OPTION FEASIBILITY STUDY (OFS)

Reinforcement of Northern Network

OFS- 000000001529-2E revision 1.0

Option description: New SVCs at Tamworth and Dumaresq, new shunt capacitor banks and uprating of Line 83, 84 and 88.

Ellipse project description: P0008825
TRIM file: [TRIM No]

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Augmentation

Approvals

Author	Quazi Hossain	Project Feasibility Studies Engineer
Endorsed	Daniel Burn	Project Feasibility Studies Manager
Approved	John Howland	Manager / Portfolio Management
Date submitted for approval	29 September 2016	

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1. Request

This Option Feasibility Study is provided in response to Option Feasibility Request 1529-2E revision 0 which includes the following scope.

- Installation of a -100 MVAr to 350 MVAr SVC at Tamworth 330 kV Substation
- Installation of a -100 MVAr to 350 MVAr SVC at Dumaresq 330 kV Switching Station
- Installation of 2 x 60 MVAr and 1 x 120 MVAr shunt connected Capacitor banks at Tamworth
- Installation of 2 x 50 MVAr and 1 x 120 MVAr shunt connected Capacitor banks at Armidale
- Installation of 2 x 120 MVAr shunt connected Capacitor banks at Dumaresq
- Uprating of Lines 83, 84 and 88 to a design temperature of 120°C

Asset Management are required to undertake a desktop assessment of the cost, timing of activities, risk analysis and practicality of carrying out the works. The needs date is 2023.

2. Considerations

2.1 Substation Works

2.1.1 Muswellbrook 330 kV Substation

At Muswellbrook substation the following bay equipment will need to be replaced to achieve the required rating.

Line	Plant	Quantity
83	Line Traps	1
	Line Droppers	1
88	Line Traps	1
	Line Droppers	1

2.1.2 Tamworth 330 kV Substation

At Tamworth substation the following bay equipment will need to be replaced to achieve the required rating.

Line	Plant	Quantity
84	Line Traps	1
	Line Droppers	1
	Disconnectors	3
	Bay Conductor	bay 1E
	Overhead strung bus and droppers	1

2.1.3 Liddell 330 kV Substation

At Liddell substation the following bay equipment will need to be replaced to achieve the required rating.

Line	Plant	Quantity
83	Line Traps	1
	Line Droppers	1
	Disconnectors	1
84	Line Traps	1
	Line Droppers	1
	Bay Conductor	Bay bK

It should be noted that the scope of work for the uprating of Lines 83, 84 and 88 as detailed in OFS 1033G includes the replacement of disconnectors and circuit breakers at Liddell due to a requirement for 63kA rated equipment. Given that Liddell power station is retiring in the 2018-23 regulatory period, it is anticipated that the X/R ratio will decrease and the fault rating of switchgear can return to the normal 50kA. As such, replacement of circuit breakers and disconnectors at Liddell have not been included in the scope of works.

2.1.4 Armidale 330 kV Substation

The scope of work at Armidale is for the installation of the following shunt connected capacitor banks.

- 2 x 50 MVAr Capacitor Banks
- 1 x 120 MVAr Capacitor Bank.

It is anticipated that the capacitor banks will be installed on the 330kV busbar.

Designs have previously been completed for the installation of two 330 kV capacitor banks at the southern end of the switchyard. It is anticipated that the third capacitor will be installed opposite of the 330 kV busbar as shown in Figure 1.

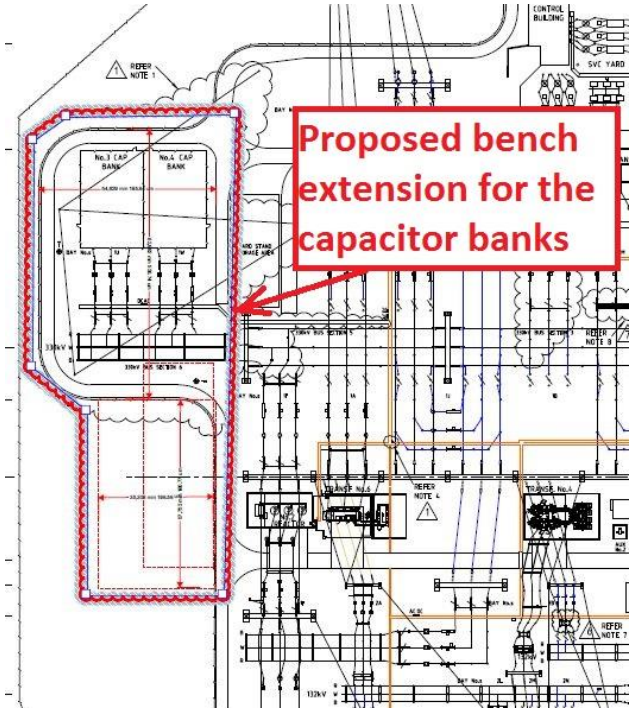

Figure 1 - Bench Extension for the Three Capacitor Banks

The works will involve:

- Bench extension of 6600m2;
- 240m of switchyard roadway;
- 240m of security fence;
- Extension of the 330 kV busbar;
- Construction of three 330 kV switchbays for the capacitor banks; and
- Construction of three 330 kV capacitor banks and associated compounds.
- Installation of control and protection schemes associated with the Capacitor banks and switchbays.

