for the siting of the wind turbines. The yellow dots indicate the provisional position of the wind turbines. The blue dots indicate field observation points. The red dots indicate sensitive areas shown in greater detail in the figures at the end of this document. The blue and green corridors indicate the position of power line alternatives 1 (blue) and 2 (green). The yellow box indicates the position of the subtstation in terms of the current layout.

5. REGIONAL GEOMORPHOLOGICAL SETTING

5.1. Description of the Affected Environment

A summary of the key aspects of the affected environment have been presented in Table 3 below.

Table 3. A summary of the key aspects of the affected environment.

STRATIGRAPHY					
ASPECT	**NOTES**				
Stratigraphy	**Stratigraphic Unit**	**Lithology**	**Age**	**Location**	**Extent**
	Unspecified	"Calcareous and gypsiferous soil"	Quaternary	The far western reaches of the area targeted for the siting of the turbines and an insignificant area in the extreme south.	Western Area = c. 210 ha. Southern Area = c. 2 ha.
	Unspecified	"Silcrete"	Cenozoic	Five patches in the south and east of the area targeted for the siting of the turbines.	Total Area of the Five Patches = c. 91 ha.
	Unspecified	"Red Aeolian Sand"	Cenozoic	Throughout the area targeted for the siting of the turbines, with the exception of the far western reaches of this study area.	Most of the area targeted for the siting of the turbines (c. 3457 ha).
Gaps in Knowledge and Monitoring Requirements					
Gaps in Knowledge	The composition (e.g. salinity) of the soils/sediments present within the study area. It is assumed for the purposes of this report that the potential occurrence of hazardous soils will be addressed in a future geotechnical assessment of the study area. Hazardous soils within this context would include inter alia acid sulphate soils, saline soils, soils with excess gypsum and soils with a high clay content.				
Monitoring Requirements	None.				

STRUCTURE	
ASPECT	**NOTES**
Faults	None of the faults indicated on the 1:250 000 (3118 Calvinia, Council for Geoscience) geological map traverse the area selected for the siting of the wind turbines. Alternative 1 passes north of a fault trace in the Hol River valley, passes close to another possible fault trace near the Jaagleegte River and traverses another possible fault trace close to the same river (Figure 3). Alternative 1a traverses the southern extremity of a fault trace. Alternative 2 only passes south of the aforementioned fault trace in the Hol River valley (Figure 3).
Seismicity	An approximation of the seismicity of the study area was obtained by using a USGS website (viz. http://neic.usgs.gov/neis/epic/epic_circ.html). In terms of the data available on this website, no earthquake epicentres were located within a 100 km radius of the northernmost extremity of the study area between 1973 and the present.
Gaps in Knowledge and Monitoring Requirements	
Gaps in Knowledge	Detailed record of the seismicity of the study area. A seismic record of the area may be obtained from the Council for Geoscience. It is assumed that a future geotechnical assessment of the study area will include an evaluation of the seismic risk to structures. For example, the top of tall structures are likely to experience greater horizontal movement than that likely to be recorded at the base.
Monitoring Requirements	None.

CLIMATE	
ASPECT	**NOTES**
Climate	
	Please refer to Table 1.
Gaps in Knowledge and Monitoring Requirements	
Gaps in Knowledge	Eskom are monitoring selected climatic variables.
Monitoring Requirements	It is assumed that this is already being carried out by Eskom and will continue if the wind turbines are constructed.

GEOMORPHOLOGY	
ASPECT	**NOTES**
Relief	Elevations within the area selected for the siting of the turbines lie between 50 m and 150 m above mean sea level (sensu 1:250 000 electronic topographical map for the study area, namely 3118). The routes followed by all power line alternatives lie below 150 m.
Landforms	
Aeolian	Vegetated dunes cover most of the area north of the main unpaved access road (known as Skaapvlei road) traversing the area selected for the siting of the turbines. These dunes are not expected to be mobile, although local wind transport of sediment and topographic alteration can be anticipated. A much smaller area is evident south of this road. Many of the more obvious linear elements within this dunefield are orientated in a north - south direction. A large linear element that extends for > 2.5 km in a west - east direction may be associated with a change in elevation in the subtopography below the aeolian dune cover. The orientation of this feature approximates that of the coastline. The area seaward of this dunefield also appears to be mantled by an aeolian sand cover, although bedforms are less distinctive than in the aforementioned area. The boundary between these two areas is difficult to discern in imagery and hence is conservatively regarded as gradational for the purposes of this report. The mantle of aeolian sand is expected to cover marine terrace gravels, at least in lower lying areas, within the study area.
Biological	Numerous, round, enigmatic structures, approximately 20 m in diameter, are assumed to represent mounds created by Meerkats (*Suricata suricatta*) or Harvester Termites (*Microhodotermes viator*) (Figure 4). Mr Hansie Visser and a labourer indicated that these features are occupied by "erdmanne", consequently these features have been attributed to colonies of meerkats. The features are also present in the area traversed by power line alternatives 1, 1a and 2. No other significant landforms of biological origin are known to be present within the study area. Calcretized root casts can be expected to occur within the unconsolidated cover of aeolian sediments, although no landform is known to be the result of these features in the area targeted for the siting of the wind turbines.

GEOMORPHOLOGY	
ASPECT	**NOTES**
Fluvial	No significant drainage lines are known to be located within the area targeted for the siting of the wind trubines. As surface erosion is expected to occur in association with the larger rainfall events, features consistent with this process are also likely to be present within the study area, albeit of a minor nature. These features could include stone pedestals, raised mounds associated with plants, rills and shallow erosion gullies. A relatively small number of drainage lines, erosion gullies and rivers and associated floodplains are traversed by the two power line alternatives (viz. alternative 1 and alternative 2). Alternative 1a traverses the Jaagleegte River. Comments with regards to their sensitivity and associated recommendations have been summarised in Table 6.
Marine	A number of marine terrace deposits are located at different elevations along the Namaqualand coast. Marine deposits are known to occur at elevations up to 90 m above mean sea level (Pether 1986). The likelihood of occurrence of the different marine terraces within the area targeted for the siting of the turbines is regarded as unlikely, even though elevations range from 50 m - 150 m above mean sea level within this area, as the area has an aeolian sediment cover. Similarly, no marine terraces are expected to outcrop along the route of any power line alternative.
Mass Movement	No significant landslides, rockfalls or other large mass movements with a significant spatial extent are known to occur in the area targeted for the siting of the turbines. Rockfalls and small slope failures may be associated with the steep slopes and scarps traversed by the power line corridors as reported in Table 6. Comments with regard to their sensitivity and associated recommendations have been summarised in Table 6.
Wetlands	A limited number (n = 7, possibly 10) of small (< 1 ha) pans were evident in satellite imagery. The largest of these pans (clay pan = 31.4952°S 18.1081°E), visited on the 8 October 2007, was located north of the unpaved road, in the area targeted for the siting of the wind turbines (Figure 23 and Figure 24). Two "waterholes" were also identified by Tim Hart during his archaeological assessment of the WEF. One probable pan is located within 50 m of a provisional position of a turbine as indicated in Figure 2. Comments with regard to sensitivity and associated recommendations have been summarised in Table 6.
Weathering Features	No notable, distinctive, weathering features are known to be present within the study area.
Sites of Special Scientific Interest	
Aeolian	None known to be present.
Biological	None known to be present.

GEOMORPHOLOGY	
ASPECT	**NOTES**
Fluvial	None known to be present.
Marine	None known to be present.
Mass Movement	None known to be present.
Weathering Features	None known to be present.
Other	None known to be present.
Gaps in Knowledge and Monitoring Requirements	
Gaps in Knowledge	1. High resolution (< 20 m contour interval) elevation data during the compilation of this report. 2. The occurrence and spatial extent of the small pans within the study area may require further investigation if the siting of wind turbines and associated infrastructure is changed from that indicated in Figure 2. The presence of the largest of these features (a clay pan) was confirmed during a site visit on the 8 October 2007. 3. Small drainage lines and shallow gullies not evident in imagery or during the site visits may be present within the area targeted for the siting of the wind turbines. 4. The nature and extent of the potentially different types of aeolian cover are relatively poorly known.
Monitoring Requirements	A photographic record of the spatial extent of surface ponding in the small pans after significant rainfall events.

