ΑΞϹΟΜ

Coopers Gap Wind Farm AGL Energy Ltd 15-Feb-2017

TC01-D Route Analysis

Wind Turbine Blade Transport

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Wind Turbine Blade Transport

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Summary

One of the key aspects involved in the construction of the Coopers Gap Wind Farm project is the transport of the key wind farm infrastructure, namely the wind turbine blades, nacelle, tower sections and hub. The blades represent the largest challenge logistically given the proposed size of the wind turbines.

A road haulage route was deemed to be the most appropriate transport solution for investigations going forward and is subsequently the subject of this report. This route (TC01) essentially consists of starting from the Brisbane Port, traveling along the Warrego Highway through Toowoomba and Dalby, and then up the Bunya Highway to Niagara Road where the project site is being planned.

The purpose of this report is to conduct a preliminary assessment of the transport of a 70 m long wind turbine blade through this route. This assessment consisted of:

- · Identifying the key intersections and turning movements the truck will undertake
- Investigating the most appropriate turning path for the truck to undertake at the key locations
- · Identifying any temporary or permanent mitigation measures that will be required in order for the truck to safely complete the turning movement.

The findings of this study are summarised in the below table. Although a number of conflicts exist, it is considered that a feasible route to the project site is available, subject to resolving the potential conflicts with the relevant stakeholders.

			Conflicts '								
ID	Street 1	Street 2	Signs	Lights	Traffic Signals	Power Pole	Kerb	Drain	Pavement	Vegetation	Private Property
1	Bishop Drive	Lucinda Drive	8 ³ or 2	0 or 4	-	-	-	1 or 0	Y or N	-	Y or N
2	Lucinda Drive	Port Drive	-	-	-	-	-	-	-	-	-
3	Port Drive	Kite Street	3	1	-	-	-	-	-	-	-
4	PoB Motorway	Gateway Motorway	-	-	-	-	-	-	-	-	-
5	Gateway Motorway	Logan Motorway	-	-	-	-	-	-	-	-	-
6	Logan Motorway	Ipswich Motorway	-	-	-	-	-	-	-	-	-
7	Ipswich Motorway	Warrego Highway	-	-	-	-	-	-	-	-	-
8A	Warrego Highway	N/A (The Range)	-	-	-	-	-	-	-	-	-
8B	Warrego Highway	N/A (The Range)	-	-	-	-	-	-	-	-	-
8C	Warrego Highway	N/A (The Range)	-	-	-	-	-	-	-	-	-
9	Warrego Highway	Tourist Road	-	-	-	-	-	-	-	-	-
10	Warrego Highway	James Street	8	-	-	-	-	-	-	-	-
11	Warrego Highway	Karrool Street	1	-	-	-	-	-	-	-	-
12	Warrego Highway	Bridge Street	2 or 0	-	0 or 2	-	Y or N	1 or 0	Y or N	-	-
13	Warrego Highway	Dalby Cecil Plains Road	-	-	-	-	-	-	-	-	-
14	Warrego Highway	Bunya Highway	1 or 1	1 or 1	4 or 0	2 or 0	N or Y	-	-	Y or Y	N or Y
15	Bunya Highway	Crawshay Street	-	-	-	-	-	-	Y	-	-
16	Bunya Highway	Niagara Road	-	-	-	-	-	Y	Y	Y	Y

¹ "or" indicates that two turning paths options exist, with the first number indicating conflicts for Option 1 and second number indicating conflicts for Option 2.

² Guardrail may also be a potential conflict, which will need to be confirmed with further detailed assessment.

³ Includes guide posts

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1.0 Introduction

This report has been prepared by AECOM Australia Pty Limited (AECOM) for AGL Energy Limited (AGL). It summarises the outcomes of a route analysis that AECOM have undertaken to take wind turbine equipment from the Port of Brisbane to the project site along Niagara Road, for the construction of the Coopers Gap Wind Farm (the Project).

This assessment is centred around the transport of blades associated with the wind turbines, with previous studies identifying that transport along the road network to be the most viable option over rail or air.

