OPTION FEASIBILITY STUDY (OFS)

Beryl Area Renewables Connection

OFS- 000000001942 revision 0.0

Option description: Establishment of Beryl 330/132kV Substation

Ellipse project No: P0013195

Project reason: Economic Efficiency - Network developments to achieve market benefits
Project category: Prescribed - Augmentation

Approvals

Author	Evan Carlow	Project Developer
Endorsed	Anwar Kurukchi	Prescribed Project Development Manager
Approved	John Howland	Manager Project Development
Date submitted for approval	8 November 2017	

Table of contents

1. Request

This Option Feasibility Study is provided in response to Need/Opportunity Statement & Option Screening Assessment 1942 – Beryl Area Renewables Connection. Project Development were requested to undertake a desktop assessment of the works associated with the establishment of a 330/132kV Beryl Substation on existing property which was strategically purchased by TransGrid.

This report provides a desktop assessment of the works described above, taking into account the cost, timing of activities, environmental issues, risk analysis and practicality of being able to complete the works.

The proposed Beryl 330kV Substation initial single line diagram, ultimate single line diagram, area network diagram and substation location is shown in Figures 1.a, 1.b, 1.c and 1.d, below.

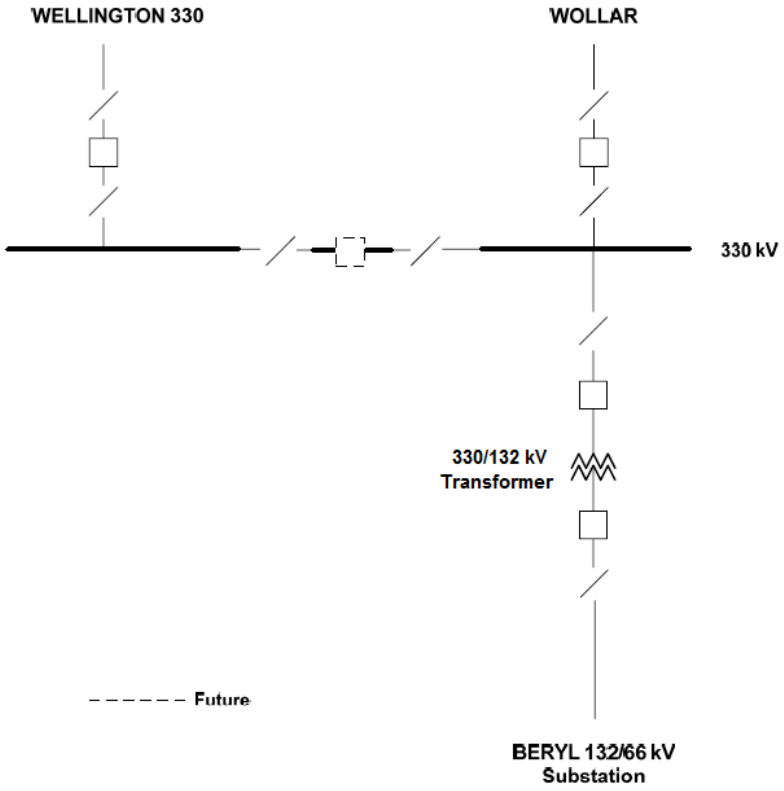

Figure 1.a – Proposed Beryl 330kV Substation Initial Single Line Diagram

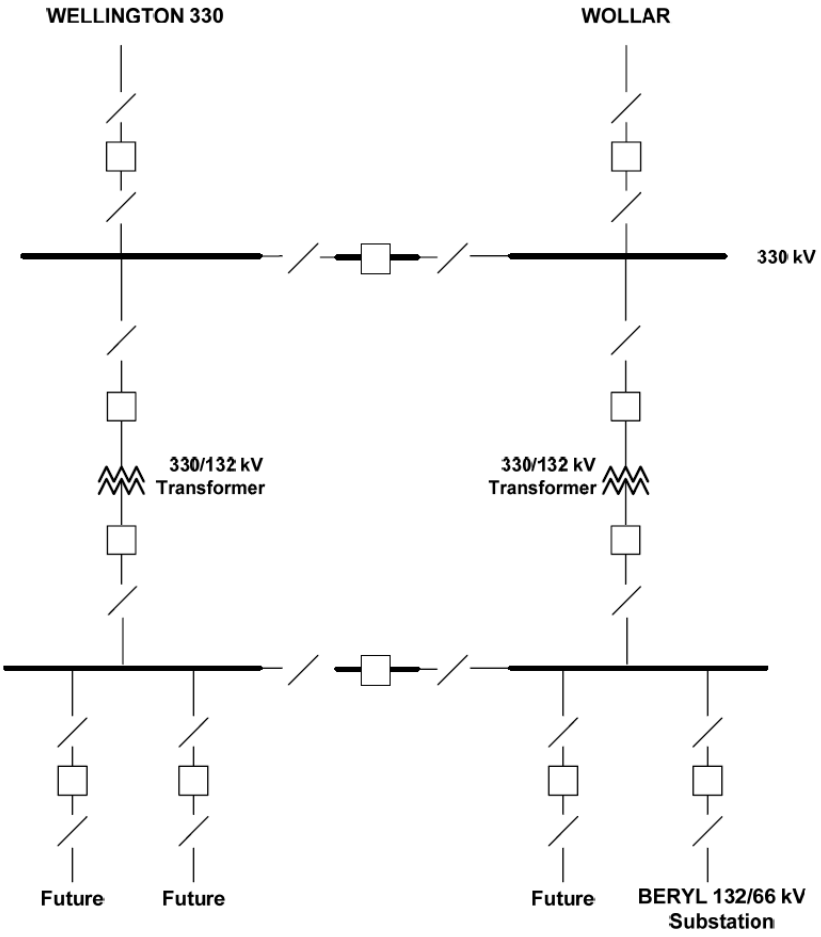

Figure 1.b – Proposed Beryl 330kV Substation Ultimate Single Line Diagram

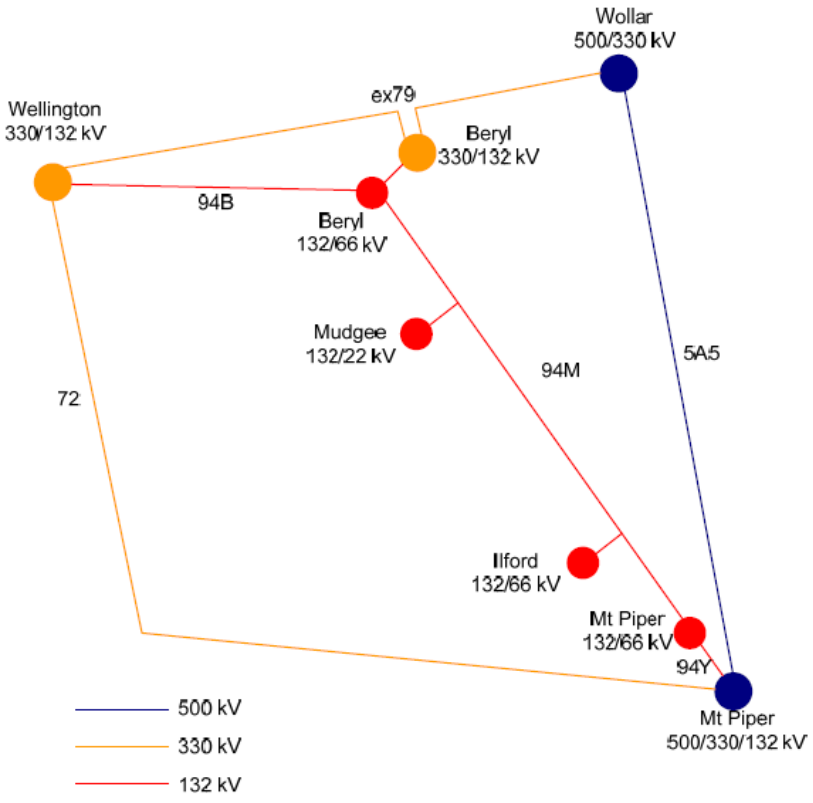

Figure 1.c – Proposed Beryl Area Network Diagram

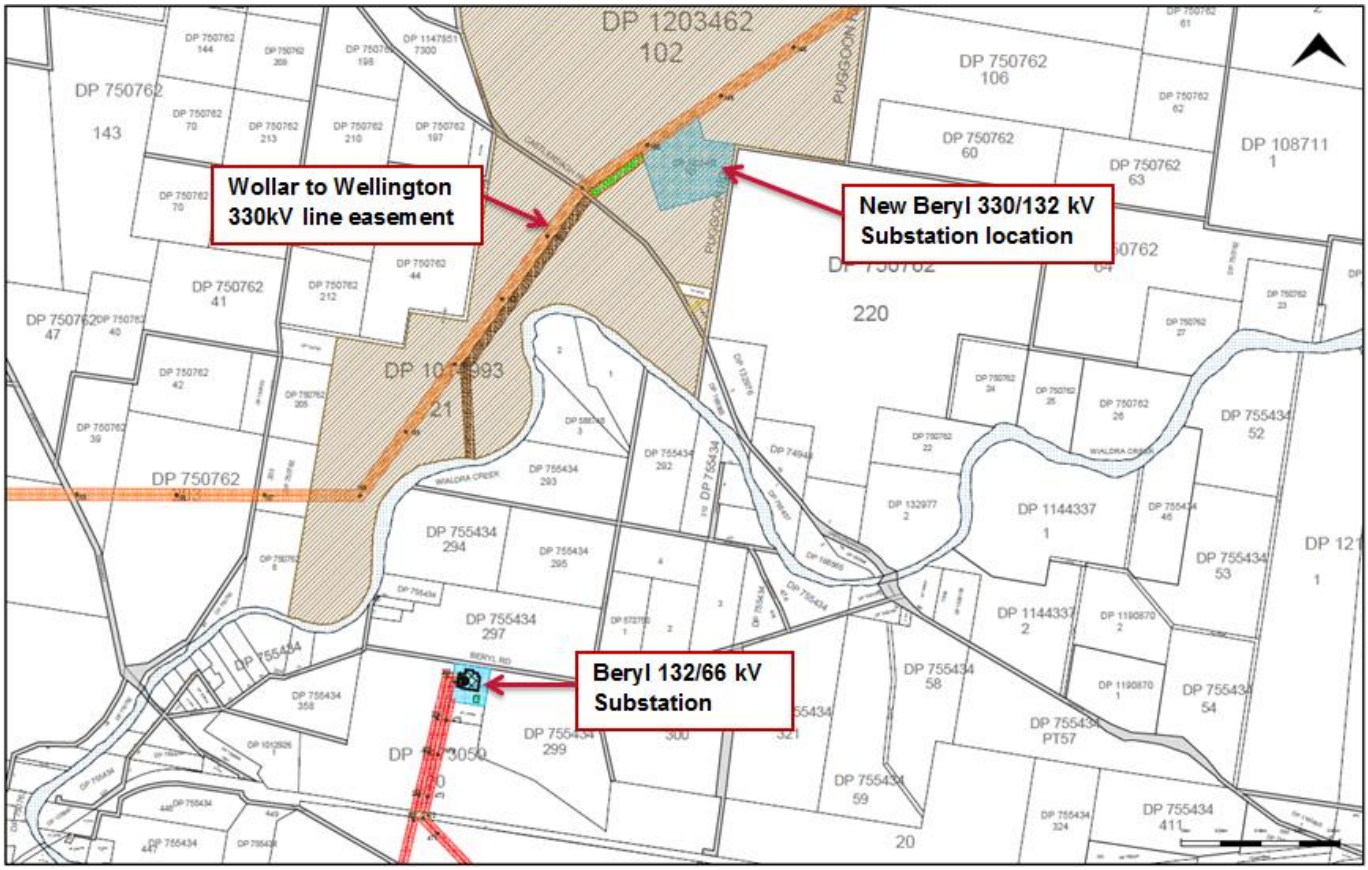

Figure 1.d – Proposed Beryl Substation Location

The proposed Beryl 132kV Substation augmentation works are shown in Figure 1.e, below.