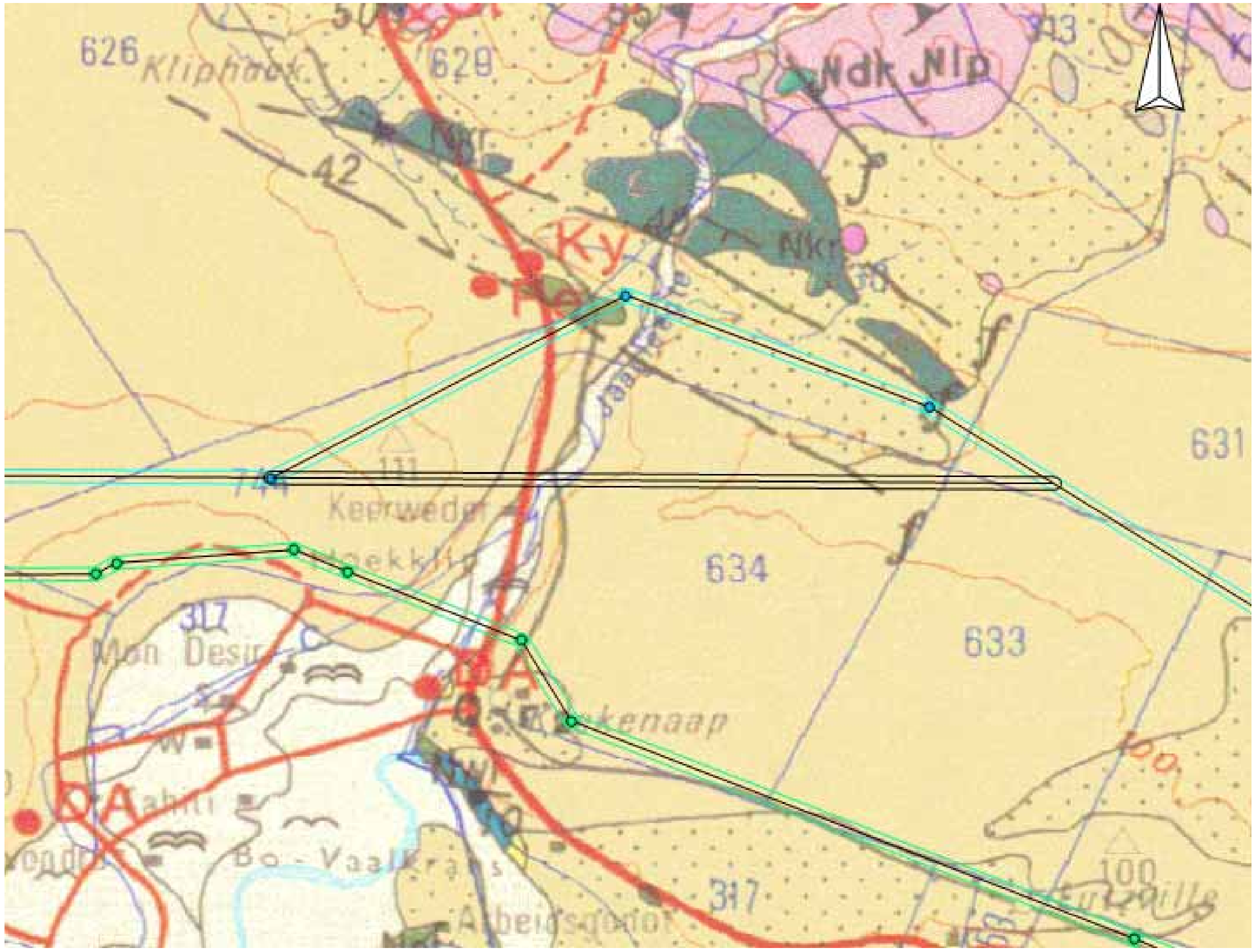

Figure 3. A view of the alternative power line alignments and the position of the faults (ƒ = fault) en route. Blue corridor = alternative 1, Black corridor = alternative 1a and Green corridor = alternative 2.

Figure 4. Bioturbated ground interpreted as a meerkat colony (31.5099°S 18.0864°E).

5.2. Present Geomorphological State

A summary of the state of the geomorphological environment in relation to selected aspects has been presented in Table 4 below.

Table 4. A summary of the state of the geomorphological environment in relation to selected aspects.

DISTURBANCE		
ASPECT	**SCORES**	**NOTES**
National Review of Land Degradation of South Africa	The metrics listed below provide an indication of the regional (i.e. magisterial district) state of the environment with regard to land degradation. This data provides an indication of which *current* impacts on the potentially affected environment could be of greatest concern. In this context, it would appear that the landscape has been the most susceptible to "loss of veld by rill, gully and donga erosion". This implies that the potential impact of the proposed project on these aspects of the environment should be addressed in the EMP phase of the assessment process. Other impacts that should be addressed include the "loss of veld topsoil by wind" and "loss of veld by sheet erosion".	
Veld degradation: Loss of cover[1]	Degree (0 = None, 4 = Extreme) = 0	See comment with regard to vegetation clearing below.
Veld degradation: Alien plants (species)[1]	Degree (0 = None, 4 = Extreme) = 2 (Moderate)	See comment with regard to alien vegetation below.
Loss of veld by sheet erosion[1]	Degree (0 = None, 4 = Extreme) = 1 (Light)	Sheet erosion is evident along some of the proposed power line alternatives (Table 6).
Loss of veld by rill, gully and donga erosion[1]	Degree (0 = None, 4 = Extreme) = 3 (Strong)	Gully erosion and channel incision is evident at a number of localities within the two power line corridors (Table 6).
Loss of veld topsoil by wind[1]	Degree (0 = None, 4 = Extreme) = 2 (Moderate)	The loss of topsoil by wind will occur throughout the area targeted for the location of the wind turbines and the areas traversed by all proposed corridor alternatives.
Loss of veld by deflation hollows and dunes[1]	Degree (0 = None, 4 = Extreme) = 0	Deflation hollows are present at a number of localities, such as either side of the unpaved access road to the area targeted for the siting of

DISTURBANCE ASPECT	SCORES	NOTES
		the turbines (west of the Jaagleegte River).
Loss of veld by overblowing[1]	Degree (0 = None, 4 = Extreme) = 0	Overblowing (aeolian sedimentation) will be associated with the loss of topsoil by wind (e.g. adjacent to deflation hollows).
Loss veld by salinisation[1]	Degree (0 = None, 4 = Extreme) = 0	Unknown, but some salinisation may have been associated with irrigated lands (e.g. associated with the Jaagleegte River).
Loss of veld by soil mining[1]	Degree (0 = None, 4 = Extreme) = 0	The extent to which soil mining takes place is unknown, but probably takes place for building sand. Namakwa Sands is located close to the alignment of alternative 1, while a large abandoned quarry is located in the Hol River valley between the two route alignments close to where the routes deviate from each other. Elsewhere, borrow pits along roads indicate that a limited amount of other mining activity has taken place in the region.
Loss of veld by acidification[1]	Degree (0 = None, 4 = Extreme) = 0	Unknown.
Loss of veld by pollution[1]	Degree (0 = None, 4 = Extreme) = 0	Unknown.
Notes	1=As listed in an electronic document that accompanies the "National Review of Land Degradation of South Africa".	
Past (only area for siting of turbines)		
Alien Vegetation	Please refer to the botanical report for further information. In his draft report (Helme 2007), the botanist (Nick Helme) noted that no alien species were recorded in Namaqualand Strandveld.	Aeolian Sediment Trap, Channel Incision, Wind Throw

