Appendix G
Traffic Assessment

aurecon

Project: Glen Innes Wind Farm

Traffic Assessment

Reference: 236777

Prepared for: Glen Innes Wind Farm Pty Ltd

Revision: 3

11 December 2013

Document Control Record

Document prepared by:

Aurecon Australia Pty Ltd
ABN 54 005 139 873
Level 2, 116 Military Road
Neutral Bay NSW 2089
PO Box 538
Neutral Bay NSW 2089
Australia

T +61 2 9465 5599
F +61 2 9465 5598
E sydney@aurecongroup.com
W aurecongroup.com

<table>
<tr><th colspan="7">Document control</th><th>aurecon</th></tr>
<tr><td colspan="2">Report Title</td><td colspan="6">Traffic Assessment</td></tr>
<tr><td colspan="2">Document ID</td><td></td><td colspan="2">Project Number</td><td colspan="3">236777</td></tr>
<tr><td colspan="2">File Path</td><td colspan="6">C:\Users\heather.tilley\AppData\Roaming\OpenText\OTEdit\EC_cs\c84869506\236777-GIWF-Traffic Assessment Final-Rev02.docx</td></tr>
<tr><td colspan="2">Client</td><td>Glen Innes Wind Farm Pty Ltd</td><td colspan="2">Client Contact</td><td colspan="3">Colin Paterson</td></tr>
<tr><td>Rev</td><td>Date</td><td>Revision Details/Status</td><td>Prepared by</td><td>Author</td><td>Verifier</td><td colspan="2">Approver</td></tr>
<tr><td>0</td><td>10 July 2013</td><td>Draft</td><td>TLN</td><td>TLN</td><td>BS</td><td colspan="2">HT</td></tr>
<tr><td>1</td><td>23 August 2013</td><td>Swept Path Assessment</td><td>TLN</td><td>TLN</td><td>BS</td><td colspan="2">HT</td></tr>
<tr><td>2</td><td>22 October 2013</td><td>Final</td><td>TLN</td><td>TLN</td><td>BS</td><td colspan="2">HT</td></tr>
<tr><td>3</td><td>11 December 2013</td><td>Final including comments from DOPI</td><td>TLN</td><td>TLN</td><td>BS</td><td colspan="2">HT</td></tr>
<tr><td colspan="2">Current Revision</td><td colspan="6">3</td></tr>
</table>

<table>
<tr><th colspan="4">Approval</th></tr>
<tr><td>Author signature</td><td>[signature]</td><td>Approver signature</td><td>[signature]</td></tr>
<tr><td>Name</td><td>Tony Nguyen</td><td>Name</td><td>Heather Tilley</td></tr>
<tr><td>Title</td><td>Transport Planner/Modeller</td><td>Title</td><td>Project Leader</td></tr>
</table>

Contents

Appendices

Appendix A

Traffic and Transport Issues

Appendix B

ECO 122 Technical Description

Appendix C

ECO 122 Installation Instructions

Appendix D

Swept Path Assessment

Index of Figures

Index of Tables

1. Introduction

Glen Innes Wind Farm Pty Ltd has engaged Aurecon to prepare a Traffic Assessment, which forms part of an overall Environmental Assessment (EA), to support an application to modify the project approval to permit the construction of the Glen Innes Wind Farm using larger wind turbine generators.

1.1 Background

Glen Innes Wind Farm was approved by the Department of Planning under Part 3A of the EP&A Act on 2 October 2009. Following an, the Land and Environment Court upheld the approval and modified conditions of consent were approved on 2 September 2010. The approval was for the construction of up to 25 wind turbine generators (WTGs) with up to 81 MW capacities (each WTG with 3 MW capacities). The 2009 Environmental Impact Study (EIS), which was originally submitted to the Department of Planning, considered WTGs with a hub height of 80 m and rotor diameter of 88-100 m. Glen Innes Wind Farm Pty Ltd now wishes to consider using more efficient WTGs. These turbines are larger with a nominal hub height of 89 m and rotor diameter of 122 m (tip height of 150 m).

1.2 Report purpose

Glen Innes Wind Farm has requested an assessment of the environmental impacts associated with the change to larger turbines. This Traffic Assessment report aims to present the potential implications of the larger turbines, if any, from a traffic and transport perspective, by establishing an understanding of the issues raised previously, the existing situation and the associated constraints. This report intends to:

- Update and supplement the previous Traffic and Transport Issues, prepared in the 2009 EIS where appropriate.
- Consider and revise transport requirements for the larger turbines where required.
- Highlight any key roads and/or intersections along the preferred transport route that warrant detailed investigations based on a Swept Path Assessment.

This assessment has taken into account the larger WTG components, the potential transport vehicle and route access as well as providing a comparative assessment of the previously approved conditions to the proposed modifications for the larger WTGs. This report is prepared as a desktop assessment, intending to provide guidance for Glen Innes Wind Farm along the approvals pathway, so that further detailed assessments may be identified and undertaken at later stages.

1.3 Supporting documents

To gain an appreciation of the proposal and the potential impacts to be assessed, the following documents have been supplied by Glen Inness Wind Farm The supporting documents, appended to this report with information extracted and reproduced where relevant, are considered for the purposes of this Traffic Assessment:

- *Glen Innes Wind Farm Environmental Assessment, Chapter 9 – Traffic and Transport Issues,* prepared by Connell Wagner, October 2008
- *ECO 122 – General description,* Technical Description, prepared by ALSTOM WIND, 29 September 2011.
- *Wind Turbine ECO 100/110 tower 75, 90m and ECO 122 T89m – Requirements for transport and installation,* Installation Instructions, prepared by ALSTOM WIND, 30 July 2012.

2. Existing traffic situation

This section of the Traffic Assessment aims to establish an understanding of the existing traffic and transport environment in terms of the current road network layout that should be considered for the proposed Glen Innes Wind Farm.

2.1 Study area

The proposed wind farm site is located approximately 15 km west of the township of Glen Innes, situated within the Local Government Area of Glen Innes Severn Council. Figure 2.1 is an extract from the 2009 EIS which illustrates the location of the wind farm site in a regional and local context. Note that some of the proposed WTG locations dotted in Figure 2.1 may have been adjusted as a result of the project updates.

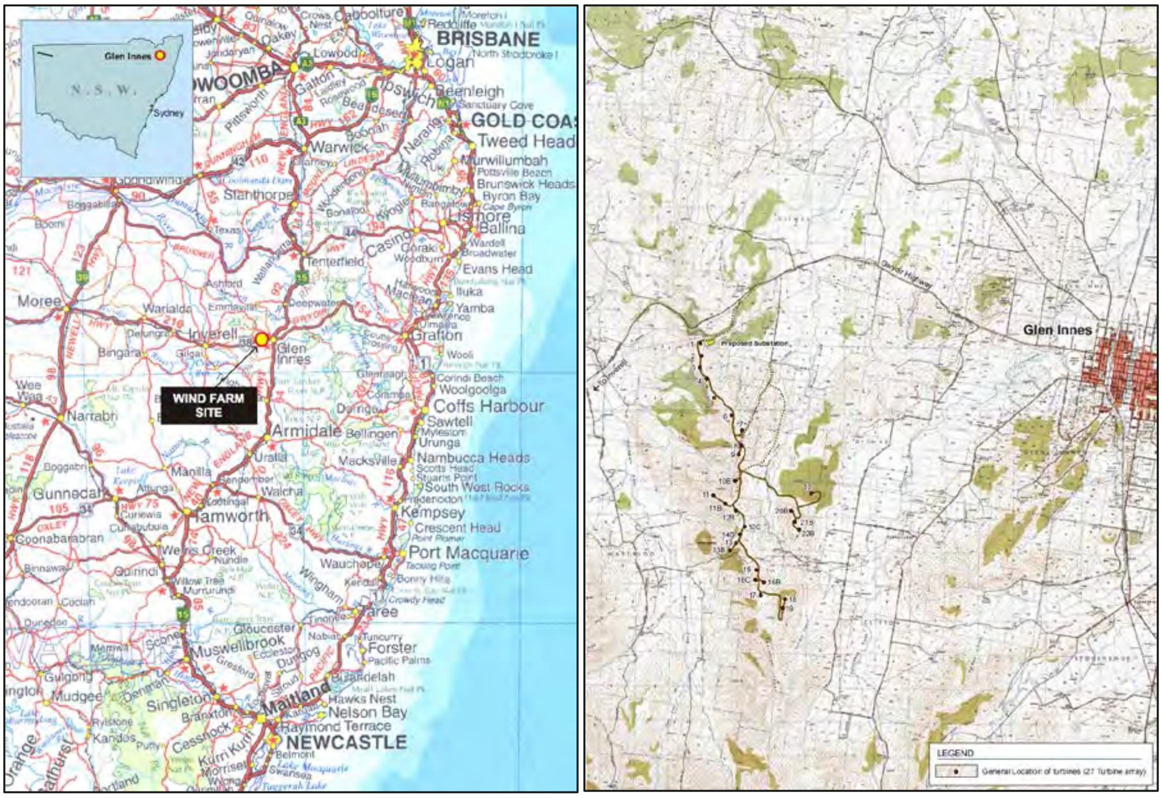


Figure 2.1 **Regional location map and locality map**

The general location of the proposed wind farm site is scattered west of Glen Innes, amongst the Waterloo Range, south of the Gwydir Highway and west of the New England Highway. Glen Innes Severn Council's website suggests that the vast majority of their roads, 758.3 km, are unsealed and there are 377.38 km of seal roads which includes 67.6 km Regional Roads (State Roads).

As previously described in the Traffic and Transport Issues report of the 2009 EIS, attached in Appendix A, the existing roads that provide potential access/egress for the wind farm site consist of, but are not limited to:

- Gwydir Highway
- Former Gwydir Highway alignment
- Rose Hill Road
- West Furracabad Road
- East Furracabad Road

2.2 Road hierarchy

Under the Roads Act 1993, roads are classified under a legal framework which divides them into three administrative categories. The NSW State, Regional and Local Road administrative system of road classification[1] generally aligns to the following model hierarchy:

- State Roads – Freeways and primary arterials
- Regional Roads – Secondary or sub-arterials
- Local Roads – Collector and local access roads

State Roads are the primary network of roads providing links within urban centres of Sydney, Newcastle, Wollongong, the Central Coast, and throughout NSW. State Roads generally include roads classified as Freeways, National/State Highways and Main Roads under the Roads Act. State Roads are the responsibility of the NSW Roads and Maritime Services (RMS) however the local governing council remains the owner, providing maintenance, for State Roads other than Freeways. RMS only exercises authority for the function of the road as a State Road (such as road pavement and structures).

Regional Roads are the secondary road network which, together with State Roads, provide for travel between towns and districts, performing a sub-arterial function within major urban centres. Regional Roads are the responsibility of the local governing council and generally include roads classified as Secondary Roads with some Main Roads.

Local Roads consist of those roads not classified under the Roads Act. Local Roads are collector and local access roads which provide linkages to State and Regional Roads as well as within developed areas. Local Roads are the responsibility of the local governing authority.

2.2.1 Alpha-numeric road numbering system

In conjunction with the road hierarchy system, from early 2013, the NSW government is phasing in a new alpha-numeric road numbering system to improve how motorists find their way across NSW, which aligns with Queensland and Victoria's nationally-agreed road numbering system.

The alpha-numeric road number system uses a combination of a letter and a number to identify a route. RMS has allocated the alphabetical character based on whether a road is considered a National or State significance from a guidance perspective and a number from 1 to 99. The letters are either:

- M – Meaning Motorway standard road of national significance. Motorways are generally major roadways with a divided carriageway of two or more traffic lanes in each direction, where opposing traffic is separated by a median strip with controlled entry and exits.
- A – Routes of National significance or important arterial roads in major urban areas.
- B – Routes of State significance.

Therefore, the New England Highway is assigned A15 and the Gwydir Highway as B76. Refer to Figure 2.2 for maps that illustrate the RMS road hierarchy classification in conjunction with the alpha-numeric road numbers for significant routes through Glen Innes.

[1] NSW Road Classification Review Panel – Final Report, August 2007, RMS

Figure 2.2 **RMS road hierarchy classification and alpha-numeric road numbers**

2.2.2 Classified roads

The following describes the features of the classified roads within the vicinity of the proposed wind farm. Table 2.1 outlines the AADT volumes for the relevant count stations, which also presents the growth rate per annum to indicate the traffic volume trends for that period. Presenting the historic traffic data for both classified roads provides an indication of the expected local and/or regional traffic volumes representative for the area.

New England Highway, A15

The New England Highway is classified as a National Highway of significance which consists of typically a two lane, two-way undivided carriageway and provides an inland north-south link between Newcastle and Brisbane. The general posted speed limit along the New England Highway is 100 km/h however this is reduced accordingly when passing through townships and other land uses. According to the RMS Traffic Volume Data for Hunter and Northern Regions 2004, the New England Highway carries an Annual Average Daily Traffic (AADT) volume of approximately 6,480 vehicles per day, south of Meade Street, within the town centre of Glen Innes.

Gwydir Highway, B76

The Gwydir Highway is classified as a State Road of significance which similarly consists of typically a two lane, two-way undivided carriageway with a posted speed limit of 100 km/h. According to the RMS Traffic Volume Data for Hunter and Northern Regions 2004, there are two count data stations along the Gwydir Highway that are within proximity to the Glen Innes Wind Farm:

- East of Lambeth Street, Glen Innes – 4,272 vehicles per day
- West of Dumaresq Street, at Furracabad Creek Bridge – 1,512 vehicles per day

As suggested by the two count stations, there is a decrease in traffic volumes westbound, away from Glen Innes, towards the proposed wind farm site. It should be noted that the counts were recorded in 2004 where the traffic volume trends may have changed over time, however this is indeterminate due to RMS not collecting and/or releasing any further traffic volume data since.

Station Number	Road	Location	Annual Average Daily Traffic Volume (AADT)				
			1995	1998	2001	2004	Growth rate per annum (1995-2004)*
91.440	NEW ENGLAND HIGHWAY	GLEN INNES-S OF SH12,MEADE ST	6552	6418	6916	6480	-0.12%
91.447	GWYDIR HIGHWAY	GLEN INNES-E OF LAMBETH ST	4598	#	4271	4272	-0.79%
91.068	GWYDIR HIGHWAY	GLEN INNES-AT FURRACABAD CK BR	1315	1654	1406	1512	1.66%

Table 2.1 AADT volumes for count stations nearby to Glen Innes Wind Farm

* Denotes station count in vehicles. # denotes missing data.

Based on the historic traffic volumes in Table 2.1, it is evident that there were minimal changes in AADT volumes between the periods of 1995 to 2004. It appears that the count stations closer to the Glen Innes town centre have marginally declined over the decade.

2.3 Heavy vehicle access

To help determine which roads permit the transportation of over-size and/or over-mass vehicles, RMS has roads and zones throughout NSW which are approved for Restricted Access Vehicles (RAV) as well as Higher Mass Limits (HML) for certain heavy vehicles to travel along. A vehicle or vehicle combination is considered to be over-size and/or over-mass if the height, width, length, rear overhang or forward projection or mass exceed the General Dimension Limits and/or Mass Limits. The heavy vehicle types for the approved operation routes of RAV and HML consist of, but are not limited to:

- Short combination vehicles (standard six-axle semi-trailers)
- B-doubles (19m B-Doubles operating greater than 50 tonnes, 23m B-Doubles and 25/26m B-Doubles)
- 4.6 metre high vehicles

Figure 2.3 is an extract from the RMS RAV and HML network maps which illustrates the classified roads in the vicinity of the wind farm site at Glen Innes. The New England and Gwydir Highways are RMS approved RAV and HML routes. Note that Glen Innes Severn Council and RMS permission is required where over-size and/or over-mass vehicles greater than the restrictions require access to transport the WTG components.

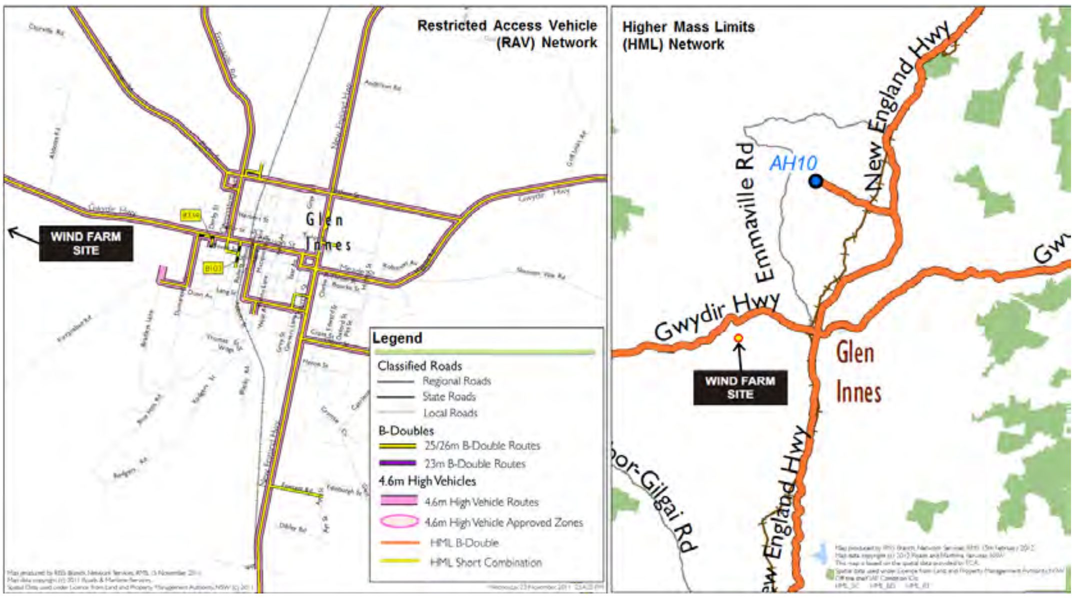


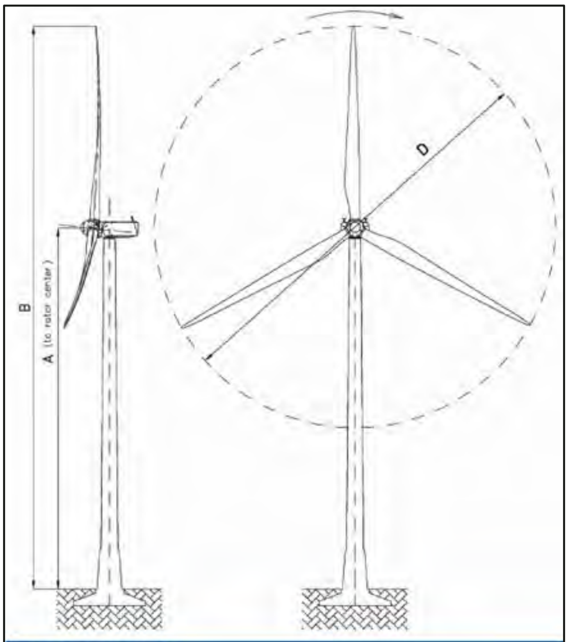
Figure 2.3 RMS RAV and HML network maps for Glen Innes

3. Glen Innes Wind Farm

3.1 Wind Turbine Generator components

This section reproduces extracts from *ECO 122 – General description,* Technical Description, prepared by ALSTOM WIND, 29 September 2011, to highlight the larger WTG components, to understand their restrictions and spatial requirements. Refer to Appendix B for further information relating to the Technical Description document.

The following figures and tables outline the general information for the wind turbine components. Figure 3.1 shows the general dimensions and specifications for the wind turbine model ECO 122 that is proposed for the Glen Innes Wind Farm site.



ECO 122 TOWER D= 122 m	T90
A - Hub height	89 m
B - Tip height	150 m

GENERAL SPECIFICATIONS	
Model	ECO 122
Wind Turbine Class according to IEC/EN 61400-1	III-A
Position of rotor relative to tower	Upwind
Hub height 1)	89 m
Rotor diameter	122 m
Rotor swept area	11 690 m^2
Rated power 2)	2.7 MW
Rated rotor speed (LSS)	12.25 rpm
Rotor speed range (LSS)	6.97 – 12.25 rpm
Tower type	89 m tubular
Foundation standard type 1)	Concrete octagonal foundation slab and concrete octagonal pedestal.
Colour	RAL 7035
Control system	Variable speed and pitch control
WEIGHTS (APPROX.)	
Blade	14 tons
Nacelle + rotor mass	165 tons

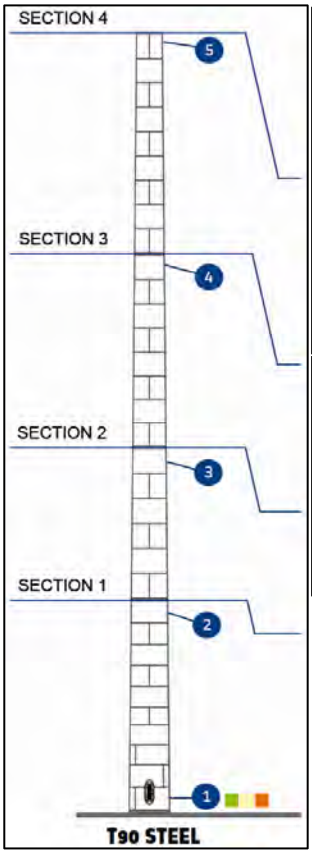
Figure 3.1 ECO 122 general dimensions and specifications

The larger model shown above contains the following increased dimensions in comparison to the previously approved WTGs:

Table 3.1 WTG dimension comparison

Dimensions (m)	Previous approved WTG	Proposed WTG, ECO 122
Hub height, A	80	89
Tip height, B	130	150
Rotor diameter, D	88-100	122

Figure 3.2 outlines the general specifications for the tower and blades of the ECO 122:



TOWER	T90
Type description	89 m tubular
Material	Steel
Foundation standard type	Concrete octagonal foundation slab and concrete octagonal pedestal. 1)
Tower base diameter	4.5 m
Steel tower top diameter	2.85 m
Corrosion class outside (EN 12 944)	C4
Color	RAL 7035

BLADES	
Length	59.3 m
Maximum cord	3.95 m
Blade surface area (1 blade) 1)	140 m^2
Weight (approx.)	14 tons

It.	Description
01	Lower platform
02	Section 1 flanges platform
03	Section 2 flanges platform
04	Section 3 flanges platform
05	Section 4 flanges platform

Figure 3.2 **ECO 122 tower and blades specifications**

From the previous Traffic and Transport Issues report, prepared as part of the 2009 EIS, an estimate for the predicted number of traffic movements related to the delivery of WTG components are reproduced in Table 3.2.

Table 3.2 **Predicted traffic movements for WTG components**

Material	Approximate Quantity / Number	One–Way Vehicle Movements	Vehicle Type
Wind turbine components			
Tower sections (4 per tower)	108	108	RAV
Nacelles	27	27	RAV
Hubs	27	27	RAV
Blades (3 per turbine) 1/truck	81	81	RAV
Generator Transformers	27	9	RAV

Due to the wind turbine components being over-sized and/or over-mass, RAVs would be required to transport the components to site. As shown in Table 3.2, the delivery of the tower and turbine component parts alone will generate approximately 252 one-way movements (which results in 504 entry and exit movements).

Typically, the delivery of the wind turbine components may be distributed over the course of three to four months so the movement of the RAVs will be scheduled to minimise impacts on the selected transport routes. A critical element of the transportation of such over-sized components would be to undertake community consultation and close coordination with local authorities, and to ensure that advanced notice and updates are regularly provided to the community, and maintaining the appropriate safeguards for road users. The proposed safeguards have been previously described in the Traffic and Transport Issues report as part of the proposed mitigation measures.

3.2 Transportation requirements

This sub-section is based on extracts from the document *Wind Turbine ECO 100/110 tower 75, 90m and ECO 122 T89m – Requirements for transport and installation,* Installation Instructions, prepared by ALSTOM WIND, 30 July 2012, to understand the potential movement restrictions with the transportation of the larger WTG components. Refer to Appendix C for further information relating to the Installation Instructions document.

It is worth noting the transportation assumptions adopted in the Installation Instructions document prepared by ALSTOM WIND are as follows:

- Existence of appropriate general access roads
- Appropriate road surface conditions
- No height and weight limitations for the required transport vehicles

Figure 3.3 illustrates indicative vehicle lengths for those most suitable to transport the wind turbine components.