1.1 Background

One of the key aspects involved in the construction of the Project is the transport of the key wind farm infrastructure, namely the wind turbine blades, nacelle, tower sections and hub. The blades represent the largest challenge logistically given the proposed size of the wind turbines. AGL has advised that the largest wind turbine rotor diameter under consideration is 140 m, placing the blade length at approximately 70 m. This blade can only be transported as a single piece.

A transport assessment conducted by AECOM in December 2016, for the project's Environmental Impact Statement (EIS), investigated the feasibility of a number of road haulage routes. AGL has advised that route TC01-D (as described in EIS, Chapter 13, Section 13.5.7.2) was deemed to be the most appropriate transport solution for the wind turbine blades and is subsequently the subject of investigations going forward and for this report.

The purpose of this report is to conduct a preliminary assessment for the transport of a 70 m long wind turbine blade along this route, as well as investigate areas along the route which may inhibit the movements of the truck and trailer.

1.2 Route

Route TC01-D as described within the Project EIS (Chapter 13, Tables 13.5 and 13.6) constitutes of the following roads (ordered from the Port of Brisbane to the project site):

- Port of Brisbane Road
- · Gateway Arterial Road
- · Gateway Extension Motorway
- Logan Motorway
- · Cunningham Highway (Ipswich Motorway)
- · Warrego Highway
- Bunya Highway
- · Niagara Highway

This report has also included a potential route within the Port of Brisbane, identified as Bishop Drive to Lucinda Drive to Port Drive.

The total length of the route is approximately 260 km. The route extends over three separate Department of Transport and Main Roads (DTMR) regions: the Metropolitan Region, the Downs South West Region and the Wide Bay Burnett Region. Roads falling within the Metropolitan region are predominantly multi-lane, national highway systems (such as the Gateway Motorway and the Logan Motorway). Within the other regions, roads consist of either two lanes along the main highways (Warrego Highway and Bunya Highway) or four lanes when passing through towns (Dalby).

The project EIS (Chapter 13, Table 13.8) also identified that a total indicative quantity of 342 turbine blades will be required to be transported. An equal number of trips will therefore also be required along this route.

1.3 Aim and Objectives

The aim of the route analysis is to identify key risks and issues that transporting a 70 m long load may present, as well as provide direction on mitigation measures that are required to make TC01-D a viable road haulage route for this purpose.

In order to achieve the aim of the route analysis, the following objectives have been defined:

- · Identify the key intersections and turning movements the truck will undertake
- · Investigate the most appropriate turning path for the truck to undertake at the key locations
- Identify any temporary or permanent mitigation measures that will be required in order for the truck to safely complete the turning movement.

1.4 Scope

As agreed with AGL, the following outlines the scope of this study:

- Assessment of route TC01-D only (includes existing Toowoomba range)
- · Assessment of one size turbine blade and one truck type only
- Assessment of key intersections or turning movements vertical or horizontal geometry of the mainline has not been completed.
- Assessment of State controlled (DTMR operated) roads and within roads within the Port of Brisbane only. Turn movements along Niagara road are not subject to the route analysis.

1.5 Assumptions and Limitations

This analysis is based on readily available desktop information. No consultation with regulatory departments, bodies or other stakeholders has been undertaken in the production of this route analysis.

It is assumed that the vehicle will be under police or pilot escort the entire route and that opposing lanes can be closed to complete turning movements when necessary.

The desktop study is based on a number of GIS aerials, as detailed in **Table 1-1**. No feature survey has been made available for the completion of this study.

Table 1-1 GIS Aerial Sources	Table 1-1	GIS	Aerial	Sources
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ID	Area	Accuracy	Date
1	Brisbane	10 cm	2015
2	Ipswich	10 cm	2015
3	SEQ Regional	30 cm	2013
4	Dalby	15 cm	2013
5	Surat Basin South	40 cm	2013

Future corridor improvements, such as the Toowoomba Second Range, are assumed to not be operational before the project start date and have not been considered in this report.

1.5.1 Design Vehicle

AGL, at this stage in the project, have not determined a design vehicle which will be used to transport the wind turbine components. Furthermore, the actual wind turbine components themselves have not been detailed in terms of their dimensions, with the exception of the largest expected blade length being 70 m. AGL have however advised that the truck is expected to be rear steer capable.