DISTURBANCE		
ASPECT	**SCORES**	**NOTES**
Vegetation Clearing	A large area (c. 565 ha, c.15 % of the study area) east of Skaapvlei, within the area targeted for the siting of the turbines, has been cleared in strips for cultivation. These strips were reputedly used for the cultivation of wheat, but have been fallow for at least 12 years (K. Jodas, pers.comm. citing farmer). The spatial extent of this affected area included the strips of vegetation that have been left more in tact. This area therefore represents an over estimate of the actual area transformed by the clearing activity. The affect of these impacted areas on sediment erosion and deposition is unknown. As these strips appear to have a much poorer vegetation cover than the untransformed areas, it is assumed that they represent an elevated erosion risk in relation to the latter strips of vegetation.	Sediment Transport
Cultivated Areas & Pasture	Please refer to the entry above, which refers to the past use of an area for wheat farming purposes. The area selected for the siting of the turbines is currently used for grazing sheep (K.Jodas, pers.comm.), although this is not on cultivated pastures.	Sediment Transport, Surface Modification (e.g. compaction)
Excavation(s)	The entrance to a possible borrow pit along the main unpaved access road is located at -31.4973^{o}S 18.0981^{o}E.	Fluvial Sediment Trap, Surface Modification

DISTURBANCE		
ASPECT	**SCORES**	**NOTES**
Impoundments	No impoundments (e.g. earthen farm dams) are known to be located within the study area. As no drainage lines are known to traverse the area targeted for the siting of the turbines, no impoundment (if present) above or below the study area is likely to represent a significant planning element from a sediment management perspective.	Fluvial Sediment Trap, Surface Modification
Livestock	At least a part of the site selected for the location of the turbines is used for grazing sheep on a rotational basis (K.Jodas, pers.comm.).	Channel Bank Modification, Sediment Transport, Surface Modification (e.g. compaction)
Roads and Tracks	One reasonably wide unpaved road (known as Skaapvlei road) traverses the study area. A number of other tracks are also present within the study area. These tracks appear to be located inter alia down fencelines and on the fringes of the area believed to have been transformed for cultivation purposes. Some of these tracks were used on a site visit on the 8 October 2007.	Sediment Transport, Surface Modification (e.g. compaction)
Sealed Surfaces	No sealed surfaces of significant spatial extent are known to be located within the study area. A possible structure (location = 31.5610°S 18.1266°E) visible in satellite imagery, at the southern extremity of the focus area, represents one possible example of a sealed surface, possibly a roof (spatial extent = c. 25 m X c. 7.5 m).	Increased Runoff, Sediment Availability
Stockpiles	No significant stockpiles are known to be present within the study area.	Surface Modification, Sediment Availability

DISTURBANCE ASPECT	SCORES	NOTES
Other	The extent of footpaths within the study area is unknown.	
Gaps in Knowledge and Monitoring Requirements		
Gaps in Knowledge	1. The extent to which road drainage ditches, tracks and other impacted areas have been affected by fluvial erosion and deposition in the study area.	
Monitoring Requirements	A baseline photographic record of roadside drainage ditches and other impacted areas on steep slopes prior to site development, should this be approved by DEAT.	

6. ISSUES AND IMPACTS

An assessment of the potential impacts associated with the project have been presented in Table 5 below. The method followed in the assessment of the impacts was one provided by Savannah Environmental (Pty) Ltd for this purpose (Appendix A).

Table 5. An assessment of potential impacts associated with the proposed project.

Impact	Nature	Extent	Duration	Magnitude	Probability	Significance	Status	
Impoundment of channelised flows by roads.	Roads constructed across drainage lines can impound flows. The smaller the design discharge for the culvert(s), the greater the likely impact on flows in the channel. <u>Recommendations:</u> Use existing roads wherever possible. Ensure new roads have culverts that are suitably sized. Ideally use	2	5	6	4	52, Medium	Negative	Direct

Impact	Nature	Extent	Duration	Magnitude	Probability	Significance	Status	
	adjoining box culverts on larger drainage lines.							
Impoundment of overland flows by roads.	Roads constructed across slopes are likely to impound and/or divert overland flow. The nature of this impact will be dependant on inter alia the length of the slope above the road, its gradient, the composition of the substrate and the nature of the rainfall event. <u>Recommendations:</u> Use existing roads wherever possible. Ensure new roads have culverts placed in topographic lows.	1	5	6	5	60, Medium	Negative	Direct
Increased runoff relative to the predisturbed state as a result of sealed surfaces (e.g. roads, roofs).	Increased runoff from a sealed surface in relation to the reference state may be associated with a relative increase in sediment transport and hence erosion on a slope or within a channel. <u>Recommendations:</u> Ensure roadside drainage ditches are sealed on steep slopes. Ensure runoff from roofs is directed towards a rainwater tank.	1	5	4	5	50, Medium	Negative	Direct
Deposition of sediment by aeolian processes adjacent to or within infrastructure (e.g. substation or visitor's centre building).	A localised decrease in wind velocity caused by an obstacle may be associated with the deposition of sediment. <u>Recommendations:</u> Establish a drift fence or shrub barrier around susceptible structures in order to trap wind transported sediment.	1	5	4	5	50, Medium	Negative	Direct

Impact	Nature	Extent	Duration	Magnitude	Probability	Significance	Status	
Accelerated aeolian sediment transport possibly leading to the development of deflation hollows.	A loss of vegetation (or other) cover will increase the susceptibility of sediments to wind erosion. Recommendations: Revegetate areas where there has been a loss of vegetation as soon as is practically possible.	1	2	2	5	25, Low	Negative	Indirect
Accelerated fluvial sediment transport and hence erosion associated with channelised/concentrated flow.	Erosion may be accentuated in flow concentration zones (e.g. culverts, roadside drainage ditches). Recommendations: Use exisiting roads wherever possible. With new roads, ensure culverts are suitably sized and roadside drainage ditches on steep sections are sealed. Construct mitre drains at regular intervals.	1	5	6	5	60, Medium	Negative	Indirect
Accelerated fluvial sediment transport and hence erosion associated with overland flow.	A loss of vegetation cover may increase the susceptibility of a sediment surface to overland flow related erosion proceses. Recommendations: Revegetate areas where there has been a loss of vegetation as soon as is practically possible.	1	2	4	5	35, Medium	Negative	Indirect
Preferential aeolian erosion of sediment adjacent to structures and subsequent subsidence.	The winnowing affect associated with local flow modication caused by structures may lead to subsidence if these structures are undercut. Recommendation: Ensure a good indigenous vegetation cover is maintained adjacent to the concrete pad at the foot of a turbine.	1	5	2	4	32, Medium	Negative	Indirect

Impact	Nature	Extent	Duration	Magnitude	Probability	Significance	Status	
Preferential fluvial erosion of sediment adjacent to structures and subsequent subsidence.	The winnowing affect associated with local flow modication caused by structures may lead to subsidence if these structures are undercut. Recommendation: Ensure runoff is deflected away from structures.	1	5	2	4	32, Medium	Negative	Indirect
Excavation of foundations for wind turbines and other project related infrastructure (e.g. access roads, substation and powerline towers).	Excavation of foundations for infrastructure will be associated with localised surface modification. Recommendation: Do not spread displaced sediment over vegetation, but rather deposit it evenly in an area devoid or largely devoid of vegetation.	1	1	6	5	40, Medium	Negative	Direct
Sandblasting of structures leading to increased maintenance requirements.	Sandblasting may lead to the erosion of plaster/mortar and potentially damage painted surfaces. Recommendation: Ensure a good indigenous vegetation cover is maintained adjacent to the concrete pad at the foot of a turbine.	1	5	2	5	40, Medium	Negative	Cumulative (additive)
A reduction in the surface area of wetlands e.g. (pans) in the study area.	Construction of roads, tracks or other infrastructure in wetlands will lead to a loss of this habitat in the study area. Recommendation: Avoid all pans and drainage lines and associated 50 m buffer zones, wherever possible for the siting of infrastructure, even if of a temporary nature.	5	5	10	1	20, Low	Negative	Direct

7. AREAS SENSITIVE TO DEVELOPMENT

7.1. Policy and Legal Overview with regard to Wetlands in South Africa

As South Africa is a Contracting Party to the Convention on Wetlands (Ramsar 1971), recommendations within this assessment and management plan are intended to be consistent with the principle of "wise use", as defined by the convention and be guided by current national legislation with regard to wetlands. Wise use is defined in Handbook 1 as "…their sustainable utilisation for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem" (Ramsar Convention Secretariat, 2004). Sustainable utilisation is defined in the same document as the "human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations".

