DETERMINATION OF ACCEPTABLE SITES FOR THE DEVELOPMENT OF A WIND ENERGY FACILITY ON THE WEST COAST CHAPTER 4

Eskom commissioned the Klipheuwel Wind Energy Demonstration Facility (north of Durbanville) in February 2003 as a research facility. As discussed in Chapter 3, the demonstration facility has provided valuable research results pertaining to the utilisation of wind as a source of energy in South Africa, and has provided guidance with regards to the establishment of a large-scale commercial facility.

4.1. Identification of the West Coast Area for further Investigation

As a part of Eskom's wind research programme, the South African Wind Resource Database compiled by the National Department of Minerals and Energy (DME), the Council for Scientific and Industrial Research (CSIR) and Eskom. Areas experiencing some of the highest wind speeds in South Africa were identified as areas of high potential for future commercial wind farm development. High-accuracy meteorological measurement stations were erected within these areas for on-going monitoring (the importance of the wind resource for energy generation is also discussed in Chapter 3).

A wind resource measurement and analysis programme must be conducted for the site proposed for wind energy development, as only measured data will provide a robust prediction of a wind energy facility's expected energy production over its lifetime through recording the incidence of wind within the required velocity range. One of these meteorological monitoring stations was established on the West Coast, north of the Olifants River in the Western Cape. Based on the lessons learnt from the Klipheuwel demonstration facility as well as the analyses on Eskom's measured wind data, Eskom determined that a full-scale commercial wind energy facility could be successfully established in South Africa on the West Coast north of the Olifants River.

While Eskom had identified the broad geographic region at a strategic level, the specific site/s within the broader area had not been identified. A preliminary site selection process (a criteria-based assessment) was undertaken by Eskom in 2006, where potential sites for the development of a wind energy facility were earmarked.

As a precursor to the EIA process, Eskom and the EIA consulting team embarked on a consultative process with DEAT and DEA&DP regarding the proposed project and the approach to undertaking further studies for the assessment of a facility of this nature in the Western Cape. It was determined, in consultation with DEAT

and DEA&DP that a site identification and selection process to determine areas along this stretch of the coastline that are suitable for wind energy development should be undertaken for a larger area (at a regional level) using the methodology developed and recommended by DEA&DP for the siting of wind energy facilities in the Province[1].

In April 2007, Eskom embarked on a regional site identification and selection process (refer to Chapter 4 for details of the site identification process) to determine and delineate areas north of the Olifants River as suitable sites for commercial wind energy development. In order to assist in addressing the challenge of ensuring that wind energy projects meet economic (including technical), social and environmental sustainability criteria, the study was based on the Western Cape Provincial guidelines for locating wind energy projects and considered other local, provincial and national strategic environmental initiatives.

4.2. Selection of Potential Sites

The core EIA consulting team, assisted by Eskom, undertook a regional assessment/site identification process (in accordance with the Regional Methodology) within the identified region in order determine boundaries of the site with the best potential from a wind resource perspective coupled with the consideration of environmental and planning criteria. This process was undertaken as a precursor to the commencement of the EIA to ensure that the EIA process could commence with a viable and practical site for investigation (understanding the importance of the role played by the wind resource for a facility of this nature).

The process of identifying and screening potential sites within the region included workshops with DEAT and DEA&DP, the involvement of and interaction with local stakeholders and holders of site-specific information, site reconnaissance inspection as well as workshops with Eskom's technical specialists. The sections which follow document the process that led to the identification of the candidate site.

The regional assessment study was based on the guidelines and findings of the Proposed Regional Methodology (Report 5) of the Western Cape Provincial Government guideline document for wind energy development (Western Cape Provincial Government, May 2006)[2]. The methodology proposed within this guideline document is intended to be a **regional level planning tool** to guide

[1] *Strategic Initiative to Introduce Commercial Land Based Wind Energy Development to the Western Cape - Towards a Regional Methodology for Wind Energy Site Selection* (Western Cape Provincial Government, May 2006).

[2] Refer to Chapter 2 for more details regarding this guideline document.

planners and decision-makers with regards to appropriate areas for wind energy development (on the basis of planning, environmental, infrastructural and landscape parameters). The area identified as suitable through this study would then be considered at a **site-specific level** through an environmental impact assessment. The use of this methodology to identify a potential site for development was supported by the competent authority for the project (i.e. DEAT; as well as DEA&DP).

In summary, the Regional Methodology guideline includes methods for the assessment and delineation of areas appropriate for wind energy development, including the use of appropriate 'negative' and 'positive' buffer zones (suitable to the South African context) to build in cumulative impact concerns, and the incorporation of landscape issues relating to landscape character, value, sensitivity and capacity. The approach and methodology followed for this assessment within the study area are detailed in Sections 4.2 and 4.3.

It is important to note that the Provincial guideline document focuses on environmental and planning issues in determining potentially acceptable sites for development. The consideration of technical factors, such as the availability of wind resources[3], proximity to the electricity grid, and access requirements is considered important, as the technical drivers (and ultimately the technical viability of the project) are critical. Without considering this technical input, the areas identified through following the Regional Methodology are recognised as areas appropriate for development, and not specifically for development of a Wind Energy Facility. Therefore, these technical considerations were considered for this study area in parallel with the regional assessment. The level to which technical issues influence the siting of a wind energy development is integrated with the findings of the regional assessment and discussed in Sections 4.2 and 4.4.

This chapter provides the outcomes of the regional assessment and technical considerations specific to the study area on the West Coast, and provides results which indicate the suitability of specific area/s for wind energy siting and development.

4.3. Methodology in Determining Areas Considered Acceptable for the Development of a Wind Energy Facility within the Identified Study Area

In undertaking the Regional Assessment for the West Coast area, four main steps (as per the Regional Methodology guideline document) were followed. These steps were then followed by a fifth step, which considered technical criteria.

[3] Discussed further in Chapter 3.

4.3.1. STEP 1: Review of the Methodology proposed by DEA&DPs guideline document

The proposed methodology, as set out by the Western Cape Provincial Government guideline document was reviewed to ensure an understanding of the requirements for following the methodology. Consideration was given to the type of data required, the approach to be followed, and the criteria/parameters which may be required to be tailored for the area under consideration.

4.3.2. STEP 2: Consultation with key Stakeholders in the area through meetings

The EIA public involvement process consultant (Sustainable Futures ZA), the EIA lead consultant (Savannah Environmental) and the EIA tourism assessment specialist consultant (Mike Fabricius) attended meetings with key stakeholder groupings to introduce the concepts of the wind energy industry to the stakeholders on the West Coast and gather relevant information to inform the site identification process (regional assessment). Information gathering sessions were held with the West Coast District Municipality (WCDM), Matzikama Local Municipality, Matzikama Business Chamber, the five local Farmers Associations, Agriculture Western Cape and the Knersvlakte Biosphere Reserve Steering Committee (refer to Appendix B for Notes for the Record from these meetings). The following outcomes and benefits were derived from these initial meetings:

» Direct interaction with key stakeholders within the West Coast District Municipality and the Matzikama Local Authority.
» Data essential to the regional assessment methodology was collected (from WCDM, Matzikama Municipality and the local conservation organisations). This included proposed plans and projects for the area currently under consideration.
» Allowed for the clarification of gaps in information, the gauging of perceptions and receipt of 'local and on-the-ground' information from stakeholders to inform the regional assessment study.

4.3.3. STEP 3: Defining the study area

This regional assessment/site identification process was undertaken for an expanded study compared to that assessed through the Eskom study undertaken in 2006. Eskom defined the boundaries of the expanded study area taking the availability of wind resources, accessibility to the electricity grid, access requirements and other technical aspects into account. The boundaries for the expanded study area were: the Olifants River in the south, the Western Cape-Northern Cape provincial boundary in the north, the N7 in the east and the coastline in the west (refer to Figure 4.1).

Figure 4.1: Study area identified for the site identification and selection process to determine areas suitable for wind energy development

4.3.4. STEP 4: Undertaking the Regional Assessment, based on the Regional Methodology proposed by DEA&DP's guideline document

The regional assessment was based on the methodology outlined in the DEA&DP guideline document Report 5: Proposed Regional Methodology.

The commonality of environmental concerns (both within the Province, South Africa, as well as internationally) as detailed in the Provincial guideline document was acknowledged. It was, however, also acknowledged that the thresholds developed to address these issues also varied significantly between localities due to varying geographical, biophysical and cultural characteristics (including salient natural features, land uses and demography), degree of landscape modification, approaches to forward planning etc. The thresholds used within the Eskom regional assessment study, therefore, included some variation, omissions and additions to the specific methodology provided within the Provincial guideline document, and a rationale for each variation was provided. This was primarily due to the differing nature of the study area considered within the DEA&DP guideline document and the study area proposed by Eskom.

4.3.5. STEP 5: Consideration of technical criteria

The results from the four steps above were then considered by Eskom together with relevant issues of a technical nature to determine whether a wind energy

facility can feasibly be sited in a particular area, or not (i.e. will the project make economic sense). The technical considerations included, *inter alia*:

» Wind potential and wind resources
» Electrical distribution and access to grid
» Environmental and planning concerns
» Land availability
» Accessibility to the area
» Public opinion
» Financial feasibility
» Regulatory requirements

These factors were not specifically addressed through the Regional Methodology assessment. The technical considerations were, however, integrated with the regional assessment findings for the study area in order to determine a **viable area for wind energy development**. The technical factors/criteria are discussed in further detail in Section 4.4 of this report.

4.4. Approach in Determining Areas Considered Acceptable for the Development of a Wind Energy Facility within the Identified Study Area (Following the Regional Methodology Proposed by DEA&DP)

4.4.1. Input Data Layers

The regional assessment has as its basis the following broad input components:

» Regional Methodology (detailed in Report 5 of the Provincial guideline document): based on composite layers (both criteria-based and subjective)
» Elements of a Criteria Based Assessment: including environmental, planning and infrastructure criteria.
» Elements of a Landscape Based Assessment: incorporating character analysis, sensitivity, value and capacity considerations.

Data layers were sourced for both the Criteria Based Assessment and the Landscape Character Assessment from existing information available for the study area. This was done in accordance with the data layers utilised for the study within the Provincial guideline document. The thresholds prescribed by this document were adhered to in most cases, unless otherwise specified - in which case the motivation/rationale for the deviation is stated.

The input components resulted in various layers of information that were merged using Geographical Information Systems (GIS) to form a combined dataset (based on a rating system related to criteria importance or landscape sensitivity)

which defined **preferred areas/zones for development** based on environmental and planning criteria.

4.4.2. Mapping the Input Layers

All the datasets were generated and mapped by MetroGIS. The resulting mapped data is provided in the figures that follow. It is important to note that an area labelled as Area 1 is indicated on each map. This area is an indicative area (approximately 37 km^2 in extent) considered to be favourable for the development of a Wind Energy Facility, and was demarcated by Eskom after the **preferred areas for development** were defined by the regional assessment, and the results considered against technical considerations. The delineation of Area 1 is, therefore, based on environmental and technical considerations and feasibility and included on the maps for reference and orientation purposes.

