MEMO

TO:	Mark Jones
FROM:	Jheeno Olidar
SUBJECT:	**EnergyConnect Route Option – Approach to Wagga Wagga Assessment**
OUR REF:	PS117658-131 Wagga Route Study
DATE:	**23 February 2021**

ENERGYCONNECT ROUTE OPTION – APPROACH TO WAGGA WAGGA ASSESSMENT

1.1 BACKGROUND

TransGrid and ElectraNet will deliver a high voltage electricity interconnector between the power grids of South Australia (at Robertstown) and New South Wales (at Wagga Wagga) with an added connection to Victoria (at Red Cliffs), known collectively as EnergyConnect (the Project). The Project will reduce the cost of providing secure and reliable electricity transmission between NSW and SA in the near term and facilitate the transition of the energy sector across the National Electricity Market (NEM) to low emission energy sources.

This route study has been undertaken to investigate options for the final ~30 kilometres of EnergyConnect to its ultimate destination terminating at Wagga 330/132kV substation should the current preferred route not be feasible

1.2 ROUTE OPTIONS IDENTIFIED

The commencement point for the options assessment is where the Option A and Option B diverge in the vicinity of Sawpit Gully, west of Holbrook Road. This point is approximately eight kilometres linearly south west of TransGrid's 330/132kV Wagga substation. This study focuses on different corridor options for the final ~30 kilometres terminating at the Wagga Wagga 330/132kV substation, shown in Annexure A Figure 2. This study considers two variants of the Option alignment, Option A and Option B, as well as an underground double circuit 330kV following the Option A route. All cases run along the same alignment from Dinawan substation until a location in the vicinity of Sawpit Gully, west of Holbrook Road, which is approximately seven kilometres south west of TransGrid's 330/132kV Wagga Wagga substation. From this point onwards, the Option A and Option B alignments are significantly different in their approach to the Wagga substation. Note that simplistically, Option A uses the right of way of existing TransGrid transmission lines No. 62 and 63 whereas Option B is entirely greenfield with no existing transmission line right of way.

1.2.1 OPTION A - REBUILD ALONG RIGHT OF WAY ALIGNMENT

Option A spans ~8 km and follows the same route as the existing transmission lines (TL)(No. 62 and 63) generally heading north-east to the Wagga substation with existing 330kV easement(s). This would aim to follow the existing rights of way from the 330kV TL No. 62 and 132kV TL No. 996. There is an opportunity to rebuild existing transmission lines No. 62 and 63 to double circuit 330kV.

The double circuit 330kV route for Option A appears feasible given the presence of existing 330kV single circuit TL No. 051. However, upon the final 3-4 kilometres approaching Wagga substation, the presence of landholders increases to once every 300-800 metres.

For clarity, the assumed intended scope for this option study for Option A is:

- Construct a double circuit 330kV line adjacent to TL No. 62 and 63)
- Transfer TL No. 62 and 63 to the new transmission line
- After transfer, demolish the old TL No. 62 and 63 structures
- Construct a new double circuit 330kV transmission line on either of the old TL No. 62 or 63 easements (depending on outages and construction staging)
- 'Make good' one of the two old TL No. 62 and 63 easements.

1.2.2 OPTION B - GREENFIELD

Option B traverses approximately 30 km (refer to Annexure A for route assumption) and would head within the vicinity of Maxwell and Big Springs before turning north, where the existing transmission lines would generally be duplicated where possible to form a double circuit 330kV TL to the 330/132kV Wagga substation.

A greenfield double circuit 330kV TL appears to have an easier route to traverse along the valley (South of Gregadoo and parallel but north of O'Briens Creek Road). However, other key considerations for this option include:

- Property and stakeholder risks are expected to be higher through Gregadoo and the valley (South of Gregadoo and parallel but north of O'Briens Creek Road) and up to the area between Gragadoo and Book Book, as these areas do not have any existing transmission lines within visual line of sight.
- The presence of the"Big Springs Homestead', which is understood to have historic importance and used as a function centre which potentially relies on its views of rural setting.