Autodesk's program AutoCAD and its Vehicle Tracking software have been used to produce the swept paths. As no vehicle dimensions are available at this stage of the project, a vehicle has been selected

from the Vehicle Tracking library. As agreed with AGL, the '55 Meter Wind Blade (Rear Bogie Pivot Steer) *Rear Street Capable' was selected and modified to accommodate a 70 m blade. This vehicle has been utilised as the design vehicle for this assessment. Turbine blade width was assumed to be 3.85m in the load outline.

Figure 1 shows the profile view dimensions of the truck used in the desktop study, with **Figure 2** displaying example turning paths for the truck. A 5 km/h design speed has been selected for all turn paths to be undertaken at. The turn paths are also representative of ideal conditions, using full pavement widths and do not allow for driver error. Damage to pavements has also not been considered as part of this assessment.





Figure 1 Truck Dimensions

Figure 2 Truck Turn Path (with and without rear wheel turning)

AGL has advised that a preferred contractor for the transportation of equipment has not been determined. The preferred contractor is deemed to be responsible for undertaking further route assessment of the TC01-D route using their selected design vehicle. This assessment has been completed as a high level route assessment to identify possible obstructions and likely mitigation requirements; however the contractor is responsible for undertaking the assessment at a more detailed level.

4

2.0 Desktop Study

2.1 Study Area

The study area, planned project site and route TC01-D are identified within **Figure 3** below, with the route highlighted. It is to be noted that at the Port of Brisbane, the path used in this study follows Lucinda Drive instead of Port Drive to avoid a significant number of roundabouts, as shown in the close up of Fisherman Island.



Figure 3 Study Area

2.2 Methodology

The methodology for the study consisted of the following:

- 1. Confirmation of route and key aims for the study
- 2. A review of the transport corridors to identify any intersections / locations where a truck would need to undertake a turning manoeuvre
- 3. A drive through along the entire corridor from Port of Brisbane to the Project Site via Niagara Road whilst taking video along the way, in both directions
- 4. Reviewing the video to confirm any constraints not identified in the initial desktop assessment
- 5. Undertaking a swept-path analysis at relevant intersections to determine whether the design vehicle can perform the turn manoeuvre
- 6. Identifying any mitigation works that might need to be undertaken.

2.2.1 Mitigation Works

Mitigation works outlined in the assessment are based on the high level solutions to conflicts observed through the GIS aerial and video drive through. These need to be confirmed and investigated further in a detailed assessment once the design vehicle has been determined.

2.3 Key Turning Movements

A desktop study identified the following intersections to be assessed along the TC01D route. **Table 2-1** below lists the key points of interest.

The criteria for selection for these locations came from two elements.

- a) A major intersection or interchange, or
- b) A particularly sharp bend or change in direction in the road. These are areas identified during the desktop study, however not all horizontal and vertical geometry of the route were assessed.

These locations were subject to further inspection during the drive through (stopping to take photos in the locations where it was safe to do so) and were used for the turning path analysis.

Table 2-1 Points of Interes	Table 2-1	Points of	Interest
-----------------------------	-----------	-----------	----------

ID	Street 1	Street 2	Approx. Lat.	Approx. Long.	٦	Гуре
		Inside Port of Brisban	e is out of scope)		
1	Bishop Drive	Lucinda Drive	-27.370915	153.187851	T - Int	ersection
2	Lucinda Drive	Port Drive	-27.394329	153.165129	Inte	rchange
3	Port Drive	Kite Street	-27.403449	153.164763	Rou	ndabout
4	Port of Brisbane Motorway	Gateway Motorway	-27.457847	153.109495	Inte	rchange
5	Gateway Motorway	Logan Motorway	-27.647594	153.072692	Inte	rchange
6	Logan Motorway	Ipswich Motorway	-27.601789	152.919328	Inte	rchange
7	Ipswich Motorway	Warrego Highway	-27.595117	152.845850	Inte	rchange
8A	Warrego Highway	-	-27.570101	151.989162	Bend	The
8B	Warrego Highway	-	-27.564156	151.985145	Bend	Toowoomba
8C	Warrego Highway	-	-27.563693	151.982118	Bend	Range
9	Warrego Highway	Tourist Road	-27.564549	151.974685	T - Int	ersection
10	Warrego Highway	James Street	-27.569823	151.974245	T - Int	ersection
11	Warrego Highway	Karrool Street	-27.564563	151.928209	T - Int	ersection
12	Warrego Highway	Bridge Street	-27.546526	151.932306	X - Int	tersection
13	Warrego Highway	Dalby Cecil Plains Road	-27.205541	151.281477	T - Int	ersection
14	Warrego Highway	Bunya Highway	-27.181337	151.262354	X - Int	tersection
15	Bunya Highway	Crawshay Street	-26.931002	151.453491	X - Int	tersection
16	Bunya Highway	Niagara Road	-26.739097	151.509046	T - Int	ersection
		Niagara Road is c	out of scope			