Criteria Based Assessment Data Layers

Environmental Criteria

» *Protected and Sensitive Areas (Map 1*)

The information contained in **Map 1** is focused on Environmental Criteria that would be negatively affected by the development of a Wind Energy Facility (i.e. negative constraints to wind energy development). These included protected and environmentally sensitive areas within the study area, namely: The Lutzville Provincial Nature Reserve, the proposed Knersvlakte Biosphere Reserve (core area (incorporating the Moedverloren Provincial Nature Reserve)), rivers, wetlands and bird habitats (Olifants River Estuary Important Bird Area no. SA099). All these categories were mapped as negative criteria for the development of a Wind Energy Facility and included a 2 km buffer zone. The buffers were used to define exclusionary zones around these protected and sensitive areas.

» *Topographical (Map 2)*

Map 2 illustrates topographical information (Environmental Criteria) that are negative constraints for the development of a Wind Energy Facility. This data includes elevation above sea level (where areas above the 150 m range were recorded as a negative), and slope, where slopes with a gradient steeper than 1:4 were not preferred/not considered as ideal locations for development. This layer has an important influence on landscape character types as, in addition to exclusionary buffers around or on ridgelines, mountains and hills, the analysis should seek to determine coastal and inland plains, as well as foothill landscape types which may have positive locational attributes for wind turbines. In addition to elevation, this map layer also utilised slope (greater than 1:4) to determine significant topographical features, and defined

ridgelines as a fundamental exclusionary layer due to visual impact concerns of wind turbines breaking skylines.

Planning Criteria

» *Urban and Industrial Areas (Map 3)*

No input layers pertaining to Planning: urban and industrial criteria were included for **Map 3** (as per the Provincial guideline document). The Growth Potential of Towns Report (DEA&DP, December 2005) makes reference to Vredendal within the study area. The predominant land uses in the study area (i.e. mining and agriculture) exclude major industrial areas that contributed as positive criteria in the Provincial study. This input layer was, therefore, omitted from this study, as it would not contribute to the outcome of the study. Other towns mentioned in the Growth Potential of Towns Report, such as Strandfontein, fall outside of the study area.

» *Coastal Areas (Map 4)*

Map 4 deals with Planning Criteria specifically aimed at managing and protecting the South African coastline as an important landscape feature. The Regional Methodology guideline acknowledges that coastlines are typically areas of high wind resource, but also usually of high environmental and aesthetic value. This guideline document states that "*in order not to arbitrarily exclude the entire coastline by means of a somewhat crude exclusionary buffer, it is proposed in the final recommended regional method that areas may be excluded from the coastal buffer due to lower scenic value*".

The West Coast coastline within the study area is of a rural nature. The majority of this stretch of the coastline has suffered severe disturbance and degradation through historic and current mining activities. These activities are typically confined to the coastal belt, and currently impact on the scenic value of the coastline to some extent. The coastline is also characterised by areas of greater 'scenic value', where striking natural features occur and/or the area has been less impacted by mining activities. It was therefore, not deemed appropriate to exclude the coastal area based on 'possible lower scenic value'. This assessment, therefore, made use of a combination of a 1 km and a 4 km buffer zone from the high water mark.

The 1 km buffer was utilised as this has a legal basis, and is consistent with the buffer distance provided for "rural areas" in the Integrated Coastal Management Bill. The 1 km buffer is indicated for the majority of the length of coastline within the study area (refer to Map 4), specifically where transformation of the coastline is evident. The area in the vicinity of the Olifants River mouth and estuary is indicated with a 4 km buffer to the coastline, consistent with the distance used for areas of 'undisturbed scenic

value' in the Provincial guideline. This 4 km buffer was used in order to preserve the potential/perceived aesthetic and tourism value seen for this area (this area is viewed as sensitive and of scenic potential).

The buffer areas indicated along the coastline demarcate 'negative' areas. It is acknowledged that the intention of DEA&DP is to limit large-scale development in close proximity to the coastline in order to minimise the potential for compromising the future potential for the coast. Eskom have acknowledged this through the technical siting exercise for the wind energy facility, where the coastal boundary of the development is proposed further inland than the 1 km buffer zone. This boundary has been demarcated at a 2 km distance inland in order to find a feasible compromise/solution between the environmental and technical (including topographic relief and wind resource potential) considerations.

Infrastructural Criteria

» *Airports and Security Sites (Map 5)*

Map 5 includes infrastructure criteria that would be negatively affected by the development of a Wind Energy Facility. A 2.5 km buffer around local airfields (those currently operational only) and a 2 km buffer from national/provincial roads was considered applicable for this study. Other infrastructure such as security sites and national key points (e.g. military bases) are not present within the study area.

Landscape Based Assessment

Infrastructural Criteria

» *Vertical and Disturbed Landscapes (Map 6)*

Positive criteria for the development of a Wind Energy Facility were identified in the form of vertically disturbed landscape corridors within the study area. As opposed to the negative map layer as discussed above, this is positive (inclusionary) map layer that recognises "vertical and disturbed" landscapes as a primary-level criteria for location of wind energy developments from a landscape perspective. The intention of inclusionary buffers is the location of wind energy developments as close as possible to landscapes that are already compromised by vertical structures such as powerlines.

The vertically disturbed landscape corridors within the study area included major transmission lines (5 km buffer for the Aurora-Juno-Helios transmission line and a 5 km buffer for the proposed Oranjemund-Juno transmission line (using the alignment as detailed within the EIA recently submitted for authorisation)) and railway lines (2 km buffer). These features are shown on **Map 6**.

Landscape and Cultural Criteria

» *Scenic Drives and Heritage Sites (Map 7)*

Map 7 in the Provincial guideline document refers to the delineation of heritage and cultural assets, as well as scenic drives and cultural routes, as negative criteria. Consultation with heritage specialists as well as SAHRA did not identify any specific cultural or heritage sites within the study area. Sites of historical value recorded on the SAHRA database are predominantly buildings within the town of Vanrhynsdorp. In addition, shell middens which are characteristic of the coastal areas typically fall within the 1 km coastal exclusion zone (Map 4). Other sites of heritage value would be identified during a site specific EIA.

Consultation with tourism specialists as well as the local municipality and tourism organisations in the area identified the Olifants River and estuary as an area of tourism importance. This area fell within the 2 km buffer zone for the River (Map 1), and the 4 km coastal exclusion zone for this area (Map 4). In addition, the N7 may (at certain times of the year, particularly the 'flower season') be considered to be a scenic route, specifically as it is a main route to the Namaqualand and Namibia. The N7 route is mapped with a 2km buffer on Map 5. Due to the overlap in mapping data, the criteria for **Map 7** were therefore not repeated as a separate layer.

» *Landscape Character and Visual Assessment (Map 8)*

The landscape-based assessment was completed according to the methodology as set out in *Report 3: Methodology 2* of the Provincial guideline document, and was aimed at defining landscape character types and their relative visual sensitivity and capacity to absorb wind energy facility development.

Map 8 shows the results of the Landscape Character and Visual Assessment as three categories of preferred areas for development, i.e. *Preferred Areas, Negotiable Areas* and *Restricted Areas*.

The results displayed on Map 8 are a composite of a criteria assessment of three input data categories, namely: vegetation/land cover, zone of visual influence (ZVI) and land form/topography. The input data categories were assessed in order to form positive or negative criteria that would aid in determining the landscape character and ultimately areas where development would be acceptable or areas where development would be unacceptable. Table 4.1 below broadly indicates the positive or negative criteria per input category.

Table 4.1: Positive or negative criteria per input category of the Landscape Character and Visual Assessment

Input Category	Positive Criteria	Negative Criteria
Vegetation/Land Cover (Source: NLC2000)	Areas largely transformed by agriculture, mining, etc.	Areas with predominantly natural vegetation
ZVI Viewshed Analysis	Areas largely hidden from main transport routes (national and provincial roads)	Areas that are highly exposed from major transport routes
Land Form/Topography	Large plains	Mountains and hills, coastal forelands and river valleys/estuaries

Map 8a indicates areas that have been permanently transformed, predominantly by agricultural and mining practises. Other areas that are indicated as '*Predominantly Natural'* include areas considered to be natural vegetation and/or land cover types with varying levels of disturbance (e.g. from grazing practices) that were not considered as severe as the transformed areas.

Map 8b is a composite of the results of two visibility analyses undertaken from vantage points along the N7 national road and the R-routes (provincial roads) within the study area. The resultant index identifies areas that are more frequently exposed to both the national and provincial roads (highly visible areas); areas exposed to either the national road or the provincial roads (visible areas) and areas that are not exposed to any of the major roads within the study area. It must be noted that the sphere of visual influence from the N7 was restricted to a 30 km distance search radius (i.e. what can be considered reasonable to be seen with the naked eye) in order to realistically model the Zone of Visual Influence.

Map 8c shows the major topographical units within the study area, identifying negative/sensitive units (river valleys, mountains, hills and coastal forelands) and open landscapes (positive units) in the form of large plains.

Map 8 shows the composite result of the Landscape Character and Visual Assessment as *Preferred Areas, Negotiable Areas* and *Restricted Areas* for development.

4.4.3. Composite Result - Preferred Areas for Development

The resultant composite of all the input criteria is illustrated in **Map 9**. This map indicates **preferred areas for development** within the study area as various combinations of positive and negative criteria. Table 4.2 indicates the possible

combinations (based on the Provincial guideline document) that resulted in the preferred areas for development index that is displayed in the map legend.

Table 4.2: Possible combinations that resulted in the preferred areas for development

No.	Description	Preference
1	Areas with more than 1 negative criteria	Highly restricted
2	Areas with one negative criteria	Restricted
3	Neutral areas (no positive or negative criteria)	Negotiable
4	Areas with one positive criteria (and no negative criteria)	Preferred
5	Areas with more than one positive criteria (and no negative criteria)	Highly preferred

The rating system utilised in this regional assessment took a more 'risk averse approach' than that put forward by the Provincial guideline. The rating system used assumed that a criteria rated as negative would always override a criteria rated as positive.

Definition of the terms used to define the level of preference are:

» ***Highly Preferred/Preferred:*** Low landscape value with a high to low capacity for change. Wind energy facility development may be possible, subject to site level assessment.
» ***Negotiable:*** Low to high landscape values, but with a high capacity to absorb change. Wind energy development in these areas may be possible, subject to site level assessment.
» ***Restricted/Highly Restricted:*** High value landscapes combined with low capacity of landscape to adapt to change. These areas should be restricted from wind energy facility development.

