Technical Note

Project:	**14C00570-01-10-210-R1_140409**	Job No:14C0070
Subject:	**Preliminary design Report**	
Prepared by:	**David Lee**	Date: 04 April 2014
Reviewed by:	**Christian Di Dio**	Date: 08 April 2014
Approved by:	**Christian Di Dio**	Date: 09 April 2014

Rev No	Comments	Prepared by	Approved by	Date
00	Submitted to Client on 08/04/2014	LD	CDD	
01	Submitted to Client on 09/04/2014	LD	CDD	

Introduction

Following the completion of an initial track layout and after the topographical data has been provided a design review was undertaken which including horizontal track realignment, vertical track review, cut and fill volume assessment, watercourse crossing identification, crane pad alignment and consideration of construction risks.

The following report summarises the findings of this review.

Track Alignment

The initial track layout produced for De Aar 1 consisted of the following:

- Approximately 60.2km of new tracks,
- 31 watercourse crossing locations, and;
- Multiple locations where the track traversed unnecessarily over steep gradients.

A reduction of the track length, the number of watercourse crossings and by avoiding areas of steep gradient the engineering works on site can be reduced. This has potential to reduce several negative impacts associated with the construction of the wind farm. By reducing the track length and avoiding areas of steep gradient will reduce the volume of cut and fill required which consequently reduces the overall development footprint and reduces construction time allowing for rehabilitation to commence at an earlier date. Reducing track length and water crossings will reduce freshwater impacts, such as erosion, sedimentation and disturbance of freshwater related habitats

A horizontal review of the proposed track was undertaken which resulted in a realigned route resulting in the following:

- Approximately 56.4km of new tracks,
- 13 watercourse crossing locations, and;
- A route better aligned with the topography of the site.

The reduction in track length equates to approximately 6,080m of stone (assumed depth of 0.4m and width of 4m) which would have to be either won on site or imported to site. The track length reduction will also result in less engineering works associated with cut and fill.

A reduction of 18 watercourse crossings will reduce the engineering works on site as well as removing engineering works at watercourses therefore removing potential environmental impacts.

Direct Tel: +44 (0)141 222 4266
T +44 (0)131 301 8733
F +44 (0)131 301 8699
E david.lee5@aecom.com
www.aecom.com

1 Tanfield
Edinburgh
EH3 5DA
United Kingdom

A vertical alignment review was also undertaken in order to review the buildability of the tracks and to produce initial cut and fill volumes, as detailed below.

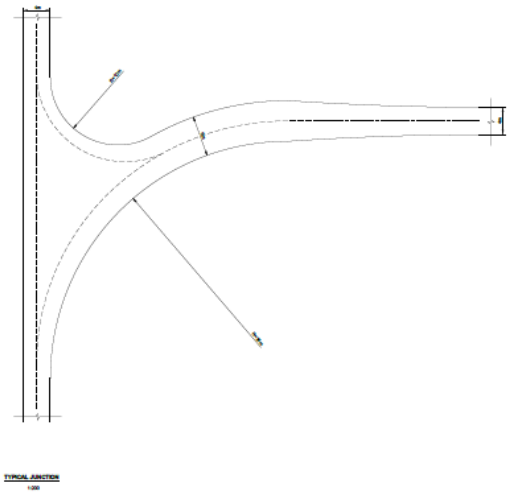
- Volume of cut = 298,200.87m^3
- Volume of fill = 244,032.45m^3
- **Net = 54,168.42m^3 (Cut)**

Track Design Specification

The horizontal and vertical alignment review and resulting track route where undertaken against the follow criteria:

- Track width;
  - Straight track (0 – 20°) – 4m
  - Bend (20 – 60°) – 5m
  - Bend (60 – 90°) – 6m
- Min horizontal curve – 35m (inside radius)
- Min vertical curve – 400m
- Longitudinal Gradient;
  - Preferred gradient – 10% (where possible)
  - Max gradient – 14%
- Track cross fall – 5% (max)
- Spacing between bends (>60°) – 40m