In terms of the Ramsar Convention on Wetlands (Iran, 1971) "…wetlands include a wide variety of habitats such as marshes, peatlands, floodplains, rivers and lakes, and coastal areas such as salt marshes, mangroves, and seagrass beds, but also coral reefs and other marine areas no deeper than six metres at low tide, as well as human-made wetlands such as waste-water treatment ponds and reservoirs" (Ramsar Convention Secretariat 2004).

In South Africa, wetlands are defined as "…land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil" (National Water Act, Act No. 36 of 1998) (NWA). Wetlands are also included in the definition of a watercourse within the NWA, which implies that whatever legislation refers to the aforementioned will also be applicable to wetlands. The types of features included within the definition of a watercourse include:

"…a river or spring…"
"…a natural channel in which water flows regularly or intermittently…"
"…a wetland, lake or dam into which, or from which, water flows…"
"…any collection of water which the Minister may, by notice in the *Gazette*, declare to be a watercourse…"

In addition, the NWA stipulates that "…reference to a watercourse includes, where relevant, its bed and banks…". This has important implications for the management of wetland areas and encroachment on their boundaries, as discussed further on in this document.

The Act defines riparian areas as "…the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas…".

Wetlands are reputed to inter alia:

- Attenuate floods;
- Retain contaminants, nutrients and sediments;
- To facilitate the recharge of groundwater resources;
- Provide an important habitat for aquatic fauna and flora; and
- Provide food, building and other materials for a variety of uses.

Riparian habitats provide similar services to those listed above for wetlands (DWAF, 2005). In addition, riparian habitats can act as corridors for the movement of wildlife and hence may be regarded as linking elements within the landscape. In contrast, endorheic pans are isolated systems (in terms of surface water flow), where drainage within a catchment terminates at a pan. Even though endorheic pans do not perform all the ecological services listed above (e.g. flood attenuation), they remain important elements within a landscape for aquatic and other wetland dependant organisms. Isolated pans and pools provide habitat for waterfowl in a similar sense to other wetland areas, although the former wetland types may be of greater importance for certain taxa such as invertbrates and frogs. For example, predation by fish may be absent from small temporary/seasonal endorheic pans. Size (of the wetland) matters for some taxa that inhabit these isolated pools/pans (Semlitsch, 2000). For example, loss of some of these pools/pans could increase the dispersal distance between suitable habitat for wetland dependant taxa, possibly making them increasingly susceptible to local extinction in the process.

In South Africa, their importance has been recognised in Chapter 1 (National Environmental Management Principles) of the National Environment Management Act (Act No. 107 of 1998), which states that, "sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure".

In terms of the Conservation of Agricultural Resources Act (Act of 1983) the following management actions are applicable:

- Removal of Category 1 plants by land users regardless of where they occur on their property,

- Removal of all Category 2 and 3 plants by land users from within a 30 m buffer of the 1:50 year water level of the wetland and within the wetland itself.

It is therefore clear, that drainage lines and other wetland areas are afforded protection by a number of legal instruments in South Africa. Development planned within these areas, will often require approval from the relevant authorities tasked with policing a piece of legislation. If any uncertainty exists in this regard they should always be consulted in order to obtain clarity on the issue under consideration

7.2. The Affected Environment

Localities or landforms regarded as sensitive to development and the associated recommendations for the avoidance of proposed project related impacts have been summarised in Table 6 below. This table excludes aeolian features, which are widespread throughout the area targeted for the siting of the turbines and within the power line corridors, as this would uneccessarily increase the size of the table, without any significant benefit. The micrositing of towers would best be done prior to construction of the line, during a dedicated site visit for this purpose. The aim of this site visit would be to ensure that all sensitive areas are avoided, wherever practically possible and when unavoidable, negative impacts mitigated or suitable offsets identified. Views of the sensitive areas are presented in sections 7.1 to 7.3.

Table 6. Sensitive areas located within the area targeted for the siting of the turbines and within each proposed power line corridor. Sensitive sites/areas are listed in the order in which they appear from Juno to the Wind Energy Facility.

Latitude	Longitude	Landform	Sensitivity	Motivation	Recommended Action	Area	Figure
-31.5938	18.4340	Gully Head.	High	Unstable and likely to migrate upslope.	Avoid placing towers within 100 m of the feature.	Alternative 1	5
-31.5659	18.4285	Erosion gully network.	High	Protected by legislation.	Avoid the area for the siting of infrastructure. Ensure maintenance road has suitably sized culvert.	Alternative 1	6
-31.5582	18.4261	Erosion gully network.	High	Protected by legislation.	Establish infratructure outside the area as indicated.	Alternative 1	7
-31.5548	18.4251	Floodplain	High	Protected by legislation.	No infrastructure within 50m of the feature.	Alternative 1	8
-31.5335	18.4159	Floodplain	High	Protected by legislation.	No infrastructure within 50m of the feature.	Alternative 1	9
-31.5323	18.4139	Gully	High	Protected by legislation.	Maintain a 50m buffer from the edge of the gully.	Alternative 1	10
-31.5173	18.3893	Pan	High	Protected by legislation.	No infrastructure within 50m.	Alternative 1	11
-31.5168	18.3880	Possible pan.	High	Protected by legislation.	Maintain a 50m free of infrastructure.	Alternative 1	11
-31.4778	18.3127	Potential headwater of drainage line.	High	Protected by legislation.	No infrastructure within 50m of riparian area.	Alternative 1	12
-31.4773	18.3113	Potential headwater of drainage line.	High	Protected by legislation.	No infrastructure within 50m of riparian area.	Alternative 1	12
-31.4765	18.3091	Floodplain	High	Protected by legislation.	No infrastructure within 50m of riparian area.	Alternative 1	13

Latitude	Longitude	Landform	Sensitivity	Motivation	Recommended Action	Area	Figure
-31.4780	18.3051	Eroded area.	High	No/very limited surface cover anticipated.	Provides an opportunity for rehabilitation (e.g. revegetation). This may lower the sensitivity of the area to erosion.	Alternative 1	14
-31.4977	18.3216	Possible pan.	High	Protected by legislation.	No infrastructure within 50m.	Alternative 1a	32
-31.4980	18.3055	Possible pan.	High	Protected by legislation.	No infrastructure within 50m.	Alternative 1a	33
-31.4980	18.3041	Possible pan.	High	Protected by legislation.	No infrastructure within 50m.	Alternative 1a	33
-31.4980	18.3025	Possible pan.	High	Protected by legislation.	No infrastructure within 50m.	Alternative 1a	33
-31.4975	18.2995	Drainage line.	High	Protected by legislation.	Maintain 50m buffer free of infrastructure.	Alternative 1a	34 & 35
-31.4979	18.2956	Floodplain	High	Protected by legislation.	No infrastructure within 50m of riparian area.	Alternative 1a	36 & 37
-31.5718	18.4164	Erosion gully.	High	Protected by legislation.	Maintain a 50m buffer from the drainage line free of any development.	Alternative 2	15
-31.5706	18.4122	Eroded slopes.	High	Towers could be undermined. Maintenance road susceptible to erosion.	Maintain a 50 m buffer around the feature free of infrastructure.	Alternative 2	16
-31.5679	18.4058	Eroded slope.	High	Towers could be undermined. Maintenance road susceptible to erosion.	Maintain a 50m buffer free of infrastructure.	Alternative 2	17
-31.5654	18.4008	Floodplain	High	Protected by legislation.	No infrastructure within 50m of riparian area.	Alternative 2	18