2.1.5 Dumaresq Switching Station

At Dumaresq there is a need to install one SVC and two 330 kV capacitor banks. In order to utilise some of the existing space at the switching station for the proposed equipment, Lines 8E/8C will need to be re-arranged and the switching station converted to a full breaker and a half arrangement.

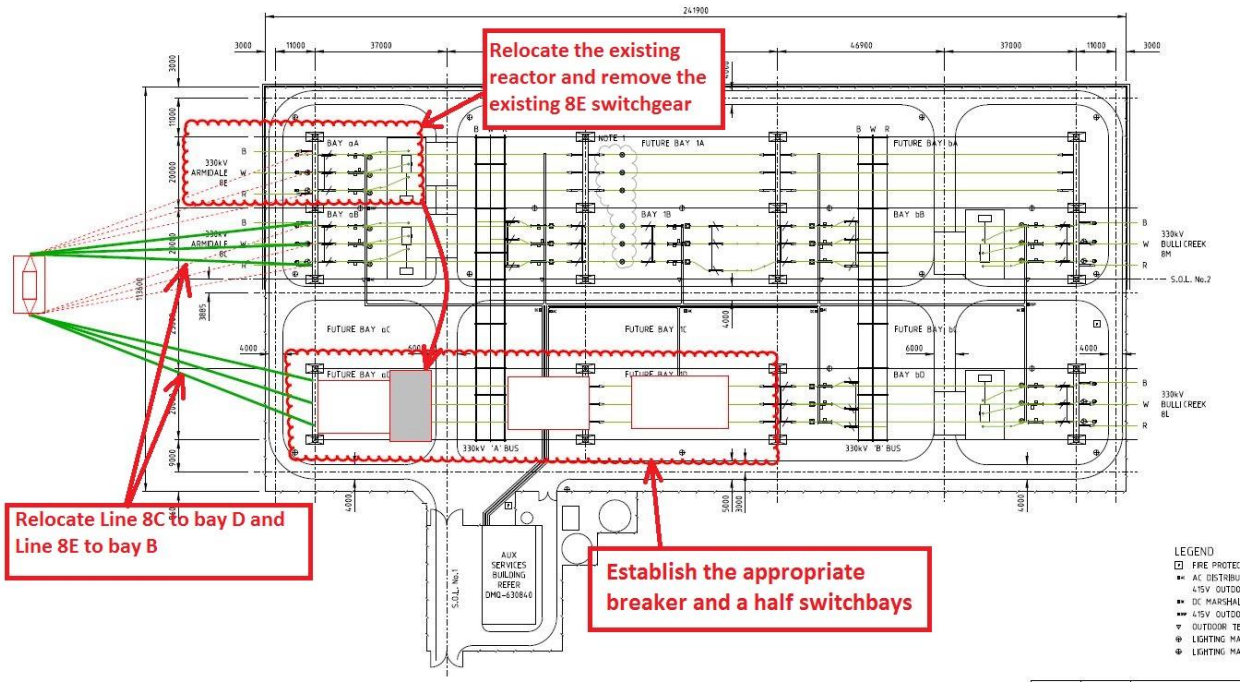

Figure 2 – Proposed Rearrangement to Breaker and a Half at Dumaresq

The first stage of works at Dumaresq will be for the conversion to a breaker and a half arrangement and re-terminating Lines 8C/8E. This will involve the installation of the appropriate HV switchbays and associated secondary systems; construction of a new 330 kV reactor bund; relocation of the existing reactor currently utilised for Line 8E; and decommissioning of the existing 8E line switchgear.