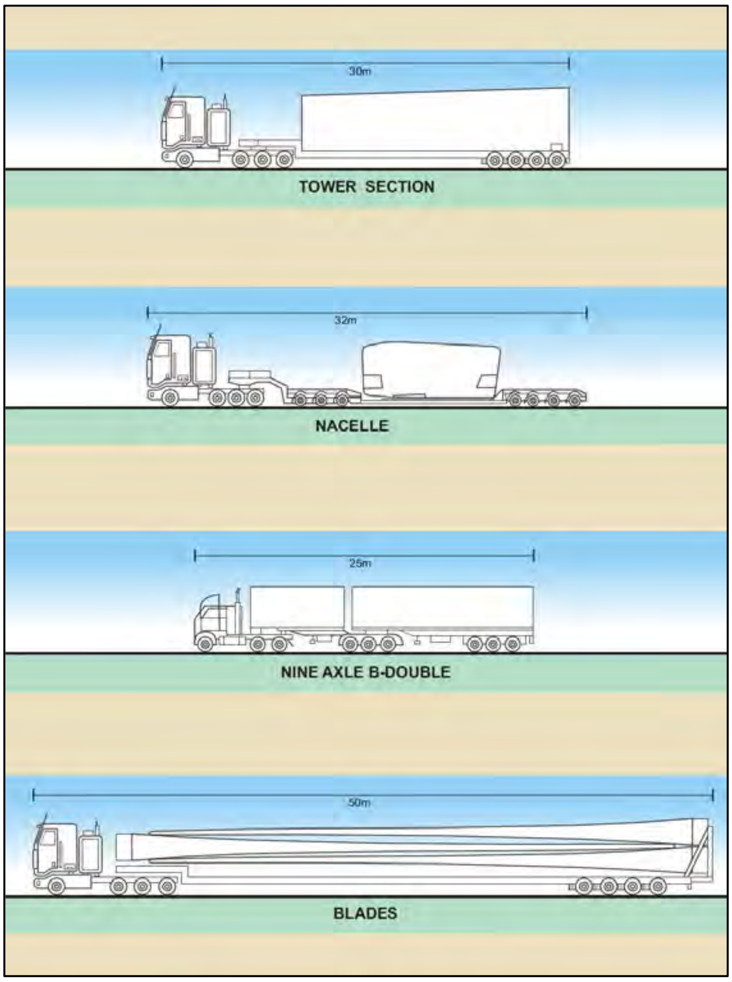


Figure 3.3 **Indicative wind turbine transport vehicle lengths**

The B-double is an Australian Standard RAV design vehicle, in accordance with Austroads guidelines. However the transport vehicles for the wind turbine components are not standard design vehicles and are expected to be a truck (prime mover) and trailer combination that would be typically suited for transporting such over-size and/or over-mass materials. Generally the tower sections, nacelle and turbine blades would be transported on a trailer, such as a low loader, with self-steering wheels on the rear axle for increased manoeuvrability. Some low loader trailers include a remote controller for the rear axles, separate to the truck driver, which would follow in a trailing vehicle, manoeuvring the rear trailer axles according to the road alignment and space allowance. Figure 3.4 depicts examples of transport vehicles for the wind turbine blade and nacelle components.

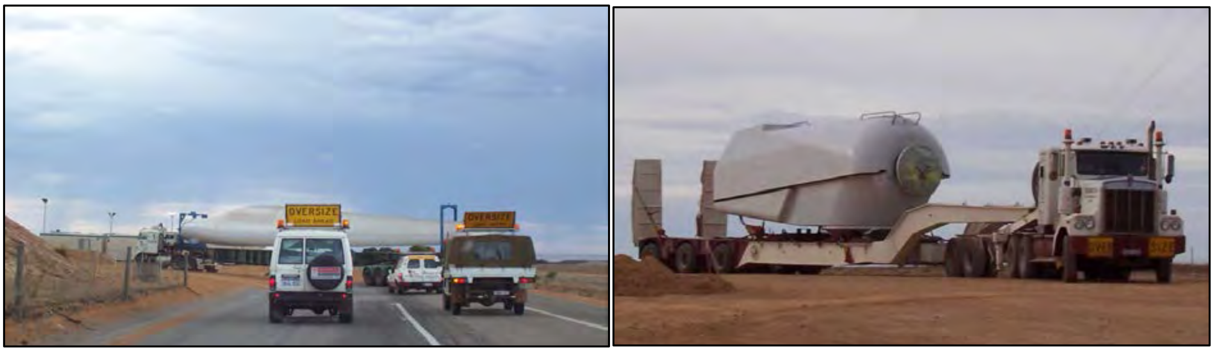


Figure 3.4 Typical wind turbine blade and nacelle transportation

For the purposes of this desktop Traffic Assessment, it is assumed that the wind turbine components will be accommodated within the low loader trailer of the transport vehicle where no overhang is present, as indicated in Figure 3.3. This is a conservative assumption, as a modest overhang would suggest a reduced trailer length and therefore a somewhat smaller turning radius is likely. However, as the proposal is to use larger WTGs components, particularly the blades (60 m in length), it is therefore expected that there will be considerable overhang for the wind turbine blade transport vehicle. This would effectively increase the turning restrictions of the vehicle therefore warranting further detailed assessment. The turning manoeuvres and degree of sweep for the wind turbine blade transport vehicle are further explored in Section 5 Swept Path Assessment.

Therefore, the specifications of the vehicles to be utilised in transporting the wind turbine components need to be determined to form a detailed transport route assessment to be undertaken as part of a comprehensive Traffic Management Plan. The Swept Path Assessments performed for the wind turbine blade transport vehicle, as part of this desktop analysis, helps to determine the feasibility and accessibility of the vehicles along the transport routes. This, in turn, will help in determining the extent of upgrading and/or modifications to the road layout required for critical junctures identified in this Traffic Assessment.

3.2.1 Dimensions and weights of wind turbine components

The dimensions and weights for transportation of the ECO 122 wind turbine components are summarised in the tables below, as referenced in the Installation Instructions document attached in Appendix C. Note that the document stipulates that the weights and dimensions include tools for transporting each component, therefore the data cannot be taken as per component.

Table 3.3 Dimensions and weights for tower sections

ECO 122 Rotor height 88.5 m				
Component* & transport tools	**Weight (t)**	**Maximum diameter (m)**	**Minimum diameter (m)**	**Length (m)**
Lower section	22	4.9	4.5	2.5
Section 1	55	4.6	4.5	11.6
Section 2	76	4.6	4.0	20.2
Section 3	68	4.0	4.0	27.4
Section 4	51	4.0	3.0	28.6

* Refer to Figure 3.2 for tower component sections

Therefore from Table 3.3, the largest component, in terms of width of the tower sections, would be the lower section, at almost 5 m in diameter. The longest component of the tower is sections 3 and 4, being almost 30 m each.

Table 3.4 Dimensions and weights for Nacelle and blades

Component & transport tools	Length (m)	Width (m)	Height (m)	Weight (t)
Nacelle ECO 122				
Block, B1	10	4.4	4.1	84
Block, B2	6.2	4.9	4.9	-
Block, BE1+BE2	8.6	2.5	2.5	4
Blades (with transport tools)				
1 unit ECO 122	60	3.7	3.5	16.5

3.2.2 Vertical and horizontal alignment route requirements

As described in Section 6 of the Installation Instructions document prepared by ALSTOM WIND, there are requirements for accesses and roadways in transporting the wind turbine components. Of those the requirements in relation to vertical and horizontal alignments for the transport routes relevant to this Traffic Assessment are summarised below.

Vertical alignment

Any adverse gradient changes along the proposed transport routes must be identified and assessed appropriately due to the length of most of the wind turbine components and the vehicles used to transport them potentially being unable to negotiate such terrain. Moreover, generally the low loader trailers used for transporting the wind turbine components contain low ground clearances, as can be seen in example Figure 3.4.

The Installation Instructions document by ALSTOM WIND stipulates that *"as a general rule, the vertical alignment parameter (Kv) will be greater than 250. The minimum distance accepted between two consecutive vertical alignments is 50 m".* By definition, the K value (rate of vertical curvature) is the horizontal distance required to affect a 1% change in the slope of a vertical curve.

Horizontal alignment

The horizontal alignment, or curvature, of the roads is as important as the vertical alignment along the proposed routes for the transportation of the wind turbine components. The ALSTOM WIND Installation Instructions considers the blades to be the most critical components for transportation due to their length.

An additional condition stipulates that *"it is required in bended parts of the road, to have 5 m free of obstacles in each side of the road, in order to allow the transport of overhanded loads (blades)".* This may be interpreted as the sections of the transport route that contain adverse horizontal curves (bends), it is required that an additional 5 m clearance on either side of the roadway should be provided to allow for the overhanging component of the wind turbine blades. Refer to Table 3.5 and Figure 3.5 below for the recommended widths and clearances for radii on bends for transporting the ECO 122 by ALSTOM WIND.

Table 3.5 **Radii on bends for ECO 122 wind turbines**

Width A (m)	Minimum radius R (m)	Excess width S, Si (m)	Condition of the bend
5	130	-	With obstacles on the inside and outside of the bends.
5	53	-	With no obstacles on the inside and outside of the bends.
5	45	3	With 3 m of excess width and no obstacles on the inside and outside of the bends
5	40	5	With 5 m of excess width and no obstacles on the inside and outside of the bends

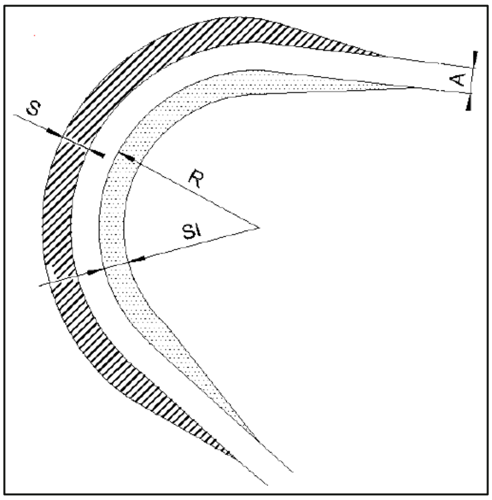


Figure 3.5 **Radii on bends for ECO 122 wind turbines**

It is noteworthy that in the event the low loader trailers selected to transport the wind turbine components, particularly the blades, consist of self-steering wheels or a remote controller for the rear axles, then the transport vehicles may be able to negotiate horizontal alignments with increased manoeuvrability. This has the potential result in minimising the required road/intersection upgrades necessary. The Swept Path Assessments discussed in Section 5 outlines the feasibility and accessibility of the wind turbine blade transport vehicles along the transport routes.

The following offers some discussion with regard to the potential sweeping manoeuvres for the wind turbine blade transport vehicle. Each of the next three figures illustrates the difference with the amount of swept area inside and/or outside of a road curvature. The intention is to highlight the benefits of adopting a transport vehicle where the low loader trailer has the capability of self-steering or remote controller rear wheel axles, which in turn will assist in reducing the amount of road/intersection upgrades required. Note the blade tip on the trailer for the following figures overhangs and that the vehicle is required to occupy both directions of roadway.

Figure 3.6[2] illustrates a general swept path manoeuvre in the instance where the low loader trailer does not have the ability of self-steering or remote controller rear wheel axles.

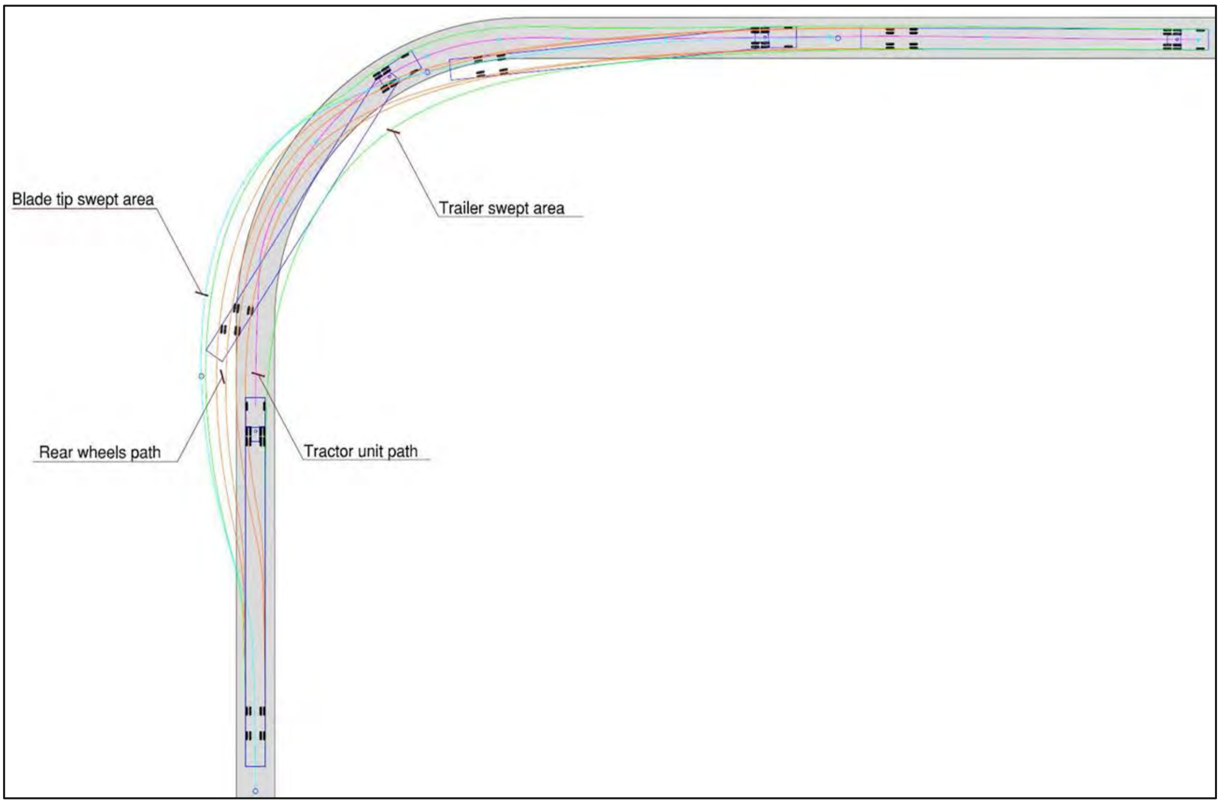


Figure 3.6 General swept path of blade transport vehicle

Figure 3.6 demonstrates that as the truck (tractor) negotiates the road curvature, the rear wheels sweep on the outside then inside of the bend, both requiring road widening and clearance.

2 http://www.windfarmbop.com, accessed July 2013

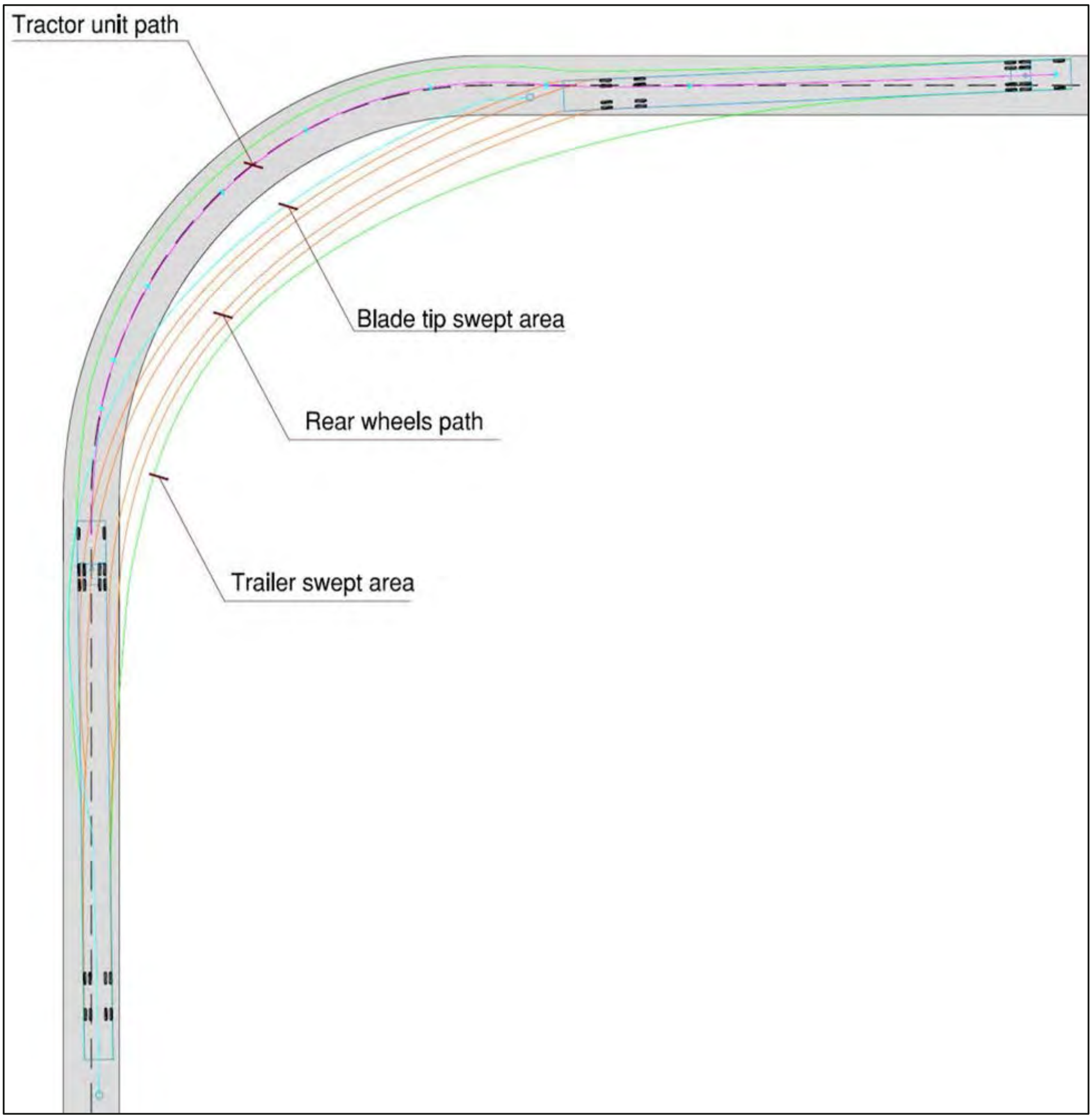


Figure 3.7 **Swept path of blade transport vehicle with steerable rear wheel axles for low load trailer showing inside bend only**

Figure 3.7[2] shows an indicative swept path of the blade transport vehicle where the low load trailer has the ability of self-steering or remote controller rear wheel axles, and in this instance the required road widening is entirely on the inside of the bend.

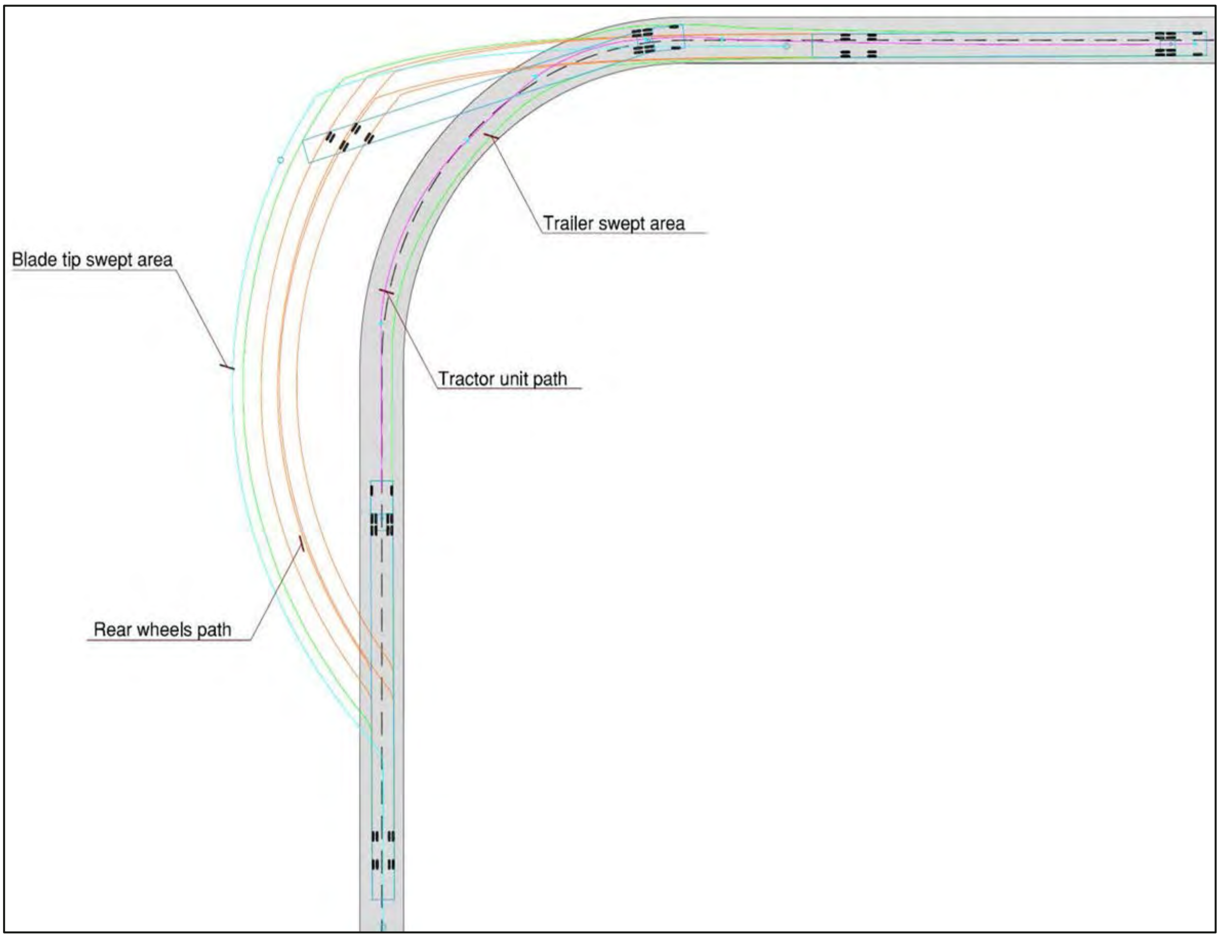


Figure 3.8 **Swept path of blade transport vehicle with steerable rear wheel axles for low load trailer showing outside bend only**

Conversely, Figure 3.8[2] illustrates the swept path of the blade transport vehicle where the trailer swings entirely on the outside of the bend. Evidently the area required for road widening and clearance in this scenario is much greater compared to the inside swept path of Figure 3.7.

4. Traffic Assessment

4.1 Approval and permits

Details of the vehicle mass, dimension limits, operating conditions and permits are described in the following RMS publications:

- Class 1 Special Purpose Vehicle Notice 2012, RMS.
- Class 1 Special Purpose Vehicle Notice 2012, Appendix 1, RMS.
- Application Class 1 Load Carrying Permit, RMS Special Permits Unit.
- Oversize and Overmass Special Purpose Vehicles, Frequently Asked Questions, June 2011.
- Low Loader Mass & Spacing Limits, Information Sheet, RMS Special Permits Unit, May 2009.
- Operating Conditions: Specific permits for oversize and overmass vehicles and loads, RMS Special Permits Unit, Version 2, August 2008.
- Heavy Vehicle Mass, Loading and Access, National Heavy Vehicle Reform Vehicle Operations, RMS, Pub. 01.029.
- Construction Requirements for Low Loader Floats, Vehicle Standards Information Sheet No. 45, September 2001.
- Vehicle Dimension Limits, Vehicle Standards Information Sheet No. 5, Revision 5, 9 November 2012.

In summary, vehicles in excess of 2.5 m in width, 4.3 m in height and 19 m in length are considered “Restricted Access” vehicles, or RAVs, and will require special permits (Class 1 application) from the governing road authority. Prior to any construction transportation tasks proceeding, the appropriate oversize and/or overmass permit must be sought from RMS. Furthermore, the use of such oversize and/or overmass vehicles must adhere to restrictions outlined in the above documents such as, but not limited to:

- Appropriate markings and signs for Special Purpose Vehicles
- Travel restrictions in terms of visibility and minimum following distances
- The use of pilot and escort vehicles
- The use of warning lights and signs

Obtaining the appropriate approval and permits for the transportation of the WTG components will not only be following due process, enhance the safety considerations for the construction of the wind farm, which when coupled with the recommended mitigation measures from the 2009 EIS, should improve the level of safety for road users.