Latitude	Longitude	Landform	Sensitivity	Motivation	Recommended Action	Area	Figure
-31.5624	18.3935	Drainage line.	High	Protected by legislation.	Maintain 50m buffer free of infrastructure.	Alternative 2	19
-31.5617	18.3933	Incised drainage line.	High	Protected by legislation.	No infrastructure within 50m of feature.	Alternative 2	19
-31.5135	18.2877	Floodplain	High	Protected by legislation.	No infrastructure within 50m of riparian area.	Alternative 2	20
-31.4841	18.1194	Pan	High	Protected by legislation.	No infrastructure within 50m.	WEF	21
-31.4889	18.1410	Pan	High	Protected by legislation.	No infrastructure within 50m.	WEF	22
-31.4891	18.1444	Pan	High	Protected by legislation.	No infrastructure within 50m.	WEF	22
-31.4899	18.1438	Pan	High	Protected by legislation.	No infrastructure within 50m.	WEF	22
-31.4952	18.1081	Pan	High	Protected by legislation.	No infrastructure within 50m.	WEF	23 & 24
-31.5157	18.1385	Possible pan.	High	Protected by legislation.	No infrastructure within 50m.	WEF	25
-31.5180	18.1381	Pan	High	Protected by legislation.	No infrastructure within 50m.	WEF	25
-31.5334	18.1159	Possible pan.	High	Protected by legislation.	No infrastructure within 50m.	WEF	26
-31.5197	18.0992	Possible pan.	High	Protected by legislation.	No infrastructure within 50m.	WEF	27
-31.5113	18.0984	Probable wetland.	High	Protected by legislation.	No infrastructure within 50m.	WEF	28 & 29
-31.5061	18.0852	Probable pan.	High	Protected by legislation.	No infrastructure within 50m.	WEF	30

7.3. Alternative 1

This section provides views of the sensitive areas listed in Table 6.

Figure 5. Gully head on the edge of the 200 m power line corridor. The headcut is expected to migrate further upslope and hence will pose a threat to any tower located in this area.

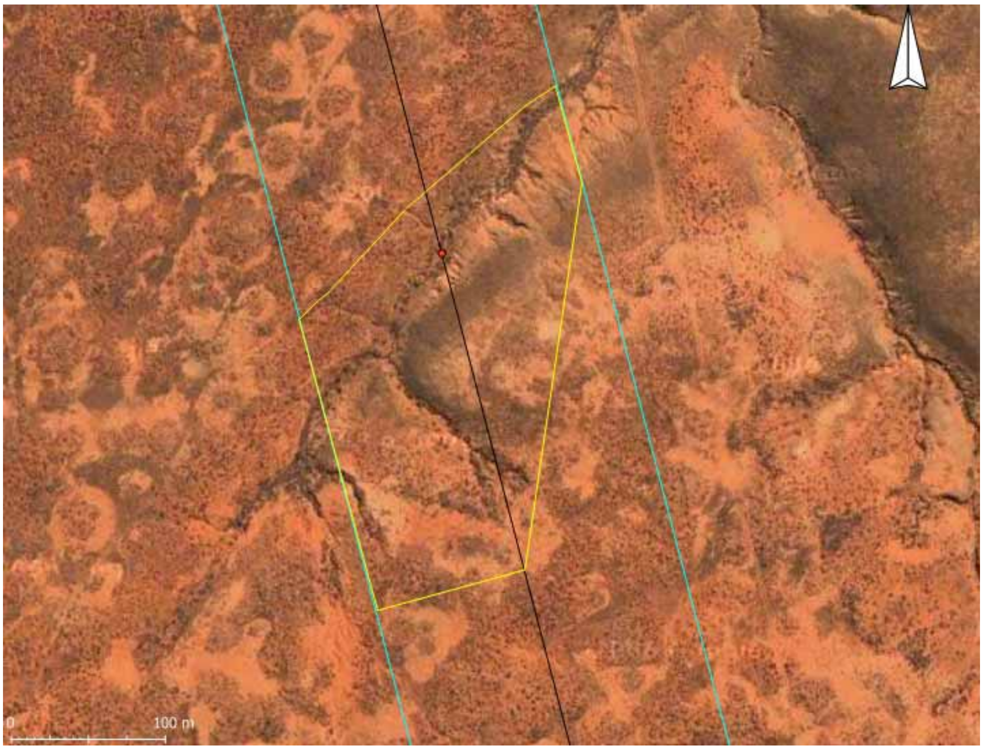

Figure 6. Erosion gully network indicated in yellow box. Note the extensive rilling present on the right hand slope of the drainage line. The erosion gullies could pose a threat to any tower located in this area. Upslope migration of eroded areas could potentially lead to undercutting of a tower.

Figure 7. Erosion gully network. Most of the area highlighted in the yellow box is likely to be highly susceptible to sheet, rill or gully erosion. Towers located in this area could be undercut by the erosion. Runoff from roads could exacerbate erosion in the area.

Figure 8. Channel of the Hol River, with riparian corridor and associated floodplain evident (yellow border). If possible, towers should not be sited in the area demarcated with the yellow lines. Ideally, no roads should traverse these riparian corridors and associated floodplains. Maintenance roads should not result in unnecessary concentration of flows, which could lead to scouring and channel incision. Erosion in roadside ditches could also lead to upslope propagation of an erosion gully. The blue dot indicates the position of a bend point. The blue

line circle represents a 100 m wide buffer around a bend point, while blue lines indicate a 100 m buffer either side of the centre of the power line corridor.

Figure 9. Broad floodplain of the Moedverloor River. If possible, towers should not be sited in the area demarcated with the yellow lines. Ideally, no roads should traverse these riparian corridors and associated floodplains. Maintenance roads should not result in unnecessary concentration of flows, which could lead to scouring and channel incision. Erosion in roadside ditches could also lead to upslope propagation of an erosion gully.

Figure 10. An incised channel segment. Towers should not be located close to this feature as fluvial erosion could result in the structure being undercut.

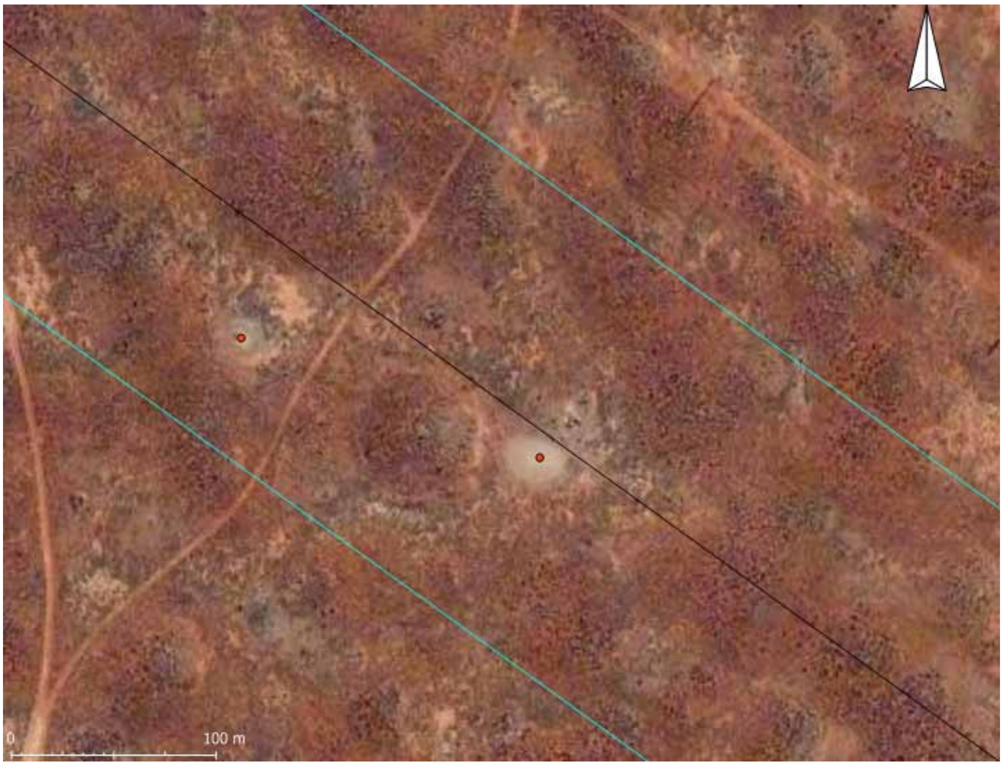

Figure 11. Two small pans located within the power line corridor.

