RIT-D Final Project Assessment Report

Southern Macarthur Growth Area

11 October 2024

Endeavour Energy

POWER together

1.0 Executive Summary

This Final Project Assessment Report (FPAR) was prepared by Endeavour Energy in accordance with the requirements of clause 5.17.4 of the National Electricity Rules (NER).

The purpose of this report is to demonstrate the basis for selection of the preferred option to provide augmented supply to the Southern Macarthur Growth Area.

The Southern Macarthur Growth Area is located in the south-west of Sydney and includes parts of the local government areas of Campbelltown, Camden and Wollondilly. The area is supplied by a 66kV overhead network supplying four zone substations at the village townships of Appin, Maldon, Tahmoor and Wilton and also supplies several major customers in diverse business activities including mining, agriculture, water supply and building materials manufacturing.

The area is planned to grow significantly during the period up to 2040 based on the NSW Government's ***Greater Macarthur 2040 Plan***. The plan outlines the release of residential housing lots, development of new town centres and the release of employment lands. Land use zoning is being changed to support the development of the widespread increase in residential housing in the area. The 66kV electricity supply network will require augmentation to support the forecast increase in electricity demand in the area.

The major development precincts within the Southern Macarthur area include:

- The Menangle Park and Mount Gilead area to include over 15,000 new residential dwellings and 24 hectares of employment land.
- The Wilton area to include over 15,000 new residential dwellings and 300 hectares of employment land.
- The West Appin area to include over 20,000 new residential dwellings and 30 hectares of employment land.

While these developments will not fully mature until 2040 and beyond, the early stages of development will require significant augmentation to the existing electricity supply in the area. The existing 66kV supply to the area is not capable of providing the supply capacity required to support these developments.

This FPAR follows publication of an Options Screening Report and a Request For Proposal process seeking non-network options that could form a potential credible option. No proposals for non-network options were received, however a letter of support for our preferred option was received in July 2024.

Four options were determined to be credible in addressing the network need and have been assessed in comparison to a 'do nothing' (or no proactive intervention) base case. These are:

- Option 1 - Establishment of a 66kV feeder connecting Nepean TS to 85J.
- Option 2 - Establishment of a 66kV feeder connecting Nepean TS to 85J via a deviation to Menangle Park.
- Option 3 – Establishment of a 66kV feeder connecting Macarthur BSP to 85J.
- Option 4 – Augment the existing 66kV feeders 851 and 852.

The 'do nothing' option is not considered credible because it will result in significant expected unserved energy in the Southern Macarthur area and would not support the NSW Government's growth plans, particularly the residential housing development plans.

Three of the options provide the establishment of a new 66kV feeder connecting to the existing feeder 85J and provide an augmented supply to the Southern Macarthur area by providing an additional path for 66KV from the north and into the southern area. One network option involves the augmentation of two existing 66kV feeders to increase their supply capacity.

The economic assessment of the credible options is shown in Table 1. Under the NER, the preferred option is the credible option that maximises the present value of the net economic benefit to all those who produce, consume or transport electricity in the National Electricity Market (NEM).

Applying this criteria, Option 1 is the preferred option at this final stage because it has the highest net market benefits. Option 1 is also the lowest cost option.

Scenario analysis has been undertaken based on three demand forecast scenarios. Sensitivity analysis has been undertaken across a range of assumptions including the discount rate, value of customer reliability (VCR) and capital expenditure. The scenario and sensitivity analysis has confirmed Option 1 as the preferred option.

Table 1 – Economic assessment of credible options (using the central demand forecast scenario)