2.4 Locality Maps

Figure 4 through to Figure 6 give context to the location of the points of interest. The numbers are referenced from Table 2-1, which are used as labels in the figures.



Figure 4 Brisbane Area



Figure 5 Toowoomba Area



Figure 6 Dalby / Bunya Area

3.0 Swept Path Outcomes

3.1 1 – Bishop Drive / Lucinda Drive

The first corner in the process of leaving the Port of Brisbane is the Bishop Drive and Lucinda Drive intersection. In this case, there are two turning path options.

Figure 7 and Figure 8 show turn path Options 1 and 2 respectively, with Figure 9 and Figure 10 allowing a better view of the on the ground conflicts.

The conflicts for Option 1 include approximately 7 x guide posts, 1 x street sign, 1 x drainage ditch, the kerb as the truck enters the adjacent ground and the ground itself (most likely unsuitable for heavy loads over 342 trips). Mitigation steps would include the temporary removal of the signs & posts and new pavement to create suitable ground conditions. The viability for the rear wheels to use land adjacent to the intersection would also need to be confirmed with the relevant stakeholder / authority, as well who would be responsible for the new pavement.

The conflicts for Option 2 include $4 \times$ street lighting poles and $2 \times$ road signs. Mitigation steps consist of installing temporary lighting or relocation of the existing ones, as well as temporarily relocating the signs.



Figure 7 Swept Path for Location 1, Option 1



Figure 8 Swept Path for Location 1, Option 2



Figure 9 Path Option 1 Clashes (Driving Towards Bishop Drive)



Figure 10 Path Option 2 Clashes (Driving Towards Lucinda Drive)

3.2 2 – Lucinda Drive / Port Drive

The truck and load clears without encroaching shoulder, as shown in Figure 11.



Figure 11 Swept Path for Location 2

3.3 3 – Port Drive / Kite Drive

The roundabout exiting Fisherman's Island requires the truck to perform a number of turns in quick succession. As a result, as shown in **Figure 12**, the end of the wing swings outs both sides of the road. The wheels however do not go over the kerb at any point.

Mitigation measures required based on high level assessment include temporary relocation of 1 x street light and 3 x road signs, as shown in **Figure 13** and **Figure 14**.



Figure 12 Swept Path for Location 3



Figure 13 Video Drive Through Capture for Location 3 (Before Roundabout)



Figure 14 Video Drive Through Capture for Location 3 (At Roundabout)

3.4 4 – Port of Brisbane Motorway / Gateway Motorway

Truck and load clears turn without any conflict, as shown in Figure 15.



Figure 15 Swept Path for Location 4

3.5 5 – Gateway Motorway / Logan Motorway

Truck and load clears turn without any conflict, as shown in Figure 16.



Figure 16 Swept Path for Location 5

3.6 6 – Logan Motorway / Ipswich Motorway

Truck and load clears turn without any conflict, as shown in Figure 17.



Figure 17 Swept Path for Location 6

3.7 7 – Ipswich Motorway / Warrego Highway

Truck and load clears turn without any conflict, as shown in Figure 18.



Figure 18 Swept Path for Location 7

3.8 8 – Warrego Highway (Toowoomba Range)

Swept paths were run on the Toowoomba Range westbound and eastbound carriageways to review possible conflicts, as shown in **Figure 19** through to **Figure 21**. From review of the aerial photography and swept paths it appears as through the vehicle can manoeuvre through both carriageways. The location of safety barriers cannot be accurately determined using the aerial photography and therefore needs to be assessed in detail once the design vehicle has been determined.

