ArupTransportPlanning

ESKOM GENERATION

WIND ENERGY FACILITY

Infrastructure and Transportation Assessment Report

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Scoping Phase of the EIA

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Contents

1 BACKGROUND AND INTRODUCTION

Arup (Pty) Ltd has been appointed to undertake a rail, road and air infrastructure, traffic and transportation assessment. This report has been prepared for the scoping phase of the EIA for the proposed construction of a Wind Energy Facility by Mr M J Pinder (Pr Eng), an Associate Engineer with 18 years experience, specialising in infrastructure and transportation planning. He is considered an independent professional as may be specified by the competent authority. This report has been prepared in partial fulfilment of the requirements of Section 33 of the EIA Regulations in terms of the National Environmental Management Act (NEMA; Act No 107 of 1998).

With reference to the “Note to all Specialists – Revision 2” dated 17th July 2007, various consultations between ESKOM, DEAT, DEA&DP and Savannah Environmental have culminated in the understanding that ESKOM need to submit a scoping study for a single wind energy facility of maximum capacity so as to reduce the need for a second wind farm in close proximity in the immediate future. Through a regional site identification study, a single 37.6 Ha site has been identified as being potentially suitable for the wind energy development of up to 100 turbines. This area comprises the farms Gravewaterkop 158 portion 5, Portions 620 and 617 of the farm Olifants Rivier Nedersetting.

Based on ESKOM’s requirements, each of the turbine units consists of a 80m high tower (approximately 4 x 20m segments), 83 ton Nacelle with hub height at 80m and with a 90m diameter rotor (3 x 45m blades). The transportation of individual components would be defined as abnormal loads in terms of Road Traffic Act (Act 29 of 1989) by virtue of the dimensional limitations (abnormal length of the 45m blades) and load limitations (e.g. the Nacelle). In addition, components of various specialised construction, lifting equipment and counter weights etc. are required on site (e.g. 200 ton mobile assembly crane and a 750 ton main lift crawler cranes) to erect the wind turbines and these also need to be transported to site.

The site is in a remote location but with good access by virtue of the existing road network providing access to the diamond mining concession areas. The dimensional requirements of the load (length / height) may require alterations to the existing road infrastructure (widening on corners, removal of traffic islands), accommodation of street furniture (electricity, street lighting, traffic signals, telephone lines etc) and protection of road related structures (bridges, culverts, portal culverts, retaining walls etc) as a result of abnormal loading. At locations some distance away from the ‘formal’ road network, site access and access around the proposed site will require special haul roads to be constructed to and within the site to accommodate abnormally loaded vehicle access and circulation. The receiving environment (i.e. the transport routes to the site) will be impacted upon and temporary road works, remote from the site itself, may be required.

2 SCOPE AND PURPOSE

The scope of the infrastructure and transportation assessment is limited to the rail network, major roads (National and Provincial Routes) and minor roads (local area access roads) in the West Coast area between Cape Town harbour / Saldanha Bay harbour in the south, the National Route 7 in the east and the proposed Windfarm site west of Koekenaap.

The purpose of this assessment is to assess the various transport route options and to identify any issues of potential significance (or “fatal flaws” or “red flags”) to be investigated and assessed in the EIA phase.

3 METHODOLOGY

The methodology for the scoping investigation was as follows:

- A regional level desk top study and assessment of the region using aerial images (Google Earth), 1:50 000 topographical maps and regional travel maps to identify transport infrastructure (railway lines, roads and road related structures), airfields, harbours and transport routes between Cape Town in the south, the N7 in the west and Koekenaap and the potential site in the north.
- A site visit with ESKOM and other members of the project team was undertaken on the 7^{th} and 8^{th} March 2007. During this period a visual assessment of the proposed site, road accesses to it from the established roads and potential transport routes along the formal road network (excluding the N7) between the harbours and the site were undertaken. The N7 was not assessed in detail because it is already established as a haul route for abnormal loads. During the visual assessment and subsequent further desk top studies, geometric challenges (e.g. intersections, sharp changes in vertical gradient, sharp horizontal bends etc.) and road related structures (bridges, culverts, canal crossings etc.), that may be affected along the transport routes were listed and recorded for further investigation.
- Members of the various road authorities (SANRAL, PG:WC (Bridge & Structures Engineer and District Roads Engineer - Ceres), West Coast District Municipality (2IC to Director : Technical Services)) were contacted individually and telephonically by the author to raise any conditions and constraints.
- A desk top rail network assessment was undertaken using 1:50 000 topographical maps and regional travel guide maps but not visual assessment was undertaken. Spoornet officials assigned to issuing route clearances were contacted to assess the feasibility of transporting components from Cape Town to Koekenaap.
- A local Crane Hire firm that specialises in heavy lifting equipment was contacted to determine the recommended specification of the type of lifting equipment necessary to install the wind turbines. Information on the transportation of this construction equipment was also obtained.