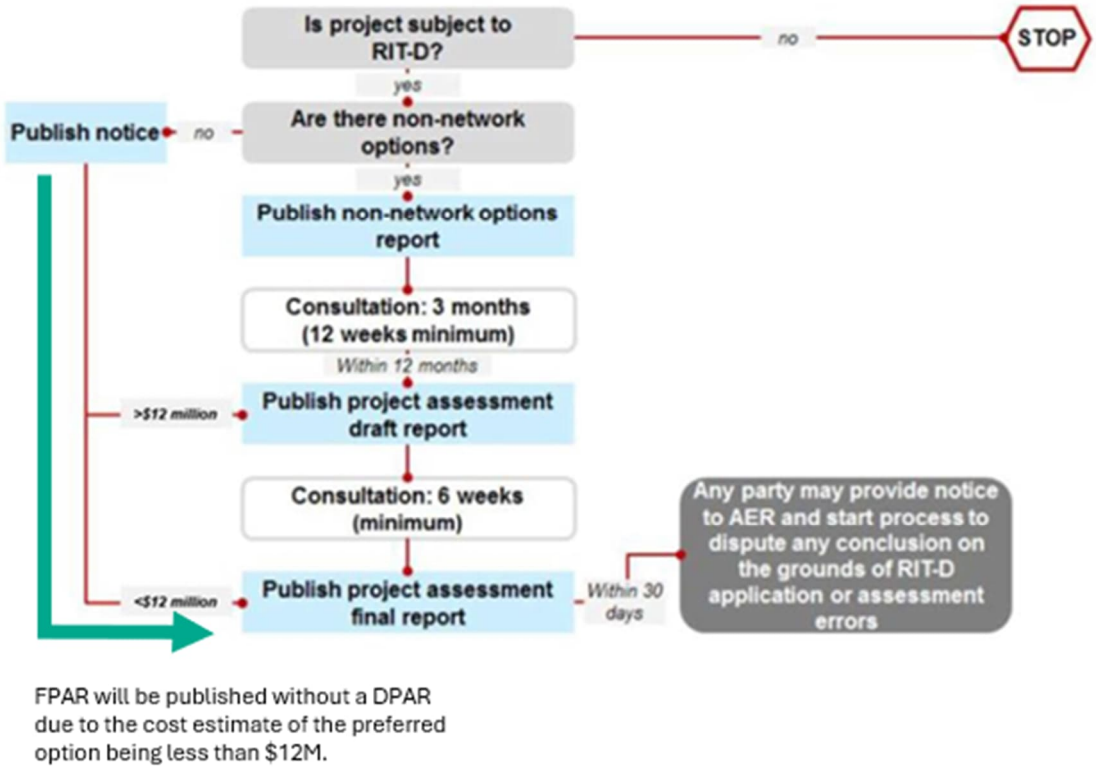
Option	Description	Project capex nominal ($M)	PV of market benefits ($M)	PV of costs ($M)	NPV ($M)	Rank
1	Establishment of a 66kV Feeder from Nepean TS to 85J.	7.5	466.3	6.2	460.1	1
2	Establishment of a 66kV Feeder from Nepean TS to 85J and include a deviation to the Menangle Park ZS.	10.5	466.3	8.7	457.6	2
3	Establishment of a 66kV Feeder from Macarthur BSP to 85J.	14.0	466.3	11.6	454.7	3
4	Augment existing 66kV Feeders 851 and 852.	20.0	222.4	16.6	205.8	4

2.0 RIT-D Process

This Final Project Assessment Report has been prepared by Endeavour Energy in accordance with the requirements of clause 5.17 of the NER and represents the final step in the RIT-D process to determine the most efficient means of providing augmented supply to the Southern Macarthur Growth Area. The RIT-D process is summarised in Figure 1 below.

The preferred option has a cost estimate of less than $12M and according to the NER, no DPAR is required.

Figure 1 – Overview of the RIT-D process



2.1 Completion of the RIT-D process

This FPAR represents the final stage of the consultation process in relation to the application of the RIT-D process undertaken by Endeavour Energy regarding providing augmented supply to the Southern Macarthur growth area. It follows the publication of the Options Screening Report (Non-network Options Report) on 8 April 2024. Endeavour Energy conducted a Request for Proposal process from April to July 2024 which used the Non-network Option Report as a set of requirements for eliciting non-network options to meet the supply needs of the area.

No proposals for non-network options were received during the three month period of the Request for Proposal being open.

Endeavour Energy did receive a letter of support for our preferred network option. This letter was from a property developer with business interests in the Menangle Park and Moreton Park Road area. Endeavour Energy appreciates the letter of support.