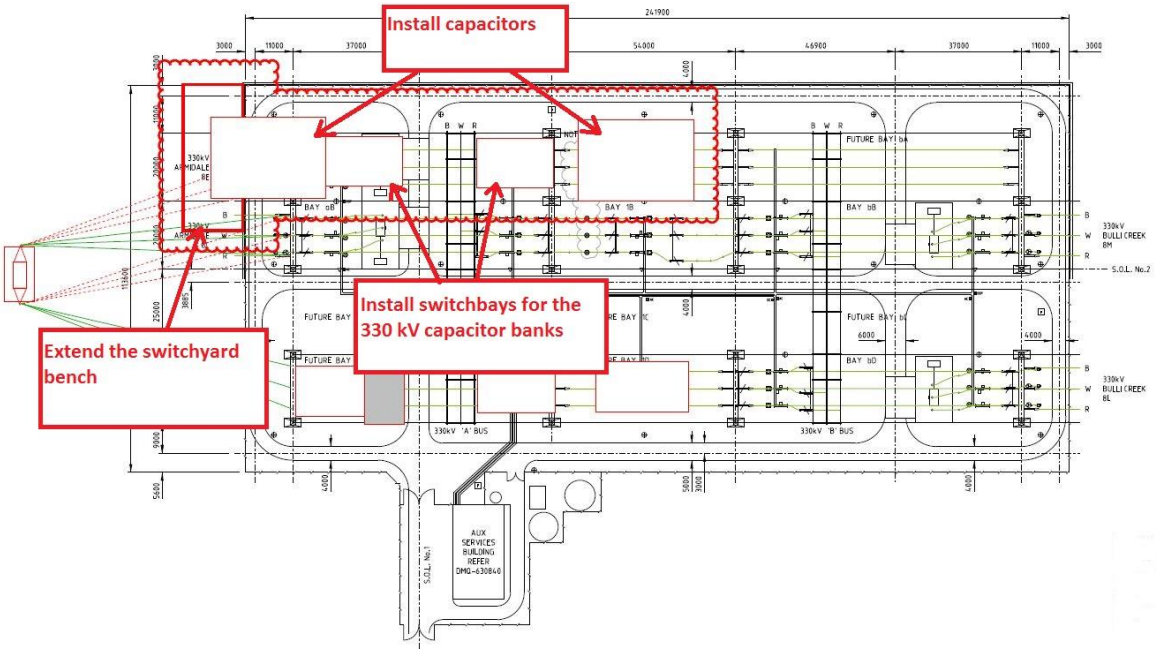

Figure 3 – Proposed Location of 330 kV Capacitors at Dumaresq

The second stage of development at Dumaresq will involve the installation of the 330 kV capacitors. To facilitate this, the switchyard bench will need to be extended by approximately 1200 sqm in the south-west corner of the switchyard.

Two switchbays and associated control and protection systems will need to be constructed to allow the capacitor banks to connect to the busbar. It is anticipated that both capacitor banks will connect to the 'A' Bus.

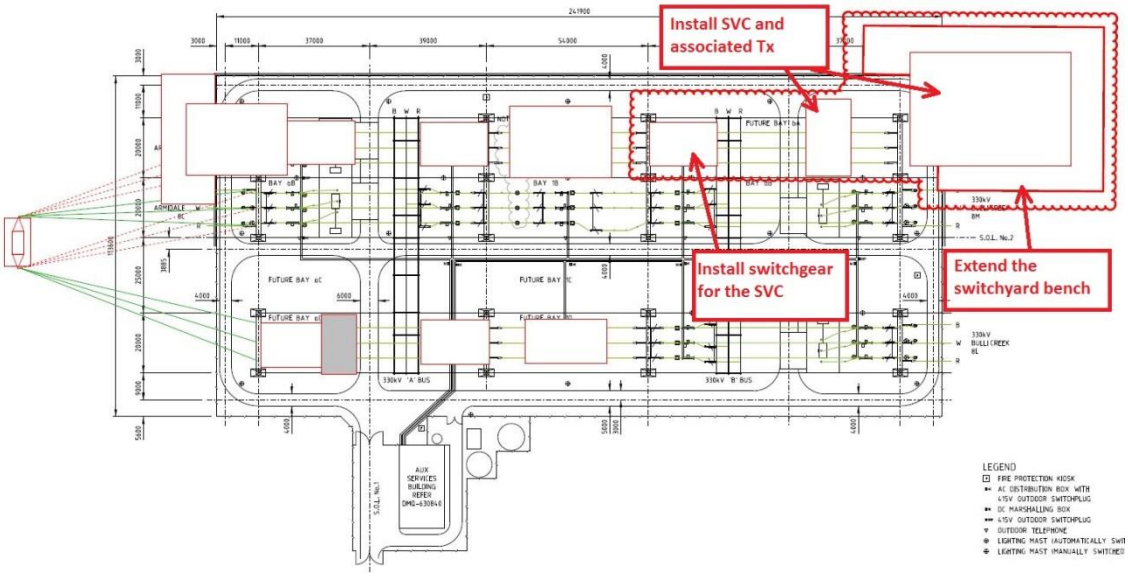

Figure 4 - Proposed Location of the SVC at Dumaresq

It is anticipated that, based on the area used by the Armidale SVC, the SVC at Dumaresq will require 6000 sqm of bench space, of which 4000 sqm will be from a bench extension. Based on the original geotechnical report for the switchyard construction it is anticipated that the proposed bench extension will require significant excavation of low strength basalt. An allowance has been included for the bulk excavation of rock using standard equipment (8000 cum).

2.1.6 Tamworth 330 kV Substation

At Tamworth 330 kV substation there is a requirement for the installation of:

- One SVC with a range of -100 MVAr to 350 MVAr;
- One 120 MVAr Capacitor; and
- Two 50 MVAr Capacitors.