Map 9 indicates that the vast majority of the area within a band approximately 10 km wide (inland from the coastline) between the Olifants and Klein Goerap Rivers is defined as preferred and/or negotiable for development. That is, from a potential to develop perspective, this area is relatively uniform. Large areas to the north of the Klein Goerap River are defined as preferred and/or highly preferred for development. This preferred rating for this area is primarily due to the proposed Oranjemund-Juno transmission line cutting through this area, which is classified as a vertically disturbed landscape.

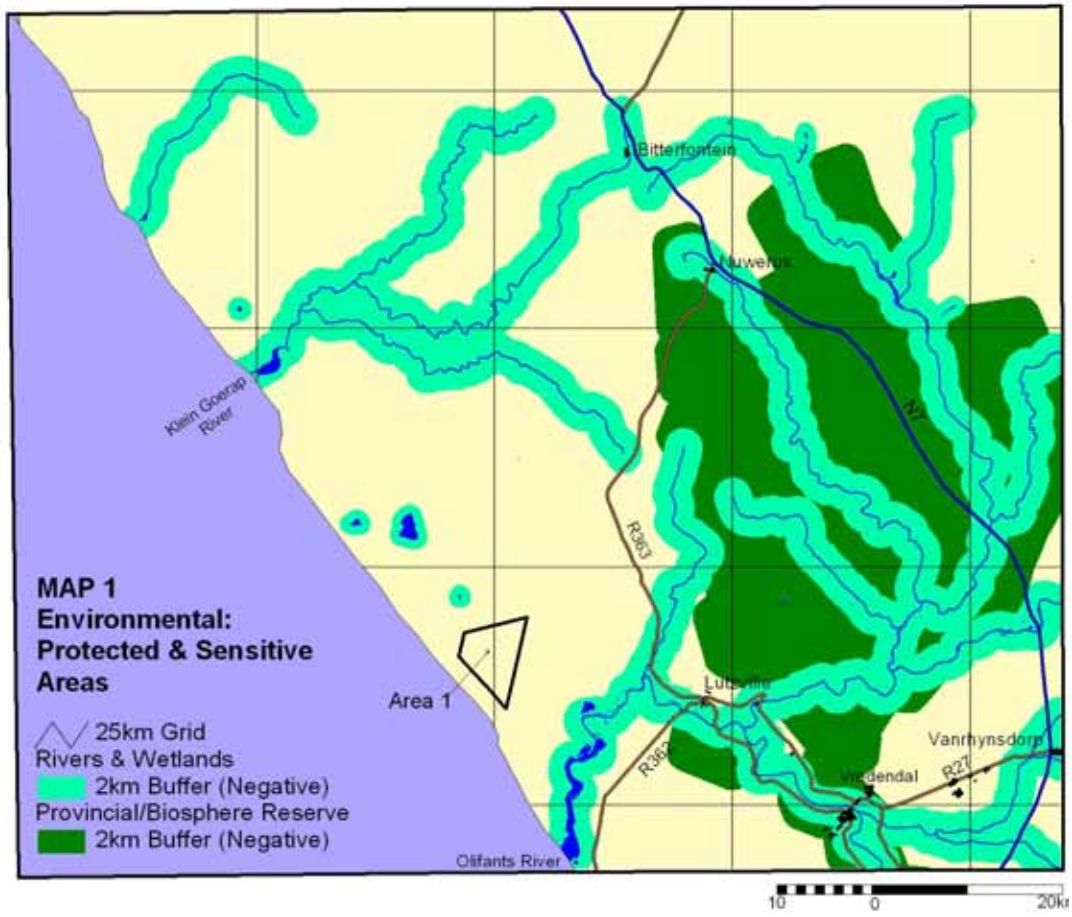
Map 9 also shows Eskom's most favourable potential area (indicated as Area 1) for development of a Wind Energy Facility. The area has been identified by Eskom in line with the outcomes of the regional assessment, combined with technical considerations and feasibility (refer to section 4.4). The proposed methodology, as set out by the Provincial guideline document allows for the

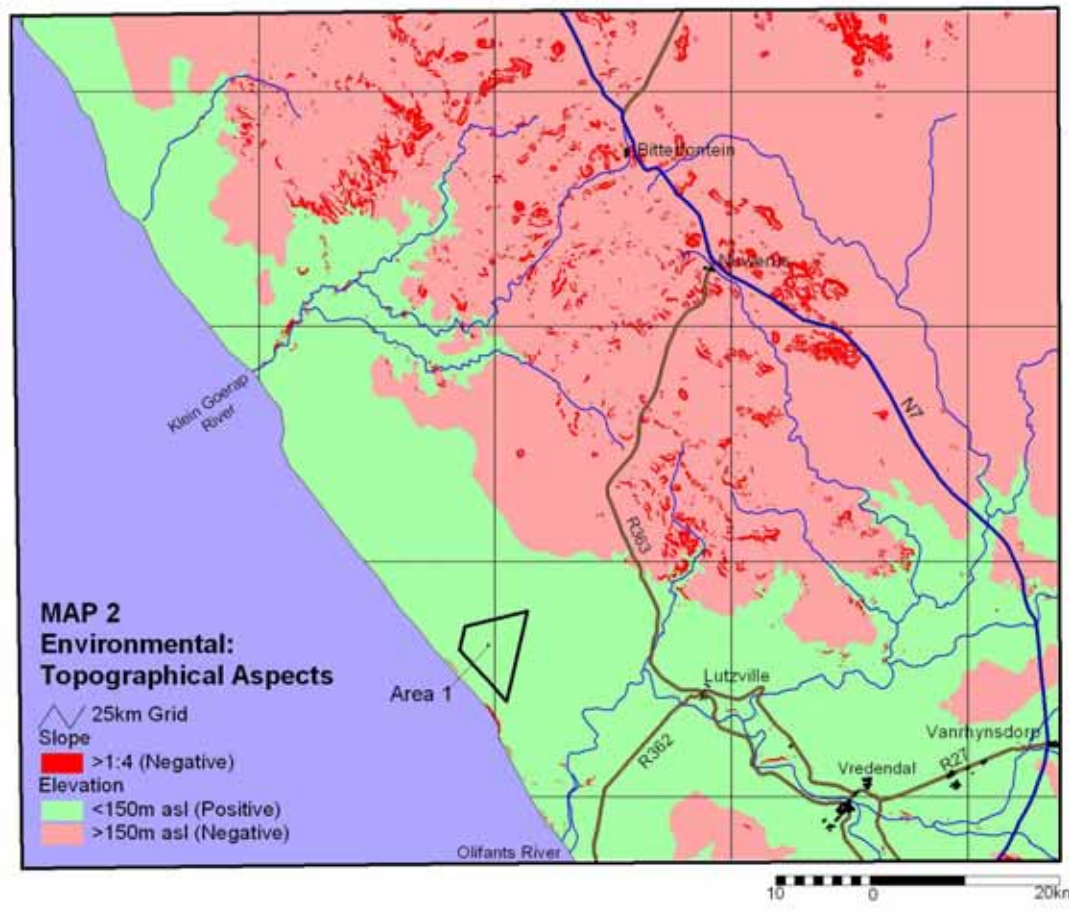
consideration of technical and/or criteria, when available and relevant, particularly wind resource data. The area as indicated (approximately 37 km^2 in extent) is an **indicative area** for potential development of the Eskom facility.

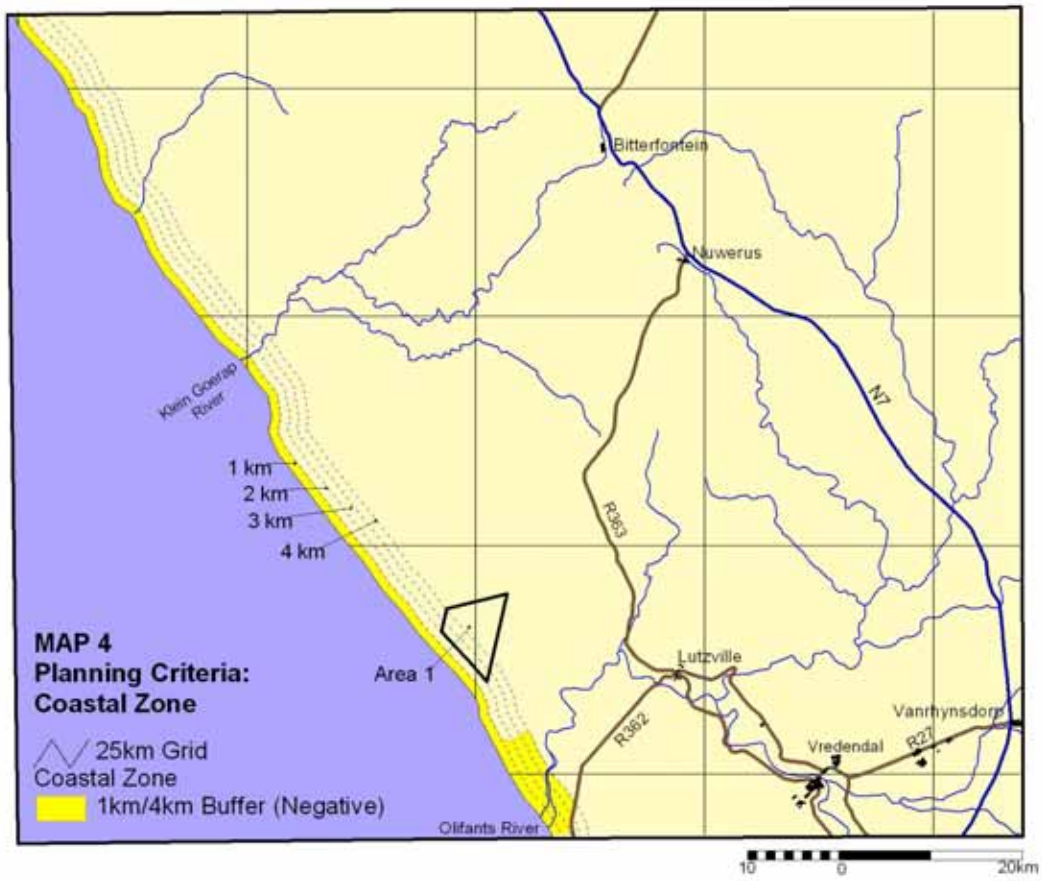
Based on Eskom's knowledge of the wind resource of the study area, the terrain (lie of the land), as well as other technical considerations, Area 1 is nominated as a feasible area for the development of a Wind Energy Facility within this broader study area. Other areas indicated to be preferred and/or negotiable areas for development from the regional assessment results could potentially be considered for future facilities (taking cumulative impacts and prescribed distances into account).

In order to address the real potential for future additional wind energy facilities within this study area, a Wind Energy Plan demarcating other viable areas would be required to be generated, taking the potential for cumulative impacts as considered within the Provincial guideline into account.