Figure 12. Headwater reaches of a drainage line in the power line corridor.

Figure 13. A floodplain at the confluence of the Jaagleegte River and a tributary. If possible, towers should not be sited in the area demarcated with the yellow lines. Maintenance roads should not result in unnecessary concentration of flows, which could lead to scouring and channel incision.

Figure 14. An eroded area possibly associated with past mining activity for Namakwa Sands, which is located immediately north of this site. Towers located in this area could be undermined by fluvial erosion.

7.4. Alternative 2

This section provides views of the sensitive areas listed in Table 6.

Figure 15. Erosion gully network. Most of the area in close proximity to the drainage line is likely to be highly susceptible to sheet, rill or gully erosion. Towers located in this area could be undercut by the erosion. Runoff from roads could exacerbate erosion in the area.

Figure 16. Scarp likely to be associated with slope failure and a high erosion risk. The headcut is expected to migrate further upslope and hence will pose a threat to any tower located in this area.

Figure 17. Steep slope subject to erosion and possible excavation. Towers located on the eroded slope would be exposed to a high erosion risk and hence should be excluded from consideration for this purpose.

Figure 18. Channel of the Hol River, with riparian corridor and associated floodplain evident. If possible, towers should not be sited in the area demarcated with the yellow lines. Maintenance roads should not result in unnecessary concentration of flows, which could lead to scouring and channel incision.

Figure 19. Incised drainage lines. Towers should not be located close to these features as fluvial erosion could result in the structures being undercut.

Figure 20. Modified floodplain of the Jaagleegte River. If possible, towers should not be sited in the area demarcated with the yellow lines. Maintenance roads should not result in unnecessary concentration of flows, which could lead to scouring and channel incision.

7.5. Area targeted for the siting of wind turbines (WEF)

This section provides views of the sensitive areas listed in Table 6.

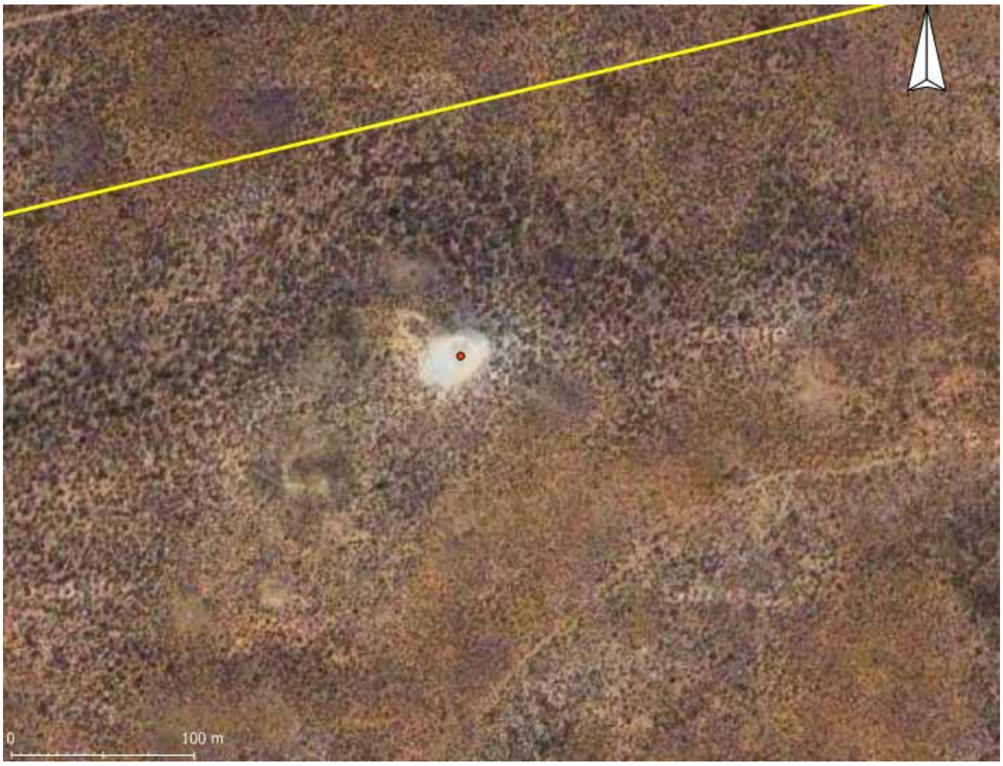

Figure 21. A very small pan in the northern reaches of the area targeted for the siting of the wind turbines.

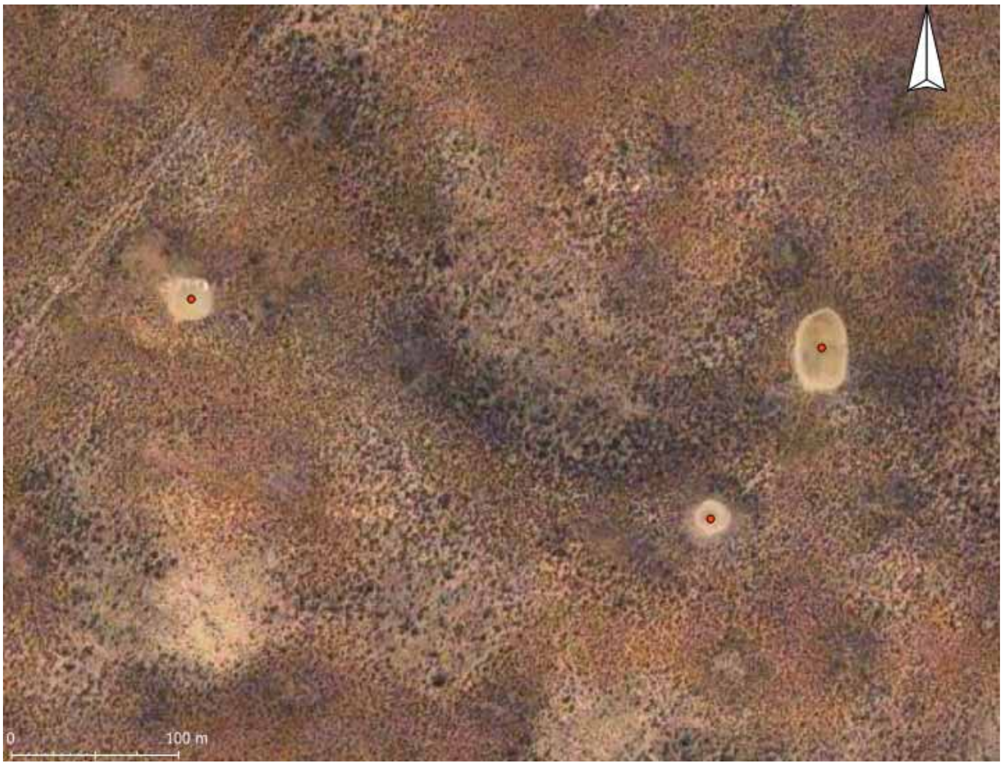

Figure 22. A cluster of small pans, north of the unpaved access road, in the eastern reaches of the area targeted for the siting of the wind turbines.

Figure 23. A view of the largest pan (albeit < 1 ha in extent) in the area targeted for the siting of the wind turbines. It is located north of the unpaved access road.