4.2 Route assessment

The following sub-sections outline the desktop assessment for the on- and off-site roads and intersections identified along the preferred transport route for the Glen Innes Wind Farm site, as described in the Traffic and Transport Issues of the 2009 EIS, which states:

“The preferred access route via the New England Highway, Gwydir Highway and the former Gwydir Highway alignment or Rose Hill Road will mean the traffic impacts during the construction phase will be minimised and road safety on the access road network can be maintained to a satisfactory standard”.

“An alternative access route via Rose Hill Road and the access track to Ross Hill is also considered suitable but would only be considered for the primary site access if use of the former Gwydir Highway route were not available”.

"Access via the former Gwydir Highway alignment or Rose Hill Road both provide safe options for existing roads users and vehicles accessing the wind farm. Sight distances for the exits from Gwydir Highway comply with recommended standards. If required, temporary controls such as speed restrictions, warning signs and traffic control could be provided to ensure the safety of the vehicles in the vicinity of the construction vehicle exit from the Gwydir Highway during construction".

Figure 4.1 shows the previously assessed transport option routes, with the preferred route from Glen Innes.

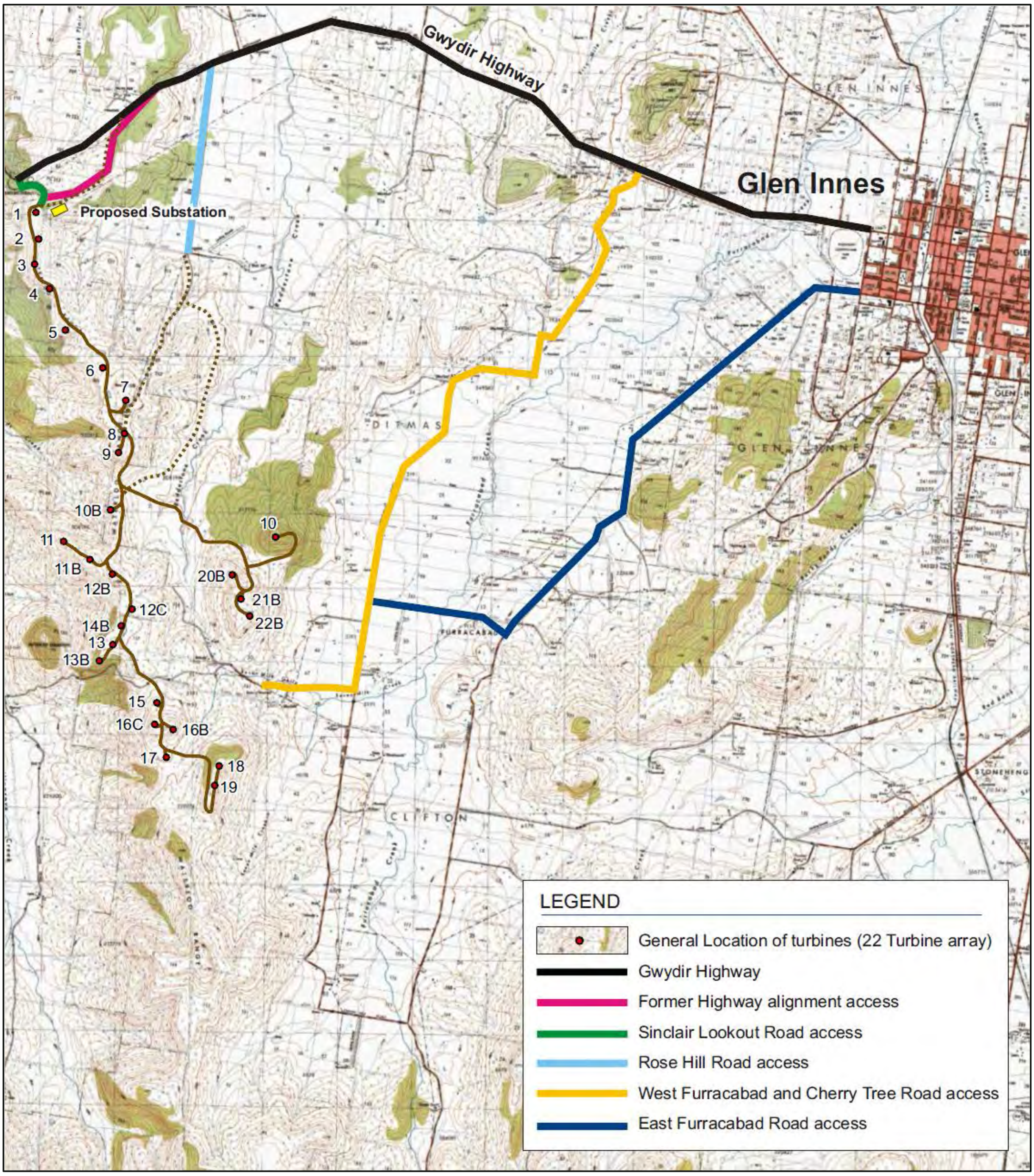


Figure 4.1 Transport option routes

In terms of transportation of the wind farm components, it is recommended that the preferred route from the point of origin (in NSW) through to the township of Glen Innes be determined and assessed as early as possible. Where some of the components will be imported from overseas and pass through the ports of Brisbane or Newcastle, it will be crucial to assess the horizontal and vertical alignments for the entire transport route/s to determine their feasibility and accessibility requirements. Figure 4.2 illustrates the preferred transport routes through the township of Glen Innes.

Figure 4.2 Glen Innes township transport route option

This Traffic Assessment has been undertaken for the preferred transport route highlighted in Figure 4.1 and Figure 4.2 that leads to the proposed Glen Innes Wind Farm site along the Gwydir Highway. The Swept Path Assessment has been performed for key intersections and roads along the preferred transport route.

The following routes assessments were performed from a desktop perspective, based on aerial mapping and photography available through the following sources:

- Spatial Information Exchange Map viewer, NSW Land and Property Information
- Google Maps and Street View

It should be noted that the aerial mapping from the above providers may have been taken at an earlier undetermined date where road features and layouts could have been changed and/or upgraded since.

4.2.1 Off-site route assessment

Public roads and intersections that make up the preferred transport route would be considered off-site routes, which consist of, but are not limited to, the following:

- New England Highway
- Gwydir Highway
- Grafton Street
- Coronation Avenue

Roads

New England Highway

The New England Highway, also known as Church Street through the township of Glen Innes, comprises the following roadside features and traffic control facilities that may affect the transportation of the wind turbine components:

- One lane with a kerbside parking lane in each direction where the carriageway is sealed and divided with a raised median island.
- A raised median island, between Taylor Street and Gwydir Highway, with kerb blisters located midblock within the kerbside parking lane.
- A raised median island between Gwydir Highway and Meade Street with a midblock signalised pedestrian crossing.
- A raised median island between Meade Street and Heron Street, which contains landscaping and vegetation within.

Gwydir Highway

The Gwydir Highway, also known as Ferguson Street through the township of Glen Innes, comprises the following roadside features and traffic control facilities that may affect the transportation of the wind turbine components:

- One lane in each direction with an undivided and sealed carriageway.
- A road bridge crossing Rocky Ponds Creek, located between West and East Avenues. The effective road width at the road bridge is approximately 8 m.
- A road bridge crossing Furracabad Creek, located west of Wellingrove Street. The effective road width at the road bridge is approximately 7 m.
- A road bridge crossing Reddestone Creek, located east of Malboona Road. The effective road width at the road bridge is approximately 7 m.

Grafton Street and Coronation Avenue

The use of Grafton Street and Coronation Avenue would be an alternative route for transporting the wind turbine components as it consists of the following road characteristics:

- Sealed carriageway with unformed shoulders and no formal line marking or kerbing. Formal kerbs along Coronation Avenue are south of Taylor Street.
- An effective sealed roadway width of approximately 7 m for Grafton Street.
- An effective sealed roadway width of approximately 8 m and 12 m north and south respectively of Taylor Street along Coronation Avenue.
- A road bridge crossing Rocky Ponds Creek, located east of West Avenue, along Grafton Street.

Intersections

The following priority controlled intersections would require detailed assessment as a result of their geometric layout and the expected spatial requirements from the wind turbine transport vehicles:

- New England Highway/Grafton Street
- Grafton Street/Coronation Avenue
- Coronation Avenue/Gwydir Highway
- New England Highway/Gwydir Highway
- Gwydir Highway/former Gwydir Highway access

The key issues for the abovementioned intersections in terms of swept paths and manoeuvrability for the wind turbine transport vehicles would be:

- The amount of swept path that occupies the inside and/or outside of the available roadway.
- Existing roadside obstructions and infrastructure such as power/light poles, utilities, road signs, drains and culverts, property fence boundaries, landscaping and vegetation.
- Uneven, unformed shoulders that is unsealed consisting of grass and/or gravel.
- Roadside embankments.

Similarly, the following roundabout intersections would also require further detailed assessment:

- New England Highway/Meade Street
- New England Highway/Oliver Street
- Gwydir Highway/Grey Street

All three roundabouts provide splitter islands for each of their approaches/departures with the central island containing road signs, vegetation landscaping and kerbing. These features potentially impose obstructions for the path of the wind turbine transport vehicles. Therefore, temporary removal of these may be necessary to accommodate the swept path of the transport vehicles. The Swept Path Assessment described in Section 5 provides some guidance as to the extent existing roadside infrastructure obstructs the turning manoeuvres of the wind turbine transport vehicle.

4.2.2 On-site route assessment

As the preferred transport route departs the Gwydir Highway, the proposed access road leading to all the wind turbine locations is considered on-site routes. The following briefly summarises conditions set out by ALSTOM WIND in their Installation Instructions document (attached in Appendix C) for the construction of on-site access tracks:

- The width of the road section shall be a minimum of 5 m in width for straight alignments and excess radii widths as stipulated in Table 3.5 and Figure 3.5.
- The acceptable gradient of the access track with a gravel surface is up to 12%.

- The absolute maximum gradient for the access track is 15%. For road sections with a gradient between 12% – 15%, the road surface will be made of concrete with steel mesh, expansion joints every 10 m and a rough surface finish.

Gwydir Highway/former Gwydir Highway alignment access intersection

Due to the near parallel orientation of the Gwydir Highway and former Gwydir Highway alignment, the proposed intersection at this location to provide access/egress for wind turbine transport vehicles should consider the following:

- Minimise the turning angle manoeuvre for wind turbine transport vehicles through appropriate intersection design and geometry in accordance with design standards.
- Provide adequate sight distance requirements according to design standards.
- Provide gradients, crossfalls and superelevation according to design standards.

The location of the proposed access point is along a relatively straight section of the Gwydir Highway with an overtaking lane at the entrance. This entry point may require to be relocated about 150 m to the east, towards Rose Hill Road, to assist the long vehicles in exiting the Gwydir Highway. However, there is a culvert located in this vicinity of the Gwydir Highway that would require long vehicles to cross over to access the former Gwydir Highway alignment.

Alternatively, should a new intersection at the Gwydir Highway/former Gwydir Highway alignment access be considered unworkable, use and upgrade of the existing Rose Hill Road intersection with the Gwydir Highway could be considered. A connecting access road could be established between Rose Hill Road and the former Gwydir Highway alignment access road. However this alternative would require the property access permission from the corresponding land owners.

5. Swept Path Assessment

To help determine the feasibility and accessibility of the wind turbine transport vehicles traversing the preferred route through the township of Glen Innes and accessing the wind farm site, Swept Path Assessments were undertaken. The swept paths were performed with the software package AutoTrack in AutoCAD using scaled aerial photography to simulate the turning manoeuvres and estimate their degree of sweep in relation to the surrounding road environment.

The swept paths help to understand the manoeuvring restrictions and requirements associated with the preferred transport routes. This section assesses the swept paths for the most critical component for transportation, being the wind blades, due to their length.

The transport vehicle template that has been used for the Swept Path Assessment is illustrated in Figure 5.1. The AutoTrack vehicle details are provided in Appendix D, along with the swept path sketches.

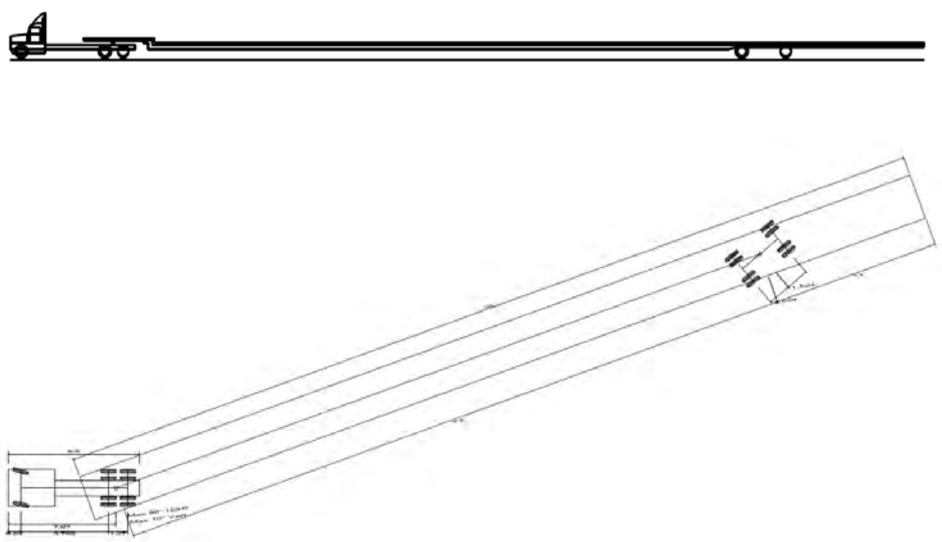
CAH Volvo FH16 8x4 + Broshuis Blade Trailer Independant Steering 62m Load 	• Overall Length = 63.07m • Overall Width = 3.00m • Overall Body Height = 3.335m • Min Body Ground Clearance = 0.487m • Track Width = 2.440m

Figure 5.1 **Blade transport vehicle used for Swept Path Assessment**

For the purposes of this Swept Path Assessment, the adopted vehicle template shown above to transport the blade component consists of independent steerable rear trailer axles that provide the benefit of increased manoeuvrability, as discussed earlier in Section 3.2.

The swept path sketches, attached in Appendix D, illustrate the following coloured profiles:

- Cyan = outer wheel path
- Green = outer body path
- Red = 0.3 m clearance envelope path

5.1 New England Highway/Grafton Street intersection

Referring to sketch number one (SK001) in Appendix D, the following comments are offered in relation to the swept path for the wind blade transport vehicle at this intersection:

- There are roadside infrastructure within the swept path of the blade transport vehicle, specifically power poles and road signage.
- There appears to be a significant level difference between the road surface and the grass verge where uneven or adverse grades would be problematic for the blade transport vehicle.
- The inner radius sweep of the trailer encroaches the northwest property boundary of the New England Highway/Grafton Street intersection.

Therefore the major constraint at this intersection involves avoiding existing electrical infrastructure. Further investigation would be required to determine the process and associated costs involved in accommodating the blade transport vehicle to avoid the power poles. However, the intersection would not require widening in terms of road pavement surface, as it can be seen in the sketch that the wheel path remains almost entirely on the road surface. Any encroachment to rural property boundaries will require permission/approval from the respective owners.

5.2 Grafton Street/Coronation Avenue intersection

Referring to sketch number two (SK002) in Appendix D, the following comments are offered in relation to the swept path for the wind blade transport vehicle at this intersection:

- The inner radius sweep of the trailer encroaches the southeast property boundary of the intersection in conjunction with power poles, road signage and roadside vegetation.
- The outer radius sweep of the trailer, in particular the tail end, may collide with trees located at the northeast of the intersection.
- Similarly, there is a significant level difference between the road surface and the verge, more so for the Grafton Street eastern approach to the intersection where there contains a culvert.

The same major constraint at this intersection relates to avoiding existing electrical infrastructure. Large trees along Coronation Avenue will require temporary removal to accommodate the inner radius sweep of the blade transport vehicle. The wheel path is able to remain on the existing road pavement surface therefore no intersection upgrade will be necessary. Permission/approval from the property owner of the southeast boundary of the intersection must be acquired.

5.3 Gwydir Highway/Coronation Avenue intersection

Referring to sketch number three (SK003) in Appendix D, the following comments are offered in relation to the swept path for the wind blade transport vehicle at this intersection:

- For the northern approach of the intersection along Coronation Avenue, sketch number three indicates that the outer radius of the trailer begins sweeping from about the second residential driveway on the eastern side. This will collide with trees, road signs and power poles.
- Similarly, the inner radius sweep of the trailer will strike a road sign and power pole located at the northwest corner of this intersection.

Again, electrical infrastructure poses as the major constraint with the intersection requiring temporary clearance of roadside objects for the sweep of the trailer. The existing road pavement area of the intersection is sufficient to accommodate the wheel path, however on-street parking along the local roads/streets should be restricted, particularly Gwydir Highway.

5.4 New England Highway/Oliver Street intersection

Referring to sketch number four (SK004) in Appendix D, the following comments are offered in relation to the swept path for the wind blade transport vehicle at this intersection:

- For the southern approach to the roundabout intersection, the sweep of the trailer collides with a light pole near the driveway and a GIVE WAY sign on the median.
- The wheel path of the blade transport vehicle is able to negotiate the intersection however the trailer body crosses over the roundabout, potentially colliding with the centre landscaping and hazard directional signs.

The light pole on approach to the intersection, in addition to the roundabout features, requires temporary removal to accommodate the sweep of the blade transport vehicle. The kerb of the roundabout may be mountable, however the centre island with landscaping is not and will need to be cleared for the sweep of the trailer.

5.5 New England Highway/Meade Street intersection

Referring to sketch number five (SK005) in Appendix D, the following comments are offered in relation to the swept path for the wind blade transport vehicle at this intersection:

- Similar to the previous intersection, the sweep of the trailer will collide with a light pole and GIVE WAY sign on the southern approach.
- The wheel path of the blade transport vehicle is able to negotiate the intersection however the trailer crosses over the roundabout island, potentially colliding with the centre landscaping and hazard directional signs.

Similarly, this intersection consists of a roundabout and similar features which will need to be addressed accordingly as recommended above.

5.6 New England Highway/Gwydir Highway intersection

Referring to sketch number six (SK006) in Appendix D, the following comments are offered in relation to the swept path for the wind blade transport vehicle at this intersection:

- Both the left and right turn manoeuvres will cross over the median islands where road signs are located.
- The outer radius sweep of the trailer, for the right turn northern approach, will collide with roadside trees, signs and any cars that are parked on-street.
- The inner radius sweep of the trailer, for the left turn southern approach, will collide with roadside objects located on the south western corner of the intersection. Furthermore, the residential property fence may be impacted by the inner swept path of the trailer. The start of the outer radius sweep of the trailer may collide with the traffic signal pole located on the median at the midblock crossing south of the intersection.
- Cars parked on the north and south side of the Gwydir Highway at this intersection will be struck by the right angled sweep of the blade transport vehicle.

Apart from the major constraint of electrical infrastructure around this intersection, the wheel path of the blade transport vehicle will drive over the medians, particularly for the northern and eastern legs of the intersection. The potential collision with parked vehicles must be minimised. Temporary on-street parking restrictions must implemented to accommodate the swept path of the blade transport vehicle.

5.7 Gwydir Highway/Grey Street intersection

Referring to sketch number seven (SK007) in Appendix D, the following comments are offered in relation to the swept path for the wind blade transport vehicle at this intersection:

- Similar to the previous roundabout intersections, the wheel path of the blade transport vehicle is able to negotiate around the centre island however the sweep of the trailer would collide with the landscaping and signage located on the roundabout.
- The property on the south eastern corner of the roundabout intersection contains an awning where appropriate consideration should be exercised with the oversized dimensions of the wind turbine components.

As with the previous roundabout intersections, the same recommendations would apply. From the sketch, the sweep of the trailer comes close to the awning of the property on the south eastern corner. Additional safeguards should be implemented so to ensure the property awning isn't struck.

5.8 Former Gwydir Highway access intersection

Referring to sketch number eight (SK008) in Appendix D, the following comments are offered in relation to the swept path for the wind blade transport vehicle at this intersection:

- There is a culvert located beneath the Gwydir Highway, approximately 100 m from the start of the westbound overtaking lane. For this reason, sketch number eight in Appendix D illustrates the entry/exit location for the blade transport vehicle at the former Gwydir Highway alignment.
- The alignment of Gwydir Highway offers unobstructed sight distance for both approaches at the proposed entry/exit location to/from the former Gwydir Highway alignment. In addition, there is a clearing of vegetation for the blade transport vehicle to veer off the main highway without having to perform any adverse turning manoeuvres.

Therefore this access intersection between the Gwydir and former Gwydir Highway must be set up with the adequate provisions for blade transport vehicles to manoeuvre in and out of. Temporarily formalising this access intersection in accordance with applicable standards/guidelines will assist with vehicle manoeuvres.

6. Conclusion

This assessment has taken into account the larger wind turbine components, the potential transport vehicle required to transport them and the constraints in their manoeuvres. This report is prepared as a desktop assessment and has evaluated the subject roads and intersections via aerial photography and mapping to assist in identifying key locations that would warrant further detailed investigations.

While assessing the potential impacts of transporting the larger turbine components, it was recommended that a swept path analysis be undertaken to confirm the route that was previously approved. No swept path assessment was undertaken as part of the 2009 EIS, although potential impacts along the route were identified.

The Swept Path Analyses undertaken as part of this assessment, ascertained that there were no additional traffic and transport impacts to those previously identified in the 2009 EIS. The Swept Path Assessment has however identified key locations along the preferred transport route where manoeuvring constraints for the transportation of the wind turbine components will be experienced, but measures to mitigate these potential impacts have been outlined below. These impacts would be considered temporary.

In light of the proposed modifications to use larger wind turbine components in comparison to the approved conditions, the preferred transport route and wind farm site access via the former Gwydir Highway, as previously established, remains unchanged.

It is also noted that the recently approved Sapphire Wind Farm is located 28 km east of Inverell and 18 km west of Glen Innes. The approval allows for up to 159 turbines with a maximum height of 157 m, turbines which are 7 m taller than those proposed for the modification for Glen Innes. The approved transport route for the larger Sapphire Wind Farm turbines includes a route through Glen Innes and along the Gwydir Highway and as such is similar to the route selected to transport the turbines to Glen Innes.

6.1 Recommendations

For the transportation of the wind turbine components, it is recommended that the preferred route from the point of origin (in NSW) through to the township of Glen Innes be determined and assessed as early as possible. Where some of the components are imported from overseas and pass through the ports of Brisbane or Newcastle, it will be crucial to assess the horizontal and vertical alignments of the transport route/s to determine their suitability and whether any potential constraints exist.

The specifications of the vehicles to be used in transporting the wind turbine components would need to be determined prior to a detailed transport route assessment being undertaken as part of a comprehensive Traffic Management Plan. Swept Path Assessments were undertaken for the vehicle delivering the most critical wind turbine component, that being the blade due to its length, to determine the feasibility and accessibility of the vehicle along the transport routes.

Based on the desktop assessment for the swept path of the blade transport vehicle, the following recommendations are offered:

- Appropriate traffic management measures for the transportation of oversized and/or overmass vehicles must be implemented, including, but not limited to, those described in Section 4.1.
- Restrict on-street parking along the preferred transport route through the township of Glen Innes so that the blade transport vehicle minimises any potential conflicts and/or collisions.
- Any existing traffic control devices and roadside infrastructure that are either removed and/or damaged as a result of the transportation of wind turbine components should be reinstated and

rectified at the cost of the contractor in accordance with appropriate standards/guidelines. This would include, but not be limited to, kerbs, footpaths, refuge islands, bollards, line marking, signs etc.
- All overhead wiring required to be temporarily relocated and/or repositioned requires the appropriate consultation and approval from the relevant electrical company.