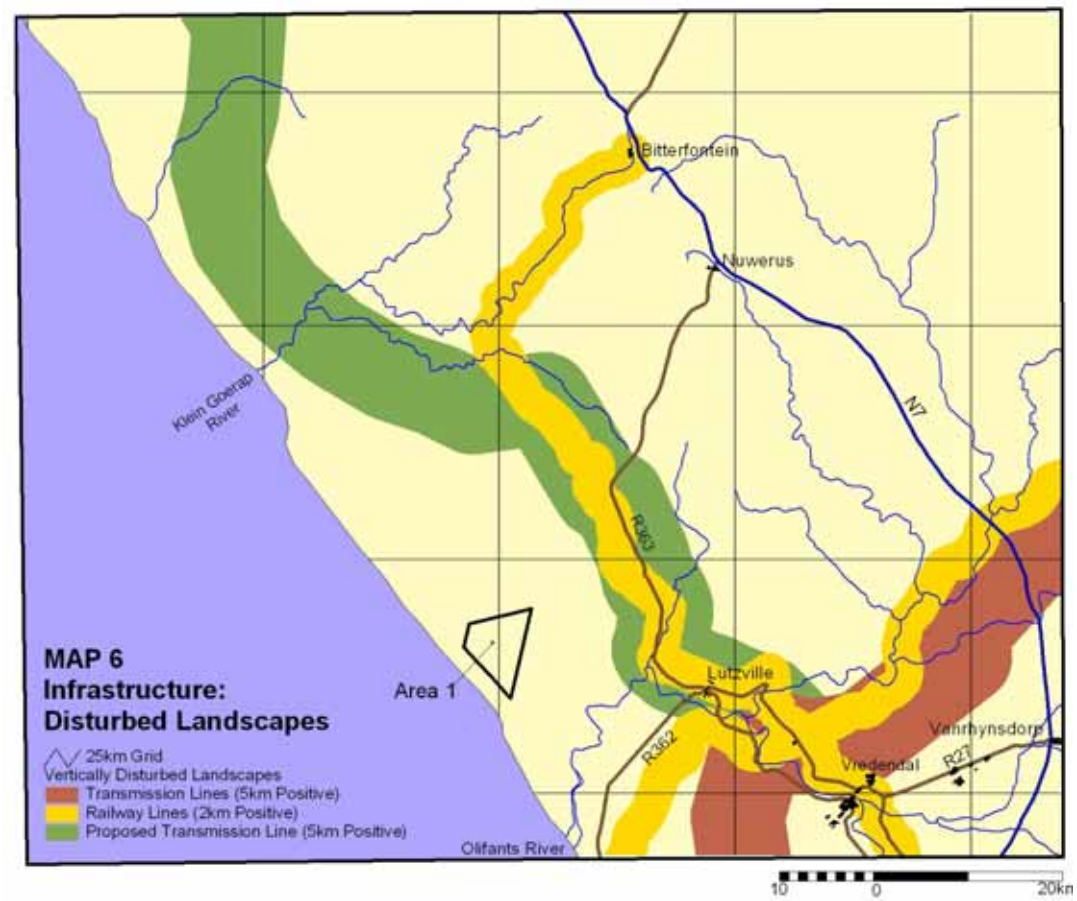
The following pages illustrate the various map layers (Maps 1 to 9) as applied to the study area.

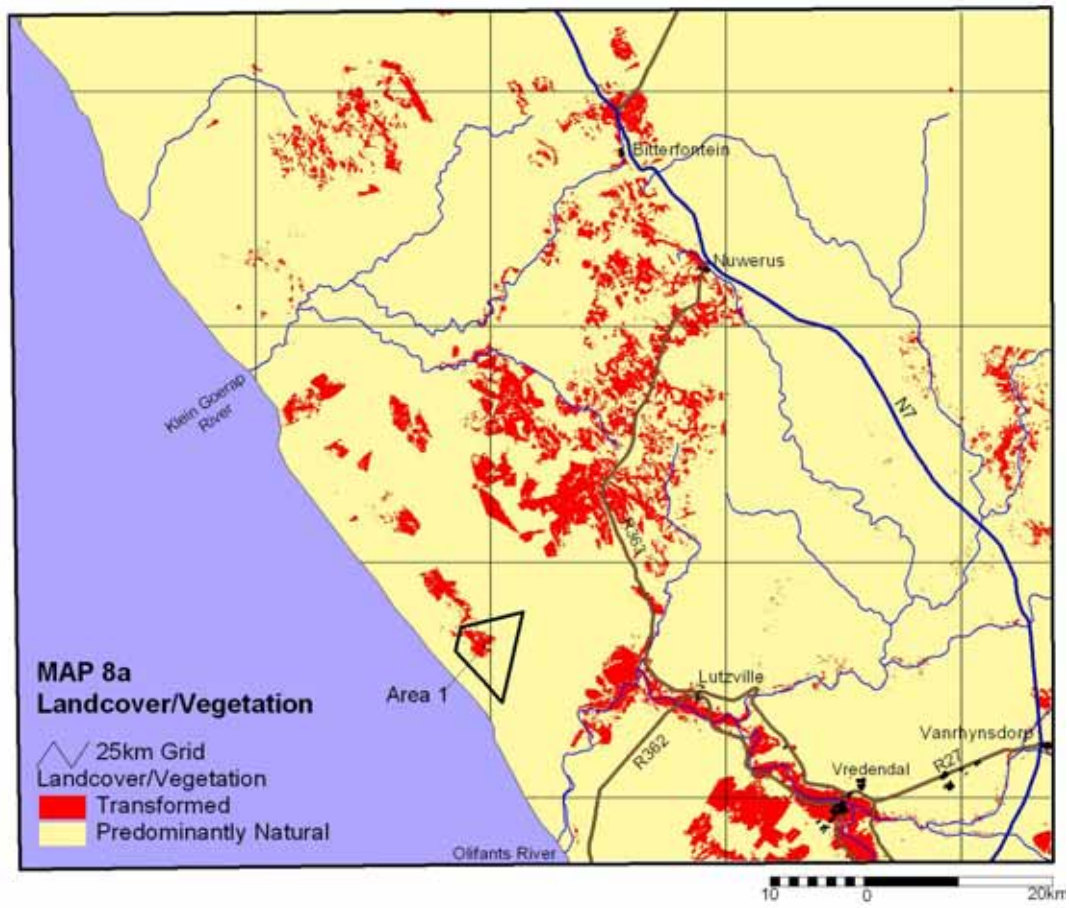

Bitterfontein
Nuwerus
Klein Goerap River
N7
R363
Lutzville
R362
Vanrhynsdorp
Vredendal
R27
Olifants River
MAP 1
Environmental:
Protected & Sensitive
Areas
Area 1
25km Grid
Rivers & Wetlands
2km Buffer (Negative)
Provincial/Biosphere Reserve
2km Buffer (Negative)
10 0 20km

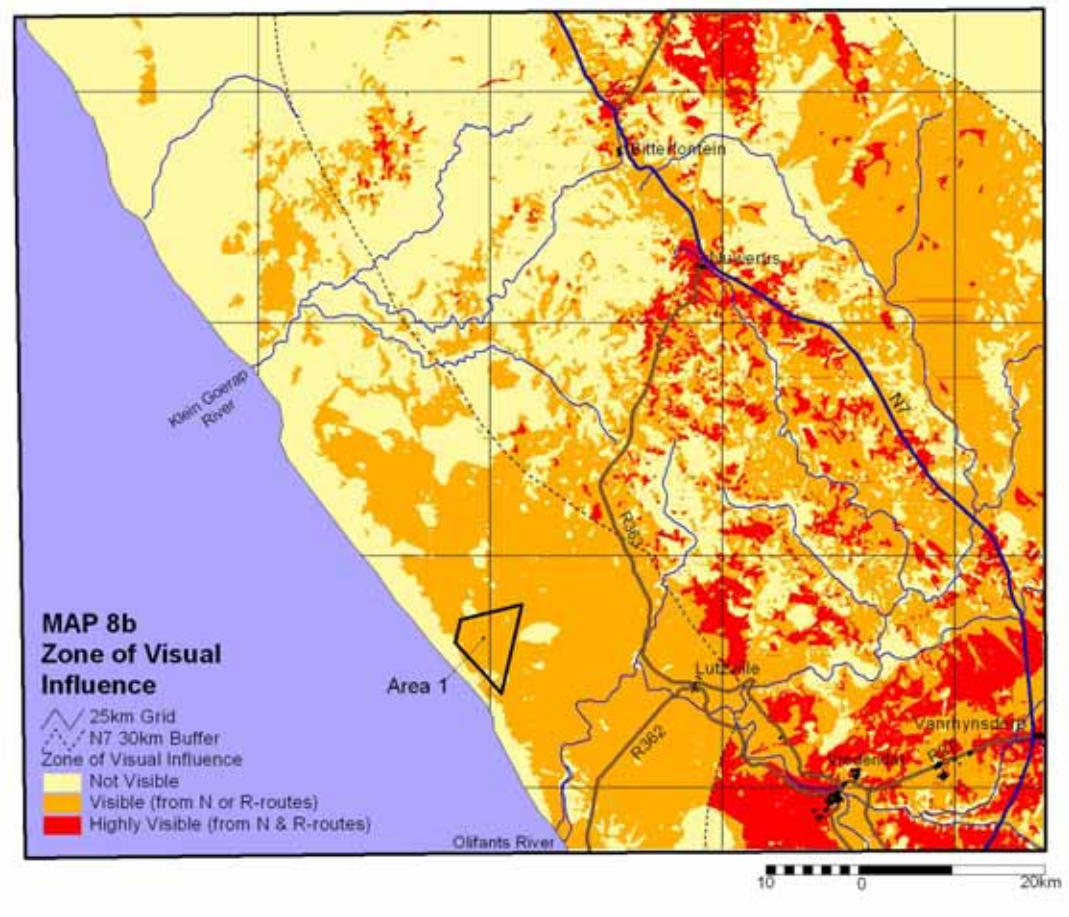

Bitterfontein
Klein Goerap River
N7
R363
Lutzville
R362
Vanrhynsdorp
Vredendal
R27
Olifants River
MAP 2
Environmental:
Topographical Aspects
Area 1
25km Grid
Slope
>1:4 (Negative)
Elevation
<150m asl (Positive)
>150m asl (Negative)
10 0 20km