4 TRANSPORTATION REQUIREMENTS

4.1 Guideline Documentation

The Technical Recommendations for Highways (TRH 11): "Draft Guidelines for Granting of Exemption Permits for the Conveyance of Abnormal Loads and for other Events on Public Roads"[1] outline the rules and conditions which apply to the transport of abnormal loads and vehicles on public roads and the detailed procedures to be followed in applying for exemption permits are described and discussed. Legal axle load limits and the restrictions imposed on abnormally heavy loads are discussed in relation to the damaging effect on road pavements, bridges and culverts. The general conditions, limitations and escort requirements for abnormally dimensioned loads and vehicles are also discussed and reference is made to speed restrictions, power/mass ratio, mass distribution and general operating conditions for abnormal loads and vehicles. Provision is also made for the granting of permits for all other exemptions from the requirements of the Road Traffic Act and the relevant Regulations.

4.1.1 Permits – General Rules

The limits recommended in TRH 11 are intended to serve as a guide to the Permit Issuing Authorities. It must be noted that each Administration has the right to refuse a permit application or to modify the conditions under which a permit is granted. It is understood that:

(a) A permit is issued at the sole discretion of the Issuing Authority. The permit may be refused because of the condition of the road, the culverts and bridges, the nature of other traffic on the road, abnormally heavy traffic during certain periods or for any other reason.

(b) A permit can be withdrawn if the vehicle upon inspection is found in any way not fit to be operated.

(c) During certain periods, such as school holidays or long weekends an embargo may be placed on the issuing or permits. Embargo lists are compiled annually and are obtainable from the Issuing Authorities

4.1.2. Load Limitations

The maximum load that a road vehicle or combination of vehicles will be allowed to carry legally of under permit on a public road is limited by:

- the capacity of the vehicles as rated by the manufacturer;
- the load which may be carried by the tyres;

[1] Technical Recommendations for Highways (TRH 11): "Draft Guidelines for Granting of Exemption Permits for the Conveyance of Abnormal Loads and for other Events on Public Roads

- the damaging effect on pavements;
- the structural capacity on bridges and culverts;
- the power of the prime mover(s);
- the load imposed by the driving axles and
- the load imposed by the steering axles.

4.1.3. Dimensional Limitations

A load of abnormal dimensions may cause an obstruction and danger to other traffic. For this reason all loads must, as far as possible, conform to the legal dimensions. Permits will only be considered for indivisible loads, i.e. loads that cannot, without disproportionate effort, expense or risk of damage, be divided into two or more loads for the purpose of transport on public roads.

4.2 Transporting Wind Turbine Components

Although there are a number of manufacturers of wind turbine units, the "Transport Guidelines"[2] for the Vestas turbine is publicly accessible and have been considered in this study. The Transport Guidelines give an indication of the size and weight of the individual components and an indication of some of the larger road based transport vehicle requirements. Wind turbine components can be transported in a number of ways with different truck / trailer combinations and configurations. These issues which will be finalised at a later stage when the transporting contractor and the plant hire companies apply for the necessary Permits from the Permit Issuing Authorities.

Nacelle:

The heaviest component of a wind turbine is the Nacelle (approximately 83 tons) and combined with road based transport has a total vehicle mass of approximately 130 000kg. Thus Route clearances and permits will be required for transporting the Nacelles by road based transport.

V90 Nacelle on a low-bed trailer (ref: Vestas Transport Guidelines V90-3.0MW)

[2] Vestas Transport Guidelines V90-3.0MW

45m Blades:

These are the longest component and need to be transported on a specially imported extendible blade transport trailer or in a rigid container with rear steerable dollies. The blades can be transported individually, in pairs or in three's although different manufacturers have different methods of packaging and transporting the blades. The transport vehicle exceeds the dimensional limitations (length) of 22m and will be allowed under permit provided the trailer is fitted with steerable rear axles or dollies.

3 x 45m Blades on extendible trailers [2]

Single 45m blade on extendible trailer [3]

Tower Sections:

The approx. 78m high tower, when assembled, consists of 4 x approximately 20m sections varying between 2773mm and 4190mm in diameter. Each section is transported separately on a low-bed trailer. Depending on the trailer configuration and height when loaded, some of these components may not meet the dimensional limitations (height and width) but will be permitted under certain permit conditions.

20m Tower section on low-bed [3]
(Very little ground clearance)

20m tower section on tri-axial trailer[4]
(Better ground clearance)

4.3 Transporting Crawler Crane, Mobile Crane and Components

A local Crane Hire Company recommended that the main lift crane that would be capable of performing the required lifts, i.e. lifting the tower sections (of between 29 – 52 tons) into position, lifting the Nacelle (83 tons) to + 80m hub height and lift the Rotor and Blades into place will need to be similar to the Liebherr Crawler Crane LR1750 with a SL8HS (Main Boom and Auxiliary Jib) configuration. A smaller 200 ton Liebherr Mobile Crane LTM 1200-5.1 is

[3] Transport Vehicles for Wind Power Plant, Goldhofer
[4] http://mysite.mweb.co.za/residents/rrsmit/v66.htm (Tower section to Klipheuwel site)

also required to lift the components and assist in the assembly of the crawler crane at each turbine location. (See reference documents for details).

***Crawler Crane LR1750* with the SL8HS boom system (Main Lifting Crane):**
The Crawler Crane will be transported to site in stripped configuration and the heaviest load will be the Superstructure and crawler centre section (83 tons). The gross combination mass (truck, trailer and load) will be approximately 133 049 kg. The boom sections, counterweights and other equipment will be transported on conventional tri-axle trailers and then assembled on site.

