

Options Evaluation Report (OER)

Line 11- Sydney South – Dapto – Tower Replacement
OER- 000000001600 revision 4.0

Ellipse project no(s):

TRIM file: [TRIM No]

Project reason: Capability - Asset Replacement for end of life condition

Project category: Prescribed - Replacement

Approvals

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Change history

Revision	Date	Amendment
00	23/10/2021	Initial Issue
01	15/11/2021	Minor Formatting and Update to Appendix B table
02	21/10/2022	<ul style="list-style-type: none">Update analysis and evaluation including:Update cost and risk with FY22 valuesUpdate on discount ratesAmendment of environmental disproportionality factorRemoval of reputational risk
03	31/10/2022	<ul style="list-style-type: none">Update Revision numbering
04	1/11 2022	<ul style="list-style-type: none">Update Revision numbering

Executive summary

Line 11 is a single circuit steel tower 330kV transmission line between Dapto and Sydney South Substations, with a route length of 68km. There are 154 structures on this single circuit line including 129 suspension towers and 25 tension towers. The line is a key link in the Sydney South coastal region, and its route traverses urban areas near the substations, bushland in the Illawarra Escarpment, Sydney Water Catchment and National Park areas and also crosses the Princes Motorway (M1) at several locations.

Line 11 is considered to have the highest level of corrosion among TransGrid's transmission lines and has a history of corrosion related defects affecting tower members, conductor/earthwire fittings, insulators and fasteners (nuts and bolts). A refurbishment project was completed in early 2018 on tension towers in line with the strategy to refurbish tension towers prior to steel loss and end of life and replace suspension structures at end of life. This need focuses on the suspension structures which are at the end of life.

Detailed analysis of asset condition information has identified that Line 11 have several condition issues which require refurbishment/replacement to address its health and maintain appropriate risk levels across the network.

The total number of suspension structures to be replaced is 55. This includes the replacement of 10km of earthwire and 68 km of conductor.

The main drivers of the need to remediate these issues are:

- Manage network safety risk levels “As-Low-As Reasonably-Practicable” in accordance with the regulation obligations and TransGrid's business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 ‘A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe’; and
- Provide economic benefit to consumers through reduction in reliability, safety and bushfire risks

The assessment of the options considered to address the need/opportunity appears in Table 1.

Table 1 - Evaluated options

Option	Description	Direct capital cost (\$m)	Network and corporate overheads (\$m)	Total capital cost ¹ (\$m)	Weighted NPV (PV, \$m)	Rank
Option A	Replace 55 suspension structures identified as highest risks with concrete or steel poles Refurbish the line components on the other remaining structures that have been identified as having condition issues	35.44	1.72	37.16	122.71	4

¹ Total capital cost is the sum of the direct capital cost and network and corporate overheads. Total capital cost is used in this OER for all analysis.

Option B	Replace all suspension structures with concrete or steel poles except Structures 30 and 129 Refurbish the line components on the other remaining structures that have been identified as having condition issues	74.1	3.61	77.71	207.24	3
Option C	Replace all suspension structures with concrete or steel poles except Structures 30 and 129 Replace the existing conductors on the line with twin Olive ACSR/GZ Replace all conductor components, hardware, fittings and insulators Refurbish the line components on the other remaining structures that have been identified as having condition issues	88.4	3.99	92.39	258.09	2
Option D	Replace 55 suspension structures identified as highest risk with concrete or steel poles Replace all conductor components, hardware, fittings and insulators	57.0	2.56	59.56	258.66	1

Option C and Option D provide similar NPV result (within 0.3%). Based on the commercial analysis, Option D is the preferred option as it yields the highest weighted NPV and is technically and commercially feasible. The main driver of the benefit in the NPV is bushfire risk benefit.

Option D will require the remaining suspension structures to be remediated at later stage beyond the 2024-2028 Regulatory Period. Due to uncertainty around the investment on the remaining structures, the re-investment of remaining structures have been excluded and will be subject to a subsequent RIT-T close to the time.

Note: Including the re-investment within 15 years of the analysis period will result in Option C (replacement of all suspension structures and conductor) to be the preferred option (within 1% of Option D).