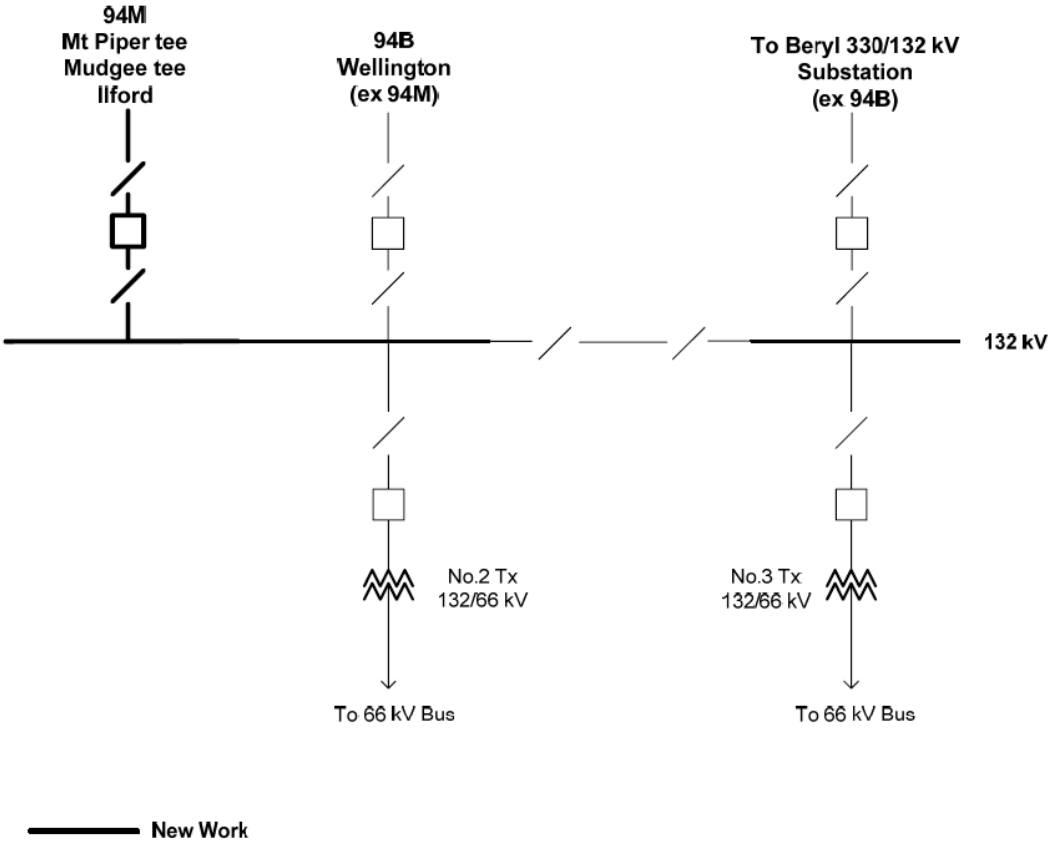

Figure 1.e – Proposed Beryl 132kV Substation Single Line Diagram

2. Considerations

The following scope of works is associated with the establishment of the Beryl 330/132kV Substation.

- Establishment of a 330/132kV Substation near Beryl on the existing site acquired by TransGrid, including the installation of the following.
    - Switchyard bench and site services.
    - 1 x 330/132kV 200MVA transformer.
    - 2 x 330kV line switchbays.
    - 1 x 330kV busbar including an allowance for future bus section switchbay.
    - 1 x 330kV transformer switchbay.
    - 1 x 132kV transformer/line switchbay.
    - 1 x 11/0.415kV 500kVA auxiliary transformer.
    - 1 x diesel generator.
    - 1 x auxiliary services building (ASB).
    - 1 x secondary systems building (SSB).
    - AC and DC distribution systems, batteries and chargers.
    - Communications equipment suitable for a 330kV site.
    - 3 x fibre optic terminals.
    - 1 x fault recorder.
    - Control and protection equipment.
    - Duplicated VF intertripping and backup PLC intertripping on Wollar and Wellington lines.
    - Unduplicated VF intertripping and unduplicated PLC intertripping on the Beryl 132 line.
- Installation of one 330kV double circuit steel lattice tension towers to cut-in the 79 Line into Beryl 330 and associated conductor stringing works.
- Acquisition of easements required for a 132kV line between the new Beryl 330 and existing Beryl 132.
- Construction of a 132kV concrete pole double circuit transmission line, strung on one side only with Mango ACSR conductor, including the installation of OPGW between the new Beryl 330 and existing Beryl 132.
- Augmentation works at the existing Beryl 132kV Substation, including the installation of the following.
    - 132kV busbar extension.
    - 1 x 132kV line switchbay.
    - 1 x fibre optic terminal.
    - Control and protection equipment.
    - Unduplicated VF intertripping and unduplicated PLC intertripping on the Beryl 330 line.
    - Duplicated 50V DC RPS systems.
- Installation of a new 132kV line termination structure on the 94M Line and re-termination of the 94M line into the new 132kV switchbay.
- Installation of a new 132kV line termination structure on the 94B Line and re-termination of the 94B line into the old 94M Line switchbay.

- Modification of existing 79 Line protection systems at Wollar 500kV Substation and Wellington 330kV Substation for cut-in of the new Beryl 330kV Substation.
- Installation of unduplicated VF intertripping and unduplicated PLC intertripping on the 94B Line at Beryl 132 and Wellington.
- Installation of duplicated VF intertripping and unduplicated PLC intertripping on the 94M Line at Beryl 132 and Mount Piper 132.
- Installation of an automatic changeover scheme for the 94M Line at Beryl 132 and Mount Piper 132.

2.1 Site general arrangement and access

The proposed Beryl 330kV Substation (Beryl 330) is located on existing property which was strategically acquired by TransGrid approximately 3km north-west of Beryl 132kV Substation (Beryl 132) and will cut-in to the existing 79 Wollar to Wellington 330kV Transmission Line approximately 56km form Wellington and 61km from Wollar. Approximately 2km of easement out from the Beryl 330kV Substation site was also acquired and approximately 1.1km of new easement between the existing easement and Beryl 132kV Substation will need to be acquired. The Beryl area satellite photo is shown in Figure 2.1.a, below.