Mobile Crane LTM 1200-5.1 (Assembly Crane):
The Liebherr LTM 1200-5.1 crane is a 5 axle vehicle with rubber tyres and will travel to site under its own power. However the counterweights will be transported on conventional tri-axle trailers and then assembled on site. The assembly crane is required to assemble the main lift crane as well as assist in the installation of the wind turbine components.

4.4 Other Plant and Equipment

In addition to the specialised lifting equipment, the normal Civil Engineering construction equipment will need to be brought to the site for site for the execution of the scope of works listed in Section 6.1 of this report. (e.g. excavators, trucks, graders, compaction equipment, cement mixers, transformers in the sub-station, cabling, transmission pylons etc.).

5 TRANSPORTATION ROUTE ASSESSMENTS

This chapter assesses various transportation options (Harbour, Rail, Air, Road), the possible routes associated with them, and identifies any issues requiring further investigation in the EIA phase. At the time of writing, it is understood that all the wind turbine components (Nacelles and Blades) will be imported. The tower sections may also be imported (depending on the tenders received), but there is a possibility that they will be manufactured ‘locally’ in the Western Cape. The transport routes between a “local” manufacturer and the transport routes included in this scoping assessment report are unknown and cannot be assessed at this stage.

The various transportation routes, location of harbours and airfields are depicted regionally in **Figure 1: “Transportation Route Map”**

5.1 Harbours

Three harbours were identified as possible entry points for the imported wind turbine components, namely Cape Town, Saldanha Bay and the fishing harbour at Lamberts Bay. Cape Town and Saldanha are both deep water ports with heavy lifting equipment on the quayside. There has been no consultation with the port authorities at this stage. Cape Town also has a mobile floating crane should the need arise. Lamberts Bays will require further investigation to determine draught clearance on entry to the port and whether the lifting equipment within the harbour has the capacity to transfer the larger loads to road based transport vehicles. Abnormal vehicle access and the adequacy of the access roads to the harbour and the road network will also require careful evaluation. For the purpose of the scoping report, all harbours are assumed possible entry points and transport routes have been assessed between them and the proposed wind farm site.

5.2 Rail Transport

At a regional level, a rail network does exist between Cape Town, Saldanha Bay, Koekenaap and ends at Bitterfontein. The railway line to the north commences at Bellville and diverges at Kalbaskraal with one route passing through Darling, Hopefield, Bergrivier and Vredenburg while the other route passes through Abbotsdale, Malmesbury, Rust, Moorreesburg, Koringberg, Piketberg, Eendekuil, Het Kruis, Paleisheuwel, Sandberg, Graafwater, Ratelfontein, Klawer, Vredendal, Lutzville, Koekenaap, Landplaas, Komkans and ending at Bitterfontein.

The Saldanha - Sishen Iron Ore railway line runs from the Iron Ore terminal at Saldanha Bay, past Velddrif and follows the coastline until Standfontein where it swings north-east passing south of Lutzville on a north-east alignment. This is a purpose built facility for transporting iron ore from the mines in Sishen to the export terminal at Saldanha Bay with no connection to the “local” rail network.

A telephonic conversation with Mr Dennis Shaw, a Spoornet official involved in authorising rail route clearances, revealed that the maximum load width is 3.302m and maximum load height is 2.896m. There is no rolling stock that can accommodate rigid 45m long blade containers, the 20m tower sections or the Nacelles and hence rail cannot be used to transport wind turbine components. Certain construction plant and equipment could be transported by rail to Koekenaap and transported to site on low beds or driven under own power.

5.3 Air Fields and Air Transport

At a regional level, local airfields were identified from travel maps as well as the 1:50 000 topographical sheets. They are indicated at Skaapvlei (now disused), Vredendal, Papendorp, Dooringbaai, Lamberts Bay, Clanwilliam, Citrusdal, Malmesbury, Vredenburg, Langebaan AFB, Ysterplaat AFB as well as Cape Town International Airport.

The possibility of a ship to shore load transfer of the wind turbine components between a bulk cargo carrier moored off shore and the individual turbine sites was briefly explored. This benefit of this option, if feasible, would be to reduce the abnormal load impact on the road network. However an internet search revealed that the Sikorsky S-92 “Multi – Mission Helicopter”, one of the largest commercial helicopters in the Sikorsky range can only lift a maximum of 4536 kg external load. This capacity is far too small to be considered of any use in the transportation of wind turbine components.

5.4 Road Transport

It is anticipated that the tower sections will be manufactured locally, either in the Cape Town Metropolitan area or in the Saldanha Bay area. The Nacelles and the 45 m blades will be imported and will need to be transported from the port of entry to the site.