Figure 24. A view of the southern reaches of the clay pan shown in Figure 22.

Figure 25. Two possible pans in the eastern reaches of the area targeted for the siting of the wind turbines.

Figure 26. A possible pan, albeit unlikely, between two rows of the turbines in the provisional layout. The yellow buffers around each turbine are 50 m wide. The feature should therefore not be affected by the siting of the turbines if the current layout is approved. If the feature is found to be a pan during the micrositing for the turbines, no access road or laydown area should be located within 50 m of it.

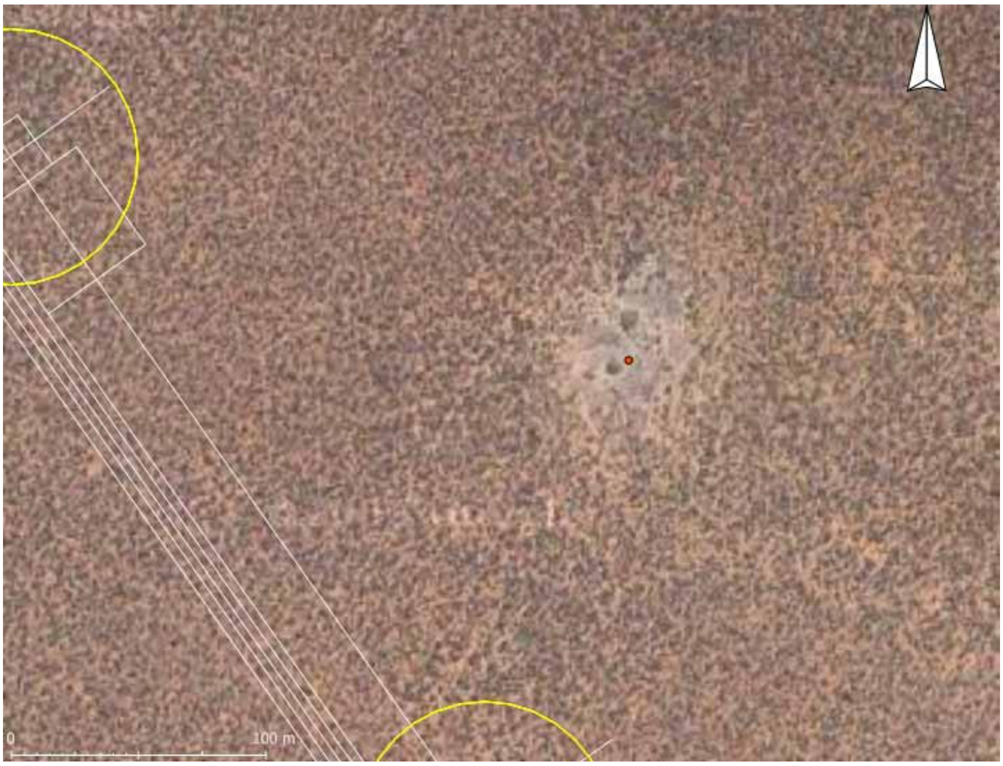

Figure 27. Enigmatic feature within the area occupied by the WEF. The feature may represent a pan. In terms of the current layout it would appear to lie in excess of 50 m of any infrastructure.

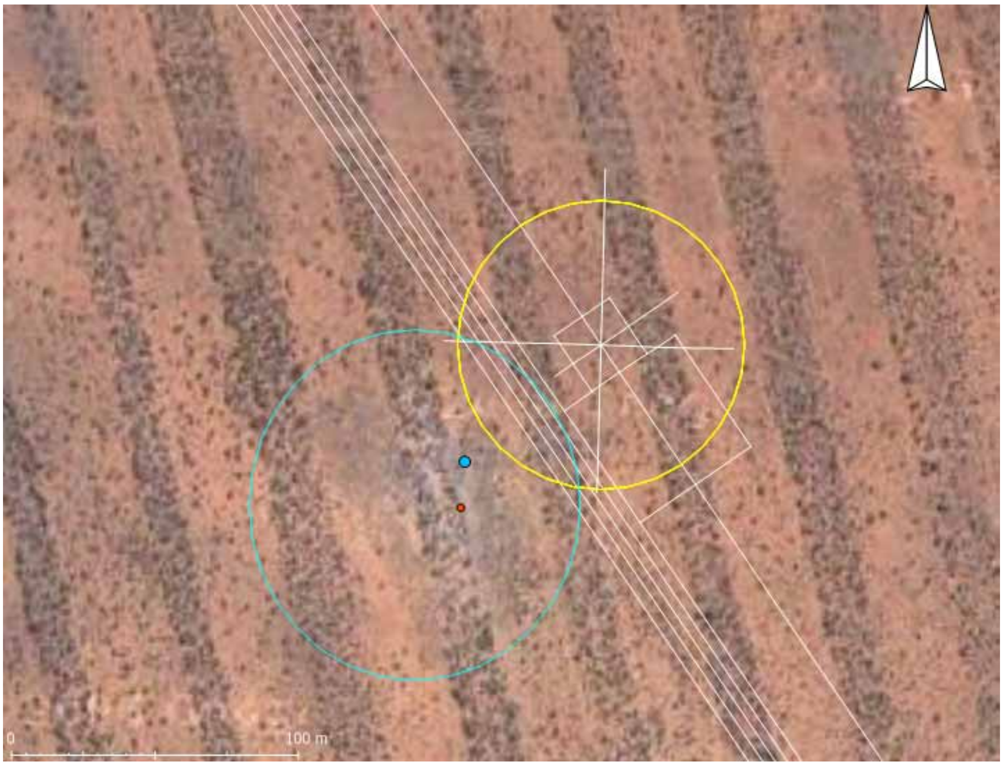

Figure 28. An area noted as a waterhole by Tim Hart (red dot). Mr Hansie Visser reported that his father informed him that after heavy rains water came up up here naturally (sense author's field notes)(blue dot = field observation point 54). Most, if not all of the waterhole, is assumed to lie within the confines of the blue circle. If the turbine is relocated > 20 m east and the access road is realigned east/north of the turbine, impacts on the wetland will be avoided.

Figure 29. A photo of the landscape taken at field observation point 54.

Figure 30. An area noted as a waterhole by Tim Hart (red dot). Most, if not all of the waterhole, is assumed to lie within the confines of the blue circle. The access road to the turbines will possibly have to be realigned slightly to remain outside the 50 m buffer around the wetland.