It is to be noted that through this section of the Toowoomba Range, the grade is at its steepest (10%+ grade). This may not only increase the difficulty of these manoeuvres, but since a design vehicle has not been determined, the maximum grade that the truck is capable of achieving these maneuverers cannot be determined.



Figure 19 Swept Path for Location 8A



Figure 20 Swept Path for Location 8B



Figure 21 Swept Path for Location 8C

3.9 9 – Warrego Highway / Tourist Road

Truck and load clears turn without any conflict, as shown in Figure 22.



Figure 22 Swept Path for Location 9



Figure 23 Site Visit Photograph for Location 9 (Looking down the Range)



Figure 24 Site Visit Photograph for Location 9 (Looking towards Toowoomba)

The optimal path for the truck for the Warrego Highway / James Street corner is for the truck itself to be on the westbound carriageway and for the rear bogie to be on the eastbound carriageway, as shown in **Figure 25**. This path does not conflict with the street lighting as other paths do; however it does require the signage (6 x corner hazard signs, 1 x 'Give Way' sign, 1 x directional sign) on the median to be temporarily removed / relocated, as shown in **Figure 26** and **Figure 27**.



Figure 25 Swept Path for Location 10



Figure 26 Site Visit Photograph for Location 10 (Looking towards the Range)



Figure 27 Site Visit Photograph for Location 10 (Looking towards Toowoomba)

3.11 11 – Warrego Highway / Karrool Street

Truck and load clears with only one conflict, as shown in **Figure 28**. This conflict with a sign towards occurs towards the end of the turn path, as shown in **Figure 29**.



Figure 28 Swept Path for Location 11



Figure 29 Site Visit Photograph for Location 11 (Looking towards Dalby)



Figure 30 Site Visit Photograph for Location 11 (Looking towards Toowoomba)

Two turn path options were created for Location 12 at the Warrego Highway / Bridge Street intersection exiting, Toowoomba. Option 1 prioritised minimising the body path outline, Option 2 prioritised minimising the wheel path outline. The turn paths for Option 1 and Option 2 are shown in **Figure 31** and **Figure 32** respectively.

Option 1 shows the vehicle using the land adjacent to the left turn slip lane, and crossing the centre median. Mitigation works for this path would include the temporary relocation of 2 x street signs, protecting an existing drain, pavement widening where traversing over ground and creating a mountable kerb around the left slip lane, as shown in purple **Figure 33**. **Figure 34** shows the kerb for the centre median is already semi-mountable, however given the number of trips required, further mitigation works to strengthen this kerb or repair it will need to assessed in further detail.

Option 2 also takes the left slip lane, however does not cross the centre median or encroach onto the footpath. As a result the load swings further into the intersection, conflicting with 1 x power pole and 2 x traffic signal poles, shown in blue in **Figure 34**.



Figure 31 Swept Path for Location 12, Option 1



Figure 32 Swept Path for Location 12, Option 2



Figure 33 Site Visit Photograph for Location 12 (Looking towards Bridge Street)



Figure 34 Site Visit Photograph for Location 12 (Looking towards Dalby)

3.13 13 – Warrego Highway / Dalby Cecil Plains Road

Truck and load clears turn without any conflict, as shown in Figure 35.



Figure 35 Swept Path for Location 13

3.14 14 – Warrego Highway / Bunya Highway

Two turning path for the Warrego Highway / Bunya Highway intersection have been created, shown in **Figure 36** and **Figure 37**, with conflicts observed in both options.

Option 1 conflicts with 1 x street light, 1 x road sign, 2 x power poles, 4 x traffic signals and vegetation within the median along the Bunya Highway exit. Multiple kerbs are crossed; and while all appear to be mountable / traversable, the viability to withstand numerous heaving loads will need to be assessed in further detail. These conflicts are shown in purple in **Figure 38** through to **Figure 40**.