Typical junction is shown below

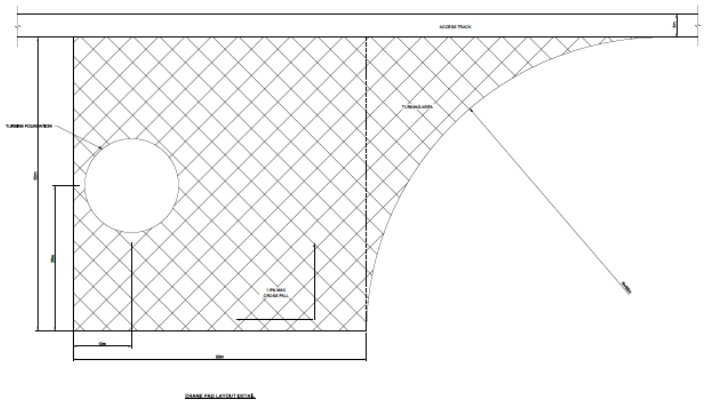


Crane Pad Alignment

The maximum cross fall for the crane pads is 1.5%, given the proposed crane pad dimensions are 50m x 50m the maximum height difference across the width / length of the crane pad is 0.75m.

The orientation of crane pads in the initial layout resulted in height differences up to 10m across the length and width of the crane pad. To try and minimise this and hence minimise the amount of cut and fill at these locations some of the crane pads have been reoriented, however due to the proposed wind turbine locations and the crane pad layout there are still locations where the height difference is up to 8m.

Typical Crane Pad is shown below



Construction Yards
The initial layout proposed the following construction yards:

- CY1 – 400m x 200m = 80,000m²
- CY2 – 400m x 200m = 80,000m²
- CY3 – 150m x 100m = 15,000m²

It is anticipated that the construction yard will consist of the following:

- Welfare facilities including;
  - Canteen
  - WC
  - Offices
  - Changing Rooms
  - Meeting Rooms
  - Parking
- Storage including;
  - Bunded fuel areas
  - Oil storage areas
- General stores (containers)
- Skips

It is believed the initial proposed size of the construction yards can be reduced to the following:

- CY1 – 350 x 200m = 70,000m²
- CY2 – 200m x 100m = 20,000m²
- CY3 – 100m x 100m = 10,000m²

The main construction material on site, crushed rock and concrete, will not be stored within these areas and turbine components will be delivered direct to the location they will be erected therefore large areas for material storage are not required

Watercourse Crossings
The number of watercourse crossings (**WC**) has been reduced from 31 to 13; the coordinates (X, Y - Cape LO25 and UTM WGS84/34) of each are listed below:

- WC1 (X,Y) -110929.2910, -3400673.0403 772141.877854; 6597810.11002
- WC2 (X,Y) -110764.2748, -3400753.9368 772303.961826; 6597723.34666
- WC3 (X,Y) -110611.2487, -3400832.4472 772454.144294; 6597639.39641

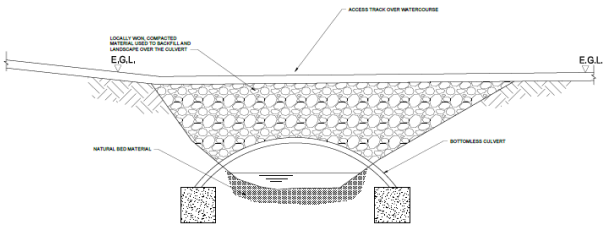
- WC4 (X,Y) -109673.7779, -3401845.4855 773355.20476; 6596593.16741
- WC5 (X,Y) -109814.7892, -3402568.2193 773188.427495; 6595875.65924
- WC6 (X,Y) -109494.1488, -3403522.0959 773474.919995; 6594910.58448
- WC7 (X,Y) -109197.4689, -3403909.6508 773757.680053; 6594512.53453
- WC8 (X,Y) -108988.0080, -3403893.1551 773967.675828; 6594521.54429
- WC9 (X,Y) -108432.0204, -3405078.2374 774481.184672; 6593316.90317
- WC10 (X,Y) -109557.7279, -3405534.5190 773339.46519; 6592900.96363
- WC11 (X,Y) -109679.8277, -3405491.1550 773218.94733; 6592948.67919
- WC12 (X,Y) -109926.0016, -3405332.6566 772978.502692; 6593115.93169
- WC13 (X,Y) -108245.5822, -3402982.4441 774742.43825; 6595405.50798