Any encroachment to property boundaries must sought the permission/approval of the respective owners. We understand that the relocation of electrical infrastructure may be a costly exercise to accommodate the swept path of the blade transport vehicle. Therefore, the identification and positioning of existing roadside infrastructure should be surveyed to determine those which may be impacted by the swept paths of the blade transport vehicle. Following their identification, estimates in costs for relocating/removal and reinstatement can be determined and refined at later stages of the project lifecycle.

The movement of the construction vehicles to/from the wind farm site, particularly involving the RAVs, will need to be undertaken in consultation with Glen Innes Severn Council and RMS and implemented in accordance with any agreed conditions. Measures to ensure safety for all road users could include upgrades to critical junctures along the preferred transport routes, appropriate signage and flashing lights, escort vehicles and/or traffic control personnel and provision of temporary speed restrictions for selected locations.

Appendix A
Traffic and Transport Issues

Glen Innes Wind Farm Environmental Assessment, Chapter 9 – Traffic and Transport Issues, prepared by Connell Wagner (now Aurecon), October 2008

9. Traffic and Transport Issues

This chapter of the Environmental Assessment describes the traffic and transport issues associated with the construction and operation of the Glen Innes Wind Farm. A comprehensive report on the traffic and transport issues has been prepared and is included as Appendix I. An overview of the report's findings is summarised in this chapter.

9.1 Overview of traffic and transport issues

The main traffic impacts of the Glen Innes Wind Farm project will occur during the construction stage of the project. This is mainly due to the additional volume of traffic and the need to use over-size and over-mass vehicles. The construction staff involving approximately 40 personnel will travel to and from the site on a daily basis. In addition, over-size loads will include about 81 trucks carrying the turbine blades of up to 49 m in length and over-mass loads will be required to transport up to 27 nacelles, hubs, generator transformers and up to 108 tower sections. A comprehensive listing of the likely infrastructure components and the resulting predicted traffic movements is outlined in Tables 9.1 and 9.2.

Once the wind farm is operational there will be a low level of traffic accessing the site including a small number of on-site staff and periodic visits by maintenance staff as required. The traffic impact during the operational phase will be minor.

The key traffic issues can be broadly divided into off-site and on-site issues.

Off-site traffic issues mainly relate to:

- movement of oversize vehicles on public roads and the timing of travel
- choice of route and ability of roads to handle the volume of construction traffic particularly in regard to over-size and over-mass vehicles
- road safety
- traffic management measures to be incorporated in project

On-site issues mainly relate to:

- location of new track work and environmental considerations
- standard of track work required, including upgrade of existing tracks
- drainage, erosion and sediment control measures to be incorporated
- restoration of any temporary tracks on completion of the works

9.2 Deliveries to the wind farm site

Some of the components of the wind turbines will be imported from overseas and may pass through ports in Brisbane or Newcastle. Options that have been considered for delivery of the turbine equipment include road or rail. A review of the option to transport the turbines by rail has shown that it is not feasible due to the vertical and horizontal clearances available on the rail system given the long loads required to be transported and due to rail services to Glen Innes having been discontinued.

The delivery of turbine and substation equipment and associated materials to the Glen Innes locality will use the New England Highway. The highway provides an inland link between Brisbane and Newcastle and passes through Glen Innes. It is a main transport route for freight vehicles, buses and cars and has a speed limit of 100 km/hour. The Gwydir Highway provides the main transport route from Glen Innes to the Wind Farm site.

At Glen Innes, the New England Highway intersects with the Gwydir Highway within the main township. Transport of equipment through Glen Innes could proceed directly from the New England Highway to the Gwydir Highway or could use an alternative route suited to large vehicles. The options for passing through Glen Innes have been discussed in Appendix I and are summarized below.

Discussions with Council and route inspections have indicated that the most suitable route for avoiding the centre of Glen Innes appears to be the northern route that goes from the New England Highway to Grafton Street, then Coronation Street and joins the Gwydir Highway about 1.5 kilometres west of its intersection with the New England Highway. Passage of vehicles through Glen Innes will require negotiation of various intersections, which may require minor temporary modifications. The final route to be used and the process for any modifications will be planned in consultation with Council.

The existing road transport infrastructure for the area surrounding the wind farm site is shown in Figure 9.1. Key local roads in the area surrounding the wind farm which could be used for access to the wind farm site are described below. The analysis of the local roads and their suitability for transport of equipment and materials to the site considered aspects of suitability of existing roads, the directness of various routes, traffic safety issues and the extent of community disturbance that may occur if a particular route was used. Based on the analysis and discussion with Council, a preferred access route has been proposed and is described in the following sections.

9.2.1 Former Gwydir Highway alignment

The most direct access to the wind farm site from the Gwydir Highway is via a now disused section of the former Gwydir Highway where it crosses the top of Waterloo Range (Plate 9.1). Local residents have indicated that the Gwydir Highway over the Waterloo Range was realigned about the time of World War 2 with the new alignment having been shifted about 500 metres to the north providing improved grades and a better alignment. The old highway alignment is still clearly visible and trafficable (Plate 9.2). It is unsealed but has a solid rock foundation, formed drainage on either side and mature trees either side of the roadway. It provides a suitable road alignment for access during construction by large vehicles to the northern end of the wind farm site.

The former highway alignment is now within the Wattle Vale Travelling Stock Route (TSR 67474) for which the Rural Lands Protection Board (RLPB) is the responsible custodian. The RLPB has been consulted in regard to the proposed wind farm development and has provided approval for the TSR to be used on a temporary basis for the wind farm construction.

Due to its suitability in terms of grades, minimal impact of rural residences and direct access to the wind farm and the substation site it is proposed that the former Gwydir Highway alignment be used as the primary access for the construction phase of the Glen Innes Wind Farm. It is considered preferable for site management to have only a single access point to the wind farm site and the former Gwydir highway alignment presents the most suitable point to enter and leave the site. Alternative access routes, such as Sinclair Lookout Road, Rose Hill Road, East Furracabad Road and West Furracabad Road are discussed below, however these routes are proposed for use only during the operational phase, if at all.

9.2.2 Sinclair Lookout Road

The Sinclair Lookout Road is an unsealed road in good condition for light vehicles. It is a winding road that rises progressively from the Gwydir Highway to Sinclair Lookout. Its location provides a possible access to the northern end of the wind farm and to the substation site. It is however considered as unsuitable for movement of the oversize vehicles and is not proposed as an access for the construction or operational phases of the project.

9.2.3 Access via Rose Hill Road

Rose Hill Road provides an access route to the middle of the wind farm in the vicinity of Ross Hill. The initial 2.5 kilometre section of this route is unsealed public road that provides access to the Rose Hill and Girrahween residences and to parts of the Rosefield property. At the southern end of Rose Hill Road is an additional 2.5 kilometres of track that leads up to the Ross communications facility and Ross Hill on the main Waterloo Range. The track could be upgraded to provide access for the construction and operations phases but is considered less suitable than the former Gwydir Highway. It is currently proposed that Rose Hill Road only be used for access during the operational phase if the former Gwydir Highway alignment is not available.

Rose Hill Road forms a 'T' intersection with the Gwydir Highway (Plate 9.3) and there is good visibility of the intersection from the eastern and western approaches of the Gwydir Highway. The short section of Rose Hill Road is straight and relatively flat and is suitable for use by the RAV vehicles (Plate 9.4). Council has advised that if this road were used by construction vehicles that sealing in proximity to residences would be appropriate. In the event that Rose Hill Road is used for construction or operation then Glen Innes Wind Power will, in consultation with Glen Innes Severn Council, arrange for the sealing of the section of road in the vicinity of the Girrahween residence and within 200 metres of the junction with the Gwydir Highway.

9.2.4 Access via West Furracabad or East Furracabad Roads

Access to the southern part of the wind farm site can be gained via either East or West Furracabad Roads and then Cherry Tree and Hillside Roads. While both routes are suitable for light vehicles a range of factors make them unsuitable for the passage of large and heavy vehicles. Factors which limit their suitability include the number of residences adjacent these roads, sharp bends that would require realignment and improvements, creek crossings for Furracabad Creek and Seven Mile Creek and various locations requiring widening. For these reasons it is not intended that either route be considered for use by the large vehicles required to transport the large and heavy items to the site.

Light vehicles could use these roads at times for access to the southern part of the site without significant impact to the local community. However, as mentioned previously, it is preferable for effective site management to maintain a single access to the wind farm site. Accordingly, Glen Innes Wind Power will direct all vehicles to enter and exit the site via the northern points, ideally via the former Gwydir Highway alignment or where that is not available via Rose Hill Road.

9.3 Nature of traffic on local roads during the construction stage

A key part of the traffic assessment for the construction phase was the analysis of the likely types and numbers of vehicles to access the site. Tables 9.1 and 9.2 provide details of the equipment and materials to be delivered to site, the estimated number of vehicle movements over the construction period and the expected vehicle types involved.

Table 9.1 addresses the delivery of the various materials and components for construction of turbines, the substation and ancillary items. Table 9.2 addresses the transport of concrete for footings.

Some of the trucks delivering the turbine components to the site will be over-size (longer than 19 metres) or over-mass (gross mass in excess of 42.5 tonnes) and are referred to as "Restricted Access Vehicles" (RAVs). Table 9.1 provides details of predicted traffic movements, other than for the concrete footings, as a gauge to indicate the transport issues to be managed.

The delivery of the tower and turbine component parts alone will generate approximately 252 one-way truck movements involving Restricted Access Vehicles (RAVs). The intensity of truck movements will vary during the construction stage. The delivery of component parts of the turbines may be spread over three to four months and the movement of these vehicles will be arranged to minimise impact on local communities. The consultation for the project will provide the community with updates on the progress of construction works, timing of remaining works and potential impacts and safeguards incorporated.

Table 9.1 - Predicted traffic movements on public roads for deliveries to the site

Material	Approximate Quantity / Number	One–Way Vehicle Movements	Vehicle Type
Materials			
Concrete – footings for turbines and substation	materials see Table 9.2	745	
	12,000 m^3 concrete	2400	Truck or semi-trailer
Reinforcing steel – footings	1,300 t	75	Semi-trailer
Road aggregate	7,550 m^3	950	Truck
Water for dust control	1-2 trucks per day	150 to 300	Truck
Select fill	650 m^3	44	Truck
Misc equipment	Nominal	60	Semi-trailer
Misc materials	Nominal	25	Semi-trailer
Wind turbine components			
Tower sections (4 per tower)	108	108	RAV
Nacelles	27	27	RAV
Hubs	27	27	RAV
Blades (3 per turbine) 1/truck	81	81	RAV
Generator Transformers	27	9	RAV
33kV/(132 or 66)kV Substation and 33kV Cables			
Substation transformer	1 or 2	1 or 2	RAV
Misc substation items	Various	22	Semi-trailer
33kV Transmission poles	4	2	RAV
33kV Underground cables	22 km	65	Semi-trailer
Site work activities			
Site establishment	Nominal	5	Semi-trailer
Cranes	2	10	Semi-trailer
Construction equipment	8	15	Various
Site disestablishment	Nominal	5	Semi-trailer
Total one-way traffic movements on public roads			
Truck movements		2,426 – 4,282	Trucks
Employees - 6 to 12 months	40 persons	4,000	Car / 4WD

Events such as pouring the concrete for a turbine footing can generate up to 75 one-way trips per day over a period of about 10 hours for the delivery of concrete by agitator trucks from an off-site location. Table 9.2 provides a comparison of delivery of concrete from Glen Innes using a fleet of agitator trucks

(Option A) versus trucks delivering materials to a batch plant for concrete production on site (Option B).

Due to the proximity of the site to Glen Innes it is expected that concrete will be imported to the site and that an on site batch plant will not be used. The contractor will need to identify the best approach. Should the contractor wish to install a batch plant on site then it is expected that the contractor will make the necessary assessment of options and obtain the requisite approval(s).

The contractor will stage the work so that footings are poured sequentially, with the construction crews preparing them, pouring them and then progressively erecting the turbines.

Table 9.2 – Predicted traffic movements on public roads for pouring the concrete footings

Material	Quantity / Number	One–Way Vehicle Movements		Vehicle Type
Option A - Concrete delivered from Glen Innes on public roads				
Concrete from Glen Innes No on-site batch plant	12,000 m³	2,400		Agitator Truck
Option B –Batch plant on-site and constituent materials delivery on public roads				
Cement	1,730 t	82	745	Semi Trailer/Truck
Aggregate	4,695 t	310		Semi Trailer/Truck
Sand	3,560 t	238		Semi Trailer/Truck
Water	1,865 kL	113		Truck
Concrete cartage	12,000 m³	On site only		Agitator Truck

Note: Road aggregate and sand to be supplied from a site to be determined in the vicinity of Glen Innes

9.4 Site Entry from Gwydir Highway

The preferred site access point to the wind farm site is directly from the Gwydir Highway (Plate 9.1) via about 1.5 kilometres of the former Gwydir Highway alignment (Plate 9.2) that is within Travelling Stock Route TSR 67474 "Wattle Vale". The location of the existing access point near the top of the Waterloo Range is on a straight section of the Highway with a passing lane on the side where the entrance is located (Plate 9.1).

To assist the long vehicles to exit the highway and enter the Travelling Stock Route it is possible that the existing entry point may need to be relocated about 100 metres to the east. Subject to relocation and upgrade to the site entrance, provision of suitable drainage works and the installation of appropriate signage at locations agreed with Council and the Roads and Traffic Authority this point is regarded as the best entry point for the following reasons:

- it provides a location where construction vehicles can safely enter and exit the wind farm site
- the location is clearly visible for highway traffic being on a straight section of road
- minimal clearing will be required for this access point and the lack of vegetation along the side where the entry point is located will assist visibility of vehicles exiting the site
- the grades from the highway to the TSR 67474 can be easily negotiated by the oversize vehicles

Use of the former Gwydir Highway alignment would require minor works including lopping of branches that overhang the roadway, minor restoration of drainage for the roadway and clearing of a limited number of trees to allow the movement from the roadway into the wind farm site. The clearing has been discussed with officers of the Rural Lands Protection Board and would be undertaken in consultation with RLPB to ensure that the impact on native trees is minimised.

An alternative access route via Rose Hill Road and the access track to Ross Hill is also considered suitable but would only be considered for the primary site access if use of the former Gwydir Highway route were not available.

Use of Rose Hill Road would require minor works and an upgrade of the track to Ross Hill. The intersection geometry of Rose Hill Road with Gwydir Highway is a 90^0 'T' intersection with the main road (Plate 9.3) having preference for through traffic and with adequate sight distances. A view along Rose Hill Road is shown in Plate 9.4. The track to Ross Hill is narrow and if used by large construction vehicles would require widening, straightening of some sections and improved drainage. The grades appear suitable.

The movement of the construction vehicles to the site from public roads particularly involving the larger vehicles will need to be undertaken in consultation with Council and Roads and Traffic Authority and implemented in accordance with any agreed conditions. Measures to ensure safety for all road users could include modifications to entry points, signage or flashing lights, escort vehicles and/or traffic control personnel and provision of temporary speed restrictions for selected locations.

9.5 On-site access management

Once vehicles have left the public roads and entered the site they will travel on tracks developed and maintained for the wind farm project. The routes of the proposed tracks is shown on Figure 1.4. Access to the substation site and the various ridges where the turbines will be located will be via specially constructed, unsealed access tracks. Small sections of some tracks in areas where there are steeper grades, if required, may be sealed to provide safe access and reduce erosion potential. Examples of steep slopes where access tracks are proposed are shown in Plates 9.5 and 9.6. These locations will require close attention to erosion control.

The proposed locations of the access tracks have been determined in consultation with the respective landowners as well as the recommendations of the ecological and heritage consultants and taking account of the nature of the large construction vehicles that will need to negotiate the grades.

Tracks are mostly located away from watercourses although several crossings of mostly dry water courses will be required. Stormwater culverts will be constructed where access tracks cross over existing creeks and gullies.

The chosen routes also minimise the need to clear existing remnant woodland and are preferentially located in cleared and often exotic pasture. Recommendations with regard to the potential impacts on flora and fauna and indigenous heritage have been considered when establishing the access routes and will be addressed by the Construction Environmental Management Plan.

In a few places along the top of the Waterloo Range, track work will need to be located through rock outcrops to provide access to the tower sites. Where rocky outcrops are impacted, the access tracks will be constructed by relocating excavated material to either side of the track to maintain the visual appearance of the ridge line and preserving or providing new habitat for reptiles.

9.6 Mitigation measures

A number of measures will be incorporated during the construction and operation of the wind farm to ensure that transport and traffic impacts arising out of the development are minimised. These measures will be incorporated into a Traffic Management Plan for the project and shall be developed in consultation with Glen Innes Severn Shire's Traffic Management Committee.

An important mitigation measure relating to construction traffic impacts will be the implementation of a community information and awareness program. Prior to construction commencing and during the construction period a program of consultation shall be initiated to ensure the local residents are fully aware of the construction activities with particular regard being given to construction traffic accessing the site. This program will include elements of the following as appropriate to the phase of works, press releases in the local newspapers, specific newsletters and individual letter drops to neighbouring residents along the access route to the site and provision of a web-site providing details of the status of works and contact details for any complaints or enquiries.

General signposting of the access roads with appropriate heavy vehicle and construction warning signs shall also be undertaken in consultation with local authorities. Specific warning signs will be located adjacent to the entrances to the site to warn existing road users of entering and exiting traffic. The use of day warning notices where signs are activated on a specific day to warn local road users of construction activities will also be considered.

Particular attention can be given to traffic control and warning signs where the geometry of the road dictates that a potential safety issue exists. On-site access will be restricted to defined tracks to ensure minimal environmental impact.

Further mitigation measures will include:

- Improvements to any public roads impacted by the project in consultation with the Council. Improvements may include an exit lane from the Gwydir Highway to the former Gwydir Highway alignment and improvements to Rose Hill Road if its use is required
- Provision of traffic control personnel where large vehicles are required to execute difficult or potentially unsafe manoeuvres on public roads
- Concurrence with permit requirements for over-size and over-mass vehicles including the use of escort vehicles as required
- Restrictions on the timing of some large equipment and materials deliveries to site to mitigate specific local impacts. In particular the following measures may need to be adopted:
  - restriction of traffic movements to avoid RAVs passing schools at Glen Innes during the school zone periods and to avoid RAV movements conflicting with school bus operations
  - local deliveries to the site during daylight hours only to mitigate safety problems on local roads and to reduce disturbance for residences near to the access roads
- Confirmation of access track routes in proximity to any environmentally sensitive areas to be guided by relevant specialists
- Establishment of an inspection and maintenance program for the local road access network to ensure condition of roads are maintained in safe state
- Maintenance program for on-site access tracks to ensure safe access
- Implementation of a pro-active erosion and sediment control plan for on-site roads and laydown areas
- At the conclusion of the construction phase, any tracks not required for subsequent operation and maintenance of the wind farm will be restored and revegetated

9.7 Conclusions

The operational wind farm will require low levels of vehicle access to the site from local roads and accordingly will only have minor impact on local traffic.

The traffic issues for the construction period require a comprehensive Traffic Management Plan and consultation with Council, the Roads and Traffic Authority and the local community. Subject to a suitable plan being developed, agreed with stakeholders and implemented with the Project's Construction EMP, the impacts can be appropriately controlled.

	
Plate 9.1 – Site Entry from Gwydir Highway showing passing lane and cleared area adjacent to Gwydir Highway	Plate 9.2 – Gwydir Highway alignment showing wide roadway between corridor of trees
	
Plate 9.3 – Intersection Rose Hill Road and Gwydir Highway showing large cleared area adjacent Gwydir Highway	Plate 9.4 – Rose Hill Road (southern part)
	
Plate 9.5 Access route Turbine 9 to Turbine 10B – Steep descent onto saddle	Plate 9.6 Steep slope access to Turbine sites 20, 21 & 22 – Steep ascent to ridge top

Appendix B
ECO 122 Technical Description

ECO 122 – General description, Technical Description, prepared by ALSTOM WIND, 29 September 2011

POWER
WIND
Alstom Wind, s.l.u.
Roc Boronat, 78. 08005 Barcelona, Spain
Phone: +34 932 257 600
Fax: +34 932 210 939
www.power.alstom.com

TECHNICAL DESCRIPTION

FRM-0966-EN_R05

DST-0484 Rev. 02		
TITLE: ECO 122 - General description		
Author:	**Checked by:**	**Approved by:**
S. Sanesteban	**J.Viscasillas**	**X. Vázquez**

REVISIONS		
Rev.	**Date**	**Author**
01	**25/07/2011**	**SS**
02	**29/09/2011**	**SS**

TABLE OF CONTENTS

1. AIM

This specification is a general technical description of the ECO 122 wind turbine. This document includes general information of the wind turbine components.

The description of main components shown in this document is only informative and it might change according to production requirements without further notice.

2. SCOPE

WT	50 Hz	60 Hz	Remarks
ECO62	☐	☐	--
ECO74	☐	☐	--
ECO86	☐	☐	--
ECO80	☐	☐	--
ECO80 2.0	☐	☐	--
ECO100	☐	☐	--
ECO110	☐	☐	--
ECO122	☒	☐	*From Serie 2.*

3. GENERAL DESCRIPTION

The ALSTOM ECO 122 is a new generation of large, high power turbines for onshore use, setting a new standard for Clean Power. The ECO 122 owes its name to its 122 m rotor diameter, one of the largest rotors available today for Class III sites, which permits to capture even greater amounts of energy. Moreover, its rated power of 2.7 MW allows for a higher energy yield.

The wind turbine has been designed following Class III-A specifications of the standard IEC-61400- 1. It is suitable for sites with a mean annual wind speed up to 7.5 m/s and an extreme gust speed with a 50 year repetition frequency of 59.9 m/s.

The design of ALSTOM wind turbines are based on the **ALSTOM PURE TORQUE™**, which is unique in the industry. Rotor deflection loads are transmitted directly to the tower whereas only torque is transmitted to the gearbox. As a consequence the gearbox lifetime is extended.

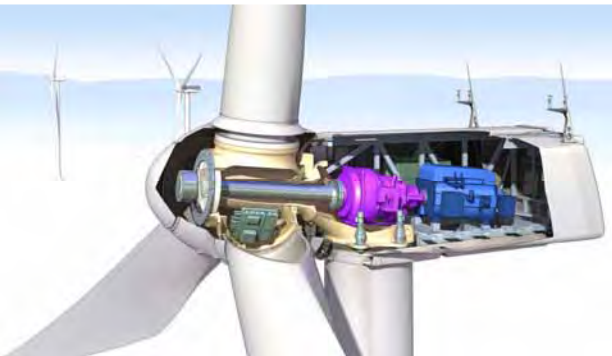
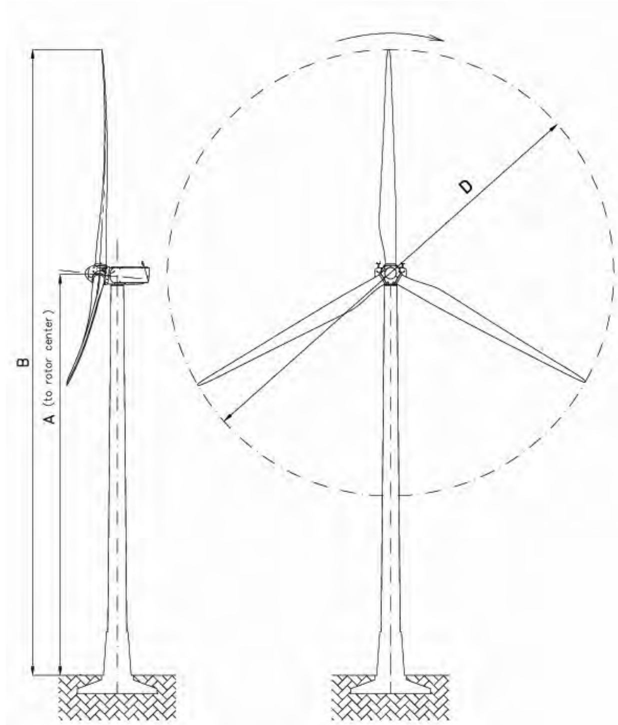


Fig. 1 – ALSTOM PURE TORQUE™ layout in ECO 100 Platform.

Safety and ergonomics have been important drivers in the design of this wind turbine. The technicians can access the rotor from inside the nacelle. Increased dimensions allow maintenance operations to be performed safely and easily. Wind turbine maintenance operations are faster and safer than ever.