It is therefore recommended that the option be scoped in detail and progressed from DG1 to DG2. In consideration of the delivery requirements and the economic benefit NPV analysis for the need, its optimal timing is 2027/2028.

1. Need/opportunity

Line 11, between Dapto and Sydney South substations, form a key link in the Sydney South coastal region. Its route traverses urban areas near the substations, bushland in the Illawarra Escarpment, Sydney Water Catchment and National Park areas and also crosses the Princes Motorway (M1) at several locations. Constructed in 1962, there are 154 structures on this single circuit line:

- > 129 suspension towers
- > 25 tension towers

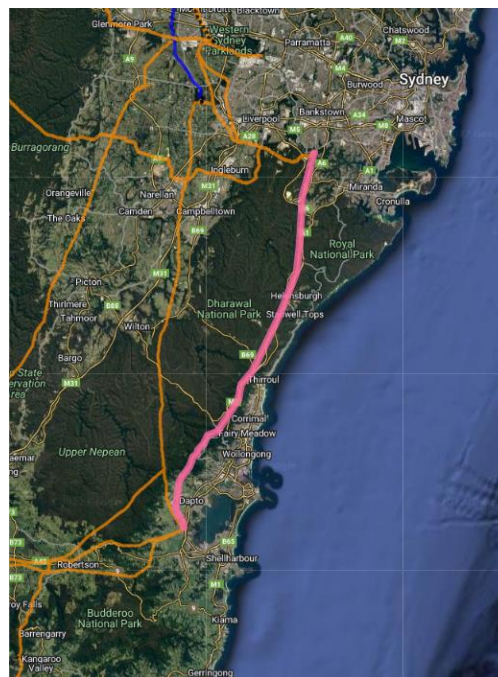


Figure 1 – Line 11 Dapto to Sydney South Location

Being near to the coast, 67% of structures on Line 11 is located in C4 category (High Corrosion area) and 33% of structures on Line 11 are located in C3 category (Medium Corrosion area). Due to its location, Line 11 is considered to have the highest level of corrosion among TransGrid's transmission lines and has a history of corrosion related defects affecting tower members, conductor/earthwire fittings, insulators and fasteners (nuts and bolts).

A refurbishment project was completed in early 2018 on tension towers in line with the strategy to refurbish tension towers prior to steel loss and end of life and replace suspension structures at end of life. This need focuses on the suspension structures which are at end of life. Detailed analysis of asset condition information have identified that 153 of the 154 structures and/or other components on the single circuit portion of Line 11 have condition issues, all of which increase the probability of asset failure. This presents a bushfire and safety risk which TransGrid is obligated to manage.

Line 11 transmission line crosses major motorways, public spaces and bushland on the urban fringe. 94% of structures on Line 11 are located in bushfire prone area. Due to its location on bushland and urban fringe, the bushfire consequence risk on line 11 is one of the highest on Transgrid's network which Transgrid is obligated to manage.

Suspension Towers

All 127 suspension towers on Line 11 have been identified as having condition issues with the structure and/or other components. Of these, 55 towers have been identified as having priority condition issues, that is, the tower has one or more members that have been identified as having a condition issue with the worst possible ratings.

Figure 2 – Photos of Deterioration of structures



It should be noted that suspension Towers 30 and 129 have been assessed to have prohibitive access at their locations, and accordingly deemed as unable to be practicably replaced. These were painted as part of the tension tower refurbishment project to extend the life of the steelwork.

The most significant element of concern is the condition of the conductor fittings, earthwire fittings and corona rings due to corrosion. These items generally had a significantly thinner layer of galvanising at the time of manufacturing compared with other steelwork on the tower. Fasteners also have no galvanising on the nut thread. Failure of these fitting attachments can result in fallen conductors.

Conductor Issues

Conductor condition issues have been identified and discussed under Needs N2595 and N2396. Smart Aerial Image Processing (SAIP) inspections carried out in 2020 have identified multiple issues with conductor along several spans on the line, including broken strands and the presence of possible conductor corrosion (indicated by bulging, visible white product, and discolouration of the conductor).

Deterioration of conductor can compromise mechanical capacity and overheating which can lead to conductor failure.