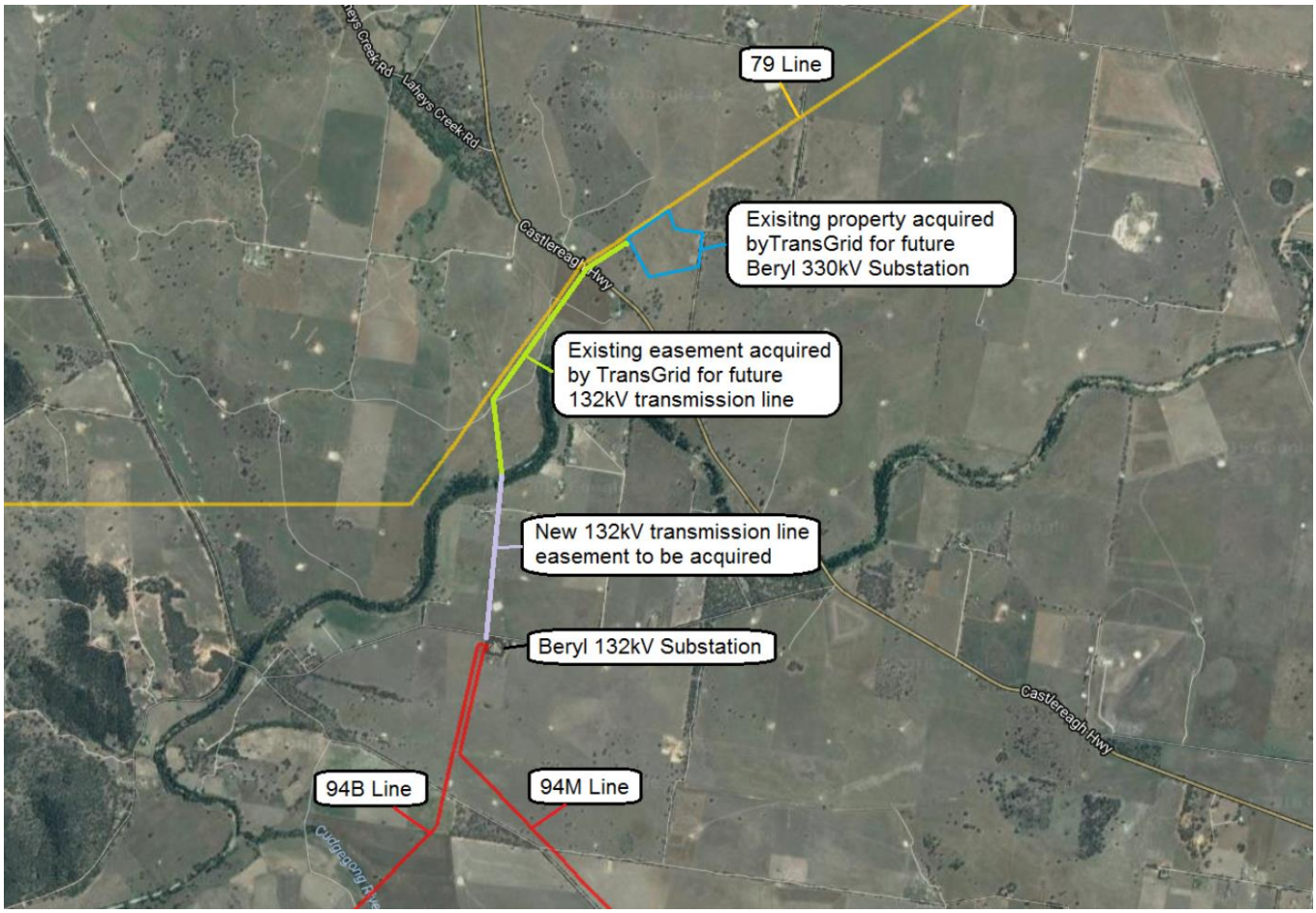

Figure 2.1.a – Beryl Area Satellite Photo

2.2 Civil works

Typical civil works will be required, including site preparation and earthworks, drainage and major cable trenches, major and minor equipment footings, oil containment system, security fencing, access road, switchyard surfacing, landscaping, secondary systems building and auxiliary services buildings.

The Beryl 330 bench size in the estimate allows for the ultimate development as discussed in Section 1.

2.3 Building works

An auxiliary services building (ASB) and one secondary systems building (SSB) will be required at Beryl 330. It is anticipated the ASB will be approximately 160m^2 in size.

2.4 Major plant and equipment

One new 330/132kV 200MVA transformer will be required at Beryl 330. It is expected that the transformer will have a lead time of approximately 18 months.

2.5 Minor plant and equipment

All new switchgear will need to satisfy the following equipment ratings.

Equipment	Continuous Current Rating (A)	Fault Current Rating (kA)
330kV busbar	3000	50kA
330kV line switchbay	2000	50kA
330kV transformer switchbay	2000	50kA
132kV transformer / line switchbay	2400	31.5kA
132kV line switchbay	1000	31.5kA

Existing switchgear at Wellington, Wollar and Beryl 132 will be suitable for the new network augmentation.

It is expected that the lead time of the primary equipment will be up to 8 months and it is expected that the lead time of the secondary systems will be up to 3 months.

2.6 Electrical works

The electrical work for this option will involve the installation of the earthgrid, new major and minor plant and equipment, high voltage connections, secondary control cabling, installation of control and protection schemes, testing and commissioning.

2.7 Secondary systems

The new site will require all secondary systems required for an unmanned 330kV substation.