Fig. 2- The ECO 122.



ECO 122 TOWER D= 122 m	T90
A - Hub height	89 m
B - Tip height	150 m

Fig. 3- ECO 122 general dimensions.

In the following tables will you find the most important wind turbines specifications and operating data.

WIND SPEED [m/s]	POWER [Kw]	POWER COEFF * CP [-]	THRUST COEFFICIENT ** CT [-]
3	64	0,33	1,07
4	182	0,40	0,91
5	399	0,45	0,83
6	715	0,46	0,82
7	1155	0,47	0,81
8	1700	0,46	0,78
9	2217	0,43	0,67
10	2546	0,36	0,52
11	2671	0,28	0,38
12	2697	0,22	0,28
13	2700	0,17	0,22
14	2700	0,14	0,17
15	2700	0,11	0,14
16	2700	0,09	0,12
17	2700	0,08	0,10
18	2700	0,06	0,08
19	2700	0,06	0,07
20	2700	0,05	0,06
21	2700	0,04	0,05
22	2700	0,04	0,05
23	2700	0,03	0,04
24	2700	0,03	0,04
25	2700	0,02	0,03

Table 1- The ECO 122 power curve.
(Density = 1.225 kg/m^3. Turbulence intensity 10%)
* Electrical power and aerodynamic power coefficient from ECO122 target power curve.
** Aerodynamic thrust coefficient calculated (from preliminary power curve pID 145).

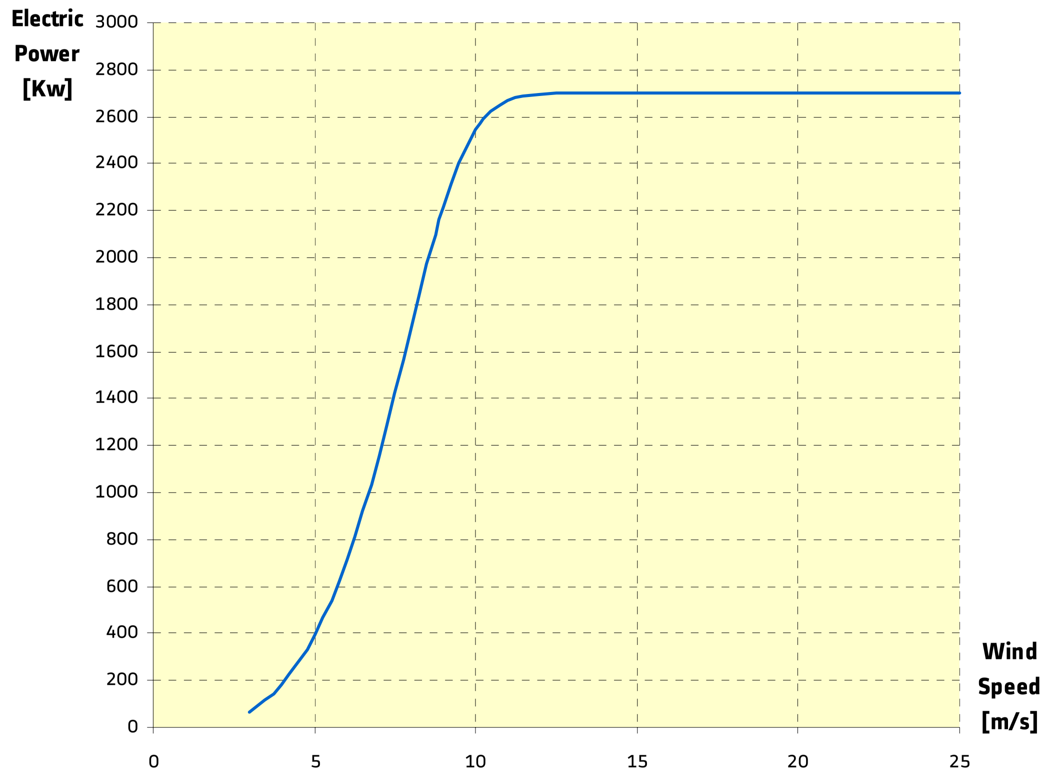


Fig. 4- ECO 122 power curve.
(Density = 1.225 kg/m^3. Turbulence intensity = 10%)

GENERAL SPECIFICATIONS	
Model	ECO 122
Wind Turbine Class according to IEC/EN 61400-1	III-A
Position of rotor relative to tower	Upwind
Hub height [1)]	89 m
Rotor diameter	122 m
Rotor swept area	11 690 m^2
Rated power [2)]	2.7 MW
Rated rotor speed (LSS)	12.25 rpm
Rotor speed range (LSS)	6.97 – 12.25 rpm
Tower type	89 m tubular
Foundation standard type [1)]	Concrete octagonal foundation slab and concrete octagonal pedestal.
Colour	RAL 7035
Control system	Variable speed and pitch control

Table 2- ECO 122 general specifications. [1)] These characteristics are guiding values and could be submitted to changes (depending local conditions). [2)] Rated power may be limited according to customer requirements.

WEIGHTS (APPROX.)	
Blade	14 tons
Nacelle + rotor mass	165 tons

Table 3- ECO 122 main weights. For more information please contact our Sales department.

OPERATING DATA	
Mean annual wind speed (maximum)	7.5 m/s
Rated wind speed	9.5 m/s
Reference wind speed (avg. 10')	42.5 m/s
Extreme gust speed (IEC)	59.9 m/s
Cut-in wind speed	3 m/s
Cut-out wind speed (600s average)	25 m/s
Instant cut-out wind speed (3 s)	34 m/s
Vertical wind inclination throughout the operative life of the wind turbine (IEC)	8°
Rated power	2.7 MW
Power density	4.33 m^2 / kW
Temperature range for normal operation[1)]	-10° C to +40° C -30° C to +40° C (CCV)
Extreme temperature range (turbine stopped)[1)]	-20° C to +50° C -40° C to +50° C (CCV)
Lightning protection IEC-61024	Level 1

Table 4- ECO 122 operating data. [1)] For more details on temperature ranges please contact our Sales department.

3.1 GENERAL AMBIENT DESIGN CRITERIA

The wind turbine has a design lifetime of 20 years according to the IEC 61400-1.

In the case that the site environmental differ from the operational data (see table 4) please contact with our commercial department. For more details please ask for the specific documentation.

3.2 ELECTRICAL GRID REQUIREMENTS

The wide application of wind energy, even in wide isolated grids, needs modern wind turbines to fulfill Transmission System Operators (TSO) requirements and provide enough transient stability to overcome grid regulations concerns. New grid codes have been introduced, establishing capacity limits that control the **active power output** of wind farms, as well as their **power factor**. Also, many system operators in Europe nowadays require wind turbines with a higher potential to sustain grid transients.

In response, ALSTOM designs its wind turbines to provide dynamic control of active and reactive power and to supply continuity against voltage drop downs. The wind turbines fulfill most international grid connection requirements – frequency and voltage control.

3.2.1 ACTIVE/REACTIVE POWER CONTROL

ALSTOM MW-class wind turbines have the capability to control the active power output with a rapid response. The reference value can be adjusted in order to limit the output at that particular level. Smooth transition from the default mode to operation with limited output prevents unnecessary mechanical loads from being transferred to the structure.

Our wind turbines can deliver/control their reactive power in the range from 0.95 lagging to 0.95 leading for the voltage range of ±10%.

3.2.2 LOW VOLTAGE RIDE THROUGH

Our wind turbines continuously supply power during voltage drop down according to International grid codes. The wind turbines comply with most of the International regulations.

- No disconnection from grid.
- No consumption of active or reactive power.
- Power production proportional to the voltage.
- Reactive power generation to help the grid recovery.

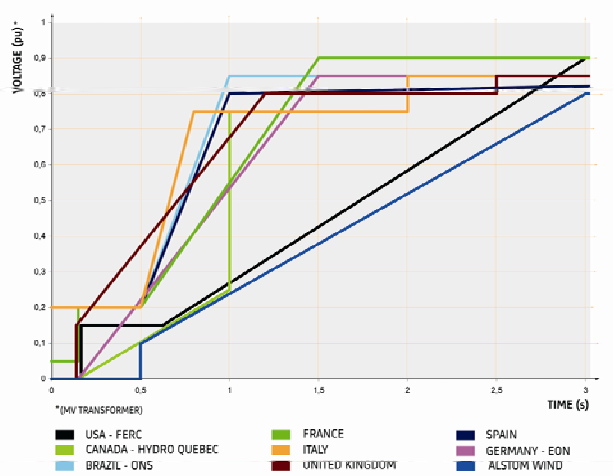


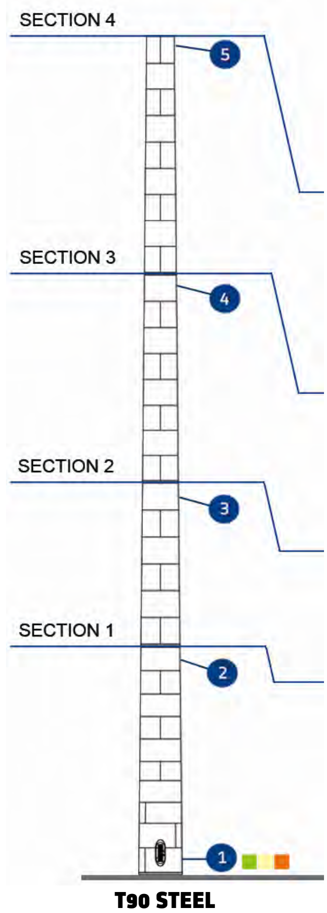
Fig. 5- International Low Voltage Ride Through requirements.

3.3 TOWER & FOUNDATION

ALSTOM 89 m steel tower has been designed in 4 sections allowing the installation in almost all soil types with minimum cost. For the 89 m tower all sections are made of steel plate. The flanges joining them are welded and bolted on each extreme.

All tower models are ALSTOM development based on proven design and previous experience in full steel and hybrid tower technology. Different platforms are placed along the tower high for the surveillance and maintenance works.

Following figure shows the structure in sections for full steel tower and the location of the most important electrical components.



It.	Description	It.	Description
01	Lower platform	(green)	Switchgear
02	Section 1 flanges platform	(yellow)	Lifting appliance control cabinet
03	Section 2 flanges platform	(orange)	PB cabinet
04	Section 3 flanges platform		
05	Section 4 flanges platform		

Fig. 6- ECO 122 - Full steel 89 m tower.

TOWER	T90
Type description	89 m tubular
Material	Steel
Foundation standard type	Concrete octagonal foundation slab and concrete octagonal pedestal. [1)]
Tower base diameter	4.5 m
Steel tower top diameter	2.85 m
Corrosion class outside (EN 12 944)	C4
Color	RAL 7035

Table 5- The ECO 122 tower main features. [1)] These characteristics are guiding values and could be submitted to changes (they depend on local standards and soil conditions).

3.4 NACELLE

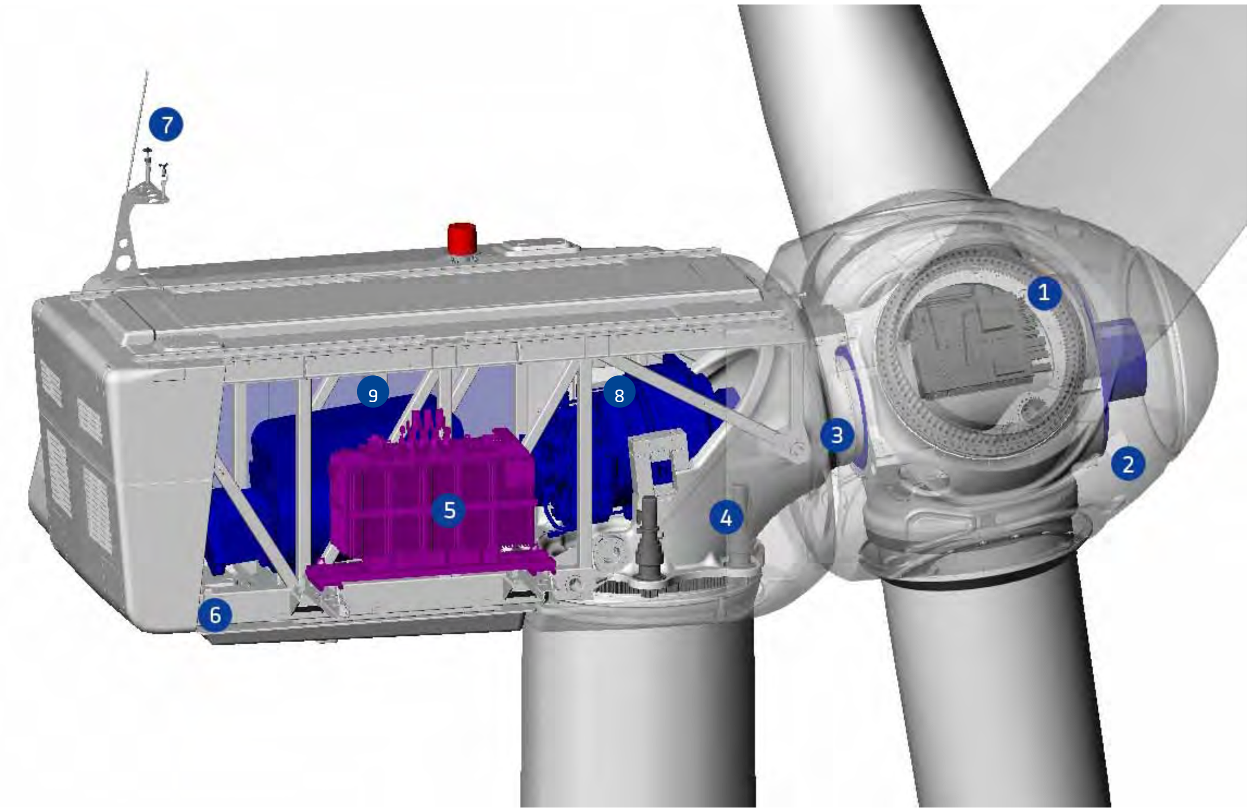
The nacelle cover is made of Glass Reinforced Plastic (GRP). Its housing is made up of three independent elements. Lateral housings provide extra space to install the power transformer, the inverter and control cabinets, while providing easy access for maintenance technicians. Placing the power transformer in the nacelle reduces the power lost during transmission from the generator to the transformer. The nacelle main frame comprises three blocks:

- The **front frame** is a conical component made by cast iron, carrying the hub through the main bearings. It directs via the central frame the rotor loads into the tower.

The front frame is bolted directly to the **central frame**, also made by spheroid cast iron, which supports the gearbox, the three guide supports and the four motors of the yaw system.

- The **rear frame**, made of welded structural steel, is bolted to the central frame and supports the generator, the hydraulic master unit, the converter and the transformer.

The nacelle contains the internal 500 kg service crane. An opening in the floor provides access to the nacelle from the tower. Other equipment on the nacelle roof is the lightning arrester, the wind sensors and the beacon lights.



It.	Description	It.	Description
01	Pitch system	06	Rear main frame
02	Rotor	07	Wind wane, anemometer, low intensity beacon and lightning arrester.
03	Front main frame	08	Gearbox
04	Central main frame	09	Generator
05	Main transformer		

Fig. 7- ECO 122 nacelle frame. On this image the most important components in the nacelle are described.

Fig. 8- Nacelle dimensions.

3.5 HUB

The hub is made by cast iron with three joint flanges for the pitch control bearings and three access points for maintenance tasks. The central conical part houses the rotor bearings.

The ECO 122 design allows the technicians full internal access to the hub directly from the nacelle.

Fig. 9 – ECO 122 hub deflector.

3.6 BLADES

The blades are manufactured according to the pre-bending concept. This concept means that the blade is created so that it reaches the optimal shape when submitted to the wind loads. Another advantage of this concept is that it allows lighter blades and a large swept area, crucial for the annual production of the wind turbine. The tip design enables the possibility to obtain a good balance between noise generation and performance.

Fig. 10- ECO 122 blades.

The next table resumes the most important characteristics of the blades:

BLADES	
Length	59.3 m
Maximum cord	3.95 m
Blade surface area (1 blade) [1)]	140 m^2
Weight (approx.)	14 tons

Table 6- Blades main features. [1)] Projected surface area.

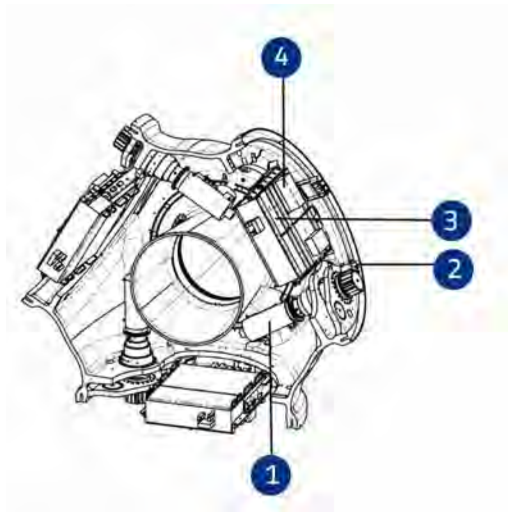
3.7 PITCH CONTROL SYSTEM

The pitch control system is made by a crown wheel supported by bearings and an electrical actuator. Each blade has an independent pitch system with its own emergency battery package. The main wind turbine braking system is also based on pitch control. The existence of independent pitch systems for the three blades, including one autonomous uninterrupted power supply in each blade, maximizes the safety factor of the wind turbine: in the event of a failure of one pitch system, the wind turbine is still capable of braking.

The next tables resume the most important mechanical and electrical characteristics of the Pitch System.

GENERAL SPECIFICATIONS	
Boxes/Blade	2 (Driver+Batt.)
Location	Pitch system has fixed position inside the hub
Battery Management	Includes remote condition monitoring
Actuators	DC Compound Motor
Encoder	SSI Encoder+Resolver Combination analyzed by the Inverter
Lubrication	Power supply of Lubric. pumps; Commands over Device Net Communication
Inverters	Includes remote control and monitoring
Others	Redundant Encoder

Table 7- ECO 122 pitch systems mechanical main features.



It.	Description	It.	Description
01	Pitch gearbox	03	Battery box
02	Enconder	04	Axial box

Fig. 11 – Elements of the pitch control system.

3.8 YAW SYSTEM

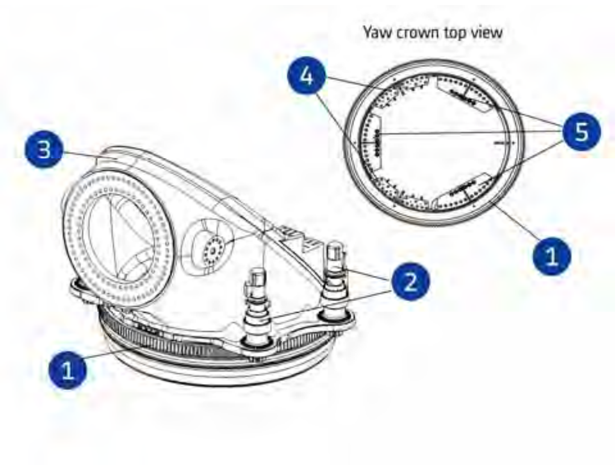
The principle of the Yaw System is the same used in other models - like ECO 100 & ECO 110 - and has the reliability proven by them, but integrates new improvements in axial and radial guiding. The sliding bearings are easy to maintain without the need of cranes. The yaw system is composed by:

- The **yaw system** (self): one crown and four pinions (with 4 motors),
- the **guiding system**: with 3 passive guiding pads, and
- the **brake system**: that includes 4 hydraulic brake callipers.

The four motors and the planetary type gear reducers drive by variables frequency. The next table resumes the general values of the yaw system.

GENERAL SPECIFICATIONS	
Number of motors	4
Reduction ratio	1266.41
Pinion / crown wheel ratio	1:17.36

Table 8- ECO 122 yaw system main features.



It.	Description	It.	Description
01	Yaw crown	04	Brake callipers
02	Gear motor	05	Guiding pad
03	Central frame		

Fig. 12 – ECO 122 yaw system, general view.

3.9 POWER TRAIN LAYOUT

The **ALSTOM PURE TORQUE**^{TM}, is designed to transmit the torque loads from the rotor to the drive train, whereas the rotor bending loads (non useful loads) are transmitted through the main frame to the tower structure. The hub is supported directly by the mainframe on two bearings, whereas the gearbox is fully separated from the supporting structure. This design avoids the introduction of rotor bending loads to the gearbox. This is proven with more than 10 years of experience since its introduction in the ECO 44 wind turbine.

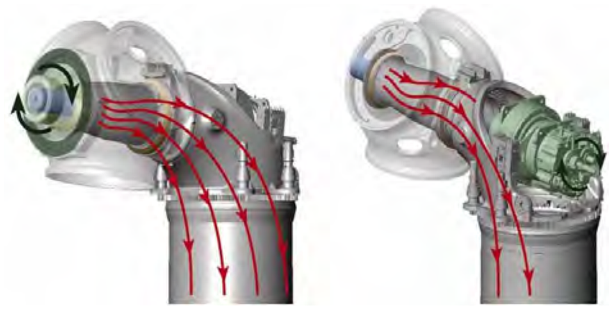


Fig. 13 – ALSTOM PURE TORQUE^{TM} The green arrows represent the torque forces and the red arrows the wind bending forces. The fixing of the rotor deflects all bending loads to the tower and only the useful torque loads are transmitted to the drive train.

3.10 GEARBOX

The wind turbine gearbox increases the relatively slow speed of the rotor to the speed required by the generator.

The gearbox is formed by two planetary stages and one parallel stage. Gearbox is the complete assembly of gears, shafts, bearings, housing, seals, lubrication system and associated components.

The gearbox is placed next to the centre of the tower, between the Low Speed Shaft (LSS) and the generator. The connection to the LSS is achieved by a bolted flange and the connection to the generator by an elastic coupling-HSS (High Speed Shaft). The gearbox is fixed to the central cast iron main frame by means of two torque arms and its gearbox supports (rubber-metal elements).

Due to the special bearings arrangement and layout, the LSS and gearbox are only loaded by main torque (Mx). The next table shows the gearbox main features:

GEARBOX	
Type	2 planetary stages + 1 helicoidally stage
Input / Output speed	12.25 rpm (input) /1 728 rpm (output)
Nominal gearbox ratio	1:141.06[1)]
Support	Elastomeric pads (Silent Blocks)

Table 9- ECO 122 Gearbox main features. *[1)] 50 Hz.*

3.11 ELECTRICAL SYSTEM

The following sections will explain the main electrical components in the wind turbine generator. The main electrical components are:

- Generator
- Power cabinet
- Converter
- Transformer
- MV Switchgear

The main electrical concept from our wind turbines is to separate the auxiliary services from the main electrical components.

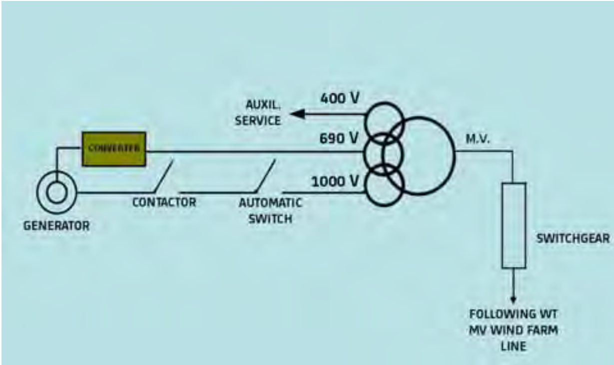


Fig. 14- ECO 122 – Basic electrical system diagram.

The auxiliary services take care of the elevator, lights, outlets, sensors, heating, cooling, yaw, pitch and control systems. Some of these have an UPS for emergency cases.

3.11.1 GENERATOR

The ECO 122 generator is an asynchronous variable speed doubly fed induction generator (DFIG), i.e. two multiphase windings sets, one at the stator and one at the rotor. The rotor side is control by the converter. One of the most important advantages of this type of generators is that, transitory, they can allow mechanical torque over the full load torque without the lost of synchronism. The next table shows the most important specifications of the generator used in the ECO 122.

GENERATOR	
Type	DFIG
Rated power	2 700 kW
Speed range	984 – 1 728 rpm [1)]
Rated generator speed	1 728 rpm [1)]
Stator voltage	1000 V
Rotor voltage	760 V
Frequency	50 Hz
Refrigeration	Water-Air

Table 10- ECO 122 generator main features. *[1)] 50 Hz.*

Fig. 15- ECO 122 generator.