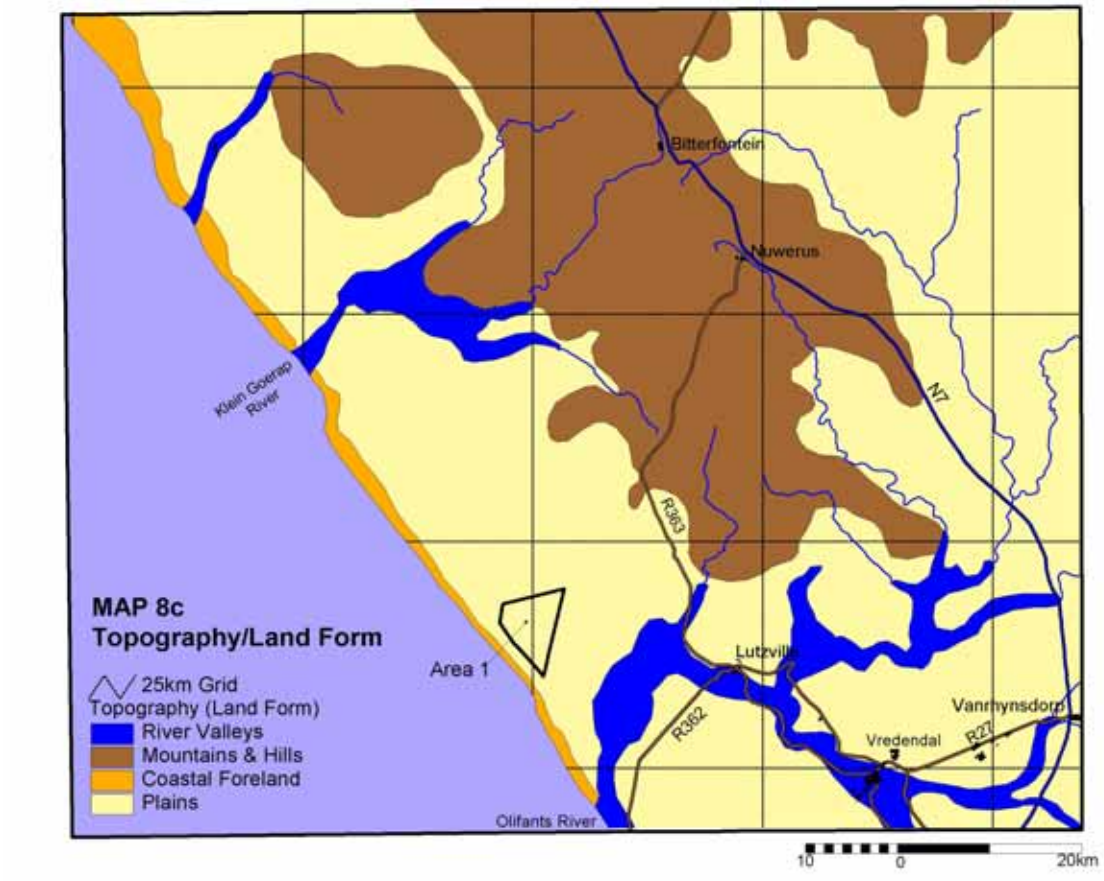

Bitterfontein
Nuwerus
Klein Goerap River
1 km
2 km
3 km
4 km
N7
R363
Lutzville
R362
Vanrhynsdorp
Vredendal
R27
Olifants River
MAP 4
Planning Criteria:
Coastal Zone
Area 1
25km Grid
Coastal Zone
1km/4km Buffer (Negative)
10
0
20km

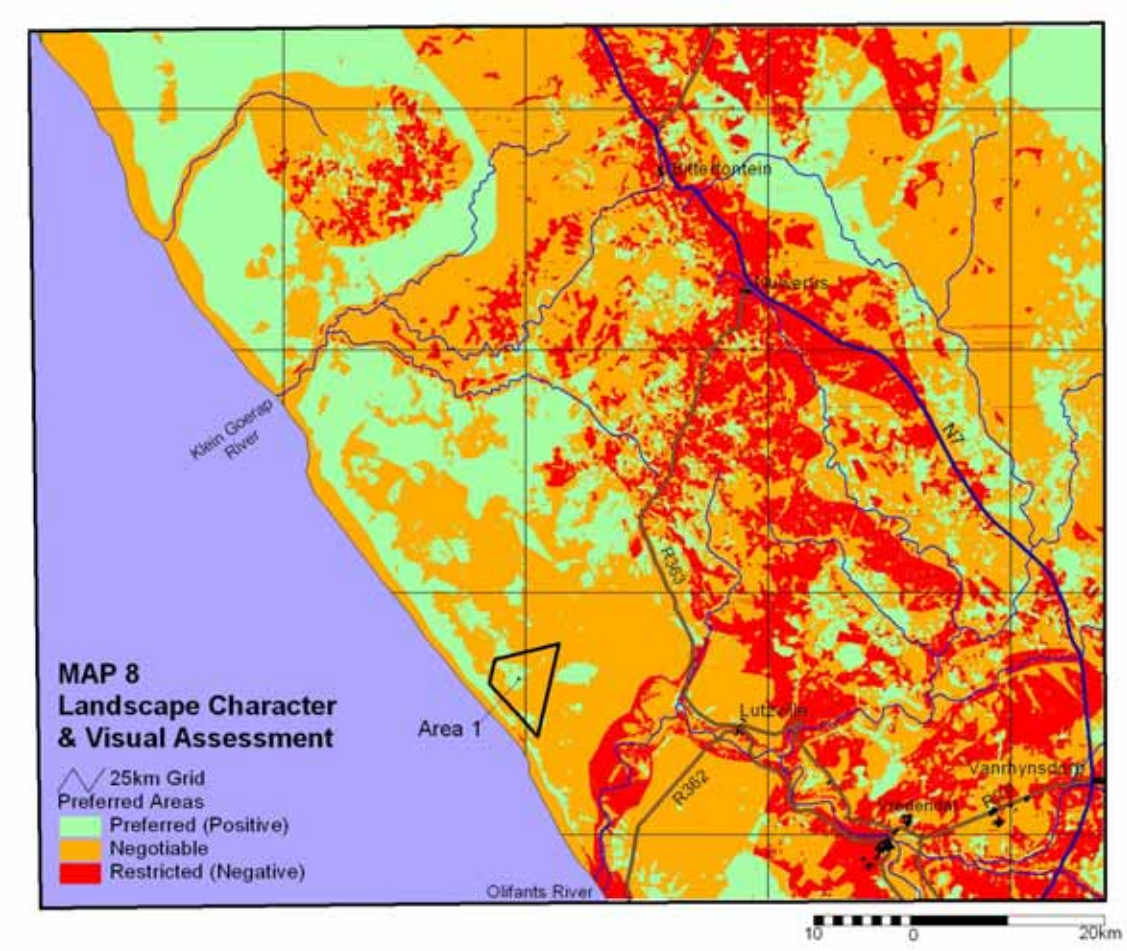

Bitterfontein
Nuwerus
Klein Goerap River
N7
R363
Lutzville
R362
Vanrhynsdorp
Vredendal
R27
Olifants River
MAP 5
Infrastructure:
Airfields & National
Roads
Area 1
25km Grid
Infrastructure
National Road (2km Negative)
Local Airfield (2.5km Negative)
10
0
20km

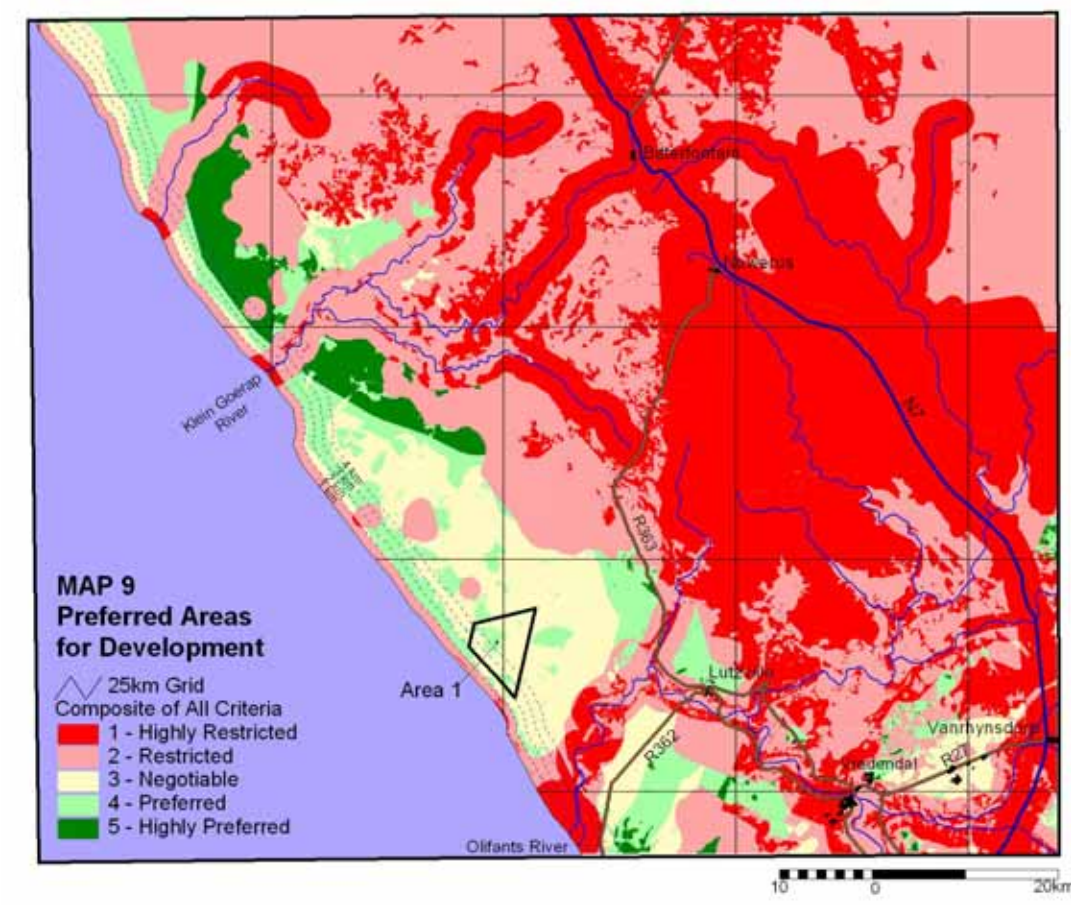

Bitterfontein
Nuwerus
Klein Goerap River
N7
R363
Lutzville
R362
Vanrhynsdorp
Vredendal
R27
Olifants River
MAP 6
Infrastructure:
Disturbed Landscapes
Area 1
25km Grid
Vertically Disturbed Landscapes
Transmission Lines (5km Positive)
Railway Lines (2km Positive)
Proposed Transmission Line (5km Positive)
10 0 20km


Bitterfontein
Nuwerus
Klein Goerap River
N7
R363
Lutzville
R362
Vanrhynsdorp
Vredendal
R27
Olifants River
MAP 8a
Landcover/Vegetation
Area 1
25km Grid
Landcover/Vegetation
Transformed
Predominantly Natural
10 0 20km


MAP 8b
Zone of Visual Influence
Area 1
25km Grid
N7 30km Buffer
Zone of Visual Influence
Not Visible
Visible (from N or R-routes)
Highly Visible (from N & R-routes)
Klein Goerap River
Olifants River
N7
R363
R362
10 0 20km


MAP 8c
Topography/Land Form
Area 1
25km Grid
Topography (Land Form)
River Valleys
Mountains & Hills
Coastal Foreland
Plains
Bitterfontein
Nuwerus
Klein Goerap River
Olifants River
N7
R363
R362
Vredendal
Vanrhynsdorp
10 0 20km


MAP 8
Landscape Character
& Visual Assessment
25km Grid
Preferred Areas
Preferred (Positive)
Negotiable
Restricted (Negative)
Area 1
Klein Goerap River
Olifants River
N7
R363
R362
R27
Vanrhynsdorp
10
0
20km


MAP 9
Preferred Areas
for Development
25km Grid
Composite of All Criteria
1 - Highly Restricted
2 - Restricted
3 - Negotiable
4 - Preferred
5 - Highly Preferred
Area 1
Klein Goerap River
Olifants River
N7
R363
R362
R27
Vanrhynsdorp
10
0
20km

4.5. Discussion of Technical Factors Affecting the Placement of a Wind Energy Facility

The placement of a Wind Energy Facility is highly dependant on technical factors – that is the available wind resource and the terrain. The technical considerations must, therefore, be weighed against other considerations (including environmental considerations) in the determination of a feasible site for the establishment of a viable Wind Energy Facility.

