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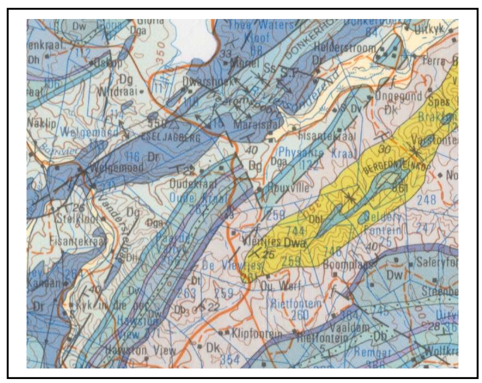
Environmental Impact Assessment for the Establishment of the Caledon Wind Farm, Western Cape Province



Environmental Scoping Report

Geotechnical Assessment

Date: November 2009

EXECUTIVE SUMMARY

The project involves the construction and operation of a 300 MW wind farm. The project requires approximately 3600 ha of land for operating 150 2MW permanent wind turbines. Transmission lines will run from the turbines to the main grid, an access road and other forms of bulk infrastructure will be required to enable construction and operations.

The receiving environment consists of farmland mainly used for grazing sheep. There is a low density of human occupation of the land almost all of which are involved in farming activities. The area is situated close to an arterial road which is accessed from the N2 National Highway.

The terrain consists of grassed hills and valleys with few trees and patches of rocky outcrop particularly along the ridge crests. The preferred location for the wind turbines is along the exposed hillslopes.

The geological conditions consist of folded shales, siltstones and sandstones of the Bokkeveld Group. The soil cover is thin and generally poor in terms of its agricultural potential.

Ground conditions are stable, there are no severe soil erosion and slope stability problems.

Geotechnical constraints are minor and relate to the presence of shallow rock over much of the area. In terms of foundation conditions this is a highly favourable site condition.

The hard ridges of sandstone and small outcrops are clearly visible and often support patches of indigenous vegetation. These areas can be avoided during the specific location of individual masts to reduce impacts due to rock blasting.

The soils are highly conductive and will require cathodic protection for the underground powerlines. Similarly the local soil conditions are not ideal in terms of their thermal resistivity, however, both issues can be mitigated in the selection of imported quartz sand for pipe bedding.

Our overall geotechnical assessment is that this site is highly favourable for the operation of a wind farm and that detailed geotechnical investigations are not required for the assessment of environmental impacts but should be undertaken to provide detailed information for engineering design once final locations and routes are confirmed.

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GEOTECHNICAL ASSESSMENT

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1 INTRODUCTION

1.1 Background

The project involves the construction and operation of 300 MW wind farm. The project requires approximately 3600 ha of land for operating 150 2MW permanent wind turbines. Transmission lines will run from the turbines to the man grid, an access road and other forms of bulk infrastructure will be required to enable construction and operations.

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The terrain consists of grassed hills and valleys with few trees and patches of rocky outcrop particularly along the ridge crests. The preferred location for the wind turbines is along the exposed hillslopes.

1.2 Scope and Limitations

The geotechnical assessment is preliminary in nature and is based on existing geological information and from a site visit and walkover undertaken in October 2009.

The aim and objective of the geotechnical assessment is to identify any geological or geotechnical constraints which may affect the feasibility of the project or give rise to an undesirable impact on the environment. The study is for environmental scoping purposes and recommends whether further detailed geotechnical surveys are necessary for the Environmental Impact Assessment.

1.3 Methodology

The geotechnical assessment is preliminary in nature and is based on existing geological information and from a site visit and walkover undertaken in October 2009 by our Chief Engineering Geologist, Dr Jon McStay.

It is understood that the proponent undertook a detailed site screening exercise at a regional level and that trial excavations have been undertaken on the farms selected for the Environmental Scoping Phase. Although no detailed formal geotechnical reporting was made available there is photographic and anectodal record of the geological conditions encountered during the site screening process.

There are a number of detailed geotechnical studies that are usually undertaken as part of detailed engineering design phase of a project of this nature. They are by nature design specific inputs for determining tender specifications and are not required for Environmental Assessments.

1.3.1 Study Area Sensitivity Analysis

In general terms the sites are considered of very low sensitivity in terms of the geological environment. The ground is stable and there are no immediate or predictable geological hazards which may give rise to significant environmental impacts. There are no geological features that have special scientific or historical significance.

1.4 General Study Area

The general study area consists of a number of adjacent farms situated west of Caledon. They have similar and predictable geological profiles.

2 GEOTECHNICAL ASSESSMENT

The geotechnical assessment is preliminary in nature and is based on existing geological information and from a site visit and walkover undertaken in October 2009.

2.1 Geology and soils

The area is underlain by interbedded siltstones, shales, mudstones and fine sandstones of the Klipbokkop Formation and Wagensdrift Formation of the Devonian age Bokkeveld Formation. The rocks are folded into a broad syncline which produces a topography consisting of ridges and valleys. The tops of the ridges are formed by a hard resistant sandstone layer. The rocks dip at approximately 25 degrees along a regional developed south-west north-east strike.