3.11.2 POWER CABINET

The power cabinet is designed and manufactured by ALSTOM. This cabinet contains the circuit breaker that protects the stator of the generator and the contactor, which it is controlled by converter and allows the connection of the generator to the grid and start producing energy. The main characteristics are exposed on the next table:

POWER CABINET	
Manufacturer	ALSTOM
Stator contactor	2050 A
Circuit breaker	2000 A
Characteristics	Cabinet frame

Table 11- ECO 122 power cabinet main features.

3.11.3 CONVERTER

The converter is located in the nacelle. The converter will help to limit the active power and regulate the reactive power to a desire set point.

The converter carries out the control of the generator rotor and adapts the generated energy to a suitable energy to be fed to the grid according to grid codes.

The features of the converter depend in high measure of the type of semi-conductors used in its construction. The ECO 122 converter is a Back-to-back AC-DC-AC based in IGBT technology. Its main characteristics are exposed on the next table:

CONVERTER	
Type	Back-to-back AC-DC-AC.
Technology	IGBT
Cooling system	Water cooled
Characteristics	Active crowbar +DC chopper. Improved LFRT performance

Table 12- ECO 122 converter main features.

Fig. 16- ECO 122 converter.

3.11.4 TRANSFORMER

The transformer allows adapting the wind turbine voltage to the wind farm voltage.

The ECO 122 presents the transformer in the nacelle. The main function of this is to step-up the wind turbine voltage to the wind farm voltage. Table 13 describes the most important technical characteristics of it.

MAIN TRANSFORMER (IN NACELLE)	
Voltage (customizable)	1000 V ; 690 V ; 400 V; 20/30 KV (customizable)
Power	3 200 kVA
Type	Liquid
Losses	Po = 2 500 W; Pk = 35 000 W
Cooling system	KN (ester)
Maximum dimensions (LxWxH)	3.00 x 1.08 x 2.09 m
Maximum Weight	6.5 Tn

Table 13- ECO 122 main transformer features.

Fig. 17- ECO 122 main transformer.

3.11.5 MV SWITCHGEAR (OPTIONAL)

The Medium Voltage Switchgear is located in the tower base. It protects the wind turbine against over currents, short circuits and ground fails. Some of the possible configurations are:

- One incoming feeder & one outgoing feeder (with and without disconnection).
- One incoming feeder & two outgoing feeders (with and without disconnection).
- End of line.

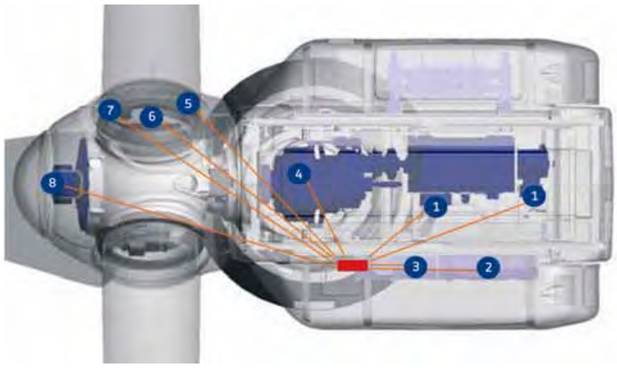
The next table shows the most important characteristics of the Switchgear:

SWITCHGEAR	
General	SF6 fully insulated, metal enclosed, lifetime sealed stainless steel tank
Highest voltage for the material (customizable)	24 / 36 kV
Rated frequency	50 / 60 Hz
Rated current	400 / 630 A
Insulation level (rated freq.)	50 / 70 kV
Insulation level (lightning impulse)	125 / 170 kV
Options	Feeder switch, motor switch, surge arrester.

Table 14- ECO 122 switchgear main features.

4. CONTROL SYSTEM

The control system of the ECO 122 is based on the **GALILEO** platform developed by ALSTOM. It is a decentralized system that implements the regulatory characteristics already used for previous platforms but provides major additional advantages.



It.	Description	It.	Description
▬	**CONTROL SYSTEM** (in control cabinet)	05	Aux. pitch box cabinet
01	Generator box	06	Axial box
02	Inverter cabinet	07	Batteries box
03	Power cabinet	08	Deflector box
04	Block 1 cabinet		

Fig. 18- The Galileo System: the control system of the ECO 122.

5. SCADA SYSTEM

ALSTOM developed its own SCADA (Supervisory Control And Data Acquisition system), based on more than 25 years of wind turbines maintenance.

The monitoring system consists of a set of electronic components, computer and infrastructure, oriented to the transmission, processing and presentation of operation data of the facility. The goal of the monitoring system is to make the information gathered in the farm available to the personnel responsible for the operation of the wind farm and provide real time data and historical data for analysis of the operation.

Additionally it allows proper monitoring of the plant from the operations building, either from the farm operations centre or from remote sites through the use of data communication systems.

5.1 SCADA COMMUNICATION FEATURES

The SCADA system allows the communication with different components. The next diagram shows a schematic SCADA communications diagram.

According to the communications diagram, the SCADA System communicates in all cases with the control system from each wind turbine, and optionally, with the control substation and/or a meteorological mast. Data structure is according to IEC-61400-25-2 standard (Communications for Monitoring and Control of Wind Power Plants – Information model). Historical data for ten minutes and system-component alarms are stored in a SQL Server database. Data communications are done by means of:

- OPC DA 2.0 for instantaneous data.
- Web Services to recover historical data and alarms and additional information attached to such alarms.

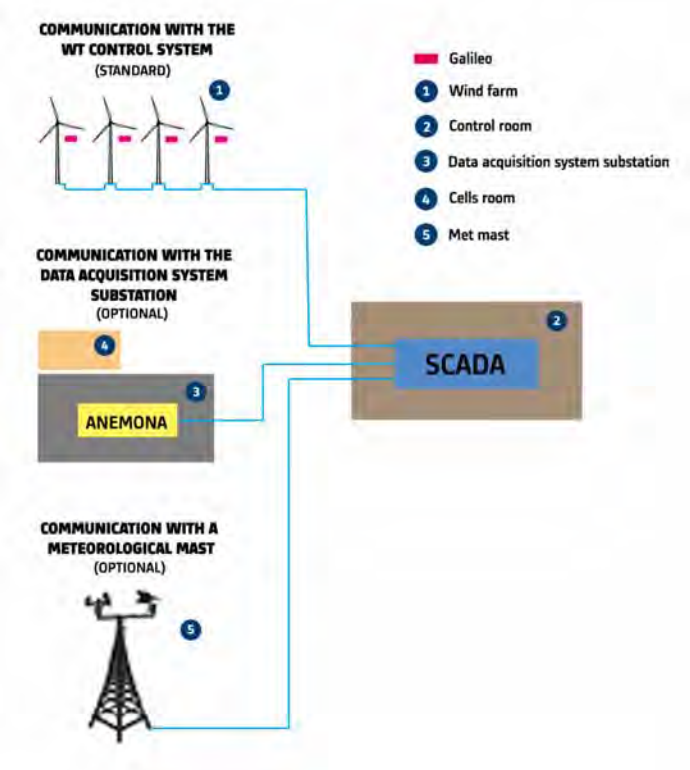


Fig. 19- SCADA communications diagram.

5.1.1 COMMUNICATION WITH THE WT CONTROL SYSTEM

As standard, SCADA provides remote access to the wind turbine data: the generated power, rotor rpm, electrical data, main components temperatures, wind conditions and wind turbine status, among others. The values are displayed in real time.

5.1.2 COMMUNICATION WITH THE SUBSTATION DATA ACQUISITION SYSTEM (OPTIONAL)

SCADA also enables the wind farm active/reactive power, voltage and frequency control. For that purpose, the installation of a power grid analyser device with a specific hardware called ANEMONAX is needed. This hardware is the interface between the SCADA and the substation components.

5.1.3 COMMUNICATION WITH THE METEOROLOGICAL MAST (OPTIONAL)

SCADA enables the integration of a meteorological data acquisition system. ALSTOM wind farms are provided with the CAMPBELL data-logger. Optionally other data-loggers can be integrated.

In general, ALSTOM offers the option to perform the integration, installation and commissioning of the following equipments:

- Met mast
- Sensors
- Sensors supports
- Deck-house
- Data-logger
- Other accessories

5.1.4 SCADA EXTERNAL ACCESSES / OPC SERVER

SCADA access is done by means of a web browser with Internet connection. Previous installation of a local application is not necessary.

Based on OPC Server DA 2.0 SCADA issues all wind farm variables of the wind farm, the met mast as well as the values calculated from SCADA itself.

SCADA GENERAL SPECIFICATIONS:

- Object Oriented
- According IEC 61400-25
- Multi-language
- OPC Server
- Standard database (SQL Server)
- Friendly GUI
- Grid integration
- Met mast integration
- Customizable stored historical data (years).

IMPORTANT NOTICE: SCADA is typically customized on each wind farm. For more and binding information please contact ALSTOM Wind Sales Department.

6. WIND FARM CONNECTIVITY

6.1 EXTERNAL WIND FARM CONNECTIVITY

To guarantee the operation and maintenance services, ALSTOM offers a remote connectivity system with the wind farms. Additionally, ALSTOM offers communications network integration with the customer or third parts by means of standard connectivity models (connectivity models can also be customized).

Usually, wind farm data requires remote access. For that purpose the networks must be integrated in accordance with ALSTOM before agreed connectivity model. The data will be sent through OPC 2.0 servers integrated on the wind farm SCADA system.

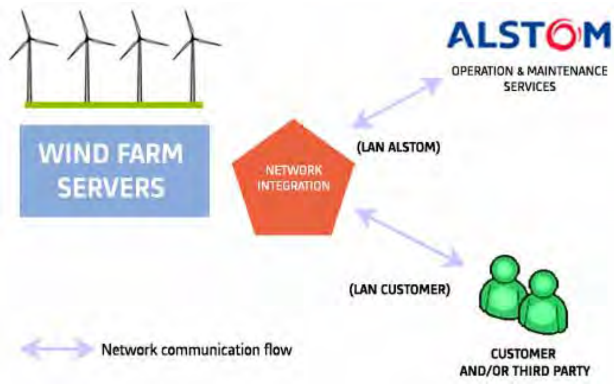


Fig. 20- Wind farm connectivity diagram.

6.2 INTERNAL COMMUNICATION CONNECTIVITY

All communications inside the wind farm are achieved by means of an Ethernet 100 Mbps network, whose infrastructure is mainly made of optical fibre.

This network features many management and redundancy characteristics. As examples: connexion of wind turbines in redundant rings, possibility of priory's traffic, remote diagnostics, and so on.

7. MAINTENANCE AND AFTER SALES SERVICE

The overall aim of the ALSTOM Maintenance Services is to ensure the optimum working order of wind turbines throughout their working life, so that they meet client expectations insofar as expected performance and reliability. A wide and flexible portfolio of services ensures adaptability to any customer need.

All maintenance activities follow the guidelines established by the ALSTOM Quality System, which is certified according to the ISO 9001 Standard and with the company's Occupational Risk Prevention System.

As decentralised units, the Operating and Maintenance areas supervise and operate the turbines in real time, programming, implementing and controlling the preventive and corrective maintenance activities. **Preventive activities also includes predictive operations in order to assure and enhance reliability performance.**

The Alstom Wind spare parts management ensures the guarantee of spares parts on site and an available stock of critical components in the warehouses.

Technical expertise is managed in different levels, form the field specialists to the area experts and the Alstom Wind Reliability Department. A double flow bottom-up and up-bottom of the information ensures knowledge sharing and quick reactions.

ALSTOM puts its clients in direct contact with the Maintenance organization; a Key Account Management structure ensures quick and homogeneous information.

In evenings and night time, when there's no physical presence of technicians on site, the Alstom Wind Control Centre monitors remotely the wind turbines to remotely reset alarms and dispatch on-call teams.

8. CERTIFICATION

All ALSTOM's wind turbines are certified according to IEC-EN standards by international organizations recognized to issue IEC-WT01 Type Certificates. These standards include the inspection of the assembly, full-scale testing of the blades and load, as well as performance and load measurements. The power curve, emitted noise and power quality are measured by independent testing laboratories and are available to our customers.

Appendix C
ECO 122 Installation Instructions

Wind Turbine ECO 100/110 tower 75, 90m and ECO 122 T89m – Requirements for transport and installation, Installation Instructions, prepared by ALSTOM WIND, 30 July 2012

POWER SYSTEMS WIND

Alstom Wind
Roc Boronat, 78. 08005 Barcelona, Spain
Phone: +34 932 257 600
Fax no.: +34 932 210 939
www.power.alstom.com

FRM- 0953 EN R01

INSTALLATION INSTRUCTIONS

IDI-0304 Rev. 09	Description of revision: **Approved**	
Wind Turbine ECO 100/110 tower 75, 90m and ECO122 T89m. Requirements for transport and installation.		
Author:	Revised by:	Approved by:
J. Terradellas	C. O'Hannrachain	E.Corrons

REVISIONS				
Rev.	Date	Description of changes	Pages Amended	Author
01	22.10.2008	Edition, Dimensions and Weights, Roadways with excess width, Diagrams		M.T
..	...	...		...
09	30.07.2012	Included preliminar dimension for ECO122 nacelle, and drawing references for T90m (4 sections) and T89m (4 sections) Drawing for crane assembly areas	4,5 21	C.Ó h. J.T.

INDEX

1. Subject

These instructions establish the general positions for transportation, handling and installation of the ECO100 and ECO110 wind turbine for 75 and 90 hub heights. It is also included in this document information regarding ECO122 with 89m hub height.

2. Responsibilities

The following hypotheses have been considered in these instructions:

- Existence of appropriate general access roads,
- Appropriate road surface conditions,
- Inexistence of height and weight limitations for the required transportation
- No obstacles imposed by the different authorities to obtain standard transportation and vehicle traffic permits.
- These instructions include the series indicated herein and any subsequent series unless otherwise indicated.

The requirements described in this document are illustrative and may by modified by ALSTOM WIND without prior notice.

Any site that does not meet with these positions must be consulted with ALSTOM WIND.

3. Verifications

Before the starting of installation, ALSTOM WIND shall receive the justification for complete fulfilling of the works executed. Only then installation process would be able to start.

ALSTOM

4. Dimensions and weights for transportation Eco100 and Eco110 tower of 75m, 90m and ECO122 89m height.

4.1. Steel tower

	Rotor height 90 m S2				
Component & transport tools	**Weight**	**Maximum diameter**	**Minimum diameter**	**Length**	**Diagram**
Lower section	22 T	4.9 m	4.5 m	2.6 m	10200042
Section 1	55 T	4.6 m	4.6 m	11.6 m	12000108
Section 2	65 T	4.6 m	4.0 m	21.7 m	12000109
Section 3	60 T	4.0 m	4.0 m	27.4 m	12000110
Section 4	45 T	4.0 m	3.0 m	28.7 m	12000111

	Rotor height 75 m (conical tower)				
Component & transport tools	**Weight**	**Maximum diameter**	**Minimum diameter**	**Length**	**Diagram**
Lower section	19 T	4.6 m	4.3 m	2.7m	10200034
Section 1	65 T	4.2 m	4.5 m	16.2 m	12000103
Section 2	66 T	4.3 m	3.7 m	28.2m	12000104
Section 3	44 T	3.7 m	3.0 m	29.1 m	12000105

	Rotor height 75 m (cylindrical tower)				
Component & transport tools	**Weight**	**Maximum diameter**	**Minimum diameter**	**Length**	**Diagram**
Lower section	19 T	4.6 m	4.3 m	2.7m	---
Section 1	65 T	4.2 m	4.5 m	16.2 m	---
Section 2	66 T	4.3 m	3.7 m	28.2m	---
Section 3	44 T	3.7 m	3.0 m	29.1 m	---

	ECO 122 Rotor height 88.5 m				
Component & transport tools	**Weight**	**Maximum diameter**	**Minimum diameter**	**Length**	**Diagram**
Lower section	22 T	4.9 m	4.5 m	2.5 m	10200046
Section 1	55 T	4.6 m	4.5 m	11.6 m	12000117
Section 2	76 T	4.6 m	4.0 m	20.2 m	12000118
Section 3	68 T	4.0 m	4.0 m	27.4 m	12000119
Section 4	51 T	4.0 m	3.0 m	28.6 m	12000120

Note: The weights and dimensions include tools used for transporting each component, so these data could no be taken as per component itself.

4.2. Nacelle ECO-100/110

Component & transport tools	Length	Width	Height	Weight	Diagram
Block, B1	10 m	4.4 m	4.1m	84 T	07800062
Block, B2	6.2 m	4.5 m	4.5 m	56 T	07800067
Block, BE1+BE2	8.6 m	2.5 m	3.5 m	4 T	07900135

4.3. Nacelle ECO-122

Component & transport tools	Length	Width	Height	Weight	Diagram
Block, B1	10 m	4.4 m	4.1 m	84 T	---
Block, B2	6.2 m	4.9 m	4.8 m	---	---
Block, BE1+BE2	8.6 m	2.5 m	3.5 m	4 T	---

4.4. Blades (with transport tools)

Component & transport tools	Length	Width	Height	Weight	Diagram
1 Unit Eco100	49 m	3.6 m	3.1 m	12.8 T	12000052
1 Unit Eco110	54 m	3.7 m	3,10 m	14.9 T	12000087
1 Unit Eco122	60 m	3.7 m	3.5 m	16.5 T	---

5. Transportation equipment

5.1. Steel transportation equipment

Component	U/ Trans	Transportation equipment description
Section TH1	**1**	A) Pipe loader collar with dolly or double clamp. B) Extendible pipe loader with self-steering wheels on rear axle.
Section 1	**1**	C) Pipe loader collar with dolly or double clamp. D) Extendible pipe loader with self-steering wheels on rear axle.
Section 2	**1**	E) Pipe loader collar with dolly or double clamp. F) Extendible pipe loader with self-steering wheels on rear axle.
Section 3	**1**	Extendible pipe loader with self-steering wheels on rear axle.
Section 4	**1**	Drop deck with self-steering wheels on rear axle.

5.2. Transportation equipment for nacelle in modular blocks

Modular nacelle	Quantity	Transportation equipment description
B 1	**1**	A) Low loader with self-steering wheels on rear axle. B) Modular with self-steering wheels on rear axle.
B 2	**1**	A) Low loader with self-steering wheels on rear axle. B) Modular with self-steering wheels on rear axle.
BE1 + BE2	**1**	Drop deck

5.3. Blade transportation equipment.

	Quantity	Transportation equipment description
Blades	**1**	Extendible deck with self-steering wheels on rear axle.

6. Requirements for accesses and roadways

The access roads to the sites must withstand the same loads and meet the same requirements as the tracks inside the wind farm itself.

The access roads must allow for the base of each wind turbine to reach the site with all its components at any time of year.

Depending on the wind farm distribution of the turbines for each site, whether it has one or several entrances, at least the following will pass along the tracks inside the wind farm per wind turbine:

- 5 Cranes per wind turbine, maximum weight 130 tons with a maximum of 15 tons per axle.
- 15 units of special transportation per wind turbine, with a maximum of 14 tons per axle.

A specific study must be carried out to determine the type of track restructuring required, the results of which may determine the general instructions given below.

- The extent of restructuring will depend on the geotechnical study, as a general rule:
- At least the existing layer of soil (scrub clearing) will be removed.
- The resulting levelled ground must be of suitable characteristics for the traffic it is to withstand to a final resistance and deformability test of up to 120 Mpa (generally load plate test) .Where required, it will be improved by providing selected or appropriate material, where possible, under no circumstances of a quality below tolerable, paying particular attention to the plasticity of the material.
- Generally, bearing capacity required is 25T/m2. Different values or tracks design have to be checked.

To improve the levelled ground and construction of embankments, special attention will be paid not only to the quality of the material but to the implementation process commonly sanctioned by the following practice: Compacting in layers with a maximum thickness of 30 cm to 95% MP, with the provision of water (irrigation).

The wearing course (surface) will be made with artificial gravel or equivalent, with materials of reduced plasticity (IP ≤ 5) being accepted. The remaining geotechnical characteristics corresponding to artificial gravel will be maintained. The thickness of the wearing course will depend on the quality of the levelled area, although will be no lower than 25 cm, compacted to 98% MP.

Correct crossways and lengthways drainage must be ensured.

In the event of pot-holes, as a general rule, a layer of at least 50 cm. of coarse aggregate will be used for restructuring to avoid water retention.

In sections of the wind farm where the road surface is made of clay, where the water table is relatively shallow or, in general, where there is a bad response to water and where it is of such a depth that complete restructuring is financial unfeasible, a double layer of geotextile will be used to separate the natural ground from the levelled area improvements in order to equal or exceed the implementation quality required, to avoid contaminating the fill material and to increase the supporting capacity of the levelled area.

The kerbs must be covered where required by the geotechnical study and, in all circumstances, must be of a sufficient capacity and remain free of plant life and obstacles that could retain water. Any brickwork must be of a sufficient section.

For easier vehicle traffic, kerbs will occasionally be filled and compacted (a typical example: interior bends). This temporary work must be removed once the foreseen traffic has ended.

Recommended slope on cut 1/2 and on fill 3/2, in line with the geotechnical conditions of the site.

The tracks must be built with a minimum banking necessary for water evacuation (crossways drainage). The direction of the banking will depend on the position of the kerbs and the final gradient of the road.

Special attention will be paid to vertical alignments on gradient changes (concave and convex) due to the length of most of the components to be transported. As a general rule, the vertical alignment parameter (Kv) will be greater than 250. The minimum distance accepted between two consecutive vertical alignments is 50m.

6.1. Radius on bends and interior roads for EC0100, ECO110 and ECO122.

According to total length of the truck the entire route from the point of origin to the site must be verified, whether the point of origin be the ports where the components are unloaded or the plants where they are manufactured. Make sure that the entire route to each site is feasible.

Where modifications are to be made at any point on the route, the outside of the bends should be narrowed and no obstacles be left on the inside. For each modification, consider whether the route where the action is to be taken is flat or on a slope and the type of road surface in question.

Bear in mind the parameters indicated in the following table (excess width, obstacles on the inside and outside of the bends, etc.) for the radii of the bends. We have considered the most critical components to be the blades, due to their length, and B1, due to its weight and to the length of the convoy required to transport this component.

Additionally, it is required in bended parts of the road, to have 5m free of obstacles in each side of the road, in order to allow the transport of overhanded loads (blades).

6.2. Radii on bends for ECO 100 wind turbines

Width (A)	Minimum radius (R)	Excess width (S, Si)	Condition of the bend
5 m	125 m	-	With obstacles on the inside and outside of the bends.
5 m	45 m	-	With no obstacles on the inside and outside of the bends.
5 m	35 m	3 m	With 3 metres of excess width and no obstacles on the inside and outside of the bends.
5 m	30 m	5 m	With 5 metres of excess width and no obstacles on the inside and outside of the bends.

6.3. Radii on bends for ECO 110 wind turbines

Width (A)	Minimum radius (R)	Excess width (S, Si)	Condition of the bend
5 m	130 m	-	With obstacles on the inside and outside of the bends.
5 m	50 m	-	With no obstacles on the inside and outside of the bends.
5 m	38 m	3 m	With 3 metres of excess width and no obstacles on the inside and outside of the bends.
5 m	33 m	5 m	With 5 metres of excess width and no obstacles on the inside and outside of the bends.