Figure 4.2 provides an indication of the proposed Area 1 with specified off-set distances from the coastline at 1 km, 2 km, 3 km and 4 km. Area 1 is indicative of an area considered to be environmentally suitable (i.e. preferred and/or negotiable in line with the results from the regional methodology followed), as well as technically suitable (in terms of available wind resource as well as the terrain of the site and surrounds). Area 1 is approximately 37.6 km^2 in extent, and has been demarcated using topographic features and property boundaries. The area is an area of flat terrain, which straddles two sizable fossilised coastal dune formations (these formations are characteristic of this coastline). The wind resources for the site are measured and known. The site has limited effect from elevated relief (albeit low-lying topographical features). The coastal boundary is offset 2 km from the coastline. The technical feasibility of siting a wind energy facility within Area 1 is further considered within this section.

Figure 4.2: Indication of proposed Area 1 (demarcated by a yellow line)

4.5.1. Wind Resource Data and its Relevance to Wind Energy Facilities

The wind speed measured at a meteorological station is determined mainly by two factors:

» the overall weather systems, which usually have an extent of several hundred kilometres, and
» the nearby topography, extending to a few tens of kilometres from the station.

The importance of these factors is discussed in further detail in Chapter 3.

Strictly speaking, the direct use of measured wind speed data for wind resource calculations results in power estimates that are representative only for the actual position and height of the wind-measuring instruments. The application of measured wind speed statistics to wind energy resource calculations in a region therefore requires methods for the transformation of wind speed statistics. Great effort at an international level has gone into the development of simulation tools to estimate resource and terrain dependency, resulting in a comprehensive set of models for the horizontal and vertical extrapolation of meteorological data and the estimation of wind resources. The models are based on the physical principles of flows in the atmospheric boundary layer and they take into account the effect of different surface conditions, shading/sheltering effects due to hills or elevated topography, terrain roughness and relief, vegetation and other obstacles, as well as the modification of the wind imposed by the specific variations of the height of ground around the meteorological station in question. Specialised software (WA_sP - developed by Risø in Denmark), is used by Eskom in the analysis of wind and terrain data on the west coast.

4.5.2. The Terrain and its Relevance to Wind Energy Facilities

The terrain on the west coast can be described as land with an open appearance of roughness length 0,05 m, as defined by the following:

» Terrain class I, i.e. water areas, open farmland, etc.
» Nearby sheltering obstacles such as cliff faces, dunes and valleys.
» Terrain height variations (topography), the most important factor in the study area.

The effect of height variation/relief in the terrain is seen as a speeding-up/slowing-down of the wind due to the topography. These effects of terrain height variations on the wind profile can most clearly be demonstrated by the well-known results from the international field experiments at the Askervein Hill on the Isle of South Uist in the Hebrides (Taylor and Teunissen, 1987; Salmon et al, 1987). Figure 4.3 shows a perspective plot of the Askervein Hill. The line

along which measurements of wind speed and direction were recorded is indicated by the meteorological towers in Figure 4.3.

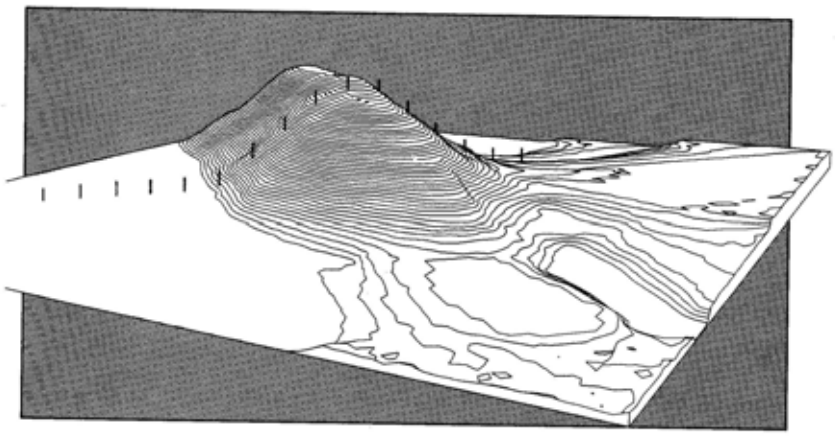


Figure 4.3: Perspective plot of the Askervein Hill

The experimental data recorded is illustrated in Figure 4.4 with the relative speed-up/slow-down (ΔS) at 10 m above ground level plotted against the distance from the crest. The relative speed variation ΔS is defined as:

$$\Delta S = \frac{u_2 - u_1}{u_1} \qquad (1)$$

where u_2 and u_1 are the wind speeds at the same height above ground level at the top of the hill and over the terrain upstream of the hill, respectively.

From the results the following can clearly be seen:

» The speed-up at the crest is 80% as compared with the undisturbed upstream mean wind speed.
» The negative speed-up (slow-down) in the front and lee of the elevated ground/hill is 20% to 40% as compared with the undisturbed upstream mean wind speed.

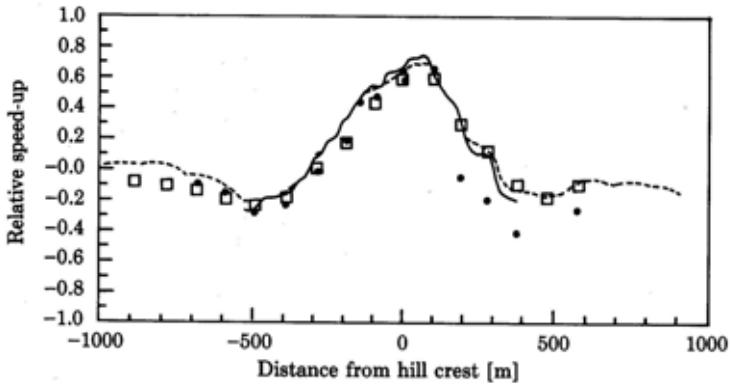


Figure 4.4: Relative speed-up ratios for flow over the Askervein hill at 10m above ground level. Measurements are indicated by dots and results from the orographic model by squares

If R is defined R as the characteristic radius of the elevated ground/hill, typically at the half-width diameter with h the height an approximate expression for ΔS can be found in Jensen *et al*. (1984):

$$\Delta S = 2\frac{h}{R} \qquad (2)$$

It is evident from the above example that elevated ground/hills exert a profound influence on the flow of air, and this has to be taken into account in the placement of turbines. It is often difficult (and impossible in complicated terrain) to apply simple formulas such as Equation 2. For this reason, it is necessary to determine the wind resource at specific locations and then in most cases to use a numerical fluid dynamic model for the calculations as found typically in WA_sP.

Actual wind measurements gathered and simulations utilising the industry standard software WA_sP were undertaken for possible wind farms placed at different distances from the coast on Area 1. Figure 4.5 provides a screen plot of the WA_sP output for turbines spaced equidistant perpendicular to the coast on the flatter terrain between the two dunes of Skaapvlei and Graafwaterskop. The plot in Figure 5 clearly indicates the slow-down effect as the turbines are placed inland away from the coastline. The further away from the coast the stronger the slow-down effect due to the land topography increasing in height above mean sea level towards Koekenaap and Vredendal.