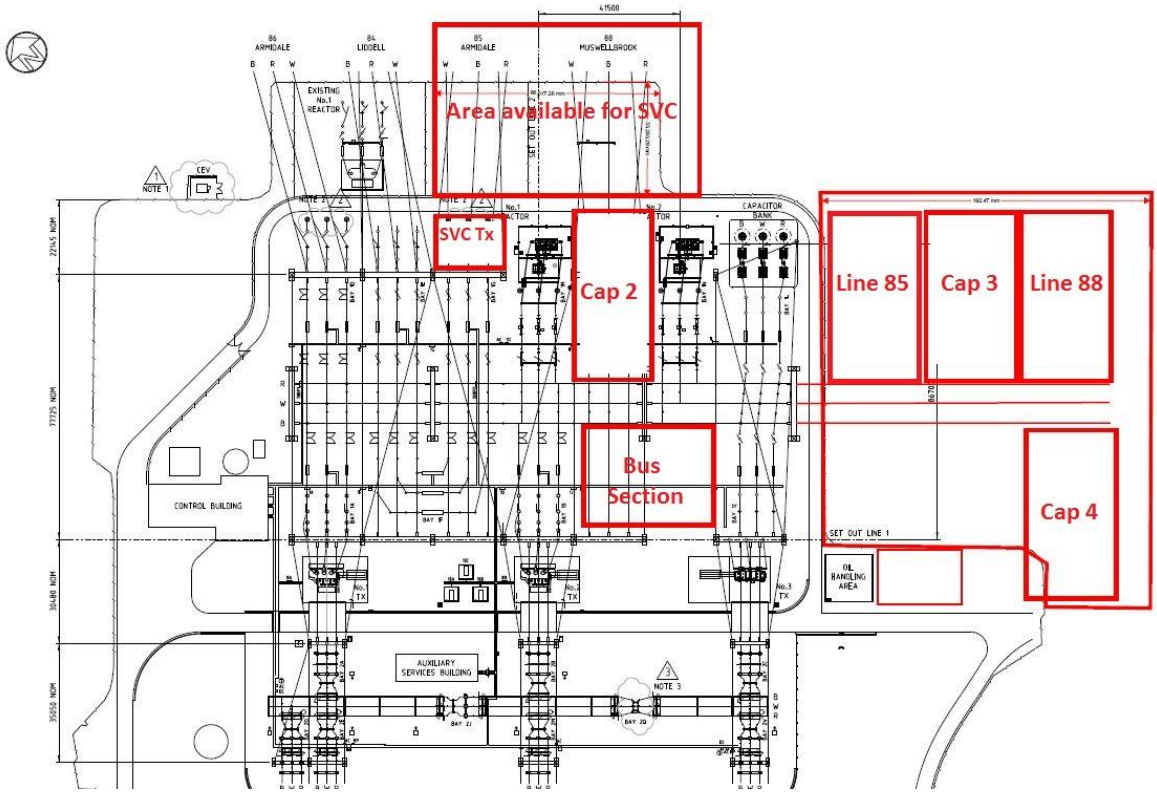

Figure 5 - Proposed Arrangement of Tamworth 330 kV Substation

In order to try and distribute the reactive plant across different bus sections, it is proposed that the SVC can be installed on the portion of bench that is currently under the Line 85 and Line 88 landing spans (with some extension of the existing bench) and a new bus section bay can be installed to separate two new capacitors from the SVC and one new capacitor.

To facilitate the construction of the SVC at this location, the switchyard will need to be extended to the south-east and new line bays constructed for Lines 85 and 88. Once the transmission lines have been cut-over to the new switchbays the bench works can proceed for the SVC.

2.1 Transmission Line Works

2.1.1 Uprating of Lines 83, 84 and 88

Lines 83, 84 and 88 were constructed for a design temperature of 85°C and a design clearance of 7.6m. The latest revision of AS 7000 indicates that transmission line clearances for 330 kV lines must be 8.0 m.

Based on Aerial Laser Survey (ALS) data and PLS-CAD models, Transmission Line Design have been able to provide some preliminary advice regarding the location and magnitude of violations that arise from operating at a higher design temperature. The scope of work to remediate the identified clearance violations are summarised below.

Line	D-strings	V-strings	Re-tensioning	Suspension structure replacements	New midspan suspension structure
83	1	-	-	-	-
84	20	1	1	4	1
88	29	35	-	67	1

It should be noted that the above scope has been determined based on a desktop assessment only. Site investigations have not been undertaken. It should also be noted that the above scope assumes that multiple D-string and V-string arrangements are allowed in each tension section.

2.1.1.1 V-string Insulator Arrangement

It is proposed that where clearance violations do not exceed 0.5m that inverted V-string insulator arrangements can be installed to raise the conductor height.

2.1.1.2 D-String Insulator Arrangement

Standard drawing TL-183232 indicates that insulators at suspension towers will be a minimum of 3m long. By removing most of the porcelain disk insulators and installing a D-string arrangement, as per drawing TL-613975, the suspension insulator arrangement can be shortened by up to 1.9m at the suspension structure. Generally, D-strings are used for clearance violations between 0.5 m and 1.0 m.

2.1.1.3 Transmission Tower Modifications

Where a clearance violation is greater than 1.0m, more onerous remediation measures must be investigated. It is anticipated that the required conductor height will be achieved by replacing the existing suspension structure with a two pole concrete H-frame structure.

Concrete poles will be jointed structures to allow pole bases to be installed prior to the erection of the main structure and cut-over of conductors. Pole structures will be erected as close as possible to the centreline of the existing transmission line route to minimise the impact to the transmission line design and construction.

2.1.1.4 Electrical Work

The electrical work associated with this option involves the re-tensioning of one span on Line 84.

The scope previously investigated and costed in OFS 1033G Rev 0 included the replacement of two hole terminal palms used at tension structures. Subsequent investigations have found that operating at a transmission line design temperature of 100°C is not likely to adversely impact on the remaining life of the joints. It is anticipated that a similar result will be observed for a temperature of 120°C, however it is noted that there is risk that this will not be the case and helical dead-end shunts will need to be installed to reduce the current passing through the terminal palms.

Replacement of terminal palms and jumper dead end fittings have not been included in the estimate for this option.

2.1.1.5 Site establishment and site access

The site establishment is estimated at 9 months based on 2 working days per low span and 1 full month for the transmission tower modification.

It is assumed that some amount of access track upgrade will be required for Elevated Working Platform (EWP) and cranes to access the tower locations. An allowance for access track upgrade using imported fill has been included in the estimate (20m per tower) and a nominal allowance for the use of temporary track panels.

Concerning the access, if the existing tower sites are difficult for access with EWPs or cranes there would be a significant impact. Therefore, there is a risk for delays on the site establishment and additional costs to upgrade site access.

2.1.2 Line Rearrangements at Tamworth Substation

In order to facilitate the installation of the SVC at Tamworth 330 kV substation, there is a requirement to divert lines 85 and 88 to new HV switchbays.