In consideration of the refurbishment works proposed under this need, there may be advantages in performing the works under a combined package, and accordingly, options have been considered under this need to address the conductor condition issues.

There is a need to remediate these issues to:

- Manage network safety risk levels “As-Low-As Reasonably-Practicable” in accordance with the regulation obligations and TransGrid’s business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 ‘A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe.’

- Provide an economic benefit to consumers through reductions in reliability, safety and bushfire risks. The direct impact of asset failure can result in fallen structure and/or conductor event with potential fire ignition and/or safety hazard consequences to the general public, as evaluated in the associated modelling. Line 11 is one of the highest bushfire consequence location.

If the condition issues on the line are not addressed in sufficient time, then the asset will operate with increasing risk of failure as it continues to deteriorate. The level of reactive corrective maintenance needed to keep the line operating within required standards may also increase, particularly when asset failures ultimately occur.

Appendix B provides a summary of the condition issues by asset component category, including the issues identified on Structures 30 and 129.

2. Related needs/opportunities

- Need N2493: Line 76/77 Refurbishment
- Need N2476: Line 12/76 Refurbishment
- Need N2474: Line 13/78 Refurbishment

3. Options

The base case for this assessment is a 'do nothing' scenario, where the assets are left in service until they fail and require replacement. In addition to the base case, three remediation options have been considered. These are:

- **Option A**
 - Replace all suspension structures on the line that have been identified as highest risk structures (55 towers) with concrete or steel pole structures, including all relevant hardware and attachments
 - Remediate line components on suspension structures 30 and 129 only that have identified condition issues based on the latest Transmission Line Refurbishment Criteria document
 - Identified conductor spacer and aerial marker condition issues across all spans, are to be addressed as per Transmission Line Refurbishment Criteria document
- **Option B**
 - Replace all suspension structures on the line with concrete or steel pole structures with the exception on Structures 30 and 129, including all relevant hardware and attachments
 - Remediate line components on suspension structures 30 and 129 only that have identified condition issues based on the latest Transmission Line Refurbishment Criteria document
 - Identified conductor spacer and aerial marker condition issues across all spans, are to be addressed as per Transmission Line Refurbishment Criteria document
- **Option C**
 - Replace all suspension structures on the line with concrete or steel pole structures with the exception on Structures 30 and 129, including all relevant hardware and attachments
 - Replace existing conductor with twin Olive equivalent conductor

- Replace all conductor components, hardware and fittings, including insulators
- Remediate any other line components with identified condition issues that have not been addressed as part of the above, as per the latest Transmission Line Refurbishment Criteria document

- **Option D**

- Replace all suspension structures on the line that have been identified as highest risk structures (55 towers) with concrete or steel pole structures, including all relevant hardware and attachments
- Replace existing conductor with twin Olive equivalent conductor
- Replace all conductor components, hardware and fittings, including insulators
- Remediate any other line components with identified condition issues that have not been addressed as part of the above, as per the latest Transmission Line Refurbishment Criteria document

3.1. Base case

It is noted that a 'run to fail' scenario, where the issues are addressed through increased asset monitoring and preventative maintenance tasks, is not a valid base case for this Need. The condition issues on the asset have already been identified through maintenance inspections, and increasing the frequency of inspections to monitor the condition issues will not necessarily address them.

The base case will instead be defined as a 'do nothing' scenario, where the assets are left in service until they fail and require replacement. The replacement cost has been captured in the NPV assessment under financial risk cost.

3.2. Options evaluated

Option A — Replace 55 suspension structures identified as highest risk with concrete or steel poles. Refurbish the line components on the other remaining structures that have been identified as having condition issues. [[NOSA N1600](#), [OFS N1600A](#)]

It is estimated that this option would cost \$37.16 million ± 25% (\$2021-22). This includes the replacement of 10km of earthwire. This option is expected to be completed within 33 months following DG1.

Option B — Replace all suspension structures with concrete or steel poles except Structures 30 and 129. Refurbish the line components on the other remaining structures that have been identified as having condition issues. [[NOSA N1600](#), [OFS N1600B](#)]

The total number of suspension structures to be replaced is 127. This includes the replacement of 10 km of earthwire.