All watercourse crossings will be installed in accordance with DWA guidelines and will be based on the following principles:

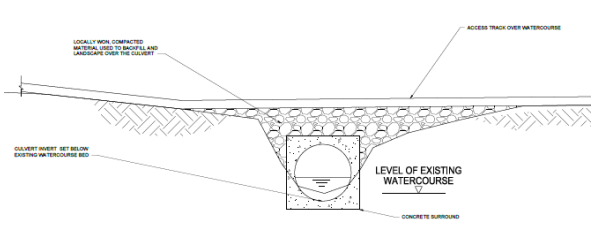
- The alignment of the culvert will be parallel to the existing channel;
- The gradient of the culvert will be similar to the existing channel;
- The width of the culvert will be greater than the active width of the channel;
- The height of the culvert will be greater than the active height of the channel;
- There will be no hydraulic drops at the inlet or outlet of the culvert; and
- The culverts will be partially buried and natural bed material reinstated within the culvert

The type and size of crossing will be determined at the detailed design stage; however, it is likely they will either a bottomless arch culvert or a closed pipe culvert depending on the watercourse size.

Typical watercourse crossings are shown below:



Bottomless Arch Culvert



Closed Pipe Culvert

Following construction, the watercourse crossings will remain in place for the lifetime of the wind farm and will then be removed and the natural bed reinstated.

Constraints and Restrictions

The main constraints and resections that present at De Aar 1 are detailed below:

- High sensitivity botanical areas
  - Present on the north eastern ridge of the site,
- Heritage areas
  - Adjacent to construction yard 3 (north eastern ridge)
- Flood plains
  - Present across the majority of the site

All of these constraints have been fully avoided with the exception of a section of track, which accesses turbine 08 and 55, which crosses a floodplain in the south west of the site.

Several watercourses are also present across the site, as previously mentioned the realigned track has removed the requirement for 13 watercourse crossings. Away from the crossings, where possible, a 35m buffer has been applied to minimise any potential impact on the watercourse.

Construction Issues

The main construction issues on site are a result of topography and the proposed wind turbine locations and are summarised below:

- Crane pad construction – due to the proposed location of several wind turbines and the proposed crane pad layout significant engineering works will be required to achieve the desired cross fall of 1.5%.
- Track construction – many of the steep gradients on site are unavoidable and therefore to achieve a desired maximum gradient of 14% sections of cut of 6 – 8m are present.
- Wind turbine erection – steep slopes are adjacent to many of the wind turbines which may make the erection of the turbine difficult. It may not be possible to assemble the blades to the rotor on the ground.
- Crane boom assembly – it might be complicate for about 30% of the hardstand/road achieves the 100m flat length for the installation of the boom of the crawler crane.
- Roads Width – due to the topography of the site the proposed specific width (straight track 4m) might create complication for transport.

Conclusions and Recommendations

The realigned track presents a more buildable route in terms of reducing the amount of engineering works required in comparison to the initial layout as well as having the potential to reduce construction costs and potential environmental impacts.

The main construction risks are a result of the steep gradient present across the site, to reduce the impact from the steep gradients it the following is recommended:

- Increase the maximum track gradient of 14% – Alternative track surface finishes or consideration of the use of tugs for turbine component deliveries would allow the track gradient to be increased and therefore reduce the amount of cut and fill required.
- Reduce the size of the crane pad layout – The current crane pads are propped to be 50m x 50m and include the turbine foundation within them. It is believed that these are oversized and a reduction in size will reduce the amount of cut and fill required.
- Micro-siting of wind turbines – Many of the wind turbines have been located on peaks across the site which will increase the amount of cut and fill associated with the crane pads as well making the wind turbine erection difficult. Micro-siting turbine to flatter areas would reduce the amount of cut and fill required as well as simplifying the erection process.
- Increase in the width the internal road at a minimum straight value of 4.5 m

ELECTRICAL LEGEND:

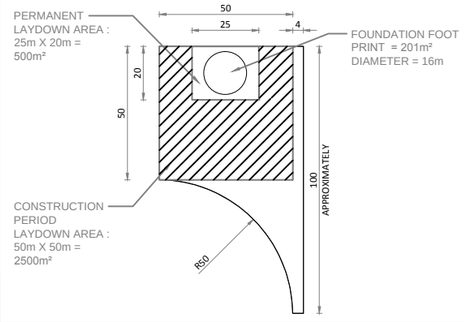
- 33kV (MV) OVERHEAD LINE ROUTE

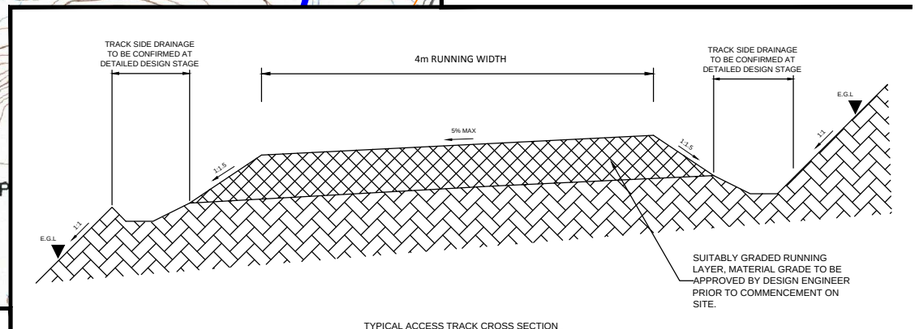
CIVIL LEGEND:

- WATERCOURSE/RIVER
- 4m ROADWAY CONSTRUCTION-OPERATION
- EXISTING ROADS
- EXISTING ESKOM LINES
- PROPOSED POWER LINE
- WTG — WIND TURBINE GENERATOR
- FRESH WATER BUFFER/SETBACK
- AQUATIC NO GO AREA
- WETLAND
- CONSTRUCTION CAMP
- CONTOURS
- BOTANICAL HIGH SENSITIVITY AREA WITH 30m BUFFER
- HERITAGE AREA WITH 15m BUFFER
- WC 01 — WATER CROSSING
- VERREAUX EAGLE NEST

TOTAL ROAD CUT VOLUME = 298 200 m³
TOTAL ROAD FILL VOLUME = 244 032 m³
TOTAL CRANE PAD CUT VOLUME = 95 475 m³
TOTAL CRANE PAD FILL VOLUME = 1 213 772 m³

TYPICAL TURBINE HARD STAND AREA
NOT TO SCALE





TYPICAL ACCESS TRACK CROSS SECTION

REV	DATE	REVISION DESCRIPTION	DRAWN

CAPE TOWN OFFICE
WATERSIDE PLACE, SOUTH GATE
TYGER WATERFRONT
CARL CRONJÉ DRIVE
TEL: +27 (0)21 950 7500
FAX: +27 (0)21 950 7502
REG. No. 1966/006628/07

DISCIPLINE: **ENERGY**

THE MASTER HELD AT THE AECOM OFFICE BEARS THE ORIGINAL SIGNATURE OF APPROVAL.

CLIENT: MULILO

PROJECT DESCRIPTION: **DE AAR 1 WIND FARM**

DRAWING TITLE: **ENVIRONMENTAL SENSITIVITY LAYOUT**

FUNCTION	NAME	SIGNATURE
DESIGNED BY		N/A
DRAWN BY	J FRANCKE	N/A
DESIGN CHECKED BY		N/A
DRAWING CHECKED BY	C DI DIO	N/A

APPROVAL - CONSULTANT

NAME		SIGNATURE	
DATE		PROF. REG No.	

DRAWING STATUS CODES:
D=DRAFT F=FINAL R=REPORT
P=PRELIMINARY C=CONSTRUCTION
T=TENDER A=AS-BUILT/RECORD

FIRST ISSUE DATE	2014-04-11	
SCALE	SHEET	SHEET SIZE
1:50.000	1 OF 1	A3

AECOM DRAWING NUMBER

AECOM PROJ. No.	SUB-No.	DISCIPLINE	NUMBER	STATUS	REVISION
14C00570	34	09	**EL01**	**P**	**04**