The main transport routes include:

- N7 (Cape Town to Klawer);
- R27 (West Coast Road, Cape Town to Velddrif), with possibly a diversion along Boundary Road – Koeberg Road and Blaauwberg Road in the Milnerton / Table View area for an super-load (GVM > 125 Ton);
- R399 (Saldanha Bay to Picketburg);
- R362 and/or R363 (Klawer to Vredendal);
- R363 (Vredendal to Koekenaap);
- Koekenaap to Site along the existing local surfaced and gravel access roads

A visual, aerial Google Earth review and desktop assessment was undertaken to identify and constraints and challenges that may occur along the transport routes such as intersections, problematic geometric horizontal and vertical road alignment, cattle grids, level (road / rail) crossings, road related structures (portal culverts, structures over canals, bridges, retaining walls etc.) and low overhead services etc.

Senior officials of the South African National Roads Agency (SANRAL), Provincial Administration: Western Cape (Bridge Engineer and District Engineer – Ceres), West Coast District Municipality and the City of Cape Town were contacted telephonically and the transportation of the abnormal loads discussed. The discussions assisted in identifying any structures that possibly needed further investigation along the proposed transport routes. The Permit Issuing Authority in this instance is the Provincial Administration: Western Cape. The crawler crane and its components will most likely be transported to the site from the Gauteng area. The location of this equipment and hence the transport route required to get it to site is still unknown, and this route has not been assessed in this report.

The various routes are depicted in more detail in Figures 2 to 12 with a description of the infrastructure item, Google Earth coordinate and issue(s) requiring further investigation.

Figure 2: Route A: Saldanha Bay Harbour (Fishing Terminal) to Velddrift (Option 1: R399)

Figure 3: Route A: Saldanha Bay Harbour (Iron Ore Terminal) to Velddrift (Option 2: R27 link)

Figure 4: Route B: Velddrif to Picketberg (R399)

Figure 5: Route C: Piketberg to Klawer (N7)

Figure 6: Route D1: Klawer to Vredendal (Option 1: R363)

Figure 7: Route D2: Klawer to Vredendal (Option 2: R362)

Figure 8: Route E: Lamberts Bay to Clanwilliam (R364)

Figure 9: Route F: Vredendal to Koekenaap (R363)

Figure 10: Route G1: Koekenaap to Site (Northern Access) (Local Road to Skaapvlei)

Figure 11: Route G2: Koekenaap to Site (Southern Access) (Local Road to Nooitgedag and beyond)

Figure 12: Route H: Cape Town Harbour to Piketberg (R27, M5 and N7)

6 IMPACTS ON THE RECEIVING ENVIRONMENT DURING THE CONSTRUCTION PHASE

6.1 Proposed Scope of Works

It is proposed that up to 100 turbines will be established at the site. Basic details pertaining to infrastructure associated with the establishment of the proposed wind energy facility include:

- 100 turbine units (approximately 78 m tower, hub height 80m, 90m diameter rotor (3x45 m blades), 9 – 14,9 rpm,);a concrete foundation of 15m x 15m for each turbine;
- an access road to the site from the main road/s within the area;
- an internal service road to access each wind turbine (approximately 5m width, longitudinal slope 8 degrees (14%), lateral slope 2 degrees (3.5%), pavement structure to accommodate 15 ton axle loads and accommodating 25 m turning radius;

  Note: Abnormal vehicles with 83 ton Nacelles and crawler crane components (or GVW = 132 000 kg) may require flatter grades on site. The geometric design specifications of the internal service roads must be confirmed in consultation with transportation companies prior to commencing with detailed design of the roads;
- a substation (approximately 50m X 50m in size; on the site in an appropriate central position, with underground distribution/cabling to each wind turbine),
- overhead powerline (132 kV distribution line) feeding into the electricity distribution network/grid at Koekenaap Substation (approximately 25km).

- Possibly a small office building and visitors centre at the facility entrance – approximately 150m sq.

The approximate turbine positions are indicated in the Regional Assessment report. At this stage the layout is still to be decided, but 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 500m to 800m. An east-west optimised layout is proposed to maximise the utilisation of the prevailing SSW winds and coastline effect and so as to avoid individual turbine turbulence effecting one other as far as possible (i.e. staggered or offset layout). A detailed micro-siting exercise will be provided by Eskom for assessment in the EIA Phase.

In terms of the proposed site area indicated in the Regional Assessment Report, and on the 1:50 000 maps in Figures 9 and 10 of this report – the assumption should be made that although during operation the area affected will comprise 100 turbines (15x15m foundation area), access roads and substation, during construction the bulk of the area “inside” the depicted footprint could suffer disturbance. Other associated infrastructure includes the access road and 132 kV powerline to connect to the grid. The existing access route to the site via Koekenaap would be considered as the first option for providing access to the site, and modifications made to the route where required. In addition, the preference is for the power line to follow the access route as closely as possible, which will also allow for access to the power line and ensure consolidation of the linear infrastructure. The actual point of connection to the grid is, however, not yet finalised.

6.2 Works Within the Site Boundary

6.2.1 Service Road: Geometric Alignment

The internal service road alignment will be informed by the final micro positioning of the wind turbines. It can also function as the main transport route during construction. The latest thinking is a grid of turbines commencing approximately 2km from the coast and then parallel and at staggered offsets of between 500 and 800m apart. The optimal service road layout would essentially be parallel roads linking the turbines. The internal road needs to be designed to accommodate the swept path (i.e. the space required in the bends and corners so that the wheels remain on the roadway) and imposed loads of all the abnormal vehicles. To enable the assembled crawler crane to move around the site and around the base of the turbine, the gradient and crossfall shall not exceed 1 degree or (1.7%). These roads will have to be constructed in advance of any components being delivered to site and will remain in place after completion for future access and possibly access for replacement of parts if necessary.