It is estimated that this option would cost \$77.71 million ± 25% (\$2021-22). This option is expected to be completed within 43 months following DG1.

Option C — Replace all suspension structures with concrete or steel poles except Structures 30 and 129. Replace the existing conductors on the line with twin Olive ACSR/GZ. Replace all conductor components, hardware, fittings and insulators. Refurbish the line components on the other remaining structures that have been identified as having condition issues. [[NOSA N1600](#), [OFS N1600C](#)]

The total number of suspension structures to be replaced is 127. This includes the replacement of 10 km of earthwire and 68 km of conductor. This option will provide the delivery efficiency through single mobilisation whilst reducing the bushfire and safety risks.

It is estimated that this option would cost \$92.39 million ± 25% (\$2021-22). This option is expected to be completed within 49 months following DG1.

Option D — Replace 55 suspension structures identified as highest risk structures with concrete or steel poles. Replace the existing conductors on the line with twin Olive ACSR/GZ. Replace all conductor components, hardware, fittings and insulators. Refurbish the line components on the other remaining structures that have been identified as having condition issues. [NOSA N1600, OFS N1600A, OFS N2396A]

The total number of suspension structures to be replaced is 55. This includes the replacement of 10 km of earthwire and 68 km of conductor.

This option will require the remaining suspension structures to be remediated at later stage beyond the 2024-2028 Regulatory Period. Due to uncertainty around the investment on the remaining structures, the re-investment of remaining structures have been excluded and will be subject to a subsequent RIT-T close to the time.

It is estimated that this option would cost \$59.56 million ± 25% (\$2021-22).

3.3. Options considered and not progressed

The following options were considered but not progressed:

Table 2 – Options considered and not progressed

Option	Reason for not progressing
Increased inspections	The condition issues have already been identified and cannot be rectified through increased inspections.
Elimination of all associated risk	This can only be achieved through retirement and decommissioning of the associated assets which is not feasible as transfer capacity of line 11 is needed in this part of the network.
Non-network solutions	TransGrid will invite proposals for potential non-network solutions as part of the RIT-T process.

4. Evaluation

4.1. Commercial evaluation methodology

The economic assessment undertaken for this project includes three scenarios that reflect:

- A central set assumptions based on current information that is most likely to eventuate (central scenario);
- A set of assumptions that give rise to a lower bound for net benefits (lower bound scenario); and
- A set of assumptions that give rise to an upper bound on benefits (higher bound scenario).

Assumptions for each scenario are set out in the Table 3 below.

Table 3 Scenario parameters

Parameter	Central scenario	Lower bound scenario	Higher bound scenario
Discount rate	5.5%	7.5%	2.3%
Capital cost	100%	125%	75%
Risk cost benefits	100%	75%	125%
Scenario weighting	50%	25%	25%

Parameters used in this commercial evaluation:

Table 4 Key parameters

Parameter	Parameter Description	Value used for this evaluation
Discount year	Year that dollar values are discounted to	2021/2022
Base year	The year that dollar value outputs are expressed in real terms	2021/2022 dollars
Period of analysis	Number of years included in economic analysis with remaining capital value included as terminal value at the end of the analysis period.	25 years
Expected asset life	Period of depreciation of the asset	50 years
ALARP disproportionality	Multiplier of the environmental and safety related risk cost included in NPV analysis to demonstrate implementation of obligation to reduce to ALARP.	Refer to section 4.3 for details.

The capex figures in this OER do not include any real cost escalation.

4.2. Commercial evaluation results

The commercial evaluation of the technically feasible options is set out in Table 5. Details appear in Appendix A.

Table 5 - Commercial evaluation (PV, \$ million)

Option	Capital Cost PV	Central scenario NPV	Lower bound scenario NPV	Higher bound scenario NPV	Weighted NPV	Ranking
Option A	27.02	98.56	37.96	25.76	122.71	4
Option B	57.20	164.29	55.88	444.50	207.24	3
Option C	69.75	204.52	69.44	553.88	258.09	2
Option D	45.51	208.55	85.12	532.42	258.66	1

Option C and Option D provide similar NPV result (within 0.3%). Based on the commercial analysis, Option D is the preferred option as it yields the highest weighted NPV and is technically and commercially feasible. The main driver of the benefit in the NPV is bushfire risk benefit.