1.2.3 UNDERGROUND 330KV

The third option is an ~8 km underground 330kV double circuit high voltage cable following the Option A line rebuild route. This undergrounding is technically challenging but feasible. Costs for this route option are significant and technical constraints would be subject to further design development.

At transmission voltages, underground power cables have higher costs, lower capacity and lower reliability than overhead TLs. Compared to the cost of an overhead TL, per kilometre, the power transfer capacity of an underground cable is approximately 60% of the power transfer capacity of an overhead line, which would constrain power flows on the backbone of the power system. An underground cable also has greater capacitance and lesser overvoltage withstand than an overhead TL, further limiting its operation in the power system and/or requiring additional plant to manage these differences, at additional cost. What this implies is that a given TL when undergrounded, will require higher design capacity in order to achieve the same performance.

The key additional challenges to consider:

- Transition from high voltage transmission line to underground cable requires a 'transition' footprint at both ends. This is at a minimum a 20 metre by 20 metre footprint for the transition that would need to be permanently occupied and secured
- Underground high voltage cables, on the consideration of power system security, will need adequate spacing from one circuit to another in addition to engineering mechanical protection.

Figure 1 Arrangement of 330kV Double Circuit Underground cable spacing

1.3 COSTING

As an exact route and design have not been selected, cost information is estimated based on averages or other general information with no topography consideration, which could lead to changes in cost as the design is finalised.

Option	Route length	Approximate total cost ($M) – 2019 dollars	Cost per kilometer
Option A	8km	26.54	$3.3M/km
Option B	30km	32	$1.1M/km
Underground option A	8km	96	$12M/km

Table 1 Costing of Route Options

There is negligible difference with the high-level cost between Option A and Option B. However, there exists a 18M additional cost for Option A if a rebuild of TL No. 62 and TL No. 63 is undertaken. A key omission due to the limitations of this study is the lack of topography consideration for costing of all options. Based on desktop visual observations of topography it is likely that the actual cost for Option B would be higher to account for additional towers/footing requirement(s).

For the underground cabling option, the high-level estimates take into consideration the following:

- The TransGrid cost estimation team have present data for the undergrounding of 330kV cables of $12M/km
- TransGrid's recent Western Sydney Airport project has shown a cost of $6M/km for underground cabling, including termination ends.

1.4 PROPERTY, STAKEHOLDERS, ENVIRONMENTAL CONSIDERATIONS

Property - A greenfield, Option B alignment presents a range of deliverability and execution risks when compared to one which is adjacent to, or uses, an existing alignment. The development of EnergyConnect will require the adjustment of existing easements and acquisition of new property and easement interests prior to the commencement of construction. There is considerable property acquisition risk with both options mainly due to conflict with existing land use and the proximity of existing sensitive receivers, including dwellings and farm infrastructure. In terms of the likely number of parcels/holdings affected, Option B carries an expected greater property acquisition risk when compared to Option A.

Stakeholders – The extent to which each option will help deliver TransGrid's objective to preserve social licence through a safe, environmentally sustainable and culturally respectful approach has been assessed based on expected stakeholder impacts, rationale for decision from a public perspective and potential for community opposition leading to timeframe or budgetary impact. A greenfield alignment has an inherently higher external stakeholder risk, as shown in the summary of considerations provided in Annexure A Table 2. This is particularly true where the environmental impacts are unknown. Option A is considered to be preferred from a stakeholder and community impacts perspective.

Environmental – The undergrounding option would result in a continuous linear impact at ground level, not dissimilar to pipeline construction. Excavation to approximately one metre below ground level would be required. Splicing chambers would need to be constructed at regular intervals. It is understood that the safety requirements would require between 20 and 40 metres (assumed) distance between each undergrounded line across three circuits. The environmental constraints of Option A are expected to be lower than Option B, with detailed considerations presented in Annexure A Table 1, and is therefore preferred from an expected environmental impact perspective.

1.5 CONCLUSION

Based on the high-level study undertaken, Option A appears to perform better across the majority of considerations comparatively on a like for like route study.