2.7.1 Protection

The installation of a 330kV source at Beryl will decrease the source impedance at Beryl 132 which may affect the critical clearance time of faults on the 94M Line. Therefore, the installation of protection intertripping on the 94M Line has been included in this study. It is anticipated that duplicated VF intertripping can be provided using the new communications network established via Beryl 330, Wollar and Mount Piper 500 and Mount Piper 132 and PLC intertripping over the 94M Line can be provided as a backup. Critical clearing time studies will need to be completed during project development to confirm system stability requirements. The 94M Line may also need to be operated radially unless critical clearance studies determine protection intertripping is not required or a 132kV busbar is established at Mudgee under Need 192, Therefore, an automatic changeover scheme at Beryl 132 and Mount Piper 132 has also been included in this study. The requirement for an auto changeover scheme should be confirmed during project development.

Provision of duplicated VF protection signalling schemes and backup PLC protection signalling scheme on Beryl 330 – Wellington OPGW will be required over the route diverse telecommunications systems established as part of this project.

Provision of duplicated VF protection signalling schemes and backup PLC protection signalling scheme on Beryl 330 - Wollar OPGW will be required over the route diverse telecommunications systems established as part of this project.

Provision of VF protection signalling scheme on the No.1 Protection and PLC protection signalling on the No.2 Protection will be required on the Beryl 330 - Beryl 132 line.

Provision of VF protection signalling scheme on the No.1 Protection and PLC protection signalling on the No.2 Protection will be required on the Beryl 132 – Wellington line.

2.7.2 Metering

It is not anticipated that any new market metering or quality of supply metering will be required.

A new fault recorder will be required at Beryl 330.

2.7.3 Communications

New communications equipment will be required at beryl 330 suitable for the connection of fibre optic and PLC communications on the 70 Wellington, 79 Wollar and Beryl 132 lines.

New communications equipment will be required at Beryl 132 suitable for the connection of fibre optic communications on the Beryl 330 line.

2.7.4 Control systems

A Substation Automation System will be required at Beryl 330.

As stated in Section 2.7.1, above, an automatic changeover scheme of the 94M Line to permit the 132kV network to be operated radially will be required at Beryl 132 and Mount Piper 132 unless critical clearance studies determine there are no system stability issues. It is anticipated the new changeover scheme can utilise new communications established as part of this project.

Drawing BER-131371_08 indicates there are spare panels available for the installation of the required control and protection panels.

2.7.5 Auxiliary supplies

The No.1 auxiliary supply shall be from the new auxiliary transformer connected to the main transformer and the No.2 auxiliary supply will be from the council supply. A diesel generator will be required to provide a backup supply.

Duplicated 50VDC power supplies will be required at Beryl 132.

Drawing BER-143810_01 indicated there is space required for the installation of the duplicated 50V DC power supplies and intertripping racks.

2.8 Transmission line route

It is anticipated that one new 330kV double circuit steel lattice tension tower will be required to cut-in the existing 79 Line into Beryl 330. It anticipated that this work will be on existing easements and property owned by TransGrid and therefore, not require the acquisition of additional property.

A 132kV concrete pole double circuit transmission line, strung on one side only with Mango ACSR conductor, including the installation of OPGW will be required between the new Beryl 330 and existing Beryl 132. The new transmission line will be approximately 3.25km in length and will be located partially on existing easement and partially on property which will require acquisition of easement. Approximately 1.1km of new easement will need to be acquired to secure rights for the construction and maintenance of the proposed Beryl 330 to Beryl 132 transmission line.

The proposed transmission line route and line works is shown in Figures 1.d and 2.1.a, above.

3. Outage requirements

It is anticipated that outages will be available to deliver the scope of works as described in this feasibility study. However, there is a risk that additional transmission line structures will need to be constructed to allow short cut over to existing lines due to outage restrictions.

4. Environmental and development approvals

It is not anticipated at this stage that the project will have a significant impact on the environment in accordance with Section 111 of the EP&A Act. This will be continually reviewed as the project develops but at this stage it is anticipated that an assessment in the form of a Review of Environmental Factors (REF) will be required. The REF will be tailored to the scale of the development.

The requirement to publicly consult on the project will be reviewed as the project develops but at this stage public consultation is anticipated. TransGrid is the likely determining authority for this project.

5. Property considerations

The new Beryl 330kV Substation, 330kV transmission line augmentation works and approximately 2.15km of the new 132kV transmission line out of Beryl 330 will be constructed on existing property and easements which was strategically acquired by TransGrid.

A new section of 132kV transmission line easement will be required between the existing Beryl 132 site and easement which was strategically procured by TransGrid, as shown in Figure 5.a, below. The new section of easement is approximately 1.1km in length.