Option D will require the remaining suspension structures to be remediated at later stage beyond the 2024-2028 Regulatory Period. Due to uncertainty around the investment on the remaining structures, the re-investment of remaining structures have been excluded and will be subject to a subsequent RIT-T close to the time.

Note: Including the re-investment within 15 years of the analysis period will result in Option C (replacement of all suspension structures and conductor) to be the preferred option (within 1% of Option D).

4.3. ALARP evaluation

TransGrid manages and mitigates bushfire and safety risk to ensure they are below risk tolerance levels or 'As Low As Reasonably Practicable' ('ALARP'), in accordance with the regulation obligations and TransGrid's business risk appetite. Under the Electricity Supply (Safety and Network Management) Regulation 2014 Section 5 'A network operator must take all reasonable steps to ensure that the design, construction, commissioning, operation and decommissioning of its network (or any part of its network) is safe.' TransGrid maintains an Electricity Network Safety Management System (ENSMS) to meet this obligation.²

In its Network Risk Assessment Methodology, under the ALARP test with the application of a gross disproportionate factor³, the weighted benefits are expected to exceed the cost. TransGrid's analysis concludes that the costs are less than the weighted benefits from mitigating bushfire and safety risks. The proposed investment will enable TransGrid to continue to manage and operate this part of the network to a safety and risk mitigation level of ALARP.

Evaluation of the above options has been completed in accordance with As Low As Reasonably Practicable (ALARP) obligations. The Network Safety Risk Reduction is calculated as 1 x Bushfire Risk Reduction (Non-Safety Bushfire Risk) + 6 x Safety Risk Reduction (Public Safety and Bushfire Safety) + 0.1 x Reliability Risk Reduction.

Results of the ALARP evaluation are set out in Table 6.

Table 6 - Reasonably practicable test (\$ million)

Option	Network Safety Risk Reduction	Annualised Capex	Reasonably Practicable? ⁴
A	8.19	2.19	Y
B	13.47	4.59	Y
C	16.56	5.46	Y
D	15.17	3.52	Y

The result of the ALARP evaluation is that all three options meet the ALARP threshold.

² TransGrid's ENSMS follows the International Organization for Standardization's ISO31000 risk management framework which requires following hierarchy of hazard mitigation approach

³ The values of the disproportionality factors were determined through a review of practises and legal interpretations across multiple industries, with particular reference to the works of the UK Health and Safety Executive. The methodology used to determine the disproportionality factors in this document is in line with the principles and examples presented in the AER Replacement Planning Guidelines and is consistent with TransGrid's Revised Revenue Proposal 2023/24- 2027/28.

⁴ Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction.

4.4. Preferred option

The preferred option is Option D, as it has the highest weighted NPV result of all the technically feasible options considered as part of this need. Option D also meets the ALARP threshold. The optimal delivery date for this option is 2027/2028 based on an optimal timing analysis (see Section 5) and taking into account the delivery and outage constraint of the project.

Capital and Operating Expenditure

The required capex expenditure is \$59.56 million (\$2021-22).

Regulatory Investment Test

A regulatory investment test for transmission (RIT-T) is required as the estimated capital cost for the preferred option is above the threshold of \$6 million.

5. Optimal Timing

In consideration of the delivery requirements and the economic benefit NPV analysis for the need, its optimal timing is 2027/2028

The test for optimal timing of the preferred option has been undertaken. The approach taken is to identify the optimal commissioning year for the preferred option where net benefits (including avoided risk costs and safety disproportionality tests) of the preferred option exceeds the annualised costs of the option. The optimal timing assessment considers the delivery requirements of the project and the estimated delivery timeline of two years in the OFS.

The commencement year is determined based on the required project disbursement to meet the commissioning year based on the OFS.

The results of optimal timing analysis is:

Optimal commissioning year: 2027/2028
 Commissioning year annual benefit: \$15.44 million
 Annualised cost: \$3.52 million

Based on the optimal timing, the project is expected to be completed in the 2024-2028 Regulatory Period.