The regional geology is part of the Cape Fold Belt. The area lies between two major fault zones which define the Botrivier valley which has formed along the south-west-north-east upthrown block of Bokkeveld shales and is bounded by the more resistant quartzite sandstones of the mountain-forming Table Mountain Group. This fault bounded valley provides an important topographic depression that controls wind direction and wind speed in the area.

There may be some faulting in the study area with bedding parallel thrusts developed along the northern limb of the syncline and minor normal faults occurring along a south-east north-west trend of tensional stress.

Soils are relatively thin particularly on the hillsides where a silty hillwash layer overlies weathered shaley rock. In the low lying areas a residual clay layer of up to 1m thick may be encountered and ferricrete is developed in areas subject to poor drainage and seepage of groundwater. In the location of the wind turbines the shallow rock condition is likely to be encountered. This is also likely to be the case for the bulk of the cable trench routes.

The soils tend to have a high sodium content and thus their agricultural potential is low. They require extensive lime addition for growing crops and thus the bulk of the farms in this area are used for grazing sheep. The thin soils and high sodicity can give rise to soil erosion problems particularly if over-grazed. However no examples of soil erosion were observed on the site reconnaissance.

Figure 1 Exposure of interbedded siltstones, mudstones and sandstones of Bokkeveld Formation.

2.2 Groundwater

The Bokkeveld Formations are best described as being poor quality regional aquifers. Groundwater yield are generally low and water quality can be moderately to highly saline. With a relatively low annual rainfall the groundwater resources of the study area are considered to be poor with limited opportunities for the drilling of successful abstraction wells.