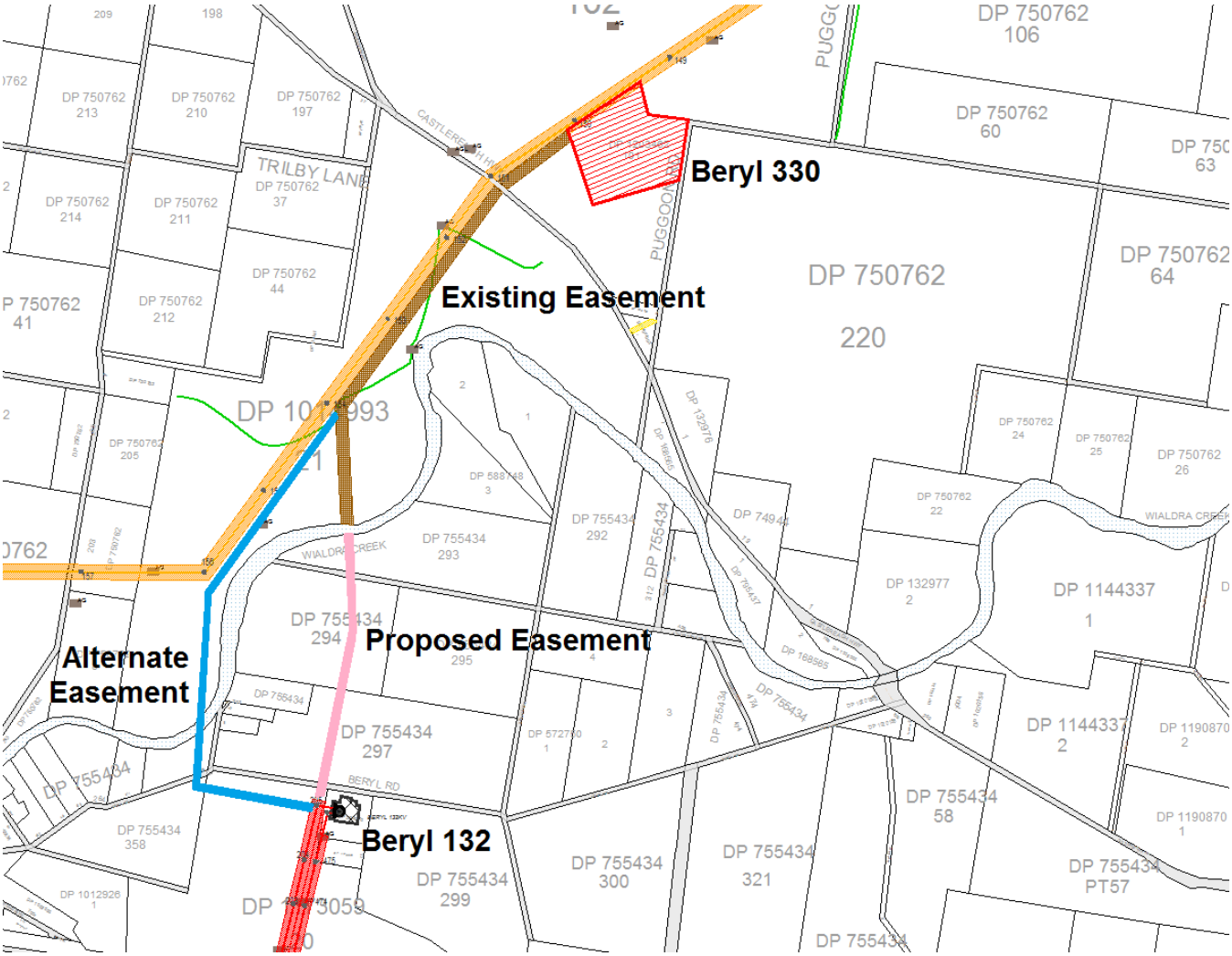

Figure 5.a – Beryl Area Property Requirements

The proposed easement was chosen to align with the existing easement already acquired by TransGrid. However, the proposed easement comes within 100m of residential houses and is parallel to an existing 66kV line which may or may not be considered to significantly increase the visual impact on the residents. If acquisition of the proposed easement is unable to be negotiated with the residents, Ministerial consent may be required to compulsory acquire the proposed easement which may delay the project and increase costs.

An alternate easement has been identified which avoids the residential houses on the eastern side of the river which traverses over a large portion of land that has the same property owner as the existing easement and may be less difficult to negotiate the acquisition of an easement. Therefore, the risk associated with acquisition of the longer alternative easement and construction of a longer transmission line has been included in the risk assessment.

6. Cost estimate

6.1 Capital Expenditure

It is estimated that this option would cost $35.3m ± 25% in $2016-17, excluding capitalised interest.