6. Recommendation

The preferred option is Option D, as it has the highest weighted NPV result of all the technically and commercially feasible options considered as part of this need.

Option D will require the remaining suspension structures to be remediated at later stage beyond the 2024-2028 Regulatory Period. Due to uncertainty around the investment on the remaining structures, the re-investment of remaining structures have been excluded and will be subject to a subsequent RIT-T close to the time.

It is therefore recommended that this option be scoped in detail, so that it can be progressed from DG1 to DG2. Total project cost is \$59.56 million (\$2021-22), including an amount of \$2.0 million to progress the project from DG1 to DG2.

Appendix A – Option Summaries⁵

Project Description		Line 11 Replacement	
Option Description	Option A - Replace 55 suspension structures identified as having priority condition issues with concrete or steel poles		
Project Summary			
Option Rank	4	Investment Assessment Period	25
Asset Life	50	NPV Year	2022
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, \$m)	98.56	Annualised CAPEX @ Central Benefit Scenario (\$m)	Annualised Capex - Standard (Business Case) 2.19
NPV @ Lower Bound Scenario (PV, \$m)	37.96	Network Safety Risk Reduction (\$m)	Network Safety Risk Reduction 8.19
NPV @ Higher Bound Scenario (PV, \$m)	255.76	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, \$m)	122.71	Optimal Timing	Optimal timing (Business Case) 2028
Cost (Central Scenario)			
Total Capex (\$m)	37.16	Cost Capex (PV,\$m)	27.02
Terminal Value (\$m)	18.58	Terminal Value (PV,\$m)	3.53
Risk (Central Scenario)	Pre	Post	Benefit
Reliability (PV,\$m)	Reliability Risk (Pre) 0.00	Reliability Risk (Post) 0.00	Pre – Post 0.00
Financial (PV,\$m)	Financial Risk (Pre) 7.65	Financial Risk (Post) 6.29	Pre – Post 1.36
Operational/Compliance (PV,\$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (Public Safety + Bushfire Safety) (PV,\$m)	Safety Risk (Pre) 243.66	Safety Risk (Post) 161.78	Pre – Post 81.88
Environmental (Non-Safety Bushfire) (PV,\$m)	Environmental Risk (Pre) 119.66	Environmental Risk (Post) 80.86	Pre – Post 38.80
Reputational (\$m)	Reputational Risk (Pre) 0.00	Reputational Risk (Post) 0.00	Pre – Post 0.00
Total Risk (PV,\$m)	Total Risk (Pre) 370.97	Total Risk (Post) 248.92	Pre – Post 122.05
OPEX Benefit (PV,\$m)			OPEX Benefit 0.00
Other benefit (PV,\$m)			Incremental Net Benefit 0.00
Total Benefit (PV,\$m)			Business Case Total Benefit 122.05

Commissioning year annual benefit (\$k):

8283.6

⁵ Figures may not add due to rounding.

Project Description		Line 11 Replacement	
Option Description		Option B - Replace all suspension structures with concrete or steel poles except Structures 30 and 129	
Project Summary			
Option Rank	3	Investment Assessment Period	25
Asset Life	50	NPV Year	2022
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, \$m)	164.29	Annualised CAPEX @ Central Benefit Scenario (\$m)	Annualised Capex - Standard (Business Case) 4.59
NPV @ Lower Bound Scenario (PV, \$m)	55.88	Network Safety Risk Reduction (\$m)	Network Safety Risk Reduction 13.47
NPV @ Higher Bound Scenario (PV, \$m)	444.50	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, \$m)	207.24	Optimal Timing	Optimal timing (Business Case) 2028
Cost (Central Scenario)			
Total Capex (\$m)	77.71	Cost Capex (PV,\$m)	57.20
Terminal Value (\$m)	38.85	Terminal Value (PV,\$m)	7.39
Risk (Central Scenario)		Pre	Post Benefit
Reliability (PV,\$m)	Reliability Risk (Pre) 0.00	Reliability Risk (Post) 0.00	Pre – Post 0.00
Financial (PV,\$m)	Financial Risk (Pre) 7.65	Financial Risk (Post) 3.41	Pre – Post 4.24
Operational/Compliance (PV,\$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (Public Safety + Bushfire Safety) (PV,\$m)	Safety Risk (Pre) 243.66	Safety Risk (Post) 103.82	Pre – Post 139.84
Environmental (Non-Safety Bushfire) (PV,\$m)	Environmental Risk (Pre) 119.66	Environmental Risk (Post) 49.65	Pre – Post 70.01
Reputational (\$m)	Reputational Risk (Pre) 0.00	Reputational Risk (Post) 0.00	Pre – Post 0.00
Total Risk (PV,\$m)	Total Risk (Pre) 370.97	Total Risk (Post) 156.87	Pre – Post 214.10
OPEX Benefit (PV,\$m)			OPEX Benefit 0.00
Other benefit (PV,\$m)			Incremental Net Benefit 0.00
Total Benefit (PV,\$m)			Business Case Total Benefit 214.10