Option A would be preferred on the basis of:

- Option B presents topography challenges hence increasing its cost relative to Option A
- Property acquisition and stakeholder concerns are considered to be a key differentiator between the overhead route options, as these would be reduced when following an existing right of way (TL No. 62 and TL No. 63) against a complete greenfield route.
- Underground double circuit presents a significant cost and technical constraints would be subject to further design development and hence difficult to assess as an efficient option.

The following table provides additional information in support of the conclusion conveyed above:

Consideration	Option A	Option B	Underground to Option A	Comment
Construction and program	O Green	O Yellow	O Red	Technically feasible however present risks existing in Option B due to the inclination of the route. Underground option is presented as red due to significant design development that is required to mitigate construction related risks of undergrounding.
Outages and network constraints	O Yellow	O Green	O Yellow	Technically feasible however present outage constraints exist mainly due to the very short recall time required when requiring outages of existing TL No. 62 and 63. Option A at a minimum requires the entire rebuild of TL No. 62 and 63 along the length of Option A
Costing	O Yellow	O Yellow	O Red	There is negligible difference with the high-level cost between Option A and Option B. There is a significant cost inefficiency with undergrounding Option A A key omission due to the limitations of this study is the lack of topography consideration for costing of Option Case B. Based on visual observations of topography it is likely that the actual cost for Option B would be higher to account for additional towers/footing requirement(s).
Property Impacts	O Yellow	O Red	O Yellow	A greenfield alignment presents a range of deliverability, 'defendability' and execution risks when compared to one which is adjacent to, or uses, an existing alignment.
External Stakeholder	O Green	O Yellow	O Green	A greenfield alignment has an inherently higher external stakeholder risk. This is particularly true where the environmental impacts are unknown.
Environmental and Planning	O Green	O Green	O Green	Corridors assessed for both options avoid Tier 1 constraints and largely avoid Tier 2 constraints there are some Tier 2 ecological constraints within both corridors. Both option corridors contain relatively equal amounts of Tier 3 constraints - the potential level of impact to these would be dependent on design (tower locations, access roads, etc through these constraints).