Option 2 conflicts with less infrastructure overall, consisting of 1 x street light, vegetation within the median and kerb on the path entry. However the path goes through a United petrol station (private property), conflicting with the petrol price sign. These conflicts are shown in blue in **Figure 38** and **Figure 39**.



Figure 36 Swept Path for Location 14, Option 1



Figure 37 Swept Path for Location 14, Option 2



Figure 38 Site Visit Photograph for Location 14 (Looking West)



Figure 39 Site Visit Photograph for Location 14 (Looking toward Toowoomba)



Figure 40 Site Visit Photograph for Location 14 (Looking towards Toowoomba 2)

3.15 15 – Bunya Highway / Crawshay Street

The turn path for the Bunya Highway and Crawshay intersection is shown in **Figure 41**. The only conflict which is seen is the how the wheels path is to edge of the pavement, which towards the edge may not be full depth pavement and therefore not of sufficient strength to withstand multiple heavy loads. Further investigation is needed to determine if road widening is required.





Figure 41 Swept Path for Location 15

The turn path for the truck entering Niagara Road is shown in **Figure 42**. The path conflicts with a large amount of vegetation, trees, a gated fence entry, ground with no pavement and a culvert structure. These conflicts are shown in **Figure 43** and **Figure 44**.



Figure 42 Swept Path for Location 16



Figure 43 Site Visit Photograph for Location 16 (Looking towards Kingaroy)



Figure 44 Site Visit Photograph for Location 16 (Looking down Niagara Road)

4.0 Findings

Table 4-1 outlines which of the investigated locations have been identified to require mitigation works.

Seven out of the eighteen locations analysed require modifications in order to accommodate the wind turbine transport truck. The most significant of these locations is the Warrego Highway / Bunya Highway intersection in Dalby, which shows a number of conflicts that will need to be overcome. Although a number of conflicts exist, it is considered that a feasible route to the project site is available, subject to resolving the potential conflicts with the relevant stakeholders.

			Conflicts								
ID	Street 1	Street 2	Signs	Lights	Traffic Signals	Power Pole	Kerb	Drain	Pavement	Vegetation	Private Property
1	Bishop Drive	Lucinda Drive	8 ³ or 2	0 or 4	-	-	-	1 or 0	Y or N	-	Y or N
2	Lucinda Drive	Port Drive	-	-	-	-	-	-	-	-	-
3	Port Drive	Kite Street	3	1	-	-	-	-	-	-	-
4	PoB Motorway	Gateway Motorway	-	-	-	-	-	-	-	-	-
5	Gateway Motorway	Logan Motorway	-	-	-	-	-	-	-	-	-
6	Logan Motorway	Ipswich Motorway	-	-	-	-	-	-	-	-	-
7	Ipswich Motorway	Warrego Highway	-	-	-	-	-	-	-	-	-
8A	Warrego Highway	N/A (The Range)	-	-	-	-	-	-	-	-	-
8B	Warrego Highway	N/A (The Range)	-	-	-	-	-	-	-	-	-
8C	Warrego Highway	N/A (The Range)	-	-	-	-	-	-	-	-	-
9	Warrego Highway	Tourist Road	-	-	-	-	-	-	-	-	-
10	Warrego Highway	James Street	8	-	-	-	-	-	-	-	-
11	Warrego Highway	Karrool Street	1	-	-	-	-	-	-	-	-
12	Warrego Highway	Bridge Street	2 or 0	-	0 or 2	-	Y or N	1 or 0	Y or N	-	-
13	Warrego Highway	Dalby Cecil Plains Road	-	-	-	-	-	-	-	-	-
14	Warrego Highway	Bunya Highway	1 or 1	1 or 1	4 or 0	2 or 0	N or Y	-	-	Y or Y	N or Y
15	Bunya Highway	Crawshay Street	-	-	-	-	-	-	Y	-	-
16	Bunya Highway	Niagara Road	-	-	-	-	-	Y	Y	Y	Y

Table 4-1 Summary Table

¹ "or" indicates that two turning paths options exist, with the first number indicating conflicts for Option 1 and second number indicating conflicts for Option 2.

² Guardrail may also be a potential conflict, which will need to be confirmed with further detailed assessment.

³ Includes guide posts