Commissioning year annual benefit (\$k):

13749

Project Description		Line 11 Replacement	
Option Description	Option C - Replace all suspension structures with concrete or steel poles except Structures 30 and 129 Replace the existing conductors on the line with twin Olive ACSR/GZ Replace all conductor components, hardware, fittings and insulators		
Project Summary			
Option Rank	2	Investment Assessment Period	25
Asset Life	50	NPV Year	2022
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, \$m)	204.52	Annualised CAPEX @ Central Benefit Scenario (\$m)	Annualised Capex - Standard (Business Case) 5.46
NPV @ Lower Bound Scenario (PV, \$m)	69.44	Network Safety Risk Reduction (\$m)	Network Safety Risk Reduction 16.56
NPV @ Higher Bound Scenario (PV, \$m)	553.88	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, \$m)	258.09	Optimal Timing	Optimal timing (Business Case) 2028
Cost (Central Scenario)			
Total Capex (\$m)	92.39	Cost Capex (PV,\$m)	69.75
Terminal Value (\$m)	46.20	Terminal Value (PV,\$m)	8.79
Risk (Central Scenario)	Pre	Post	Benefit
Reliability (PV,\$m)	Reliability Risk (Pre) 0.00	Reliability Risk (Post) 0.00	Pre – Post 0.00
Financial (PV,\$m)	Financial Risk (Pre) 7.65	Financial Risk (Post) 2.11	Pre – Post 5.54
Operational/Compliance (PV,\$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (Public Safety + Bushfire Safety) (PV,\$m)	Safety Risk (Pre) 243.66	Safety Risk (Post) 69.24	Pre – Post 174.42
Environmental (Non-Safety Bushfire) (PV,\$m)	Environmental Risk (Pre) 119.66	Environmental Risk (Post) 34.15	Pre – Post 85.51
Reputational (\$m)	Reputational Risk (Pre) 0.00	Reputational Risk (Post) 0.00	Pre – Post 0.00
Total Risk (PV,\$m)	Total Risk (Pre) 370.97	Total Risk (Post) 105.50	Pre – Post 265.48
OPEX Benefit (PV,\$m)			OPEX Benefit 0.00
Other benefit (PV,\$m)			Incremental Net Benefit 0.00
Total Benefit (PV,\$m)			Business Case Total Benefit 265.48

Commissioning year annual benefit (\$k):