Nature of the Impact: A grid pattern of roads not following a particular contour (e.g. 100m contour) may result in roads being too steep to accommodate abnormally loaded vehicles getting to the turbine sites. To achieve smooth ‘flat’ gradients may require significant cut and fill earthworks but this can only be quantified once the maximum longitudinal gradients have been established from the transport contractors and during the design phase.

Extent of the Impact: Confined to the internal study area but may result in extensive disturbance or local modifications on the site.

Potential Significance: It could be very significant for individual sites in the proposed "ideal" turbine grid pattern if a turbine location is not accessible by the abnormal transport vehicles. An individual site may not be accessible or it may be positioned it too close to an adjacent turbine site – possibly a compromise on optimised spacing. The power and ability of the transport vehicles to traverse various gradients with abnormal loads need to be determined prior to designing the alignment of the internal service roads. The impact of the service roads is that they will be permanent and vegetation will not be permitted to re-establish on them.

6.2.2 Material for Road Pavement Structure

During construction, the service road must be built to support 15 ton axle loads to support the abnormal loads delivering the Nacelles, Crawler Crane and other components. The Crawler crane when assembled has a tracked width of 11m. There are a number of options for sourcing road building material for the establishment of the internal service road. One option is to obtain suitable spoil material from the adjacent diamond mining concession area where it is anticipated that large quantities of suitable road building material can be obtained from the mining tailings. A second option is that suitable road building material will have to be sourced from commercial sources and transported to the site by trucks. It is assumed existing commercial quarries / mining permits have already been authorised and are available in the area. If not, an appropriate source of material (or borrow pit) will have to be located and mining rights established through the Department of Mineral and Energy Affairs.

Nature of the Impact:

- **Transporting** materials from sources external to the site and mining concession areas will add direct and cumulative axle loading impacts onto the existing road network external to the site. On bituminous surfaced roads, and depending on the cause of failure, this is likely to manifest as surface failures, initially as 'crocodile cracking' of the bituminous surface followed by potholes and extensive 'crocodile cracking' in the wheel path. If the base course fails due to excessive loading, the failure is likely to manifest as longitudinal rutting in the wheel tracks of the road surface. Gravel roads will deteriorate faster, create significant dust, experience accelerated gravel loss and formation of corrugations.
- If the **materials** from the diamond mining tailings and commercial sources are not suitable or available, it may be necessary to identify and open new borrow pits. This requires a new mining application concessions involve a separate EIA process

Extent of the Impact: The additional construction traffic has the potential to lead to premature failure of the roads, both surfaced and gravel, between the source and the site. The gravel roads may need regular grading to smooth out the surface, but may need to be re gravelled after completion of the project to restore it to its former condition. It may be worth considering formalising the main local access to an asphalt surface, provided the existing pavement structure is adequate. This will require further investigation and a detailed pavement design. (See Section 6.2.6: External Roads).

Potential Significance: The construction activities and significant abnormal loads to the site could have a significant negative impact on the existing road network external to the site. Whilst it is not considered a "red flag", the impact on the existing external roads should never the less be included in and mitigated as part of the project.

6.2.3 Working Platform and Crawler Crane Lay down area

A lay down area will be needed for the erection of the crawler crane, and would have to be compacted and levelled to accommodate the assembly crane. The assembly crane needs to access the main lifting crane from all sides and when the main lifting crane is fully assembled on the ground. The lay down area required at each re-establishment location will need to be approx. 20m wide x 150m long.

To enable the assembled crawler crane to move around the site and around the base of each turbine, the gradient and cross-fall of the working platform shall not exceed 1 degree or (1.7%) either way. If these geometric requirements cannot also be achieved for the service road between turbine installations, the crane would have to be stripped and re-assembled in each location, requiring another lay-down area at each site. This requirement is possible if the service road follows the existing contours, but in a grid pattern arrangement, it will not always be possible to achieve these flat grades. There is approximately a 3 day period required to strip, transport and re-assemble the crawler crane at a new turbine location. The maximum ground bearing pressure that the crane would exert when fully assembled will be 13N/m2 under the track pads. For the main lift crane to travel between wind turbine installations (either assembled or stripped), the roadway will need to be approximately 11m wide to accommodate the crawler cranes tracks. In order for the crawler crane to travel fully rigged between turbine sites to roadway will need to be 11m wide designed to the geometric specifications above and with a pavement structure designed to support the tracks width and bearing pressure. To manoeuvre and travel fully assembled on site, the working area around the base of the turbine and the access roads between turbines will also need to support the loading. The construction of the 11m wide roadway may be undertaken in two halves. One side, say 6m, to full pavement structure to carry the abnormally loaded vehicles and construction traffic and the other side, say 5m, simply cleared and compacted sand to a widening up to 11m to accommodate and support the filly rigged crawler crane tracks only.

The crawler crane superstructure, crawler centre, travelling gear (tracks) and counter weights but without the main booms and auxiliary jib can travel on the un-compacted sand between turbine sites and the 5m wide compacted strip will not be necessary.