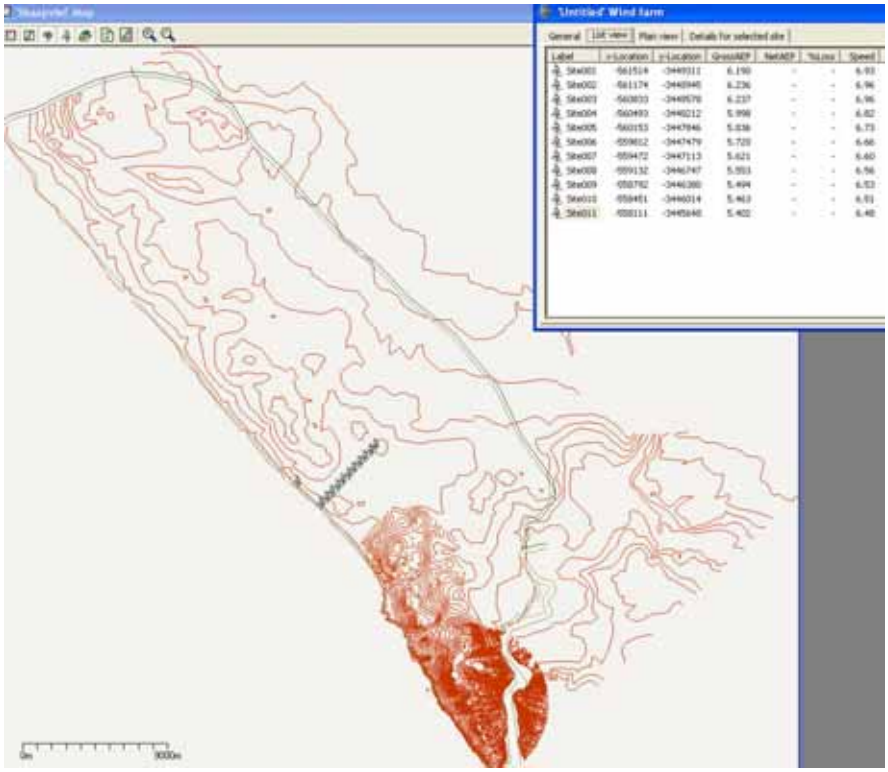


Figure 4.5: WA_sP output for Area 1

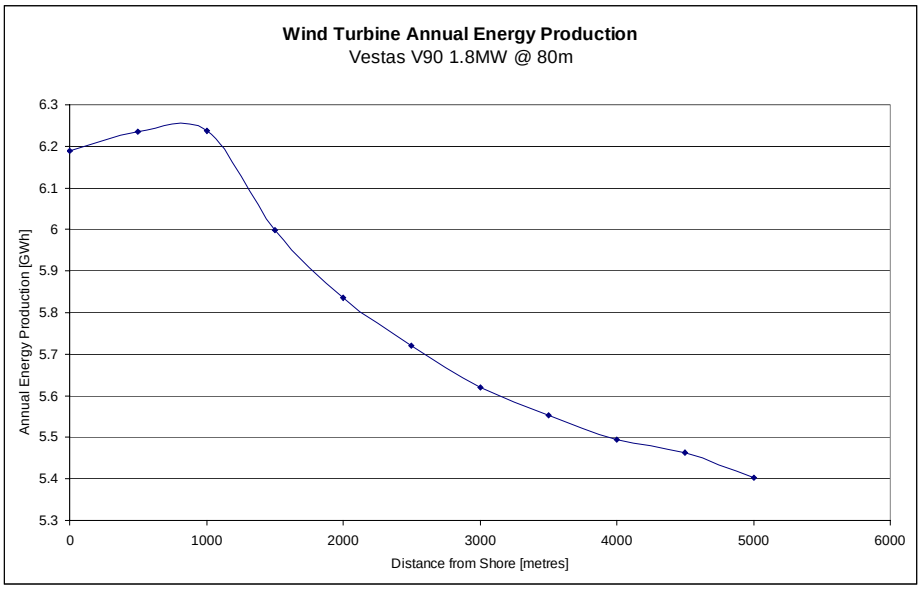


Figure 4.6: Slow-down and reduction in anticipated annual production for a 2 MW mainstream wind turbine on Area 1

Indicated in Figure 4.6 are actual calculated production values based on a mainstream industry standard turbine. The plot shows a reduction in production of approximately 15% between a turbine placed at 1 km and one at 5 km. The ideal location (peak in production) of wind turbines would be at a distance of between 1 km and 2 km away from the coastline.

4.5.3. Consideration of Technical Factors

Area 1 as indicated in Figure 4.2 is, in terms of the results of the Regional Assessment, a preferred area for development. The placement of a wind energy facility in Area 1 must, however, consider the following technical factors:

» Predominant wind direction (SSE in this case)
» Distance from coast (1 km to 5 km with associated loss in production – anything more is unrealistic)
» Obstruction obscuring the wind farm in the topography (dunes etc causing shading effects and turbulence of air flow)
» Land - size and availability for layout
» Effect of adjacent turbines – minimum spacing (due to wake turbulence)
» Practicality of layout (underground electrical infrastructure length and interlinking roads)

The ***optimal*** placing of a wind energy facility with the highest production yield on this site would be along a 1 km line inland from the coast (confirmed by the maximum in production in the plot in Figure 4.6 above). The optimal layout would optimise the exposure of all turbines to the prevailing winds, which are mainly from a SSW direction. The layout would be a single row of turbines (evenly spaced) following the natural coastline at a distance of about 1 km to 2 km.

In reality this layout would be ***impractical*** due to the long length of such a layout and would rather be optimised by locating the turbines closer together (3 to 5 rows), but still making maximum use of the minimum distance to coast that yields maximum production.

A ***practical*** layout could begin with the first row of turbines 2km inland from the coastline to optimise the wind resource, while still exercising sensitivity regarding proximity to the west coast coastline. The next row would be slightly offset further inland roughly separated 500 m to 800 m (refer to Figure 4.7). Figure 4.7 illustrates an east-west optimised layout to a) maximise the utilisation of the prevailing SSW winds and coastline effect and b) not avoid individual turbine turbulence effecting one other as far as possible (i.e. staggered or offset layout).

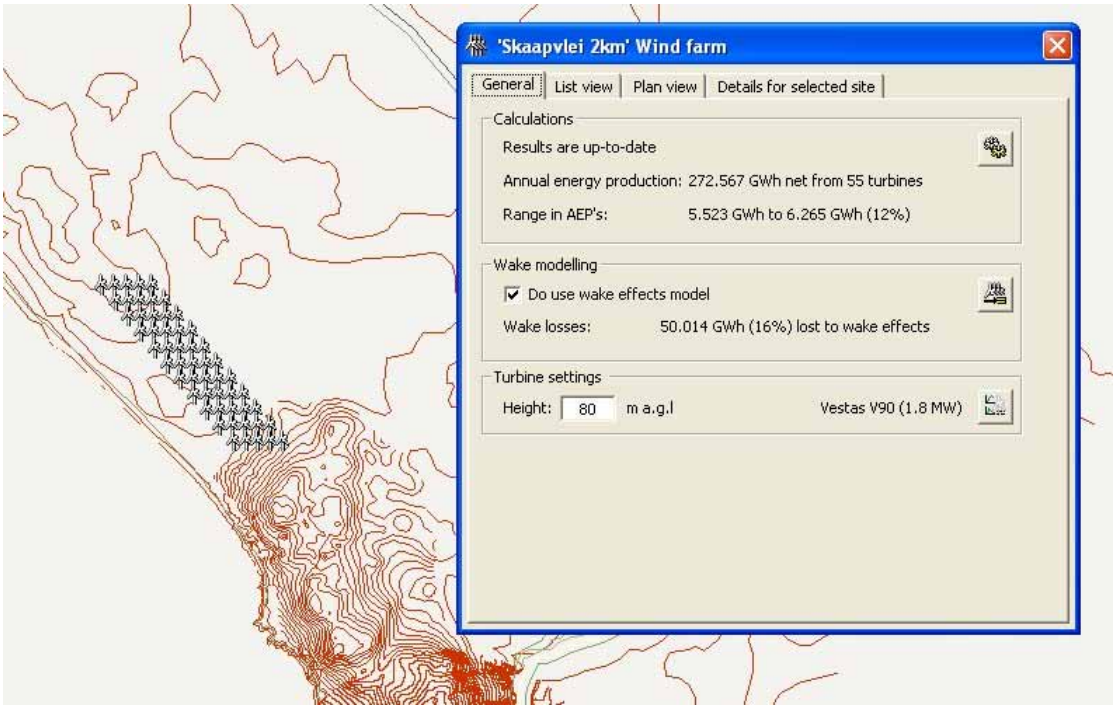


Figure 4.7: Real practical layout starting at a distance of 2km inland from the coastline

The total production expected from this layout offset 2 km from the coastline is 273 GWh annually.

Further studies were undertaken to determine how such wind energy facilities located at varying distances from the coast would perform. Table 4.3 provides an indication of annual production (and in turn, loss in production against annual production for a facility located 1 km from the coastline) compared to distance from coastline for a 100 MW facility.

Table 4.3: 100MW Wind Turbine Production

	1km Distance	2km Distance	3km Distance	4km Distance
Annual Production	282 GWh	273 GWh	258 GWh	250 GWh
Loss in Annual Production		-9 GWh	-24 GWh	-32 GWh

The efficiency of a wind energy facility placed further inland is affected by both the wind effects resulting from distance from the coastline as well as change in relief and terrain (and the shadowing effect from the Graafwaterskop dune in the south (in line with the prevailing wind direction). Figure 4.8 provides a real practical layout beginning at a distance of 4 km inland from the coastline.

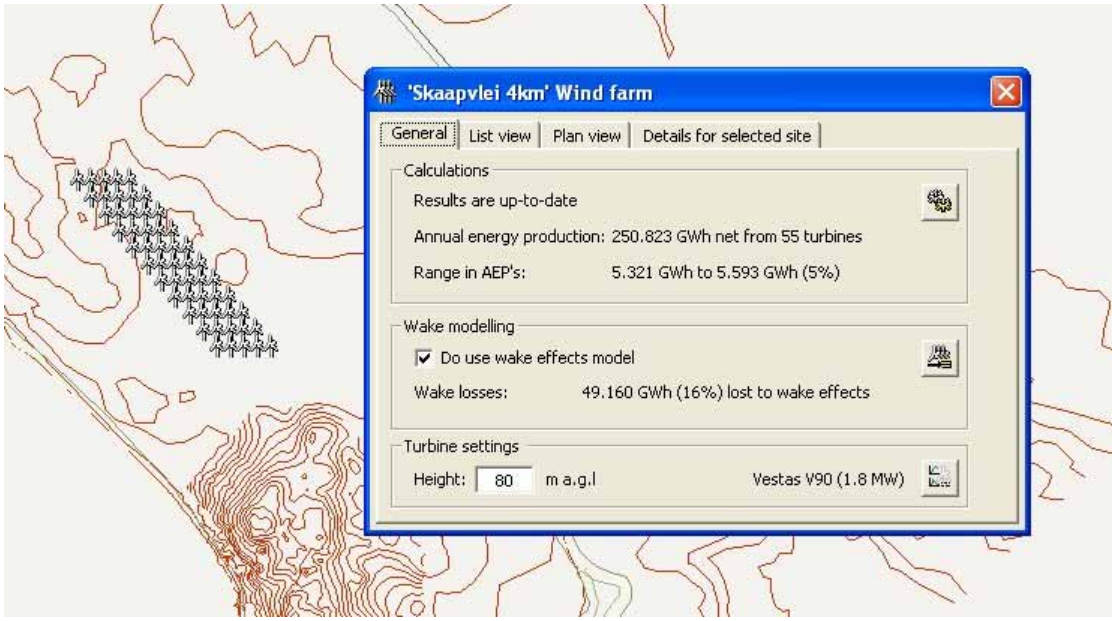


Figure 4.8: Real practical layout starting at a distance of 4 km inland from the coastline

The total production expected from this layout offset 4 km from the coastline is 250 GWh annually.

The production difference is 23 GWh annually (i.e. from the table above, the difference between 32 and 9 GWh) between the placement of a facility starting at 2 km and at 4 km inland from the coastline. With a 2 MW class mainstream turbine typically generating 5 GWh[4] annually under west coast wind resource conditions, the difference in production is equivalent to an additional five (5) turbines required to equal production. This requires additional land-take, and contributes to the cumulative environmental impacts. A modern 2 MW class mainstream turbine costs R20 Million installed (which equates to R100 Million for five turbines, or 10% of the projected project cost of a 100 MW facility).

The commercial viability of a wind energy facility is already put at risk by the variability in wind resource at any given location, as well as the high capital cost of generating equipment. Placement of the facility at a location outside that of the most optimal production would further hamper the roll-out of renewable technology facilities in South Africa by Eskom and/or other parties.

[4] This value refers to the generated capacity of electricity during a single year. This means of the 8 760 hours in a year, the turbine will operate for only 26% of the year. The turbine therefore will only operate 2 277 hours in a year. For a nominal 2MW turbine, over the 2 277 hours, the plant will generate 4 555MWh of electricity. This translates into 4.55GWh which rounded up = 5GWh.