16909.54

Project Description		Line 11 Replacement	
Option Description		Option D - Replace 55 Suspension Structures identified as having priority condition issues and Replace existing conductors	
Project Summary			
Option Rank	1	Investment Assessment Period	25
Asset Life	50	NPV Year	2022
Economic Evaluation			
NPV @ Central Benefit Scenario (PV, \$m)	208.55	Annualised CAPEX @ Central Benefit Scenario (\$m)	Annualised Capex - Standard (Business Case) 3.52
NPV @ Lower Bound Scenario (PV, \$m)	85.12	Network Safety Risk Reduction (\$m)	Network Safety Risk Reduction 15.17
NPV @ Higher Bound Scenario (PV, \$m)	532.42	ALARP	ALARP Compliant? Yes
NPV Weighted (PV, \$m)	258.66	Optimal Timing	Optimal timing (Business Case) 2028
Cost (Central Scenario)			
Total Capex (\$m)	59.56	Cost Capex (PV,\$m)	45.51
Terminal Value (\$m)	29.78	Terminal Value (PV,\$m)	5.66
Risk (Central Scenario)		Pre	Post Benefit
Reliability (PV,\$m)	Reliability Risk (Pre) 0.00	Reliability Risk (Post) 0.00	Pre – Post 0.00
Financial (PV,\$m)	Financial Risk (Pre) 7.65	Financial Risk (Post) 2.99	Pre – Post 4.66
Operational/Compliance (PV,\$m)	Operational Risk (Pre) 0.00	Operational Risk (Post) 0.00	Pre – Post 0.00
Safety (Public Safety + Bushfire Safety) (PV,\$m)	Safety Risk (Pre) 243.66	Safety Risk (Post) 79.61	Pre – Post 164.05
Environmental (Non-Safety Bushfire) (PV,\$m)	Environmental Risk (Pre) 119.66	Environmental Risk (Post) 39.97	Pre – Post 79.69
Reputational (\$m)	Reputational Risk (Pre) 0.00	Reputational Risk (Post) 0.00	Pre – Post 0.00
Total Risk (PV,\$m)	Total Risk (Pre) 370.97	Total Risk (Post) 122.57	Pre – Post 248.40
OPEX Benefit (PV,\$m)			OPEX Benefit 0.00
Other benefit (PV,\$m)			Incremental Net Benefit 0.00
Total Benefit (PV,\$m)			Business Case Total Benefit 248.40

Commissioning year annual benefit (\$k):

15442.08

Appendix B – Structure with Condition Issues by Asset Category

Asset Component Category	Cause	Effect	Consequence	No. of Structures
				All Options
Conductor Dampers	Dampers are drooping.	Damaged conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	3
Conductor Fittings	Corrosion of fittings.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	21
Conductor Spacers	Corrosion of spacers.	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	104
Corona Rings	Minor repair required due to missing corona ring	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	16
Earthwire	Corrosion of Earthwire	Fallen conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	10
Earthwire Bonding	Poor connection and bird caging.	Possible transfer potential, earth current and voltage gradient issues	Safety incident resulting in potential injury or death	11
Earthwire damper	Damaged	Fallen Conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	1
Earthwire Fittings	Corrosion of fittings	Fallen conductor	Bushfire resulting in potential loss and property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	35

Asset Component Category	Cause	Effect	Consequence	No. of Structures
				All Options
Foundations	Corrosion on foundations and hole adjacent to foundations	Fallen structure and conductor	Bushfire resulting in potential loss and property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	2
Groundline steel	Corrosion on leg at the ground line. Deteriorated members and foundations can impact the structural integrity of the tower.	Fallen structure and conductor	Bushfire resulting in potential loss and property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	18
Insulator	Porcelain insulators have reached end of serviceable life	Fallen Conductor	Bushfire resulting in potential loss and property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	62
Public Safety – Aerial Marker Balls	Faded.	Aircraft collision with conductor.	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	3
Public Safety – Climbing Deterrents	Deteriorated	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	93
Public Safety – Danger Signs	Deteriorated	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	68
Public Safety – Structure ID signs	Deteriorated	Unauthorised access	Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	28
Structure Earthing	Poor connection	Possible transfer potential, earth current and voltage gradient issues	Safety incident resulting in potential injury or death	4
Tower Base	Corrosion of Tower members. Failure of critical members can compromise structural integrity	Fallen Structure and Conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	45

Asset Component Category	Cause	Effect	Consequence	No. of Structures
				All Options
Tower Body	Corrosion of tower members. Failure of critical members can compromise structural integrity.	Fallen structure and conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	86
Tower Crossarm	Corrosion of tower members. Failure of critical members can compromise structural integrity	Fallen structure and conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	86
Tower Fasteners	Corroded fasteners. Can compromise structural integrity.	Fallen structure and conductor	Bushfire resulting in potential loss of property and/or life Safety incident resulting in potential injury or death Line outage with potential network reliability impacts	101