The expected expenditure profile for this project (excluding capitalised interest) based on a standard spending curve distribution is as follows:

	Total Project Base Cost	Year -3	Year -2	Year -1	Year 0
Estimated Cost– non-escalated ($m 2016-17)	35.3	1.1	4.8	14.3	15.1

Notes:

1. The cost has been estimated from a scope of work determined by a limited review of the project, as detailed in section 2.
2. The values used in the estimate were generally obtained using PD / CE's Estimating System
3. The estimate has been prepared on the basis of standard bays and allowances for the works, with adjustments as detailed in this study for the specific option scope.
4. The estimate has an uncertainty of +/- 25%
5. Substation – 330kV New, Substation – 132kV Augmentation, Transmission Line – 330kV Augmentation and Transmission Line – 132kV Augmentation factors have been used.
6. No allowance has been included in the estimate for exchange rate variations.
7. No adjustment for forward escalation has been included in the totals above. Based on forecast commodity escalation, the nominal estimated cost in each year (i.e. the amount in 2018-19 is in forecast $2018-19) is as follows:

	Total Project Budget Cost	2019-20	2020-21	2021-22	2022-23
Nominal escalated cost ($m)	42.0	1.2	5.5	16.8	18.5

7. Project and implementation method

The project is expected to be completed in an estimated 44 months from the issue of a Project Development Initiation document, allowing 18 months for project development and issue of the PAD and 26 months for project completion following issue of the PAD.

The key dates for this program are detailed below.

Milestone	Duration (Months)	End of Month
Issue of PDI	0	0
Concept Design Complete	6	6
Regulatory Approval Complete	18	18
Draft REF Complete	9	13
Issue IFC Designs	8	16
Environmental Approval	14	18
Issue PAD (DG2)	2	18
Prepare Specification	4	22
Advertise and Review Specification	4	26
Award Contract	-	26
Possession of site	4	30
Practical Completion	12	42
In-Service Date	2	44

This program has been based on the standard program template for a Substation - New Greenfield project.

This timeframe assumes the completion of the following steps prior to issue of the PAD.

- Environmental Approval complete with all environmental issues affecting scope identified.
- Property acquisition complete for the substation site prior to PDI issue.
- Concept design completed to the point of having a defined single line diagram, concept general arrangement and concept transmission line connection arrangement to accurately define project scope.
- Regulatory Approval processes complete.
- Any specifications for long lead time plant (eg: transformers/reactors) completed ready for advertising when PAD is issued or plant able to be ordered on existing period orders.
- PAD issued within two months of completion of IFC designs.

For this option the following key risks to the program have been identified:

a) If property acquisition is not complete by the time of issue of the PDI, the issue of PAD will be delayed. This risk is considered possible and should be managed as part of the Portfolio Management process to ensure early identification of an appropriate site and strategic purchase;

b) No geotech, environmental or other studies have yet been completed. If unusual conditions are found, these may extend both the project development and the construction periods. This risk is considered possible and should be managed by early issue of the PDI.

c) The program makes allowance for normal inclement weather. If periods of abnormal rainfall occur the program will be delayed.

In the event that these risks occur, project development and PAD issue will be delayed and the project construction period could be extended.

8. Project delivery risks

The key risks outlined in the table below have been identified and will need to be managed as part of this project. In the event that these risks occur there could be impacts to both project cost and time for completion. These risks should be assessed in detail during project development.

Risk	Treatment
Safety Risks	
There are the normal risks associated with working on a construction project or in a live high voltage station and in close proximity to a live line.	Ensure that all works are carried out in accordance with TransGrid's Safety Rules and standard policies and procedures. All site works are to be managed using a site specific safety management plan.
There are normal risks associated with the design of substations and transmission lines and the associated access.	Ensure that all design works are carried out in accordance with TransGrid's standard designs, policies and procedures. Ensure that all design work is carried out in accordance with TransGrid's safety in design processes.
Environment Risks	
There are the normal risks associated with the delivery of large capital projects that may impact on the environment.	Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures.
Community / Property Risks	
There is a risk that property owners will oppose the proposed works and new easements required.	Implement a Communication Strategy in accordance with TransGrid's standard policies and procedures and consult with property owners early in the project development stage.
Project Delivery and Program Risks	
There are the normal risks associated with the delivery of capital projects.	Implement TransGrid's standard policies and procedures during all phases of the work.
Program may be delayed if Regulatory Approval has not been completed in time.	Ensure that Regulatory Approval is completed in a timely manner.
Program may be delayed if the equipment orders are not placed with sufficient lead time.	Ensure that equipment is ordered as early as possible to suit the project program.
Program may be delayed if outages cannot be obtained	Prepare an implementation plan and providing the earliest possible notification of the required outages.
Project may be delayed if appropriate resources are not available	Ensuring that the project is given the appropriate priority.
Project may be delayed as a result of issues detailed in Section 7 of this report.	Issue PDI with sufficient float to ensure that the needs date can be met.

9. Change History

Revision	Approver	Amendments
0	J. Howland	Initial Issue