4.6. Feasible Alternative for Consideration within the EIA Process

The outcomes of the regional assessment and technical considerations have resulted in the identification of an area (referred to as Area 1 on Figure 4.9) on the West Coast which is considered suitable for the development of a Wind Energy Facility. This area has been determined from the regional assessment which considered planning and environmental criteria (area indicated to consist of preferred and negotiable areas for development), as well as a technical assessment and feasibility (considering the wind resource and terrain).

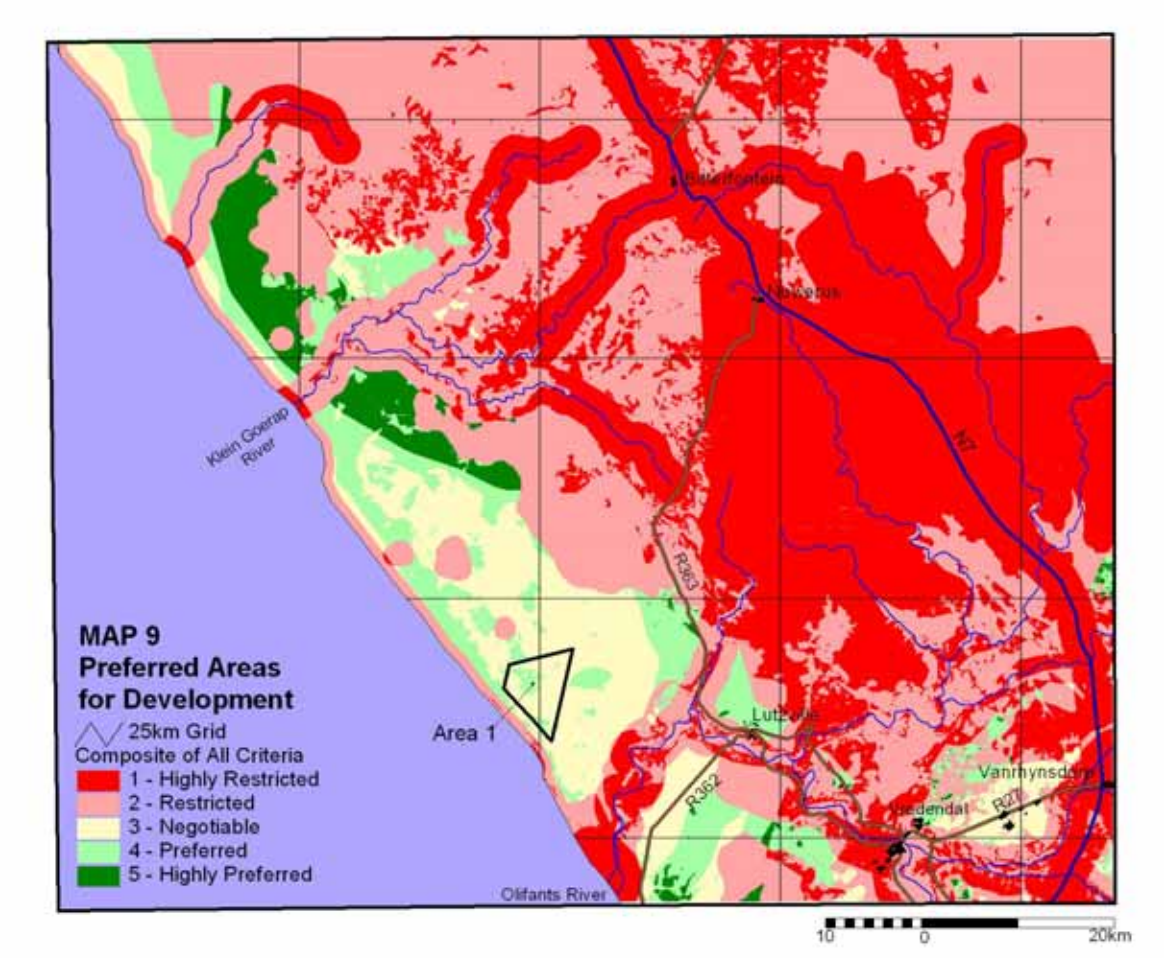


Figure 4.9: Map from the Regional Assessment which indicates preferred areas for development

Figure 4.9 indicates that a relatively uniform 'band' of up to 20 km inland from the coastline is considered to be highly preferred/preferred and/or negotiable for development. Restricted and highly restricted areas within this 'band' are primarily associated with perennial and/or non-perennial water features such as rivers and pans.

Larger discrete areas indicated as being preferred and/or highly preferred were initially considered as potential areas for the development of a wind energy facility:

» The area to the south of the Olifants River (indicated as a preferred area due to the presence of the railway line, which presents a vertically disturbed landscape in this area) was not considered feasible due to the proximity to the Olifants River as well as the towns of Papendorp, Ebenhaeser and Strandfontein.
» The area to the immediate north and south of the Klein Goerap River (indicated as a preferred area due to the proposed Transmission line (awaiting authorisation by DEAT), which presents a vertically disturbed landscape in this area) was not considered feasible due to the proximity to the Klein Goerap River, land availability, poor access, as well as the distance from the existing Transmission grid (i.e. point of connection for the transmission of the power generated by the wind energy facility). The construction of a powerline to connect to the grid will also have an impact on the environment.
» A central area between the Olifants and Klein Goerap Rivers indicated as preferred and/or negotiable areas was considered feasible, but requires the site to fall outside of the areas demarcated as restricted areas for development.

As discussed in sections 4.5.1 and 4.5.2, the wind resource and terrain was also considered in determining the preferred area. Area 1 as reflected in Figure 4.9 is a flat area straddled by raised dune topography, which ensure minimum disturbance to the wind resource. Area 1 is therefore considered an optimal area for the development of a wind energy facility in this study area based on planning and environmental criteria (area indicated to consist of preferred and negotiable areas for development), as well as a technical assessment and feasibility (considering the wind resource and terrain).

Consistent with the methodology for siting wind energy facilities in the Western Cape, Eskom seek to undertake a site-level environmental impact assessment for the demarcated/selected area (referred to as Area 1). This demarcated area is an indicative area (approximately 37 km^2 in extent) considered to be favourable/most viable for the development of a large-scale Wind Energy Facility. The identification of this site is supported by the following:

» The area is demarcated as “preferred” and/or “negotiable” from an environmental and planning perspective.
» The area is designated by Eskom as a preferred area for this facility from a technical feasibility perspective (and have provided motivation from the technical and commercial perspectives, along with a **practical and viable** layout with the first row of turbines 2 km inland from the coastline).

A report detailing the outcomes of the regional assessment and technical considerations was submitted to DEAT and DEA&DP in June 2007 for their review and comment, as agreed with the competent authority. As indicated in a letter received from DEAT in this regard (refer Appendix C), the DEAT accepts the process followed, and has advised that results of this study are considered to be acceptable. It was requested that a Scoping Report and Plan of Study for EIA be submitted to DEAT for consideration further to the investigation of the site in terms of the EIA Regulations. In addition, the following issues were raised by DEAT and DEA&DP for consideration:

Issue	Response / way forward
The purpose of the cumulative criteria in the regional methodology was to select sites that would optimise other potential favourable sites (i.e. to ensure that by selecting a specific site/area, other favourable sites/areas are not eliminated due to their proximity to the first site). (DEA&DP)	The intention of the site identification process was to select a site on the basis of the best match of environment, planning and technical considerations. This site is considered to be the most favourable site for the development of a wind energy facility (considering technical criteria strongly) in an approximate 30 km radius.
DEAT and DEADP require the following issues to be further investigated in the Scoping/EIA phases: » Alternatives with regards to design, the layout of the activity, the technology to be used and operational aspects of the activity.	The alternatives are raised within Chapter 7 and will be further investigated in the EIA Phase when additional information is available to inform the assessment.
DEAT and DEADP require the following issues to be further investigated in the Scoping/EIA phases: » According to the Coastal Zone Policy, the proposed site would potentially impact on two wetlands. This aspect should be further investigated and incorporated into the layout of the wind facility	Areas classified as wetlands have been identified through the specialist scoping studies (refer Appendix K, L, M and O). This aspect will be investigated in further detail in the EIA Phase (refer Chapter 8, 9 and 10).

Issue	Response / way forward
The coastline is utilised for camping and recreational purposes. This particular coastline has been impacted by mining activities, but certain areas must still be regarded as 'more valuable' based on its aesthetic value. Increase buffers around these areas will be more appropriate. Specific reference is made to Brand-se-Baai, Gert-du-Toit Baai and Papendorp and that any visual impact on these areas must be avoided as they represent areas of aesthetic, ecological and tourism value. (DEA&DP)	Areas considered to be sensitive receptors from a social, tourism, noise or visual perspective have been identified through the specialist scoping studies (refer Appendix S, U, R and W) and the public participation process. Areas used by the public for recreation and tourism will be identified and given due consideration (refer Chapter 8, 9 and 10). This aspect will be investigated in further detail in the EIA Phase.
Consider the gravel road from De Punt to Brand-se-Baai as part of the visibility analysis, as this is used by the public to access all the coastal areas (including recreational and camping sites). This will add a much more accurate assessment of the visual sensitivity of the immediate coastal areas. (DEA&DP)	
It is not clear whether the additional required infrastructure (especially if linear) was taken into consideration with the assessment of potential sites (as a technical criterion). The potential impact of any additional required infrastructure could assist in differentiating between potential regional alternative sites (e.g. the impact of additional roads or power lines going through sensitive areas). (DEA&DP)	Infrastructure associated with the proposed wind energy facility has been included in the Scoping Phase (in terms of identifying potential issues associated with such infrastructure). This will be investigated and assessed in further detail in the EIA Phase (refer Chapter 8, 9 and 10).

Following the regional assessment, it was Eskom's intention to proceed with an EIA process for the proposed Wind Energy Facility. As this Regional Assessment has guided Eskom to site/locate their proposed facility within an area/zone of preference (as per the regional methodology followed), no alternative locations/sites will be required to be considered through the EIA process.

The demarcated area is an indicative area (approximately 37 km^2 in extent) considered to be favourable/most viable for the development of a large-scale Wind Energy Facility. This area comprises the following farm portions:

» Portion 5 of the farm Gravewaterkop 158 (known as Skaapvlei)
» A portion of Portion 620 of the farm Olifants River Settlement
» A portion of Portion 617 of the farm Olifants River Settlement

The demarcated area is considerably larger than that area required for the facility (considering an area in the order of 25 km^2), which allows for a degree of flexibility in turbine placement to accommodate both technical factors (wind resource and/or lie of the land) and environmental factors (sensitive environmental receptors). This broader area (as reflected in the figure below) has been considered within this Final Scoping Report.