Nature of the Impact: To achieve smooth 'flat' gradients may require significant cut and fill earthworks. A large area needs to be cleared, levelled and compacted at each turbine location resulting in disturbance to existing conditions.

Extent of the Impact: Confined to the internal study area but may result in extensive disturbance of the site. The extent of the impact could be reduced if part of the lay down area lies over the new service road alignment.
Potential Significance: Can be managed.

6.2.4 Sub-station, Underground and Overhead Power lines

The 11kV underground cable routing will be very dependent on the final turbine layout and the cable routing can be optimised at a later stage. It is proposed to install the wind farms' substation at a central location within the facility. It is assumed that the 132kV distribution lines feeding into the electricity distribution network / grid at the Koekenaap or Juno Substation will be installed above ground on pylons. . From this point, the overhead power line following the Skaapvlei – Koekenaap road (Route G1) to the substation can be installed.
Nature of the Impact: On the wind farm site, the 11kV cables will be buried in narrow trenches approximately 1m deep. It will be a single disturbance of the ground followed by backfill and reinstatement. The 132kV cables will be installed on overhead poles and the impact is limited to the excavation of the hole which will be at numerous limited locations along the verge of the existing roads, through Koekenaap to the substation.
Extent of the Impact: On site it is confined to the cable routes themselves. The extent of the impact external to the site is limited to the cable route.
Potential Significance: Low

6.2.5 Concrete Batching Plant

Each turbine installation requires a 15m x 15m x 2 to 3m deep concrete foundations. Significant quantities of concrete are going to be required for the base foundation of each turbine. The batching plant needs to be near a potable water supply and it is assumed a batching plant will be established in a neighbouring town or remote plant where water is accessible. Concrete will be prepared at the batching plant and conveyed to the turbine sites in cement mixer trucks. The sand, stone and cement will be obtained from commercial sources and stockpiled in bins and silos at the batching plant. Other alternatives will be investigated such as establishing batching plants in the Vredendal or Lutzville area and transporting the concrete to site.
Nature of the Impact: Whether concrete is transported from the batching plant external to the site, or the sand, stone and cement is brought to site and batched from Skaapvlei, the operation will add direct and cumulative axle loading impacts onto the existing road network. On bituminous surfaced roads, and depending on the cause of failure, this is likely to manifest as surface failures, initially as crocodile cracking of the bituminous surface followed by potholes and extensive crocodile cracking in the wheel path. If the base course fails due to excessive loading, the failure is likely to manifest as longitudinal rutting in the wheel tracks of the road surface. Gravel roads will deteriorate faster, create significant dust, experience accelerated gravel loss and formation of corrugations.
Extent of the Impact: The additional construction traffic has the potential to lead to premature failure of the roads, both surfaced and gravel, between the source and the site. The gravel roads may need regular grading to smooth out the surface, but may need to be re gravelled after completion of the project to restore it to its former condition.

Potential Significance: The construction activities and significant abnormal loads to the site could have a significant negative impact on the existing road network external to the site. Whilst it is not considered a "red flag", the impact on the existing roads should never the less be mitigated as part of the project.

6.3 External Road Works

6.3.1 General

Following a detailed transport evaluation of swept paths, structural capacity of existing roads and structures etc. a number of minor external work projects may be required between Cape Town and the site.

Nature of the Impact: Will most likely be road widening and corners at intersections, removal of traffic islands and replaced with road pavement structure, relocation of street furniture, installation of temporary support to culverts and canal crossings, vertical re-alignment of existing road to accommodate clearance of low-bed trailers and horizontal re-alignment of tight bends to accommodate 45m blade trailers.

Extent of the Impact: Likely to be localised to the point where small scale modifications, mitigating measures may be required.

Potential Significance: There may be a number of very significant issues (see Figures 2 to 11) that will be raised for further investigation by the permit issuing authority. In order to obtain route clearance, the transportation contractor will need to comply with all the permit conditions.

6.3.2 Proclaimed Trunk, Main and Divisional Roads – Road Pavements

Generally, the surfaced road network has been designed to carry a certain number of axle loads (known as E80's) in its lifetime. Abnormal loads simply increase the number of axle loads over a shorter period of time. It is assumed that the existing surfaced roads will be able to withstand the loading, but the existing gravels will need regular routine maintenance during the construction period.

Nature of Impact: The DR 2225 (Figure 10: Route G1) is the un-surfaced gravel road to Skaapvlei and it is going to be impacted upon by the abnormal wheel loads (specifically those with load limitations) and construction traffic. These vehicles will impart additional axle loading onto the existing road pavement structure. The structural capacity of the surfaced roads and un-surfaced gravel roads varies depending on the sub-soil conditions, sub-grade support material, and the thickness and quality of the materials making up the road pavement structure. The existing gravel layer thicknesses and hence the structural strength are unknown at this stage. The locals have indicated that the road surface can become very poor as the riding surface degrades under normal traffic. It is graded as part of the Road Authorities routine maintenance responsibilities. Gravel roads are re-gravelled on a regular basis and the structural capacity of the pavement structure can vary significantly.