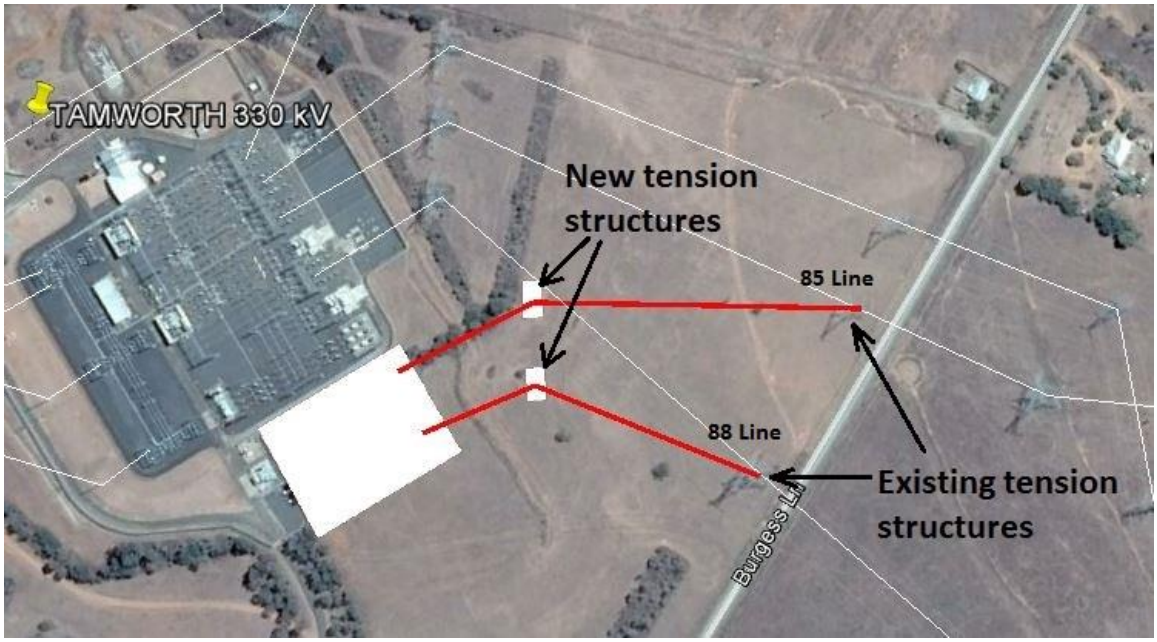

Figure 6 - Proposed Rearrangement of Lines 85 and 88

For each line a single tension structure will be required. It is anticipated that the route length of the new section of Line 85 will be 290 m and the route length of Line 88 will be 215 m.

3. Outage requirements

3.1 Line Uprating

It is anticipated that all outages on Lines 83, 84 and 88 will be restricted to shoulder periods. Outages on these lines have a high likelihood of having impacts on the electricity market, so outages should be kept to daily outages where it is possible and practical to do so. It is anticipated that daily outages would be possible for the following works.

- Transmission line insulator replacements;
- Line Trap replacements;
- Replacement of droppers within HV switchbays;
- Replacement of HV conductor within the HV switchbays; and
- Replacement of overhead strung bus within switchyards.

It is anticipated that suspension structure replacements and disconnector replacements for the purpose of line uprating can be carried out in 2 to 3 day outages.

It should be noted that outages on either Line 83 or Line 88 will make the load at Muswellbrook radial. For this reason, Line 83 and Line 88 cannot be taken out of service at the same time and recall on these lines should be

kept to a minimum so that supply can be restored to Muswellbrook in the event of a trip of the remaining in-service line.

3.2 Armidale

The majority of the works at Armidale can be completed without HV outages. An outage will be required on the A Bus Section 5 when connecting the new section of busbar. This work will need to be scheduled during shoulder periods. Consideration should be given to taking the HV outage outside normal work hours or on weekends to avoid introducing a constraint on the QNI import into NSW.

3.3 Dumaresq

Dumaresq will require outages on Line 8C, 8E, 8L and 8M in order to convert the switchyard to breaker and a half arrangement. The majority of these outages will be daily outages except where the cut-over of Lines 8E and 8C to the new switchbays which could take up to three days to complete.

It is anticipated that outages will be limited to shoulder periods and will be dependent on load flows at the time of the outage.

3.4 Tamworth

Assuming that the majority of bench extension works and construction of HV equipment on the new bench can be completed without outages, it is anticipated that outages will be required for:

- The establishment and connection of a new bus section breaker switchbay;
- The connection of the new bus extension;
- Cut-over of lines 85 and 88;
- Connection of the SVC; and
- Connection of the new capacitor bank on the existing bus

Outages on Lines 85 and 88 will generally not be problematic at any time of the year provided the outage on Line 88 does not clash with an outage on Line 83 (as noted in Section 3.1).

Bus outages on the Bus Section 3 will make the load radial through the No.1 Transformer. For this reason, control measures to achieve a short recall will need to be considered. Outages on Bus Section 3 are likely to be restricted to shoulder periods and it is preferred that the cotton ginning season (May to September) is avoided. Bus outages are likely to constrain the QNI, so may be difficult to obtain.

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.

At this stage, the key environmental constraints are considered to be:

- Operational noise due to the additional reactive plant;
- Community risks associated with the adverse response to the project;
- Potential impacts to ephemeral watercourses at Dumaresq;
- Ecology, should field surveys identify the presence of threatened species (low risk)

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.