Due to the cost estimate of the preferred network option being below the $12M threshold identified in the NER, no Draft Project Assessment Report is required.

2.2 Contact details

All enquiries regarding this FPAR should be directed to Endeavour Energy's Portfolio Management Office at consultation@endeavourenergy.com.au.

3.0 Description of the identified need

This section provides a description of the identified need and sets out the key assumptions and methodologies that underpin the identified need for this RIT-D.

3.1 Relevant area of our network

The Southern Macarthur area is located approximately 50km south-west of Parramatta. It is south of Campbelltown and the village of Douglas Park is approximately the geographic centre of this area. We have used the place name of 'Southern Macarthur' to help represent the identified need for the supply of electricity to this area.

Figure 2 below shows the geographic location of the Southern Macarthur area for this study.

Figure 2 – Southern Macarthur in relation to Western Sydney and Parramatta

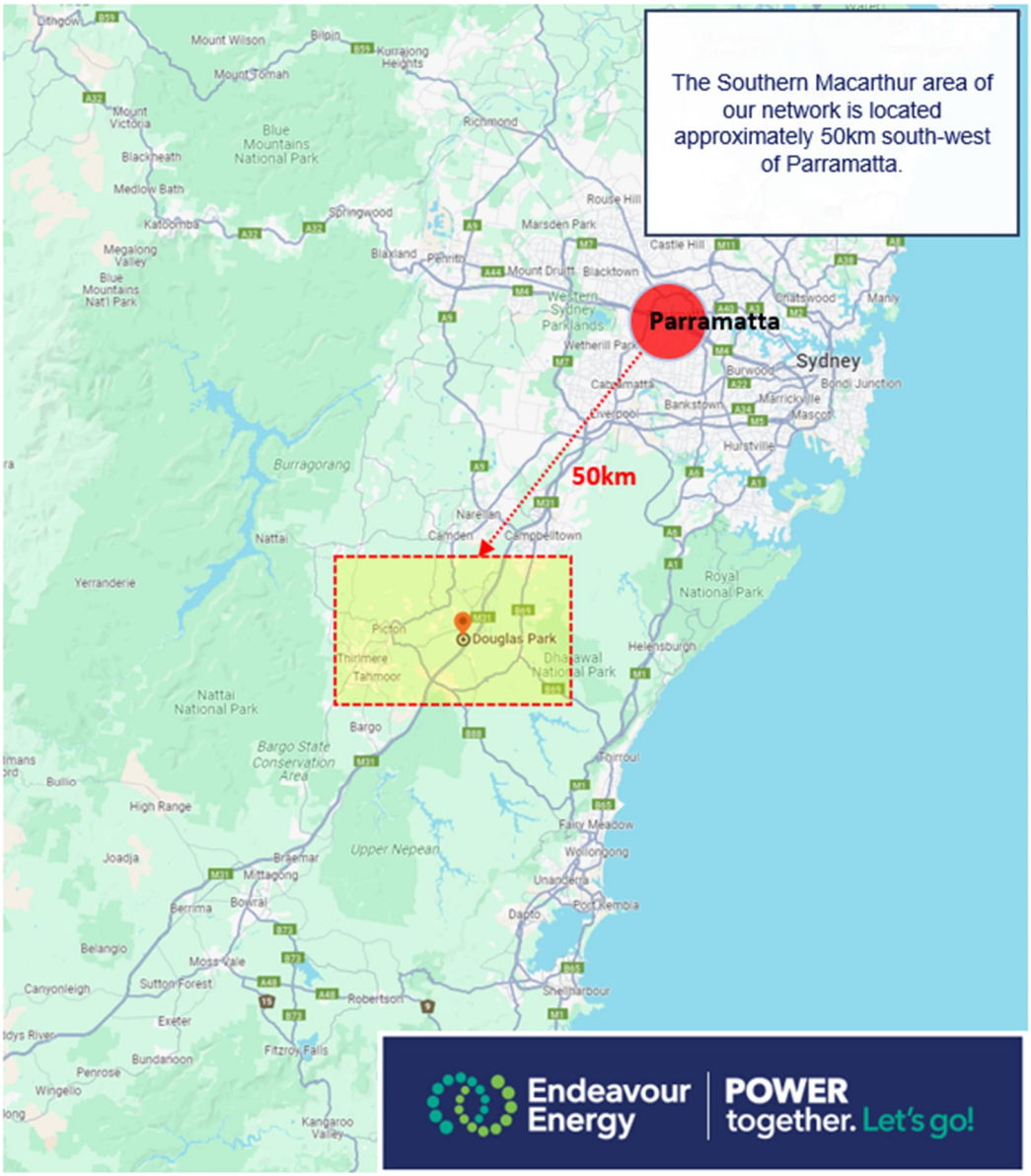
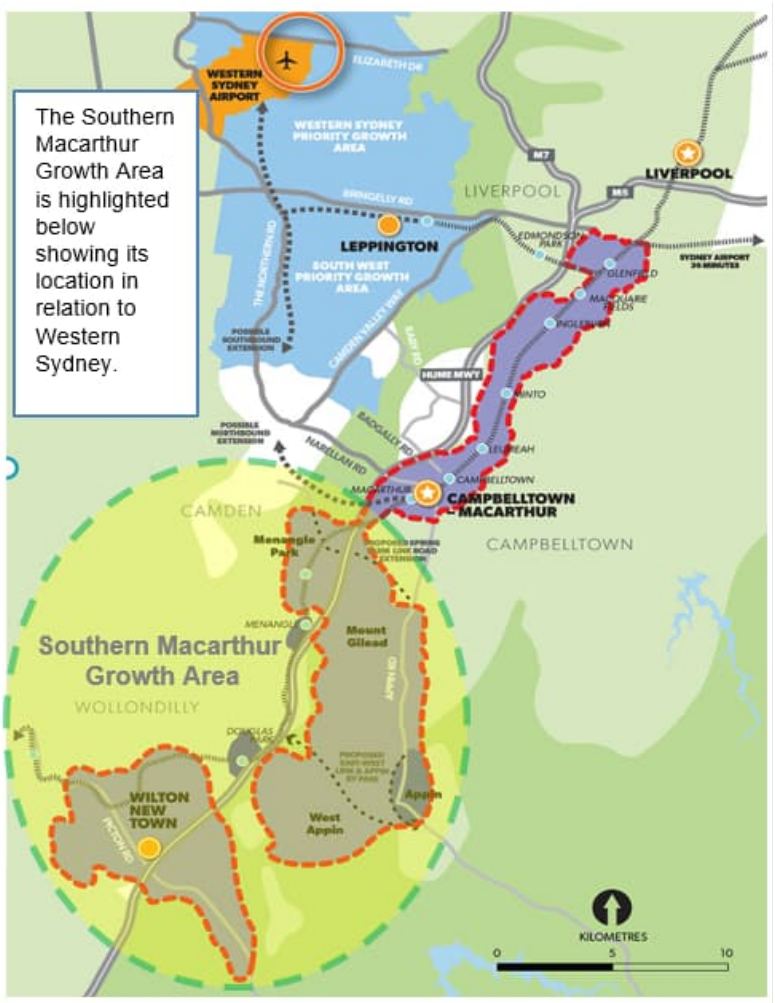