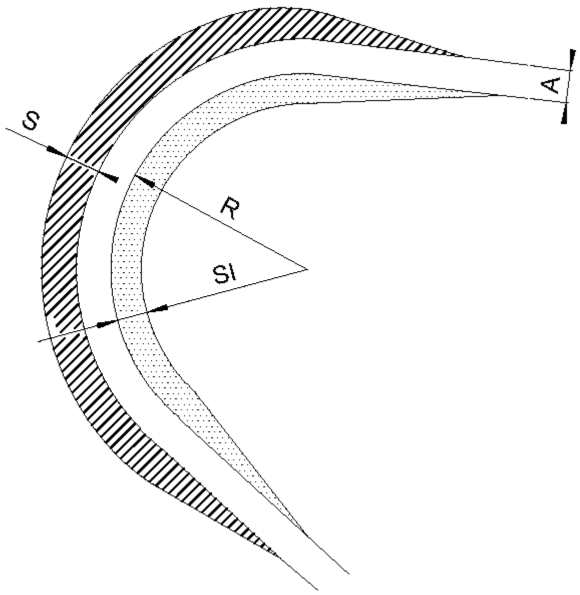
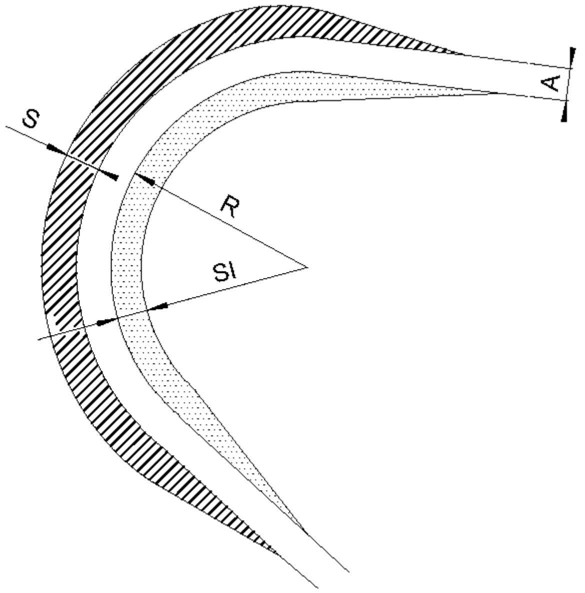


Fig.1

6.4. Radii on bends for ECO 122 wind turbines

Width (A)	Minimum radius (R)	Excess width (S, Si)	Condition of the bend
5 m	130 m	-	With obstacles on the inside and outside of the bends.
5 m	53 m	-	With no obstacles on the inside and outside of the bends.
5 m	45 m	3 m	With 3 metres of excess width and no obstacles on the inside and outside of the bends.
5 m	40 m	5 m	With 5 metres of excess width and no obstacles on the inside and outside of the bends.



7. Construction work requirements, 75m/89-90m tower.

A crane with lattice boom installed on chain chassis (CC) or truck chassis (TC) must be used to install ALSTOM WIND wind turbines with a 75/89-90 meters tower. Additionally a narrow track chain chassis crane could be considered.

A CC crane is recommended for installation of towers, adapting the tracks inside the site for movement of the chain crane mounted inside the wind farm among wind turbines, if possible.

ALSTOM WIND offer shall include and detail any crane solution is considered for every project, according to site conditions, designed tracks and crane's availability.

7.1. Installation with TC crane

In the case of a TC crane, the boom must be completely removed when moving it from one wind turbine to another. The tracks may be 5 metres wide. The following must be taken into account when using this model of crane.

- ➢ Cost of completely removing the crane in each position on site.
- ➢ Cost must include auxiliary equipment and the workforce for the main crane.
- ➢ Time involved in moving the main crane.

7.2. Installation with CC crane

In the case of the CC crane and where ground conditions allow as such, there are 2 options.

- ➢ Adapt the interior tracks to the necessary width to move the mounted C.C. crane, producing a 12-metre road or a 5-metre road and a temporary roadway of 2.5 metres.
- ➢ Provide tracks that are 5 metres in width and dismantle the C.C. crane for each position (the cost of dismantling the crane in each position must be considered, as with the TC crane). In this case, the track requirements are the same as for a T.C. crane model.
- ➢ Time involved in moving the main crane.

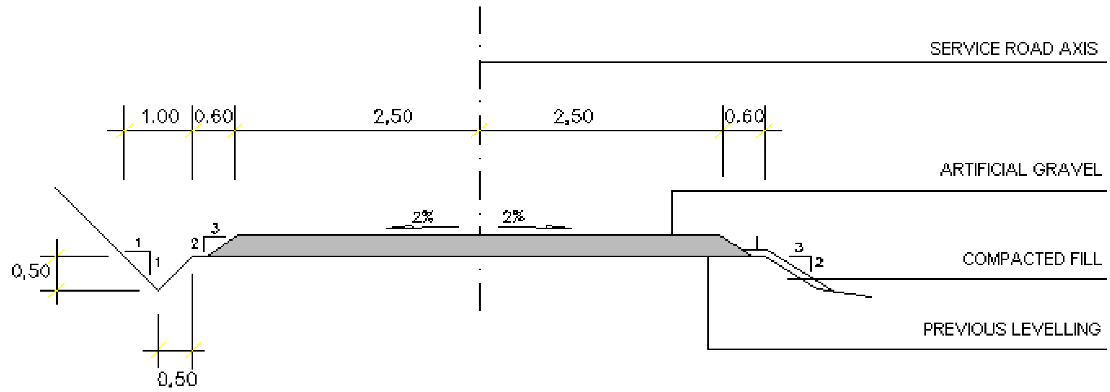
7.3. Installation with Narrow Track CC crane

This case is a complementary option for CC crane, called narrow track,

- ➢ Adapt the interior tracks to the necessary width to move the mounted Narrow Track C.C. crane, with only a 6-metre road.
- ➢ Time involved in moving the main crane.
- ➢ Availability and cost to be considered in Alstom offer.

7.4. TC crane

For wind turbines with a hub height of up to 75/89-90 m., the road must be 5 m wide in line with the following diagram:



Detailed view of the profile of the on-site track for 5 metre-wide roads.

Fig.2

The width of the road surface will be 5 m on straight sections. The excess widths indicated in Section 7.1 will be implemented on bends and, therefore, must be planned with a sufficient excavated width to cover banks, kerbs and other roadway elements as well as the aforementioned width.

7.4.1. Track gradients.

- The acceptable gradient with gravel paving is up to 12%. The provisions indicated in the previous section apply to sections with these characteristics.
- The absolute maximum gradient of the tracks is 15%. For sections with a gradient of between 12 and 15%, the provisions in the above section apply, except for the road surface that will be made of concrete with C20, a minimum thickness of 20 cm. and steel mesh, expansion joints every 10 metres and a rough surface finish.
- On all accounts, for gradients between 12 and 15%, the need for towing transport must be assessed and its cost evaluated.

7.4.2. Platforms for mounting the T.C. crane lattice boom

Where the installation involves TC cranes, the following is required to mount the lattice boom on this crane :

- A cleared, levelled area measuring 120 metres in length x 4 in width alongside the 5-metre road connecting the different wind turbines. This area begins at the wind turbine platform.
- 2 areas to locate the auxiliary cranes mounting the lattice boom.
- The platforms for locating the auxiliary cranes that mount the lattice boom on the main crane must be 12x10 metres. These areas must be close to the tracks connecting several wind turbines in the wind farm and 60 and 80 metres from the centre of the wind turbine installation platform.

7.5. C.C. Crane

- Option 1: a compacted track (as defined in Point 6) 12 metres in width on its straight sections. All 90° bends must be 15 metres in width. These dimensions are only valid during installation.

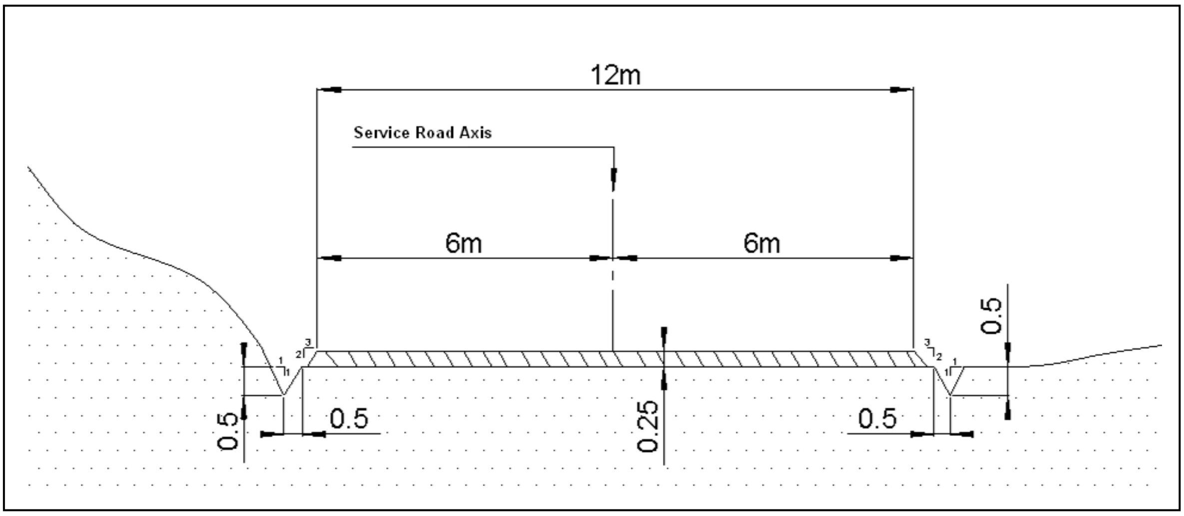


Fig.3

- Option 2: the 5 metre-wide track in the wind farm is available to move the crane. A temporary 2-metre track is adapted (12 metre working width) and duly compacted and levelled. The crane passes a chain along the permanent 5-metre track and the 2nd chain along the track adapted for the crane to move along. After the crane has passed, the temporary track is removed. The necessary civil engineering equipment is required on site for this option throughout the installation.

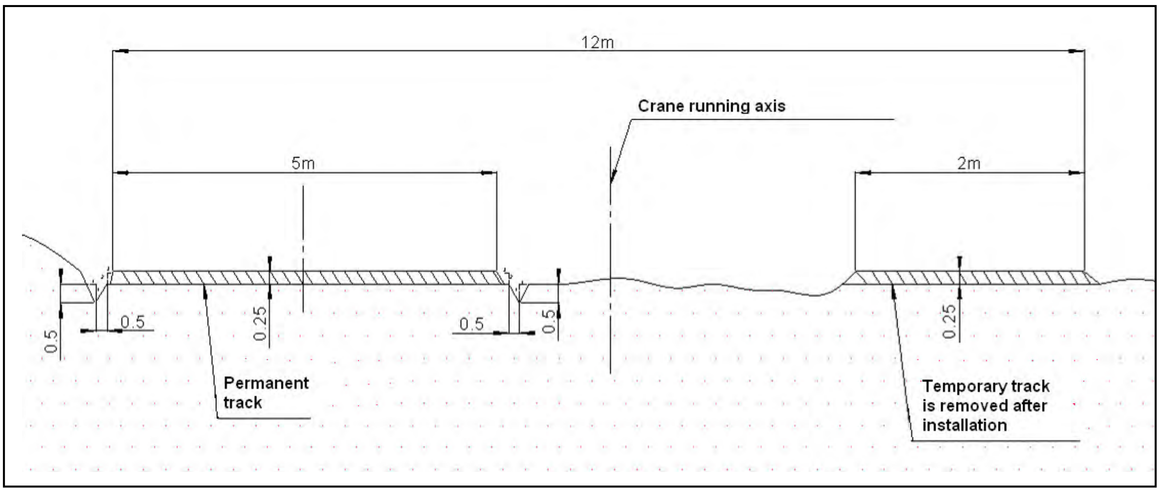


Fig.4

7.5.1. Gradients of the tracks for moving the mounted C.C. crane.

- In the two options, the acceptable gradient for moving the mounted C.C. crane is 6% lengthways and 1% sideways.
- The area along which the crane chains move must be compacted to withstand a minimum pressure of 25 T/m^2
- To move the mounted crane, the sideways and lengthways gradient conditions indicated in the above point must be met. Where these conditions are not met, the crane must be totally or partially dismantled with the subsequent cost of the operation. Where the crane is dismantled, the necessary gradients are the same as for the T.C. crane.

The above requirements must be met before moving the main crane while mounted among the wind turbines on site.

Where the crane cannot be moved while mounted, its movement times between each wind turbine require auxiliary cranes, transportation equipment and operating personnel, etc. All of this necessary equipment is expensive and must be evaluated for each wind farm.

7.6. Narrow Track C.C. Crane

The use of "chain chassis narrow track" crane could be considered as an option. This type of crane, even they are more expensive, allow installation of wind turbine with 6 metres internal tracks without the requirement to dismount the crane between wind turbine's positions. On the other hand, the availability of such type of cranes is very limited in the market compared with the other type of cranes and requires being booked long time in advance. However such solution can be considered if the wind farm internal tracks design requires such approach.

In this case 6 metre-wide track in the wind farm is available to move the narrow track crane. An extended width is needed in bends to 90º until to 1,5m of additional wide surface. Additionally a cleaned area shall be considered in every side of the road of to 2m more in all sections of the road.

Finally it has to be planned not having any height limitations from obstacles as aerial cabling, bridge, trees,… as this crane can move with all its equipment mounted.

7.6.1. Track gradients.

- The acceptable gradient with gravel paving for this crane is to 10%. The provisions indicated in the previous section apply to sections with these characteristics.
- Transverse gradient of the tracks shall not be over 2%.
- The area along which the crane chains move must be compacted to withstand a minimum pressure of 25 T/m^2

8. Installation mounting platforms

8.1. T.C. crane

The mounting platform is the area where the crane is placed to hoist the wind turbine. It is also used to temporarily store the different components. The platform where the crane is located must have surface that is able to withstand the stress transmitted by the crane to the ground during the hoisting of the different components.

The process to following during platform construction must be the same as for the tracks and is defined in Point 7 of this document. The construction process is the same as for the tracks (restructuring, levelling, filling and compacting, etc. The material required in all cases must be similar as that used for the roadways.

- The maximum gradient accepted in the crane operating area for cranes on wheels (TC) is 2% both lengthways and sideways.
- The platform in the site area must withstand the pressure transmitted by the cranes to the ground through the distribution plates. The bearing capacity of the hard standing is 25T/m2 with a minimum deformability of the area where the crane is located. In order to assure this value, the load plate test on the platform shall reach the value of Ev2>80Mpa (Mn/m^2) including Ev2/Ev1<2.
- The minimum operating area of the main crane varies between 22 and 28 metres.
- The final finish of the platform will be 15 centimetres thick with rock gravel pavement compacted to 98% MP.

8.2. C.C. crane (including Narrow track)

The mounting platform is the area where the crane is located to hoist the wind turbine. It is also used to temporarily store the different components. The platform where the crane is located must have surface that is able to withstand the stress transmitted by the crane to the ground during the hoisting of the different components.

The process to following during platform construction must be the same as for the tracks and is defined in Point **7** of this document. The construction process is the same as for the tracks (restructuring, levelling, filling and compacting, etc. The material required in all cases must be similar as that used for the roadways.

- The maximum gradient accepted in the crane operating area for crawler crane (CC) is 1% lengthways and 0.5% sideways.
- The platform in the site area must withstand the pressure transmitted by the cranes to the ground through the chains. The bearing capacity of the hard standing is 25T/m2 with a minimum deformability of the area where the crane is located. In order to assure this value, the load plate test on the platform shall reach the value of Ev2>80Mpa (Mn/m^2) including Ev2/Ev1<2.
- The minimum operating area of the main crane for 90-metre towers varies between 18 and 24 metres.
- The final finish of the platform will be 15 centimetres thick with rock gravel pavement compacted to 98% MP, like the track.

9. Platform dimensions for cranes with T.C. and C.C. crane (including Narrow track)

- The dimensions of the platform are given in the table below and are valid for 75/89-90meters towers.
- The base of the wind turbine may, under no circumstances, be more than 0.5 m above the mounting platform.
- The area where the main crane is stabilised is within the turning radius. The table below indicates the turning radius as RG, to be confirmed according to crane considered in each project. This area must be particularly compacted. Guidelines of how to position the crane are given in the attached platform distribution diagrams.
- Access to the platform from the track for cranes, trucks and vehicles must be easy and there must be no differences in level between the roadway and the platform. Where the cable trench runs between the platform and the track, the cable pathway is recommended to be protected by concreting it. The surface must be the same as for the platform and the roadway.
- The area near the wind turbine (the scored area in the following diagram) located between the crane site and the base of the tower must be at the same level as the platform and must be compacted.
- Crane stabilisers or other loads may not be located on the foundation fill.
- All wind turbines must have a temporary storage area near the platform. The storage area must be flat, at the same level and compacted to withstand the same loads as the platform.
- The components can be stored at the foot of the wind turbine if a temporary storage area is provided. If no storage area is provided alongside the platform, a storage yard must be established in the wind farm and the components re-transported to the base of each wind turbine using the cranes already in position. The dimensions of the storage yard are indicated in Point 11 of this document.
- The base of the tower must be located according with the distance [E] defined in the fig.5.

Rotor height	75/89-90 m
Crane turning radius (RG)	22-28 m
A =	32 m
B =	35 m
C =	9 m
D = movement of the dismantled crane	5 m
D = movement of the mounted crane	12 m
E =	15 m
F =	10 m

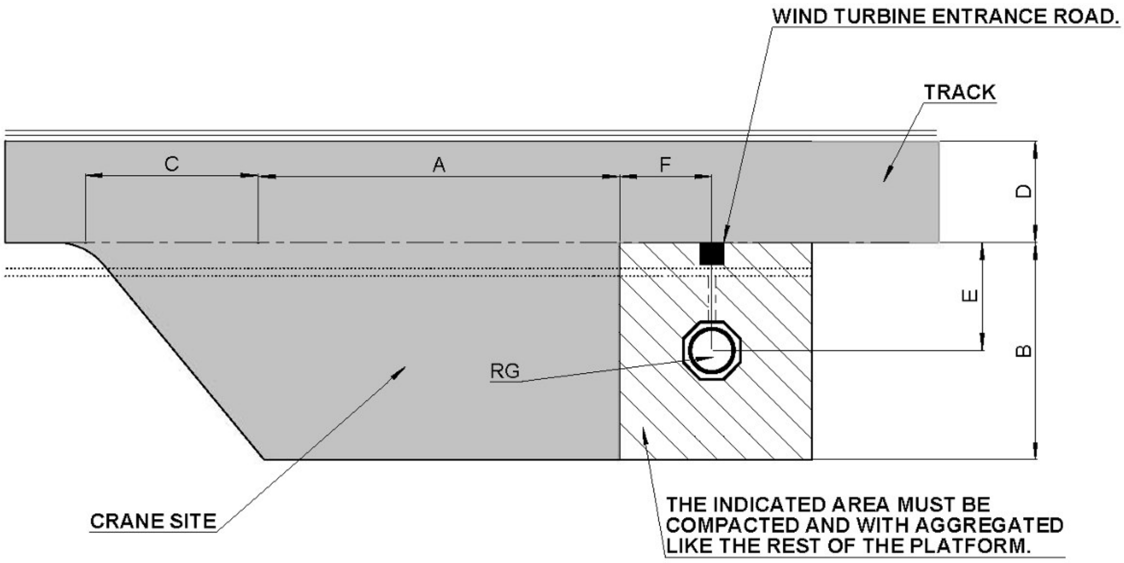


Fig.5

10. Requirements for storage areas.

If, due to reasons attributable to each site, there is no storage area alongside the platform, a storage yard must be established in the wind farm.

The storage yard is only necessary during the installation process. Preparation of the yard must be the same as for the wind turbine mounting platform and it must be compacted to 50% thereof.

Depending on each wind farm, the storage yard may be used for all components or for separated components, blades, blades + section 3 + section 4, etc.

If it is decided on the one accomplishment or several zones of storing with location different from the assembly platform of each turbine the decision should be in accordance with Alstom. Once reviewed the design of area/s Alstom it will transfer his approval and/or commentaries, as the influence on assembly logistics, of the turbines.

10.1. Area required per component.

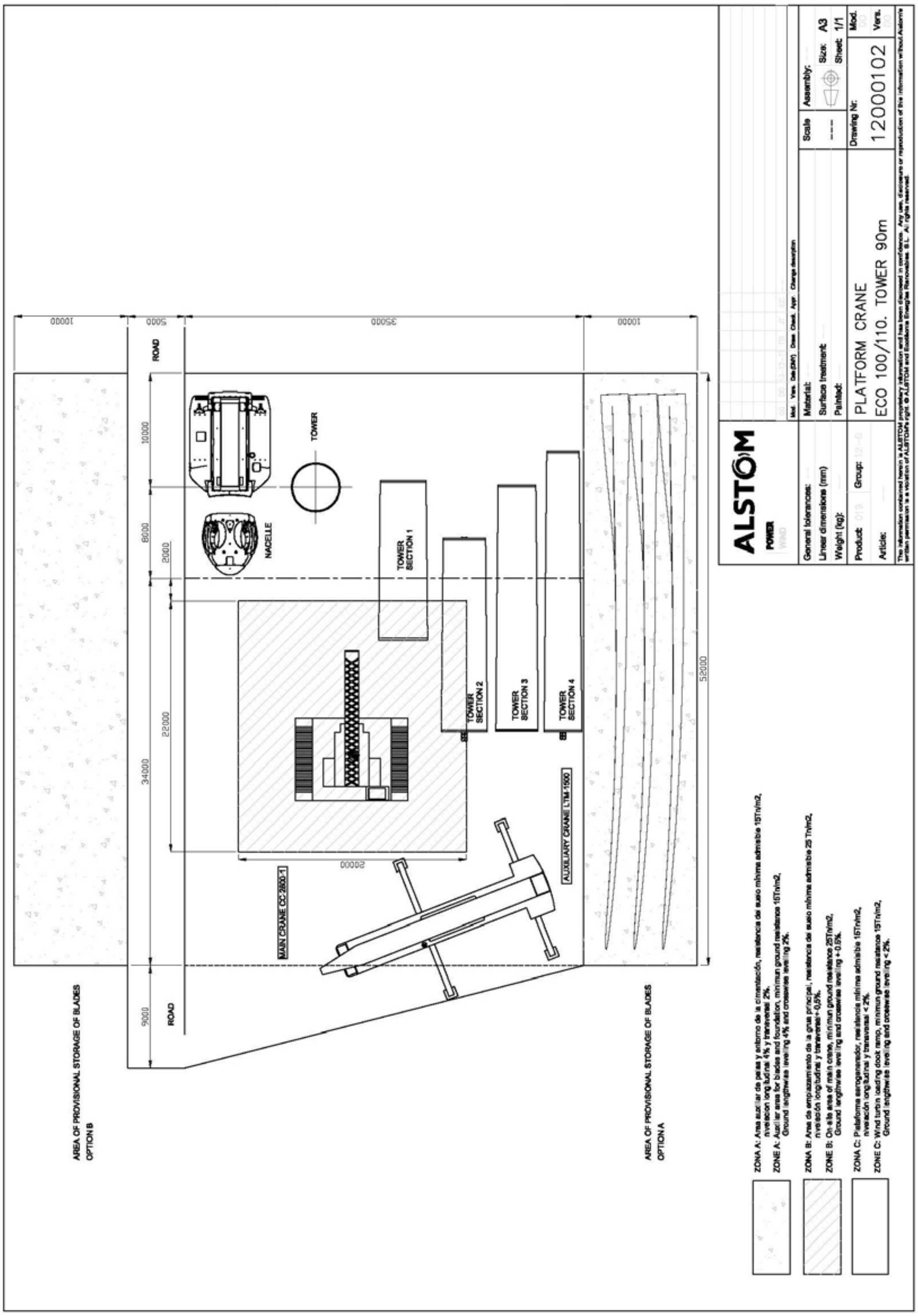
Component	**Hub height 75/89-90 m**	
	Length	**Width**
Tower section 1	18 m	5 m
Tower section 2	28 m	5 m
Tower section 3	30 m	4.5 m
Tower section 4	30 m	4.5 m
Nacelle	15 m	8 m
BE1+BE2	15 m	8 m
Blades **Eco100**	50 m	12 m
Blades **Eco110**	55 m	13 m
Blades **Eco122**	63 m	15 m