This option is to augment the QNI capability and involves significant investment; therefore it is considered that this option will be subject to the RIT-T process.

5. Property considerations

It is not anticipated that this option will require additional property to be purchased for the substation and switching station augmentations. However, easements may need to be moved if new suspension structures are built adjacent to the existing transmission line.

6. Cost estimate

6.1 Capital Expenditure

It is estimated that this option would cost $134.347m± 25% in $2016-17 as per the following table.

Item	Cost ($m)
Upgrade of Line 83	0.04
Upgrade of Line 84	2.14
Upgrade of Line 88	20.83
Substation Works for Line Upgrades (Muswellbrook and Liddell)	1.33
Armidale Capacitors	10.66
Tamworth SVC and Capacitors (including TL diversions)	50.25
Line 82 and 8E Cutover	0.22
Turn-in of Line 85	1.87
Turn-in of Line 88	1.52
Dumaresq SVC and Capacitors	45.48
TOTAL PROJECT COST ($m)	**134.34**

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 -4	Year -3	Year -2	Year -1	Year 0
Estimated Cost– non-escalated ($m 2016-17)	134.34	1.94	4.98	29.9	47.76	49.76

Notes:

1. The detailed breakdown provided in the above table is approximate only and is based on the total scope and nature of works included in the option. Individual numbers cannot be used for estimation of other projects or to separately cost components of this estimate.
2. The cost has been estimated from a scope of work determined by a limited review of the project, as detailed in section 2.
3. The values used in the estimate were generally obtained using PS / PSE's Estimating System.
4. The estimate has an uncertainty of +/- 25%
5. "Transmission Line 330 kV Augmentation", "Substation – 330 kV Augmentation", Substation – 330kV Capacitive" and "Substation – SVC" factors have been used.
6. 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	2018-19	2019-20	2020-21	2021-22	2022-23

Nominal escalated cost ($m) *	156.13	2.06	5.44	33.69	55.14	59.80

7. Project and implementation method

The project is expected to be completed in an estimated 57 months from the issue of a Request for Project Scoping, allowing 14 months for completion of scoping studies and issue of the PAD and 43 months for project completion following issue of the PAD.

The key dates for this program are detailed below:

	Duration (Months)	End of Month
Issue of RPS	0	0
Concept Design Complete	4	4
Environmental Approval Complete	12	13
Regulatory Approval Complete	12	13
Issue PSS	12	13
Issue PAD (DG2)	1	14
Switchyard Works:		
Specification Preparation	3	17
Tender and Tender Analysis Period	3	20
Award Contract	1	21
Possession of Site	3	24
Practical Completion	6	30
SVC:		
Detailed Design/Specification Preparation	3	17
Tender and Tender Analysis Period	8	25
Award Contract	1	26
Manufacture, Delivery and Erection	30	56
In-Service Date	1	57

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

- Environmental Assessment complete;
- Concept design complete;
- Regulatory Approval progressed sufficiently so as to not prevent DG3 being reached; and
- PAD issued within one months of completion of PSS.

For this option the following key risks to the completion of project scoping and PAD issue have been identified:

a) Regulatory Approval timeframe assumes that there will be no contentious issues with the decision to proceed with this project option. If this is not the case, then obtaining the final approval could take as long as 20 months.
b) The project program is based on the assumption that the overall program will be determined by the time required to design, manufacture, install and commission two SVCs at two locations and that all other works can be delivered concurrently with the SVC design and manufacture. Staging requirements for the work may mean this is not possible.

In the event that these risks occur, project completion will be delayed and the project needs date may not be met. It is recommended that the RPS be issued with sufficient float to minimise the risk of the needs date not being met. Alternatively, contingency plans should be developed for the risk that the needs date cannot be met.

The program is based on the specific scope included in this report. If this option is combined with other options on the same site, the total project construction time frame will extend by a period that will be dependent on the availability of outages and staging of the total package of works. This should be allowed for when determining the date for issue of the RPS.

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 scoping.

Risk	Treatment
Safety Risks	
There are the normal risks associated with working on a construction project on a transmission 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 working on a construction project within a live high voltage substation.	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.
Property Risks	
There is a risk that property acquisition will be required if new transmission line structures are offset from the existing transmission line alignment.	Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures.
Community Risks	
There are the normal risks associated with the delivery of large capital projects that may impact on local communities.	Implement a Communication Strategy in accordance with TransGrid's standard policies and procedures.
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.

Risk	Treatment
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 as a result of issues detailed in Section 7 of this report.	Issue RPS with sufficient float to ensure that the needs date can be met.
System Risks	
Load connected to Muswellbrook becomes radial during an outage of either Line 88 or Line 83. Supply will be lost to Muswellbrook if there is an unplanned outage of one of these lines during a planned outage of the other line.	Plan works for periods of low load (shoulder periods) and develop interim control measures to enable short recall where possible.

9. Change History

Revision	Approver	Amendments
0	J. Howland	Initial Issue
1	J. Howland	Updated to 2016/17 dollars.