1.6 LIMITATIONS STATEMENT

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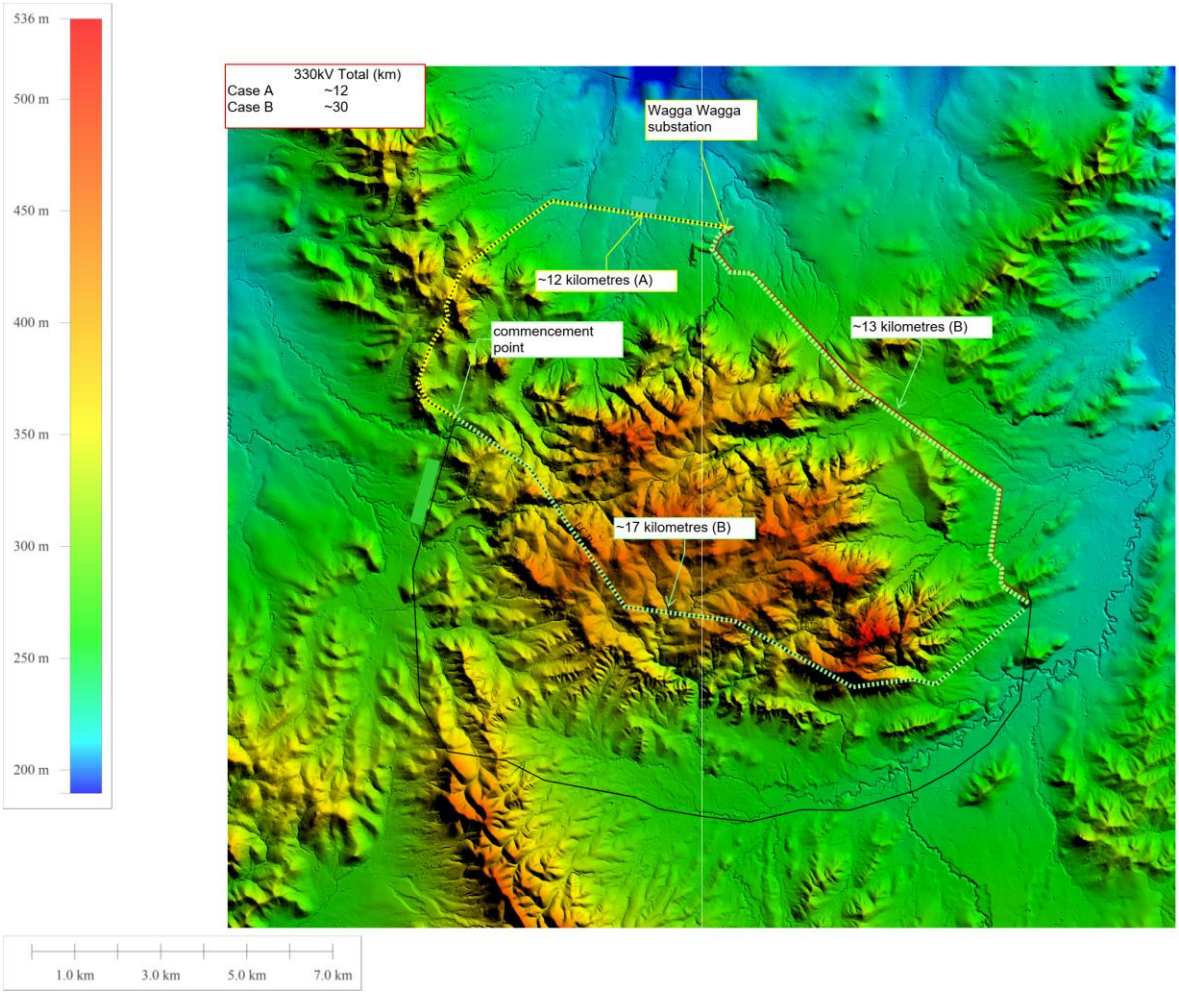
ANNEXURE A



Route Options against topography

Environmental Considerations of Corridor Options

	OPTION A	OPTION B	ASPECTS ONLY RELATING TO POTENTIAL UNDERGROUNDING
Approximate length (km)	As per Figure 3	As per Figure 3	n/a
T1 Constraints			
Ecology (Ramsar wetlands)	None	None	n/a
Heritage (World heritage areas)	None	None	n/a
Land tenure (Defence land)	None	None	n/a
Land Use	No built-up areas	No built-up areas	n/a
	No aerodromes / registered airports	No aerodromes / registered airports	n/a
T2 Constraints			
Ecology	No threatened fauna records within the SAII	No threatened fauna records within the SAII	n/a
	No threatened flora records within the SAII	No threatened flora records within the SAII	n/a
	No State Forests	No State Forests	n/a
	No NPWS Reserves	No NPWS Reserves	n/a
	No Protected Areas	No Protected Areas	n/a
	No important wetlands	No important wetlands	n/a
	No migratory bird flight path protection areas crossed		
	No natural waterbody crossings	No natural waterbody crossings	n/a
	54 hectares Threatened Ecological Communities (EPBC Act)	105 hectares Threatened Ecological Communities (TEC) (EPBC Act)	n/a
	64 hectares Threatened Ecological Communities records (SAII)	130 hectares Threatened Ecological Communities (TEC) records (SAII)	n/a
Heritage	No Heritage conservation areas	No Heritage conservation areas	
Land Tenure	No Commonwealth Land sites	No Commonwealth Land sites	

