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Preliminary Geotechnical Assessment for Seeland Development Trust Wind Farm, St Helena Bay, Western Cape

Date: May 2010
Seeland Development Trust Wind Farm, St Helena Bay, Western Cape
PRELIMINARY GEOTECHNICAL ASSESSMENT

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1 INTRODUCTION

1.1 Background

The project involves the construction and operation of a 20 to 40 MW wind farm on a community farm near St Helena Bay, Western Cape. 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 and cattle. 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 the R 399 arterial road which links St Helena Bay to Vredenburg.

The terrain consists of rolling hills with rocky outcrop particularly along the ridge crests. The preferred location for the wind turbines is on the high points of the ridges.

1.2 Scope and Limitations

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 May 2010 by our Chief Engineering Geologist, Dr Jon McStay.

Although no detailed formal geotechnical reporting was made available the geotechnical conditions can be inferred from outcrop patterns and from cuttings and excavations on the site.

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. The thin soil cover is derived from the underlying granite bedrock. These
soils have a high exchangeable sodium percentage and tend to be dispersive and thus prone to erosion.

There are no geological features that have special scientific or historical significance.

1.4 General Study Area

The general study area consists of a community farm, Langeklip, operated by the Seeland Development Trust. The available land for siting wind turbines consists of ridges of granite with a shallow soil cover. Therefore no preferred or more favourable alternative site can be motivated for on the basis of geotechnical considerations.

Figure 1 : Location of proposed site inland from the settlement of Laingville, near St Helena Bay..
2   GEOTECHNICAL ASSESSMENT

2.1 Geology and soils

The area is underlain by granites of the Vredenburg pluton of the Cape Granite Suite. The granites intrude the basement rocks of the Precambrian age Malmesbury Group metasediments and have ages estimated to be approximately 550 Ma.

The granites form a distinctive topography of rolling hills with domes and pinnacles of granite outcropping.

The Vredenburg granites have been quarried for use as road aggregate, railway ballast and for bulk rock fill in the construction of breakwaters and harbour. An old quarry is located to the south of the town of St Helena Bay.

Soils are relatively thin particularly on the ridges where a coarse sandy hillwash layer overlies weathered rock. 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 and cattle. The thin soils and high sodicity can give rise to soil erosion problems particularly if over-grazed.

There are examples of soil erosion and donga formation that can be observed along the access road to the site.

Figure 1 Exposure of granite domes forming a low ridge to the south of the site.
Figure 2: Extensive soil erosion in granite soils on hillslopes to the north of the site.

Figure 3: Circular depression in soft weathered granite forming a cattle pan in between domes and ridges of harder granite.
2.2 Groundwater

The Cape Granites in the St Helena Bay area are best described as being poor quality regional aquifers. Groundwater yields are generally low and water quality can be moderately to highly saline with TDS of between 300-1000 mS/m. 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.

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 17m depending on the overall height of the mast. 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 rock condition in this area is generally considered favourable for founding the masts. However the dome and pinnacle structure of the granite subcrop creates a
highly variable and unpredictable rock profile which makes excavation and anchoring
difficult.

In general founding depth would be approximately 1.5m to 2.0m, which will result in
the need for rock blasting to create an even rock surface for casting the base.

The bearing capacity in the granite is estimated to be at least 2 MPa which is well in
excess of 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 pinnacles of granite that form outcrops 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.

2.3.2 Cable Trenches

Excavation conditions for trenches will require heavy ripping with a large hydraulic
excavator and may require blasting of rock depending on the depth of excavation and
the subcrop pattern of the granite.

The ground conditions are generally very dry over most of the site however the soils
are moderately to 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, eg 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.

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 sandy and gravelly
nature of the shallow soil cover. The soils are however prone to erosion and thus
attention to road drainage measures is important to avoid scouring along access
roads. Temporary access roads require the importation of a suitable wearing-course
gravel to improve trafficability for heavy vehicles and reduce the risk of erosion of the natural subgrade.
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 that cannot be adequately addressed by simple engineering measures.

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

Geotechnical constraints relate to the presence of shallow rock over much of the area. In terms of foundation conditions this results in highly variable excavation depth to hard rock and difficulty in establishing a large flat foundation base for casting the large concrete plinth required for the masts. Rock blasting is a highly likely over most of the preferred turbine locations.

The shallow rock condition will increase the costs and timeframes associated with excavation for turbines and cable trenches.

The hard domes of granite and small outcrops are clearly visible. 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.

The soils are dispersive and have a moderate to high susceptibility to erosion. Rehabilitation of re-vegetation of disturbed areas after the completion of construction will be necessary to mitigate against erosion and loss of topsoil.

Our overall geotechnical assessment is that this site is 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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WSP Geoprojects