OPTION FEASIBILITY STUDY (OFS)

Reinforcement of Northern Network

OFS- 000000001529-1A revision 1.0

Option description: Upgrade Line 85 and Rebuild Line 86 on Existing Easement

Ellipse project description: P0008825
TRIM file: [TRIM No]

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Augmentation

Approvals

Author	Quazi Hossain	Project Feasibility Studies Engineer
Endorsed	Daniel Burn	Project Feasibility Studies Manager
Approved	John Howland	Manager / Portfolio Management
Date submitted for approval	29 September 2016	

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1. Request

This Option Feasibility Study is provided in response to Option Feasibility Request 1529-1A Rev 0 which requests Asset Management undertake a desktop assessment of the costs and timing associated with uprating Line 85 from 983 MVA to 1200 MVA and rebuilding Line 86 on the existing easement.

2. Considerations

2.1 Line 85 Uprating

The scope of work associated with the uprating of 85 Line from 983 MVA to 1200 MVA involves correcting low spans due to the increased operating temperature of the conductor to 120 °C. Transmission Line and Cable Design have advised where low spans will exist and the magnitude of the violation.

Back Structure Number	Ahead Structure Number	Clearance (m)	Violation (m)	Proposed Solution
6	6A	7.67	-0.33	V-Strings
6E	6F	7.47	-0.53	D-Strings
14	15	7.97	-0.03	V-Strings
20	21	6.93	-1.07	Structure Replacement
24	25	7.45	-0.55	D-Strings
27	28	7.37	-0.63	D-Strings
28	29	7.77	-0.23	V-Strings
31	32	6.41	-1.59	Structure Replacement
32	33	7.51	-0.49	Nil
33	34	7.01	-0.99	D-Strings
35	36	6.25	-1.75	Structure Replacement
36	37	6.95	-1.05	Nil
37	38	7.8	-0.2	Nil
38	39	6.97	-1.03	Structure Replacement
41	42	7.97	-0.03	V-Strings
50	51	7.51	-0.49	V-Strings
64	65	7.8	-0.2	V-Strings
65	66	7.54	-0.46	V-Strings
67	68	7.51	-0.49	V-Strings
72	73	7.77	-0.23	V-Strings
82	83	7.58	-0.42	V-Strings
83	84	7.04	-0.96	D-Strings
97	98	7.96	-0.04	V-Strings
111	112	7.99	-0.01	V-Strings
112	113	7.51	-0.49	V-Strings
120	121	7.47	-0.53	D-Strings
123	124	7.79	-0.21	V-Strings
126	127	7.77	-0.23	V-Strings
130	131	7.76	-0.24	V-Strings
131	132	7.76	-0.24	V-Strings

Back Structure Number	Ahead Structure Number	Clearance (m)	Violation (m)	Proposed Solution
133	134	6.86	-1.14	Structure Replacement
134	135	7.11	-0.89	Nil
135	136	6.96	-1.04	Structure Replacement
136	137	7.44	-0.56	Nil
142	143	7.84	-0.16	V-Strings
149	150	6.13	-1.87	Structure Replacement
151	152	7.96	-0.04	V-Strings
162	163	7.72	-0.28	V-Strings
172	173	7.77	-0.23	V-Strings
177	178	7.97	-0.03	V-Strings
178	179	7.79	-0.21	V-Strings
182	183	7.9	-0.1	Nil
183	184	6.58	-1.42	Structure Replacement
184	185	7.98	-0.02	V-Strings
203	204	7.96	-0.04	V-Strings
206	207	7.37	-0.63	D-Strings
216	217	6.44	-1.56	Structure Replacement
218	219	6.09	-1.91	Structure Replacement
220	221	7.12	-0.88	D-Strings
224	225	6.91	-1.09	Structure Replacement

In order to determine the appropriate remediation measure the following assumptions have been made:

Criteria	Solution	Qnty
Violation less than 0.5m	V-string insulators required on both structures of the span.	25
Violations between 0.5m and 1.0m	D-string insulator installation on both structures of the span.	8
Violations greater than or equal to 1.0 m	Replace the existing suspension structure with a two concrete pole H-frame structure.	11

It should be noted that the replacement of one structure will generally remove all violations on either side of the new structure so the requirement for V-strings or D-strings on these spans will be removed.

2.1.1 V-string Insulator Arrangement

It is proposed that where clearance violations do not exceed 0.5m that inverted V-string insulator arrangements can be installed to raise the conductor height.

2.1.2 D-String Insulator Arrangement

Standard drawing TL-183232 indicates that insulators at suspension towers will be a minimum of 3m long. By removing most of the porcelain disk insulators and installing a D-string arrangement, as per drawing TL-613975, the suspension insulator arrangement can be shortened by up to 1.9m at the suspension structure. Generally, D-strings are used for clearance violations between 0.5 m and 1.0 m.

2.1.3 Transmission Tower Modifications

Where a clearance violation is greater than 1.0m, more onerous remediation measures must be investigated. It is anticipated that the required conductor height will be achieved by replacing the existing suspension structure with a two pole concrete H-frame structure.

Concrete poles will be jointed structures to allow pole bases to be installed prior to the erection of the main structure and cut-over of conductors. Pole structures will be erected as close as possible to the centreline of the existing transmission line route to minimise the impact to the transmission line design and construction.

2.2 Line 86 Rebuild

Line 86 is currently a 330 kV transmission line with a route length of 111 km. The first 3.7 km from Tamworth 330 kV substation is of double circuit steel lattice tower construction, with the majority of the transmission line being two pole H-frame construction.

It is anticipated that the scope of work to rebuild the 86 Line will exclude the double circuit steel lattice tower section and that the new transmission line will be two concrete pole H-frame construction.