The West Coast normally experiences a relatively hot and dry climate, but extensive thunder showers during July 2007 revealed that the stormwater run-off can become trapped by virtue of the gravel berm's on both sides of the road. The berms result from the grading operations where excess gravel material is scrapped to the sides of the road forming a low mound along the edges. In a sag vertical curve, stormwater run-off can become trapped & flood the roadway. Under these conditions, trucks transporting abnormal loads through the flooded area will almost certainly get bogged down in saturated sub-soil conditions.

Extent of Impact: The transportation of components and construction vehicles will have an impact all roads along the proposed transport routes, but road pavements are designed to support a certain number of axle loads during their life. Gravel roads (DR 2225 specifically) are likely to deteriorate at an accelerated rate forming corrugations and uneven riding surface with associated gravel loss.

Potential Significance: Very significant. DR 2225 is the only un-surfaced portion of the route and a maintenance strategy will need to be submitted to the satisfaction of the Provincial Governments, District Roads Engineer (DRE). The DRE's permit conditions are likely to be that the public road shall be accessible to the public at all times and kept in an acceptable condition and that the applicant (ESKOM) shall be held responsible for returning the road to it's original if not better condition upon completion of the project. It may be worth considering re-constructing DR 2225 as formal surfaced rural road, with appropriate storm water drainage, between Koekenaap and Skaapvlei to provide a good quality transport route during construction and avoid the on-going gravel road routine maintenance that will be required to keep the road in good condition at all times. It will also provide a good quality access road to the Wind Energy Facility for maintenance personnel and possibly tourists and interested groups visiting the Facility.

7 CONCLUSIONS AND RECOMMENDATIONS

- The route(s) assessment from Saldanha Bay to Site were undertaken from a purely visual and desktop assessment point of view. Assuming suitable agreements, necessary alterations, protection, accommodation of structures etc can be reached to the satisfaction of the permit issuing authorities and affected land owners, ROUTES A1 (or A2), B, C, D1, F, G1 are considered the most suitable routes between Saldanha Bay and the site.

- These routes appear to be navigable by vehicles carrying the 45 meter blades and by vehicles carrying the 83 ton Nacelles, however, depending on the trailer used, there may be load restrictions imposed on certain older bridges and structures by the Provinces Bridge Engineer. These restrictions are normally imposed upon a transport contractor applying for the abnormal load permits once the configuration and specifications of the transportation vehicles is known.

- The "issues to be investigated" are contained in the above Figures 1 to 11, and summarises the potential problem areas requiring more detailed investigation.
    - o Routes A1 and A2 (Saldanha Bay Harbour to Velddrif): Abnormal vehicle access, lifting, swept path at intersections, dimensional limitations, load limitations;

- Route B (Velddrif to Piketberg): Swept path at intersections, dimensional limitations, load limitations;
- Route C (Piketberg to Klawer): swept path at intersections, dimensional limitations of the vehicles carrying the 45m blades needs to be checked with the geometric alignment (both horizontal and vertical) of the Piekenaarskloof Pass between Piketberg and Clanwilliam.
- Route D1 (Klawer to Vredendal R363): Swept path at intersections, dimensional limitations, load limitations on bridges, structures over canals, and vertical clearance at sharp change in vertical road alignment at an at-grade railway crossing;
- Route D2 (Klawer to Vredendal R362): Swept path at intersections, dimensional limitations, load limitations on bridges, structures over canals, and vertical clearance at sharp change in vertical road alignment at an at-grade railway crossing;
- Route E (Lamberts Bay to Clanwilliam R364): Abnormal vehicle access to harbour, lifting equipment at harbour, swept path at intersections, dimensional limitations, load limitations on bridges, structures over rail / canals / rivers, and vertical clearance at sharp changes in vertical road alignment accessing the harbour;
- Route F (Vredendal to Koekenaap R363): Swept path at intersections, dimensional limitations, load limitations on structures over canals.
- Route G1 (Koekenaap to Skaapvlei): Swept path at intersections, dimensional limitations, load limitations on structures over canals.
- Route G2 (Koekenaap to Nooitgedag): Swept path at intersections, dimensional limitations, load limitations on structures over canals. Beyond the existing formal 8m wide gravel road appears to be a lower standard 3-4m wide access road to Nooitgedag. The road will need to be considerably upgraded to Nooitgedag, and new construction for an extension northwards to the proposed site, to be suitable for carrying the abnormal loads to site. Additionally there are many issues in terms of land take / ownership and road realignment that will need to be resolved before this route becomes credible.
- Routes H (Cape Town Area to Piketberg): The R27 road over Diep River bridge has a very limited load bearing capacity and loads >60 tons are routed as shown in Figure 11. The infrastructure associated with the N7 has been designed to accommodate abnormal super-loading and no problems are envisaged. However, the geometric alignment (both horizontal and vertical) and swept path of the vehicles carrying the 45m blades needs to be checked through the Piekenaarskloof Pass between Piketberg and Clanwilliam.

From a visual inspection of the transport routes it appears at there are no issues that are insurmountable making it impossible for components to be transported to site. Should a single route (e.g. Route C in the Piekenaarskloof Pass) turn out to be un-passable by 45 m trailers, alternative routes or mitigating measures would need to be identified.