	No Native Title sites	No Native Title sites	
	No Declared Aboriginal Places	No Declared Aboriginal Places	
Land Use	No Intensive and irrigated horticultural areas	No Intensive and irrigated horticultural areas	
	No current mining titles	No current mining titles	
T3 Constraints			
Ecology	No threatened fauna records (non-SAII)	Wide range of threatened fauna records including Koala and Squirrel Glider susceptible to fragmentation issues (non-SAII)	n/a
	No threatened flora records (non-SAII)	No threatened flora records (non-SAII)	n/a
	14 locations of woodland vegetation patches greater than 5 hectares in area (total of 95 hectares)	23 locations of woodland vegetation patches greater than 5 hectares in area (total of 370 hectares)	Contiguous linear trench through woodland areas may require greater woodland clearance
	8 key fish habitats	9 key fish habitats	Trenching / jacking underneath hydrological features could increase potential impacts, cost and maintenance
	138 riparian corridors	271 riparian corridors	
Heritage	13 recorded Aboriginal sites	no recorded Aboriginal sites	
	no recorded State heritage sites	no recorded State heritage sites	
Floodplain hydrology	138 drainage line crossings	271 drainage line crossings	Trenching / jacking underneath hydrological features could increase potential impacts, cost and maintenance
	No flood prone land	No flood prone land	n/a
Land use and property	17 buildings	20 buildings	
Planning approval risk(s)	Confirmed to follow Critical SSI planning approval pathway		
Landscape and visual impact	Slightly increased visual impact due to presence of taller structures near existing transmission line corridors (132 kV and 330 kV)	Slightly increased visual impact due to presence of taller structures near existing transmission line corridors (132 and 330 kV) and new visual impact in previously greenfield areas (confirmed homestead ~2.5km away with new view)	Potentially less visual impact as transmission line would be underground

Summary of Considerations

Consideration Category	Impacted Stakeholder	Option A Advantages	Option A Disadvantages	Option B Advantages	Option B Disadvantages
EnergyConnect efficiency		➢ Use of existing right of way	➢ Challenges in existing transmission line cross overs. ➢ Impacts existing landholders adjacent to TL No. 62 and TL. 63	➢ Avoids cross overs of existing 330kV transmission lines	➢ There exists steep terrain for this route.
System security / network constraints			➢ Depending on outages required for TL No. 62 or TL. 63, staging of the build may be impacted		
Interfaces with HumeLink			➢ This route requires two new easements along the alignment of existing TL No. 051		
Undergrounding	➢ Impacted land(s)	➢ Provides options for route(s) which may mitigate project delays due to access / property acquisition.	➢ Cost ➢ Technically feasible but challenging	➢ Provides options for route(s) which ➢ May mitigate project delays due to access / property acquisition	➢ Cost ➢ Technically feasible but ➢ challenging
Costing			➢ Should construction staging or implementation require a significant rebuild of TL No. 62 or TL No 63, this would imbalance the present cost equality.		➢ Topography not being considered will increase the present cost equality as presented in this report

Consideration Category	Impacted Stakeholder	Option A Advantages	Option A Disadvantages	Option B Advantages	Option B Disadvantages
Property/ Easements	Affected and adjacent landholders	➢ Lower number of affected land holders ➢ 'Brownfield option' with most properties already affected by existing TransGrid TL ➢ Existing easements can be optimized ➢ Overall lower property risk ➢ Minimal line crossings required	➢ Consolidation of TL's required to support solution considered challenging ➢ May require 'whole of property' acquisitions where impacts cannot be mitigated		➢ Higher number of affected land holders ➢ Mostly greenfield ➢ Limited collocation opportunities ➢ New easements required for those areas east of Holbrook Road (i.e. TL No. 62) ➢ Overall higher property execution risk ➢ Multiple line crossings required (vis 62/996) ➢ Optics of option are poor when compared to Ec/A
Government stakeholders	Local Council	➢ Compensation for easement acquisition over Gregadoo Waste Management Centre	➢ Potential easement impact to Gregadoo Waste Management Centre		➢ Environmental disturbance to undeveloped area and community unease ➢ Greater visual impact
	State agencies and regulators				➢ Increased likelihood of adverse compulsory acquisitions
Environment and planning		➢ Lower cumulative planning risk for co-located transmission lines ➢ Anticipated lower environmental impacts where colocation is			➢ Higher cumulative planning risks with greenfield proposal for various aspects (land use, visual, EMF) ➢ Moderate/high mitigated residual environmental impacts