A more comprehensive discussion of factors influencing the construction work can be found in OFS 1555B.

3. Outage requirements

All insulator replacements and construction works can be carried out with daily outages. The rebuild of 86 Line would require:

- New concrete H-frame structures to be built adjacent to the existing wood pole structures;
- New concrete pole butts are to be installed prior to attaching the remainder of the concrete pole and crossarm; and
- Conductor to be restrung during daily outages and re-energised on the sheaves.

System Operations have advised that daily outages are available on 85 and 86 Lines during the autumn and spring shoulder periods provided that short recall times are achievable and the line is made available at night.

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

It is not anticipated that any new property will be required, however there is a risk that new access track or the upgrade of existing access tracks will require new access rights to be negotiated.

Where new structures are erected adjacent to the existing Line, the easement may need to be shifted accordingly.

6. Cost estimate

6.1 Capital Expenditure

It is estimated that this option would cost $70.48m ± 25% in $2016-17 as per the following table.

Item	Cost
Line 85 Uprating	$4.56m
Line 86 Rebuild	$65.92m
TOTAL PROJECT COST ($m)	**70.48**

The expected expenditure profile for this project based on a standard spending curve distribution is as follows:

	Total Project Base Cost	Year -4	Year -3	Year -2	Year -1	Year 0
Estimated Cost– non-escalated ($m 2016-17)	70.48	0.37	0.4	1.19	3.17	65.35

Notes:

1. The detailed breakdown provided in the above table is approximate only and is based on the total scope and nature of works included in the option. Individual numbers cannot be used for estimation of other projects or to separately cost components of this estimate.
2. The cost has been estimated from a scope of work determined by a limited review of the project, as detailed in section 2.
3. The values used in the estimate were generally obtained using PS / PSE's Estimating System
4. 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.
5. The estimate has an uncertainty of +/- 25%.
6. '330kV Augmentation' factors have been used.
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	2018-19	2019-20	2020-21	2021-22	2022-23
Nominal escalated cost ($m) *	85.47	0.4	0.4	1.8	3.8	78.4

7. Project and implementation method

The project is expected to be completed in an estimated 52 months from the issue of a Request for Project Scoping, allowing 20 months for completion of scoping studies and issue of the PAD and 32 months for project completion following issue of the PAD.

The key dates for this program are detailed below:

	Duration (Months)	End of Month
Issue of RPS	0	0
Concept Design Complete	4	4
Environmental Approval Complete	12	14

Regulatory Approval Complete	20	20
Issue PSS	4	18
Issue PAD (DG2)	2	20
Advertise Specification Call Tenders	3	23
Contract Award	4	27
Possession of Site	4	31
Practical Completion	21	52
In-Service Date	0	52

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

- Environmental Approval complete;
- Concept design, including transmission line route plan and line schedule complete;
- Regulatory Approval processes complete;
- PAD issued within two months of completion of PSS.

For this option the following key risks to the completion of project scoping and PAD issue have been identified:

a) Environmental approval of the project assumes that significant community opposition to the project will not be encountered. Should significant opposition be encountered, delays of up to 6 months could occur.

b) Property acquisition may require some level of compulsory acquisition. The timing of this acquisition is subject to both completion of the environmental approval process and approval to progress to the stage of compulsory acquisition. Further delays could be experienced in this process which may delay Possession of Site for parts of the route. This risk is considered unlikely to occur due to the float allowed in the program.

c) The project scoping period is dependent on completion of the Regulatory Approval process. Delays in this approval will impact on project completion.

d) The program is dependent on outages of the existing line for construction. These outages are dependent on system conditions and can be cancelled if the line is required in service to meet supply needs. This can significantly extend the construction period. Delays can also occur as a result of periods of wet weather coinciding with times when outages are possible for work. It is considered possible that delays to the program will occur as a result of one or both of these factors.

e) These line outages can be recalled in 2-4 hours and are not allowed during summer or winter. During these periods, outages will be put on hold and it is expected that the project will be suspended for 3 months. It has been considered in the risk for this project.

Transmission line works programs are inherently uncertain until such time as detailed studies and community consultation processes are completed. Accordingly it is likely that delays may occur to this project that result in a program that varies from that detailed above.

It is recommended that the RPS be issued with at least six months float to minimise the risk of the needs date not being met. Alternatively, contingency plans should be developed for the risk that the needs date cannot be met.

The program is based on the specific scope included in this report. If this option is combined with other options on the same site, the total project construction time frame will extend by a period that will be dependent on the availability of outages and staging of the total package of works. This should be allowed for when determining the date for issue of the RPS.

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 scoping.

Risk	Treatment
Safety Risks	
There are the normal risks associated with working on a construction project 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.
There are risks associated with disturbing and/or adversely impacting on flora and fauna, heritage sites and water courses along the transmission line.	Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures.
Property Risks	
There is a risk that easement acquisition will be required for this project.	Conduct an Environmental Assessment of Project in accordance with TransGrid's standard policies and procedures.
Community Risks	
There are the normal risks associated with the delivery of large capital projects that may impact on local communities.	Implement a Communication Strategy in accordance with TransGrid's standard policies and procedures.
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 as a result of issues detailed in Section 7 of this report.	Issue RPS with sufficient float to ensure that the needs date can be met.

9. Change History

Revision	Approver	Amendments
0	J. Howland	Initial Issue
1	J. Howland	Updated to 2016/17 dollars.