10.2. Area required per wind turbine.

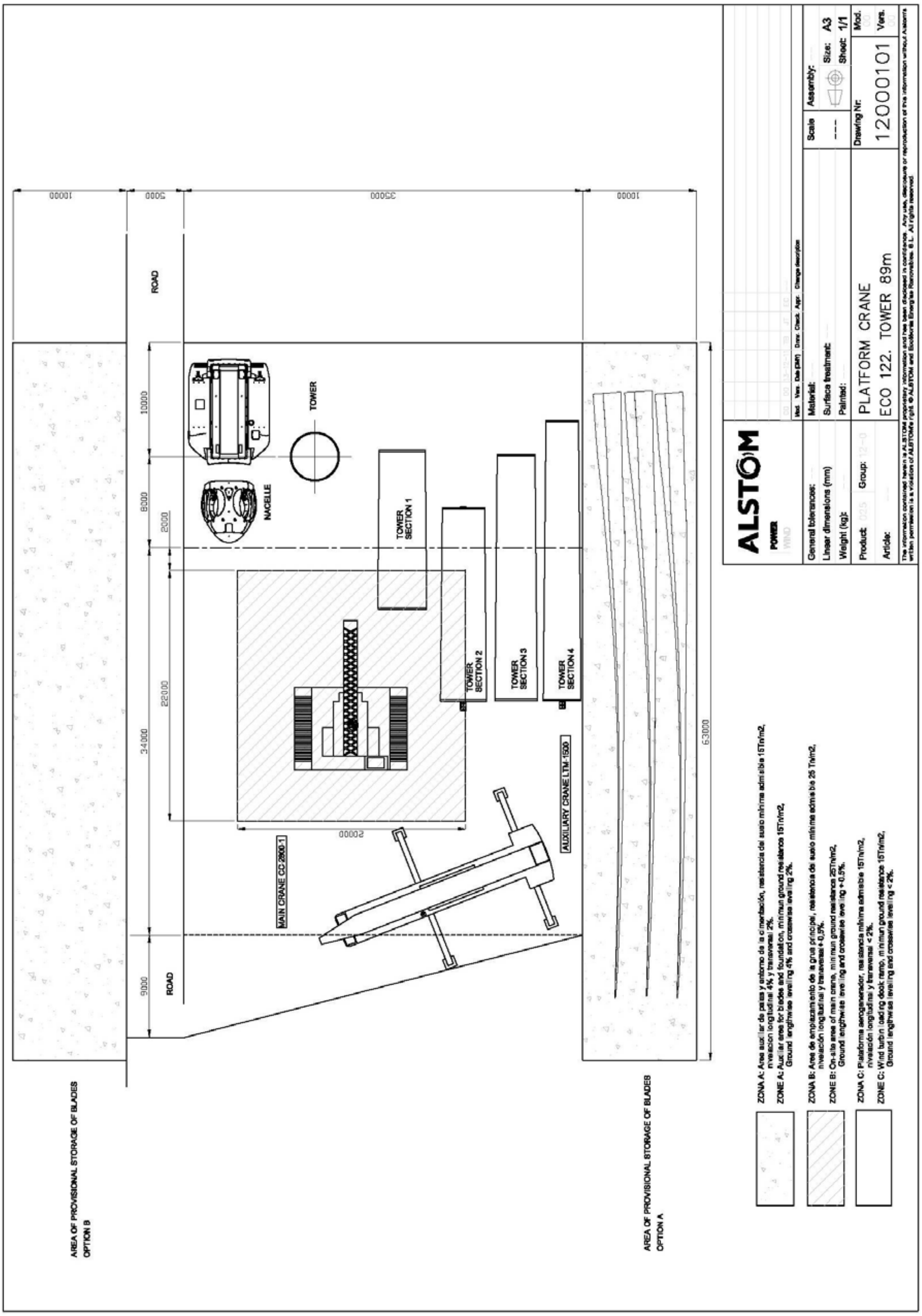
	Hub height 75/89-90 m	
Component	**Length**	**Width**
Total storage area	55 m	51 m

11. Appendix: Illustrative Diagrams

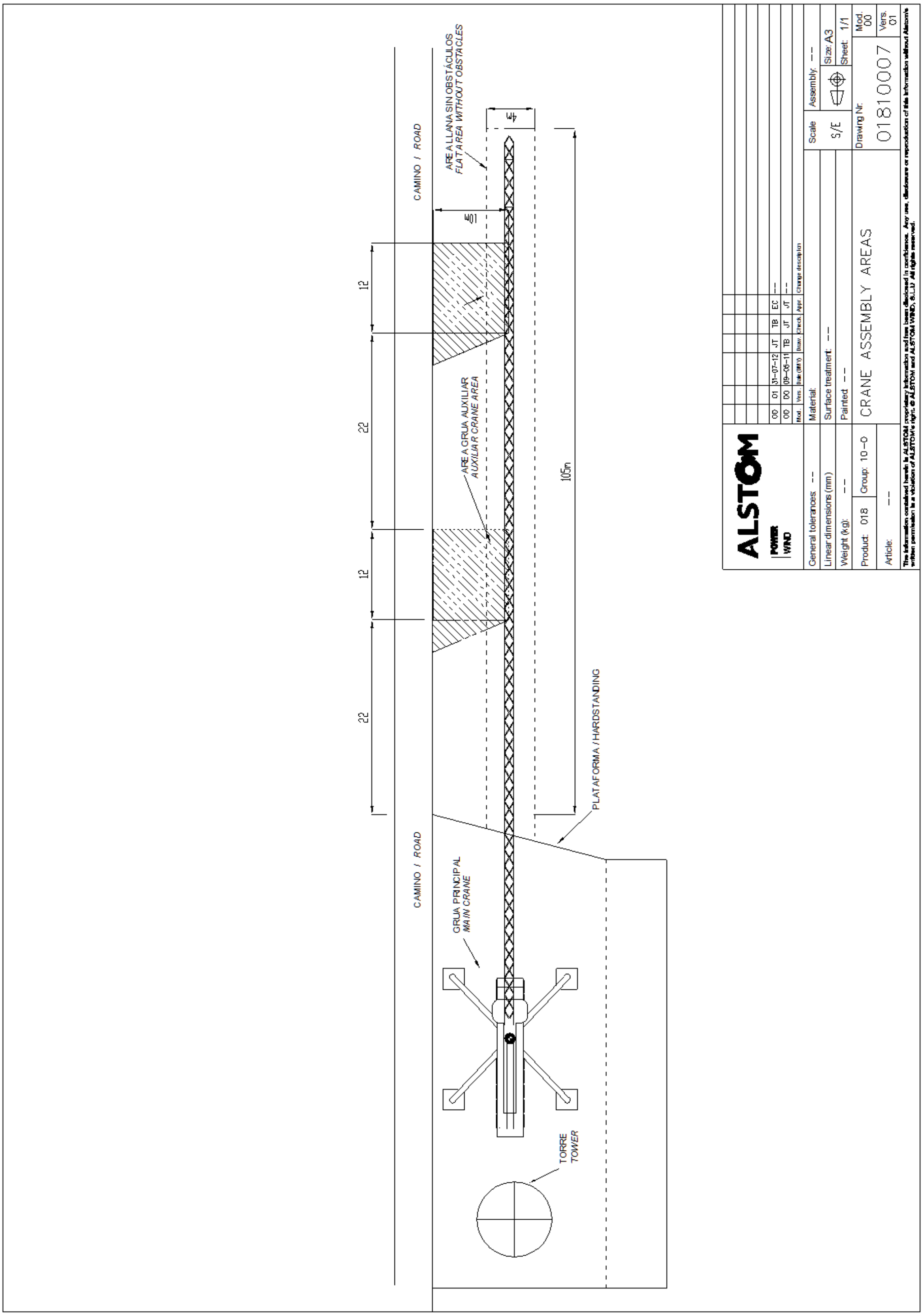
11.1. CC crane and components distribution on platform with ECO100/110 with 90m tower. (Same hardstanding dimensions for 75m tower)



11.2. CC crane and component distribution on platform for ECO 122 89m steel tower.



11.3. Auxiliary areas for assembly and disassembly TC crane, and for CC crane if necessary.



Appendix D
Swept Path Assessment

AutoTrack vehicle details

New England Highway and Grafton Street intersection

Grafton Street and Coronation Avenue intersection

Gwydir Highway and Coronation Avenue intersection

New England Highway and Oliver Street intersection

New England Highway and Meade Street intersection

New England Highway and Gwydir Highway intersection

Former Gwydir Highway access

AutoTrack Vehicle Details Ref:

Vehicle Name: **CAH Volvo FH16 8x4 + Broshuis Blade Trailer Independant Steering 62m Load**
Type: Articulated vehicle
Category Savoy
Classification Savoy

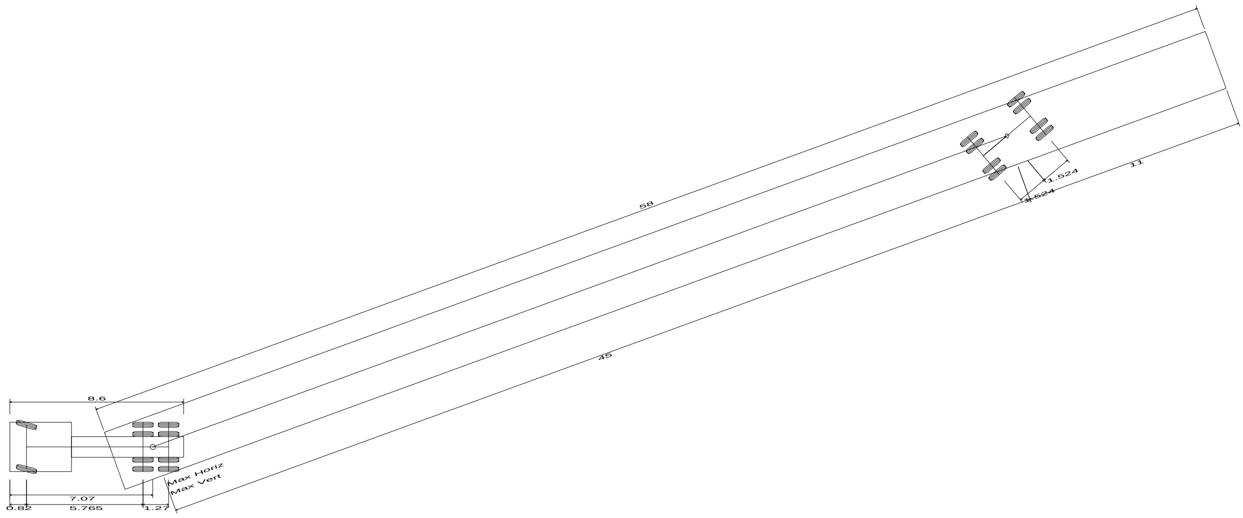
Source: Volvo & Broshuis

Description: independant steering

Notes:

Unit 1 Name: CAH Volvo FH16 8x4 + Broshuis Blade Trailer Independant Steering 62m Load Tractor

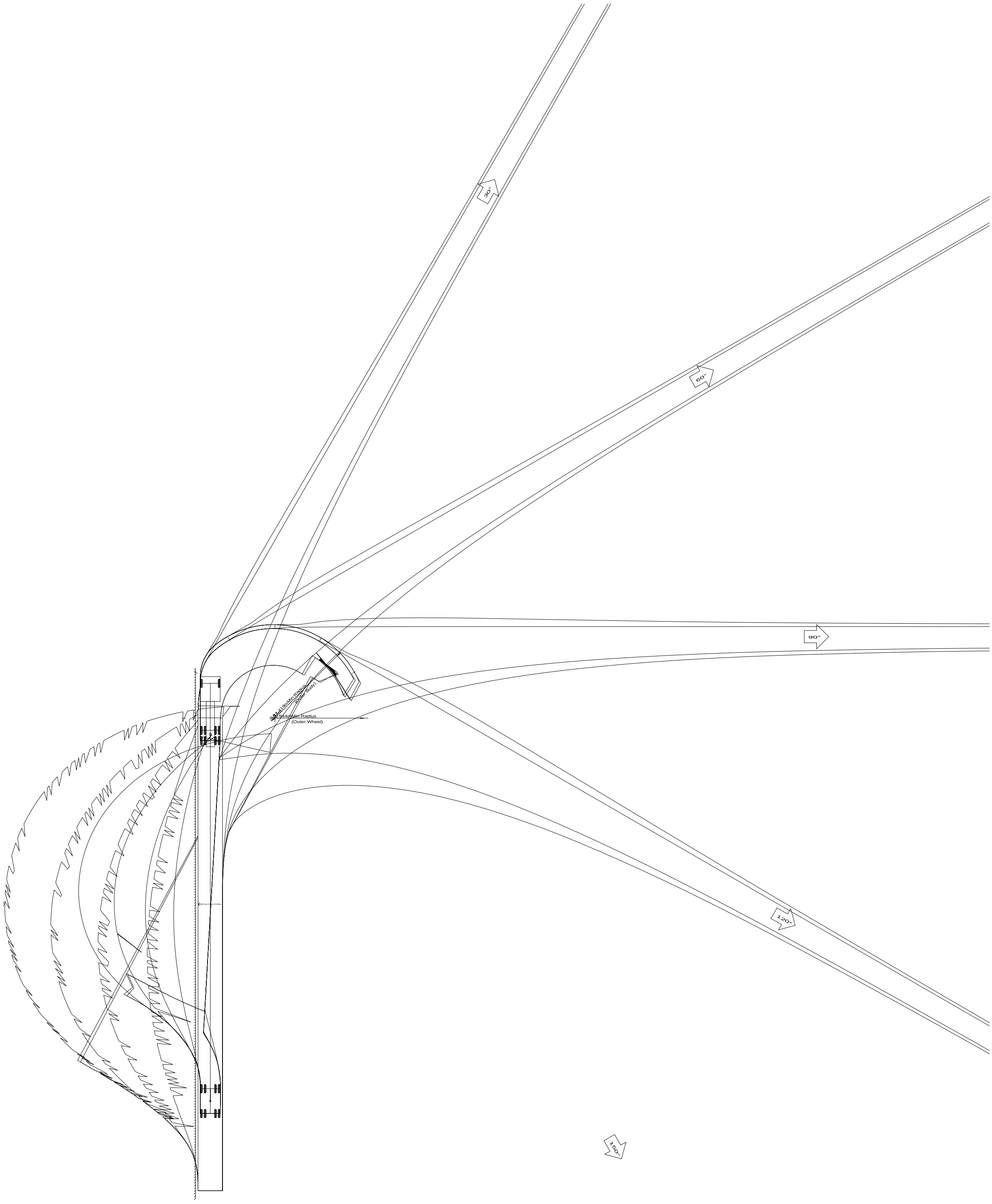
Unit 2 Name: CAH Volvo FH16 8x4 + Broshuis Blade Trailer Independant Steering 62m Load Trailer 1



CAH Volvo FH16 8x4 + Broshuis Blade Trailer Independant Steering 62m Load

Overall Length	63.070m
Overall Width	3.000m
Overall Body Height	3.335m
Min Body Ground Clearance	0.487m
Track Width	2.440m
Lock to Lock Time	6.00s
Max Steering Angle (Virtual)	40.00°

AutoTrack Vehicle Details Ref:



aurecon
www.aurecongroup.com

CLIENT
GLEN INNES WIND FARM PTY LTD

REV	DATE	REVISION DETAILS	APPROVED
1	23/08/13	DRAFT	

SCALE	SIZE
NTS	A3

DRAWN: T.NGUYEN
DESIGNED: T.NGUYEN
VERIFIED: B.SMITH

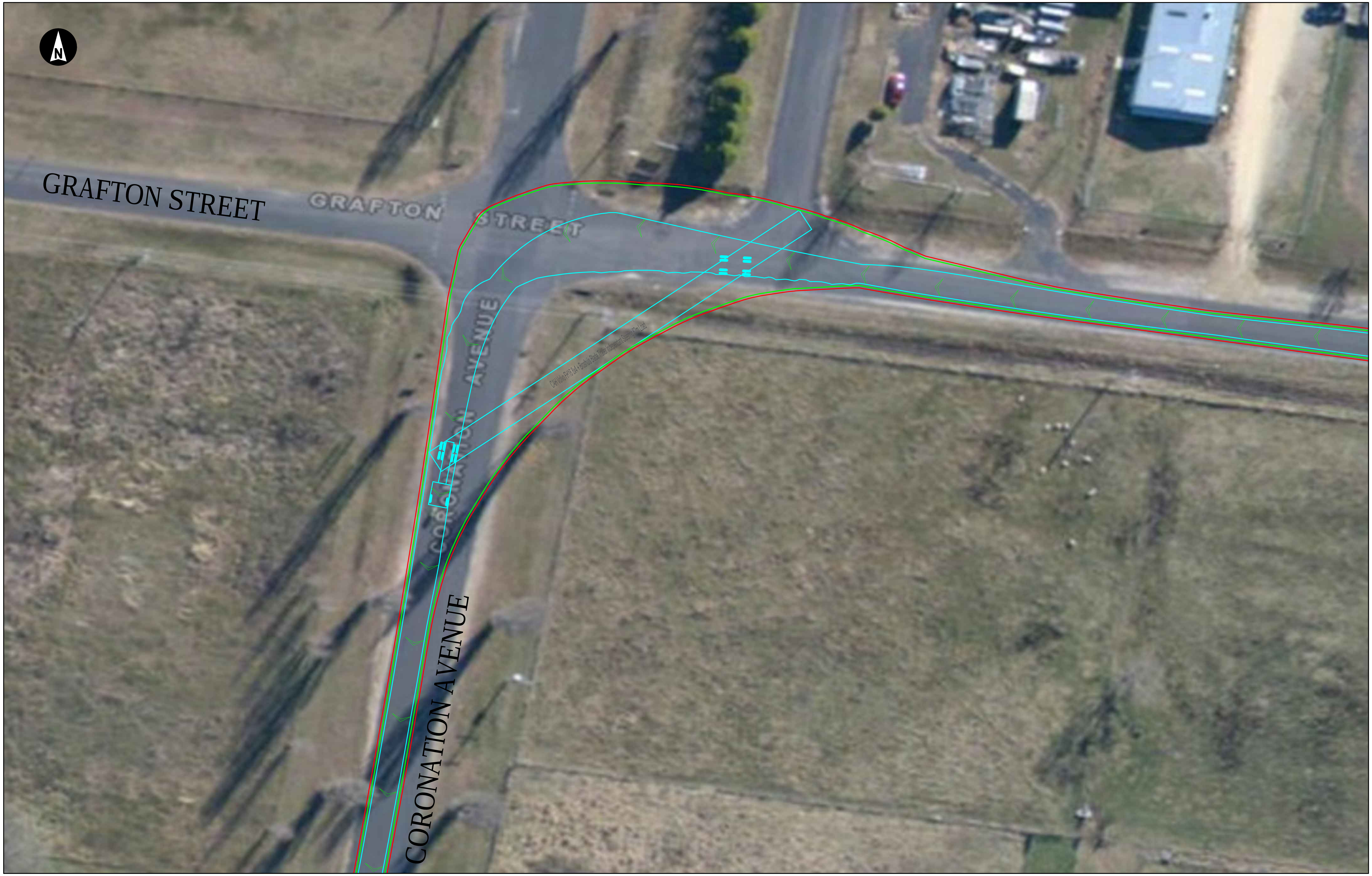
PRELIMINARY
FOR INFORMATION ONLY

APPROVED
PROJECT DIRECTOR DATE

PROJECT: GLEN INNES WIND FARM

TITLE: SWEPT PATH ASSESSMENT - WIND BLADE VEHICLE
NEW ENGLAND HIGHWAY AND GRAFTON STREET INTERSECTION

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	236777				SK001	



aurecon
www.aurecongroup.com

CLIENT	REV	DATE	REVISION DETAILS	APPROVED
GLEN INNES WIND FARM PTY LTD	1	23/08/13	DRAFT	

SCALE	SIZE
NTS	A3

DRAWN: T.NGUYEN
DESIGNED: T.NGUYEN
VERIFIED: B.SMITH

PRELIMINARY
FOR INFORMATION ONLY

APPROVED
PROJECT DIRECTOR DATE

PROJECT: GLEN INNES WIND FARM

TITLE: SWEPT PATH ASSESSMENT - WIND BLADE VEHICLE
GRAFTON STREET AND CORONATION AVENUE INTERSECTION

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	236777	–	–	–	SK002	–

aurecon
www.aurecongroup.com

CLIENT
GLEN INNES WIND FARM PTY LTD

REV	DATE	REVISION DETAILS	APPROVED
1	23/08/13	DRAFT	

SCALE	SIZE
NTS	A3

DRAWN: T.NGUYEN
DESIGNED: T.NGUYEN
VERIFIED: B.SMITH

PRELIMINARY
FOR INFORMATION ONLY

APPROVED
PROJECT DIRECTOR DATE

PROJECT: GLEN INNES WIND FARM

TITLE: SWEPT PATH ASSESSMENT - WIND BLADE VEHICLE
GWYDIR HIGHWAY AND CORONATION AVENUE INTERSECTION

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	236777				SK003	

aurecon
www.aurecongroup.com

CLIENT	REV	DATE	REVISION DETAILS	APPROVED
GLEN INNES WIND FARM PTY LTD	1	23/08/13	DRAFT	

SCALE	SIZE
NTS	A3

DRAWN: T.NGUYEN
DESIGNED: T.NGUYEN
VERIFIED: B.SMITH

PRELIMINARY
FOR INFORMATION ONLY

APPROVED
PROJECT DIRECTOR DATE

PROJECT: GLEN INNES WIND FARM

TITLE: SWEPT PATH ASSESSMENT - WIND BLADE VEHICLE
NEW ENGLAND HIGHWAY AND OLIVER STREET INTERSECTION

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	236777				SK004	

aurecon
www.aurecongroup.com

CLIENT	REV	DATE	REVISION DETAILS	APPROVED
GLEN INNES WIND FARM PTY LTD	1	23/08/13	DRAFT	

SCALE	SIZE
NTS	A3

DRAWN: T.NGUYEN
DESIGNED: T.NGUYEN
VERIFIED: B.SMITH

PRELIMINARY
FOR INFORMATION ONLY

APPROVED
PROJECT DIRECTOR DATE

PROJECT: GLEN INNES WIND FARM

TITLE: SWEPT PATH ASSESSMENT - WIND BLADE VEHICLE
NEW ENGLAND HIGHWAY AND MEADE STREET INTERSECTION

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	236777	–	–	–	SK005	–

aurecon
www.aurecongroup.com

CLIENT	REV	DATE	REVISION DETAILS	APPROVED
GLEN INNES WIND FARM PTY LTD	1	23/08/13	DRAFT	

SCALE	SIZE
NTS	A3

DRAWN: T.NGUYEN
DESIGNED: T.NGUYEN
VERIFIED: B.SMITH

PRELIMINARY
FOR INFORMATION ONLY

APPROVED
PROJECT DIRECTOR DATE

PROJECT: GLEN INNES WIND FARM

TITLE: SWEPT PATH ASSESSMENT - WIND BLADE VEHICLE
NEW ENGLAND HIGHWAY AND GWYDIR HIGHWAY INTERSECTION

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	236777				SK006	

aurecon
www.aurecongroup.com

CLIENT
GLEN INNES WIND FARM PTY LTD

REV	DATE	REVISION DETAILS	APPROVED
1	23/08/13	DRAFT	

SCALE	SIZE
NTS	A3

DRAWN: T.NGUYEN
DESIGNED: T.NGUYEN
VERIFIED: B.SMITH

PRELIMINARY
FOR INFORMATION ONLY

APPROVED
PROJECT DIRECTOR DATE

PROJECT: GLEN INNES WIND FARM

TITLE: SWEPT PATH ASSESSMENT - WIND BLADE VEHICLE
GWYDIR HIGHWAY AND GREY STREET INTERSECTION

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	236777	–	–	–	SK007	–

aurecon
www.aurecongroup.com

CLIENT	REV	DATE	REVISION DETAILS	APPROVED
GLEN INNES WIND FARM PTY LTD	1	23/08/13	DRAFT	

SCALE	SIZE
NTS	A3

DRAWN: T.NGUYEN
DESIGNED: T.NGUYEN
VERIFIED: B.SMITH

PRELIMINARY
FOR INFORMATION ONLY

APPROVED
PROJECT DIRECTOR DATE

PROJECT: GLEN INNES WIND FARM

TITLE: SWEPT PATH ASSESSMENT - WIND BLADE VEHICLE
FORMER GWYDIR HIGHWAY ACCESS

DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
	236777				SK008	

Aurecon Australia Pty Ltd
ABN 54 005 139 873
Level 2, 116 Military Road
Neutral Bay NSW 2089
PO Box 538
Neutral Bay NSW 2089
Australia
T +61 2 9465 5599
F +61 2 9465 5598
E sydney@aurecongroup.com
W aurecongroup.com