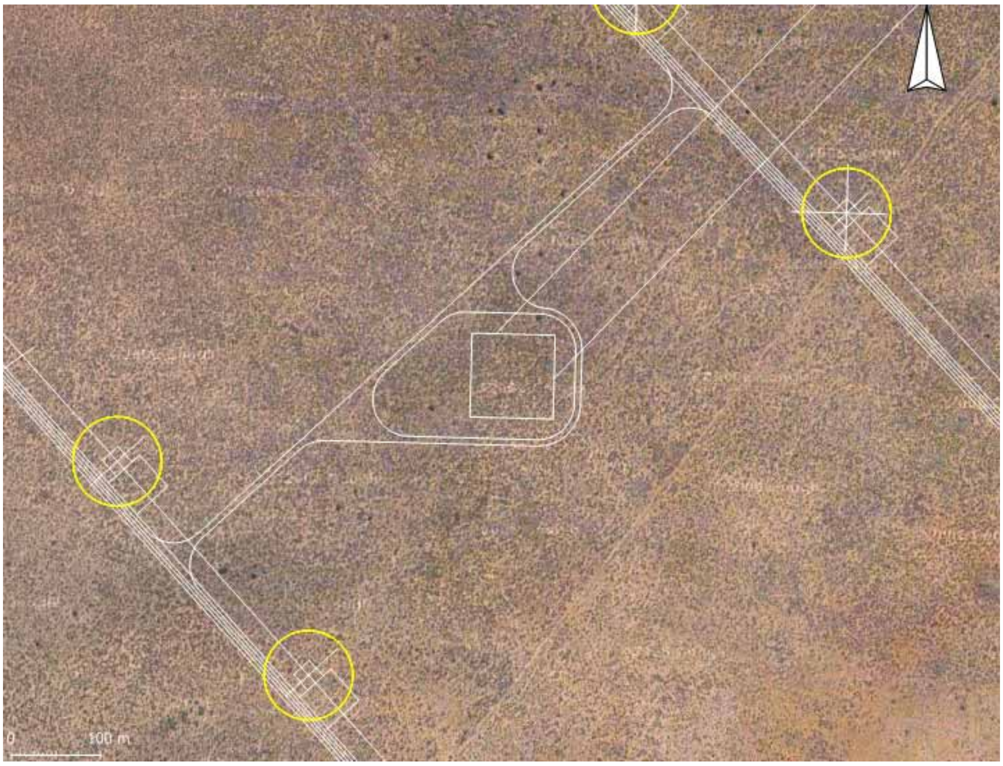

Figure 31. The area in the vicinity of the substation. Yellow circles indicate a distance of 50 m from a turbine. White square indicates the position of the substation in terms of the current layout. Note that it does not lie in close proximity to any sensitive area, with the obvious exception of the substrate, which is sensitive to wind erosion.

7.6. Alternative 1a

This section provides views of the sensitive areas listed in Table 6. Alternative 1a represents a variation of alternative 1 as indicated in Figure 1.

Figure 32. Enigmatic feature within the alternative 1a power line corridor. The feature may represent a pan, a blowout or another unknown feature. Even if the feature were to prove to be a pan, it would appear that it could easily be avoided for the siting of the towers or the access/maintenance road.

Figure 33. Three enigmatic features within the alternative 1a power line corridor. These features possibly represent deflation hollows and or pans. The feature furthest west appears to have a dune ridge associated with it orientated in a northwesterly direction. If all three features represent pans (worst case scenario) towers should be located > 50 m from the

edges of the pans. Similarly, in the aforementioned scenario, an access/maintenance road should not be located closer than 50 m to any of the features.

Figure 34. Drainage line (approximate border outlined in yellow) upstream of the Jaagleegte River bridge on the road between Vredendal and Namakwa Sands. The blue dot indicates the location of field observation point 63.

Figure 35. A view of part of the riparian area indicated in Figure 33.

Figure 36. A view of the Jaagleegte River floodplain downstream of the bridge on the road between Vredendal and Namakwa Sands. The blue dot indicates the location of field observation point 63.

Figure 37. A view downstream of part of the area indicated in Figure 34.

7.7. Summary

- All wetlands, drainage lines and associated buffer zones (viz. 50 m) should be excluded from the development footprint. Where impacts on these features are regarded as unavoidable suitable mitigation measures and offsets will need to be considered.
- Ideally, unvegetated and poorly vegetated aeolian dunes and sediments, which represent a high erosion risk, should be avoided for the siting of infrastructure. However, as most of the area selected for the siting of the turbines and within the powerline corridors is associated with such areas, the crests of dunes, which represent the most sensitive component of the landscape, should be avoided wherever possible.
- Steep slopes susceptible to slope failure, rock fall or that represent a very high erosion risk do not appear to be present with the area selected for the siting of the turbines, although such areas are present within the proposed power line corridors.

8. CONCLUSIONS

- The study area is located close to the Namaqualand coast and is underlain by aeolian sediments.
- The most sensitive landscape elements for planning purposes in the study area and within the power line corridor will be the presence of wetlands (e.g. pans)/drainage lines. These features should be excluded from any development footprint wherever possible.
- In terms of the current WEF layout one turbine and associated access road (see Figure 28) are possibly located within 50 m of a wetland (row three inland of the coast), while the access road down another row of turbines (row two inland of the coast) may pass within 50 m of another (see Figure 30). However, it would appear that by moving the turbine and access road (in the case of the former) and the access road (in the case of the latter) at least 20 m and 10 m respectively these concerns may be avoided.
- The significance of two listed impacts was low, with the rest regarded as moderate.
- No Sites of Special Scientific Interest are known to occur within the study area.
- As power line alternative 2 is shorter (hence potentially less cumulative impact of maintenance road on landscape), has fewer sensitive areas located along its length and is only associated with two as opposed to three floodplain traverses, it is regarded as the preferred option from a geomorphological perspective. This does not imply that alternative 1 is unsuitable, merely that alternative 2 is the preferred option.

- In relation to alternative 1a, a variation of alternative 1, there does not appear to be a significant difference in terms of preferability between the two variations. Alternative 1 is possibly marginally preferable to alternative 1a, as the sensitive areas on alternative 1 appear to be more easily avoided than those on alternative 1a, event though the former is longer and would be associated with a potentially greater cumulative impact on the landscape.

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Only one wind turbine and associated access road, in terms of the current layout possibly lies within 50 m of a pan, while the access road down the second row of turbines inland of the coast appears to pass within 50 m of another. It appears that it will be relatively easy to route access roads to avoid wetlands where they occur within 50 m of these features. As most geomorphologically sensitive areas are of limited spatial extent (< 200 m at their widest), it would appear that they can be avoided with careful siting of towers. As power line alternative 2 is shorter (hence potentially less cumulative impact of maintenance road on landscape), has fewer sensitive areas located along its length and is only associated with two as opposed to three floodplain traverses, it is regarded as the preferred option from a geomorphological perspective. This does not imply that alternative 1 is unsuitable, merely that alternative 2 is the preferred option. In relation to alternative 1a, a variation of alternative 1, there does not appear to be a significant difference in terms of preferability between the two variations. Alternative 1 is possibly marginally preferable to alternative 1a, as the sensitive areas on alternative 1 appear to be more easily avoided than those on alternative 1a, event though the former is longer and would be associated with a potentially greater cumulative impact on the landscape.

9. REFERENCES

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APPENDIX A – Method for Assessment of Potential Impacts (quoted from document provided Savannah Environmental (Pty) Ltd

Direct, indirect and cumulative impacts of the above issues, as well as all other issues identified will be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, where it will be indicated whether the impact will be local (limited to the immediate area or site of development), regional, national or international. A score between 1 and 5 will be assigned as appropriate (with a score of 1 being low and a score of 5 being high).
- The **duration**, where it will be indicated whether:
  - the lifetime of the impact will be of a very short duration (0–1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2-5 years) - assigned a score of 2;
  - medium-term (5–15 years) – assigned a score of 3;
  - long term (> 15 years) - assigned a score of 4; or
  - permanent - assigned a score of 5.
- The **magnitude**, quantified on a scale from 0-10, where a score is assigned:
  - 0 is small and will have no effect on the environment;
  - 2 is minor and will not result in an impact on processes;
  - 4 is low and will cause a slight impact on processes;
  - 6 is moderate and will result in processes continuing but in a modified way;
  - 8 is high (processes are altered to the extent that they temporarily cease); and
  - 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** *of occurrence*, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale, and a score assigned:
  - Assigned a score of 1–5, where 1 is very improbable (probably will not happen);
  - Assigned a score of 2 is improbable (some possibility, but low likelihood);
  - Assigned a score of 3 is probable (distinct possibility);
  - Assigned a score of 4 is highly probable (most likely); and
  - Assigned a score of 5 is definite (impact will occur regardless of any prevention measures).
- the **significance**, which shall be determined through a synthesis of the characteristics described above (refer formula below) and can be assessed as low, medium or high.
- the **status**, which will be described as either positive, negative or neutral.
- the *degree* to which the impact can be *reversed*.

- the *degree* to which the impact may cause *irreplaceable loss of resources*.
- the *degree* to which the impact can be *mitigated.*

The **significance** is determined by combining the criteria in the following formula:

S=(E+D+M)P; where

S = Significance weighting
E = Extent
D = Duration
M = Magnitude
P = Probability

The **significance weightings** for each potential impact are as follows:

- < 30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- > 60 points: High (i.e. where the impact must have an influence on the decision process to develop in the area).