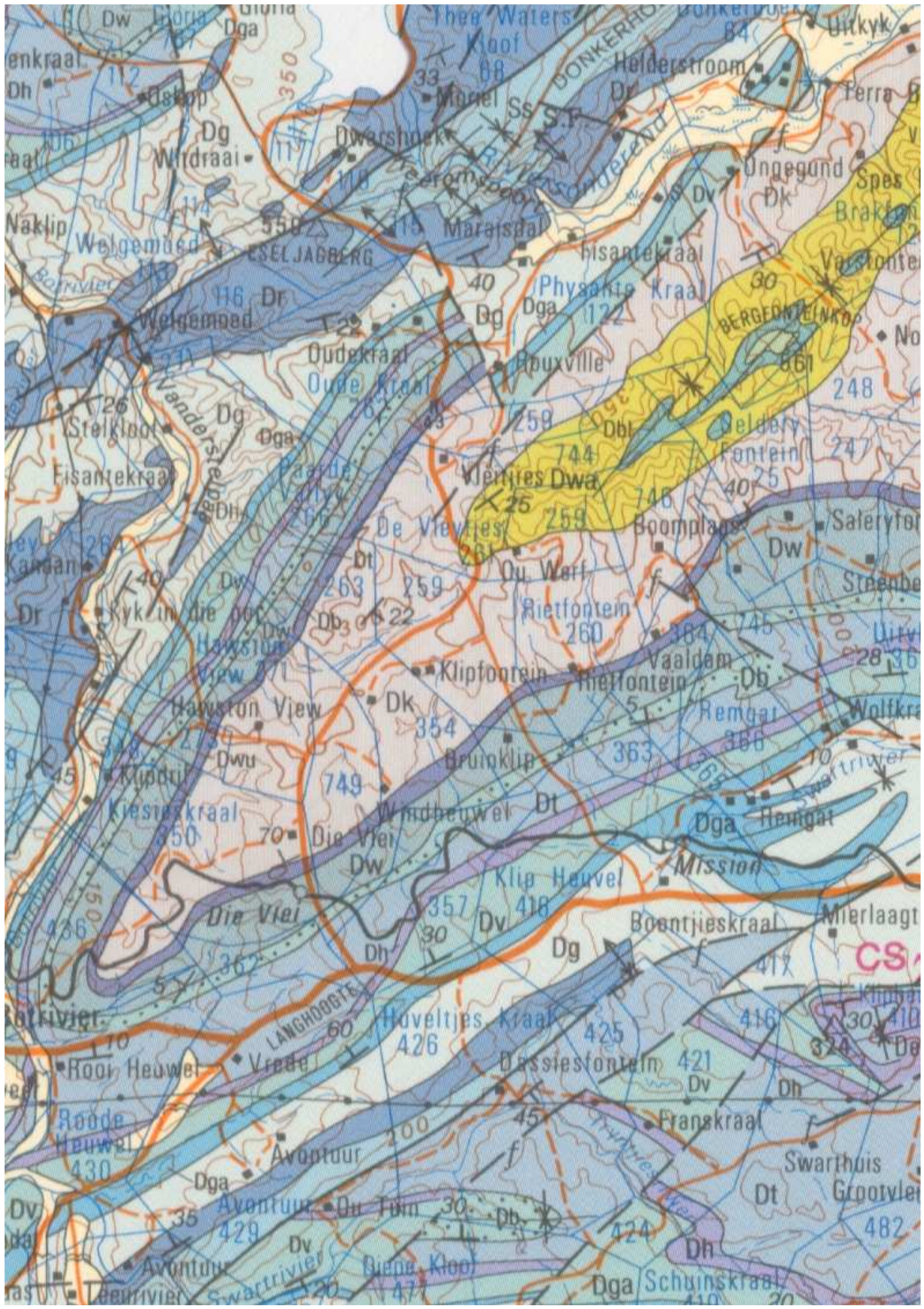

Figure 1 : 1:25 000 Geological Series (1997) Regional Geology of the Caledon Wind Farm area. Dwa- Wagen Drift Formation, Dk – Klipbokkop Formation.

2.3 Geotechnical conditions

2.3.1 Foundations for Wind Turbines

Wind turbines are normally founded on large round or square raft-like concrete bases with a central base with a basal diameter of 5.5m surrounded by a concrete raft with a diameter of 17.3m. The mast structures are not particularly heavy in terms of foundation loading, as the load is distributed evenly over the large foundation area. However, the masts are subjected to high wind shear and thus dense soil with a moderate to high shear strength and bearing capacity is required for founding. Therefore foundation conditions are a key constraint on engineering costs and affect project feasibility.

The 'soft to intermediate' rock condition in this area is considered highly favourable for founding the masts. In general founding depth would be approximately 1.9m, which corresponds closely to the expected depth of excavation possible in the rock without the need for rock blasting. The bearing capacity in the fractured shales is estimated to be at least 500 kPa which is double the required bearing capacity for the anticipated loads of the operating wind turbines. If the rock condition at the bottom of the excavation is highly uneven rock dowels can be used to prevent sliding of the concrete base. After casting the foundation area is backfilled with compacted rock and soil to a level of 0.95m above the concrete foundation and flush with the base.

The hard sandstone that forms the hill ridges should be avoided in the specific locating of individual masts. The rock would require blasting in order to provide the depth of foundation required for the masts.

The location of the wind turbines on the higher ground ensures that there is no influence of the water table on foundations and reduces the risk of chemical corrosion of the concrete bases.

Figure 3: Intact rock condition encountered in trial drilling of a siliceous mudstone.

2.3.2 Cable Trenches

Excavation conditions for trenches will require heavy ripping with a large hydraulic excavator. In general the siltstones and mudstones are rippable, while the hard sandstone bands and areas of ferricrete may require the use of hydraulic hammers.

As the ground conditions include areas of mudstone and ferricrete the soils are highly conductive and thus special measures for cathodic protection are required. The cables should be installed in a conduit sleeve with a bedding of clean granular material and backfilled with compacted soil. The excavated material from the trenches may not be suitable for use as backfill for trenches, the rock fill is oversized and difficult to compact where load-bearing densities are required, e.g. for trenches underneath roads. The more weathered rock is clayey and also has poor compaction properties for use as trench backfill. As the majority of the cabling will be installed through open farmland the issues of trenching and backfilling are considered to be relatively minor constraint on construction.

The cable trench backfill should be well compacted quartz sand backfill, which has the lowest thermal resistivity of natural soil materials. The determination of the thermal properties of borrow pit sources of sand or existing commercial sources is a task for detailed engineering design.

Figure 4 : Trenching conditions in Bokkeveld shales. Onset of heavy ripping conditions for rock excavation at approximately 1.5m.

2.3.3 Access Roads

It is understood that the turbines will be transported to site using special trucks and that temporary access roads will be constructed to enable site access.

The road subgrade conditions are generally good due to the shallow soil cover. Most farm roads are simply cut to grade to intercept the rock surface which forms an unpaved road surface. The temporary access roads can be constructed in similar manner with the provision for additional wearing-course gravel where required to make grade.

3 CONCLUSIONS AND RECOMMENDATIONS

3.1 Geotechnical Influences on the Environmental Impact Assessment

There are no predictable geological or geotechnical impacts associated with the construction or operations of the wind turbines.

Ground conditions are stable, there are no severe soil erosion and slope stability problems that require unusual or special construction measures to be used.

Geotechnical constraints are minor and relate to the presence of shallow rock over much of the area. In terms of foundation conditions this is a highly favourable site condition.

The hard ridges of sandstone and small outcrops are clearly visible and often support patches of indigenous vegetation. These areas can be avoided during the specific location of individual masts to reduce impacts due to rock blasting.

The soils are highly conductive and will require cathodic protection for the underground powerlines. Similarly the local soil conditions are not ideal in terms of their thermal resistivity, both issues can be mitigated in the selection of an imported quartz sand for pipe bedding

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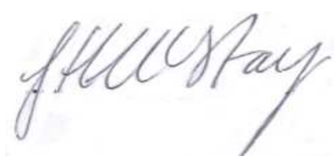

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