- For all routes, accredited escorting (or police escort) will be required for the Nacelle, Tower Sections and Blade component trailers to negotiate the routes and to assist with traffic control and control oncoming traffic flow for the entire route surveyed.

- It is anticipated that Police escorts will be required for the movement of all of the components.

- Permits will be required for transporting all components. These permits are at the discretion of the Permit Issuing Authorities. The issue of these permits is a major consideration before addressing the physical capability of the transport companies to deliver these components.

- It is recommended that adequate temporary warning signs implemented to warn other road users at critical points during the construction phase.

- All hedges, shrubs, bushes, trees and overhanging branches along the nominated routes must be trimmed to allow a minimum envelope of 5m wide x 5m high along the road.

- It is anticipated that the turbine components once landed, will either be stored at an appropriate holding area in Cape Town or Saldanha Bay and transported to the site at regular intervals over a 1 -2 year construction period. Where practical, any street furniture, signage, traffic signals, street lighting etc. along the route should be moved permanently to a location that will allow a minimum roadway envelope of 5.0 meters by 5.0 meters. This approach will eliminate the need to move any street furniture in the future should replacement components be need during operations and routine maintenance.

- In critical areas where land take or road widening is required, the road construction must conform to the minimum specification suitable for the transfer of axle loadings up to 16 tonnes (refer Vestas V90 'transport and erection guidance notes').

- After the tower dimensions have been agreed to, it is recommended that a "dry-run" with an empty extendable 45m blade trailer (or similar approved) and the most critical tower section trailer should be undertaken between the two harbours and the site entrance. This is in order to confirm the visual assessment contained in this report and test the requirements for road alterations both horizontally and vertically. The test run should be completed with an empty trailer, so that in an emergency or at the points where land take has been recommended, but not progressed with, or in the case of vertical issues there is insufficient ground clearance, the trailer can be 'closed' until it is past the hazard. The test run should be attended by Turbine manufacturers, project managers, Police, Provincial and District Municipality representatives and other interested parties with responsibility for road alterations.

- The maximum gross vehicle weight (GVW) anticipated for 90 Meter diameter rotor turbines could be the Nacelle at approximately 130 tonnes. The maximum GVW anticipated for transporting the superstructure and crawler centre section of the main lift crawler crane is approximately 133 tonnes. Therefore, a full route access report is recommended, in order to determine the acceptability of 'Gross Vehicle Weights' and 'Axle loading' issues, for bridges, culverts and structures for the entire route, the results of which have not been applied for in terms of the depth and level of reporting required for this report.

- Generally, the surfaced road network has been designed to carry a certain number of axle loads (known as E80's) in its lifetime. Abnormal loads simply increase the number of axle loads over a shorter period of time. It is assumed that the existing surfaced roads will be able to withstand the loading, but the existing gravels will need regular routine maintenance during the construction period.

Important Notes

- For the purpose of this report, the Blade trailer has been nominated as the longest overall loaded vehicle type that could be used for delivering the wind turbine components to site. However, there are components that when loaded are smaller 'overall' but which may have one or two dimensions that would exceed the dimensional limitations. E.g. Width of Bottom Tower sections are up to 4.5 m wide (For 90m Rotor turbines).

- However, the turbine manufacturers have differing tower designs. Therefore until specific tower dimensions are confirmed, the exact swept path areas and ground clearance of loaded tower trailers are un-quantifiable. Therefore it should be noted that all assessments and inspections have been done so with the intention of producing information to highlight any specific anticipated problems. This includes highlighting of potential 'Land take' requirements, possible 'Street furniture' implications, and road alignment issues.

- Land take is usually referred to when land is required from private land owners and road widening is usually referred to when land is required within a road reserve. However the details of the nominated land take and road widening contained in this report are highlighting the expected areas of concern, and can only be confirmed by swept path analysis. The boundaries between private land and Council property are assumed by using obvious demarcation such as fence lines/hedges etc. It should be noted that actual road reserve / private land boundaries are not substantiated in this report and can only be authenticated by carrying out land searches.

- All route inspections and assessments, and subsequent conclusions and recommendations are deemed accurate by Arup SA (Pty) Ltd at the date that this report is created. We cannot be held responsible for the development of future road schemes or alterations to the routes surveyed that may leave this report inaccurate.

- This report is based solely on a preliminary visual inspection and desktop study. Nothing in this report shall be construed in any way as committing Arup SA (Pty) Ltd to confirming the ability of the routes to deliver turbines to site before a 'test run' has been undertaken, and any accommodation/ remedial works undertaken which are to the Permit Issuing Authority and the appointed Transport Operators satisfaction.

Reference documents

1. Technical Recommendations for Highways (TRH 11): "Draft Guidelines for Granting of Exemption Permits for the Conveyance of Abnormal Loads and for other Events on Public Roads"

2. Vestas Transport Guidelines V90-3.0MW

3. Transport Vehicles for Wind Power Plant, Goldhofer

4. Riaan Smit's website, http://mysite.mweb.co.za/residents/rrsmit/v66.htm

5. Liebherr Crawler Crane LR1750 Transportation Information

6. Liebherr Mobile Crane LTM 1200-5.1