Figure 3 below shows the Southern Macarthur Growth Area and its relation to the major precincts in NSW Planning's 2040 plan for the Greater Macarthur area. The Menangle Park, Appin and Wilton areas will see major development that will transform the existing rural residential villages into town centres with large new developments of residential dwellings.

Figure 3 – Southern Macarthur Growth Area including the precincts in the Macarthur 2040 Plan by NSW Planning



3.2 Planning Methodology

Endeavour Energy applies a probabilistic planning methodology to evaluate the customer needs and the network constraints and the value of expected unserved energy in order to determine the appropriate timing for network augmentation projects. Network constraints are analysed in terms of the load at risk, energy at risk and the expected unserved energy. The trigger for initiating network investment is based on a cost benefit analysis and compares the annualised cost of the preferred network option with the option benefits. Network augmentation is only taken further if the option benefit or the reduction in the cost of expected unserved energy outweighs the network augmentation cost required to reduce the unserved energy.

The analysis of the Southern Macarthur growth area takes into account the limited existing supply in the area and the fact that the area is mainly supplied from two 66kV overhead feeders. The Southern Macarthur area also includes embedded generation related to certain mining operations. The level of embedded generation provides supply to the area, however it is variable in nature and is not under the control of the distribution network service provider and cannot be solely relied upon to supply customers in the area.

Our planning methodology includes a thorough and conservative analysis of the demand forecast. Including the likelihood of delays in developments and the diversity of non-coincident customer maximum demand. We use three demand forecast scenarios to cover a range of outcomes to test the robustness of the planning. The optimal timing of the implementation of solution options is important to avoid being either too early or too late in meeting customer's needs and to optimise network augmentation timing for the benefit of all stakeholders.

3.3 Key assumptions underpinning the identified need

The identified need for this RIT-D is to increase the supply to the Southern Macarthur Growth Area. The area is subject to the NSW Government's "Greater Macarthur Plan 2040" which will result in the large release of land for residential dwellings and for employment lands. The existing supply capacity to the area is based on the historical customer base of rural residential villages and a small number of major customers. The key assumptions underpinning this are below:

- The demand forecast for the Southern Macarthur area is based on the government's plans to increase residential dwellings and industrial land. It also includes the moderate growth in the existing customer base and the small number of very large customers who take their supply directly from the 66kV network.

- The rate of development anticipated by the demand forecast for the Greater Macarthur 2040 Plan have been prudently moderated over the time period based on observation of major developer activity in the area and formal network connection enquiries.

- The existing 66kV supply network is capacity constrained and consists of two long route feeders to supply the four zone substations in the area and the major customers who take their supply directly from the 66kV network. The capacity constraint is seasonal based due to the continuous rating of the overhead feeders being lower in the summer period. The loss of one of the 66kV feeders during the peak demand summer period is likely to lead to loss of supply to customers.

- There is a large level of embedded generation within the area related to certain mining operations. The embedded generation provides a significant portion of the supply to the area, however it is privately owned and operated and the generation exports to the network based on the availability of waste coal seam methane gas which is dependent upon mining operations. This generation cannot be solely relied upon to provide supply reliability to the standard required by our customers.

- There are numerous future network investments that will be required in the period from 2025 to 2040 to support the growth plans of the area, these include zone substations located closer to major residential housing estates and town centres. These investments are continuously being assessed and they would be enabled by increasing the supply to the area and in particular by augmenting the 66kV supply.

3.3.1 Demand forecast

We have developed our demand forecast for the Southern Macarthur Growth Area by considering the existing customer base, the expected new customers connecting to the network in relation to the Government's growth plans and the demand of the major customers including the level of embedded generation.

The existing customer base consists of customers supplied from our zone substations at: Appin, Maldon, Tahmoor and Wilton and the major customers who take supply directly from the 66kV network. We have extensive data and information on the historical demand of these customers. For the projected customer growth related to the release of land for residential dwellings we are guided by the Government's 2040 plan.

Table 2 below shows the planned land release precincts, dwelling numbers and employment lands (expressed in Hectares) identified by the NSW Government. The values shown are the final development plans projected for 2040 and provide a basis for Endeavour Energy's demand forecast. Our demand forecast is a conservative view of these projections and take into account the rate of development based on monitoring network connection requests from major developers and the development of other infrastructure including roads and water.

Table 2 – NSW Government's "Macarthur Growth Plan 2040" – Land Release and Dwellings by 2040.

Land Release Precinct	Number of Dwellings	Employment Land (Ha)
Menangle Park & Mount Gilead	18,100	24
Wilton New Town	16,600	344
West Appin	23,590	32
Total	**58,290**	**400**

Based on our analysis of the existing customer base including the level of embedded generation and the projected growth in the area we have developed three demand forecast scenarios, they are:

- a central demand scenario, where existing customer demand and growth proceeds at a level that we consider most likely and it assumes that the level of embedded generation continues at the **average** level of recent years;
- a low demand scenario, where existing customer demand and growth proceeds at a level that we consider most likely and it assumes that the level of embedded generation is at the **higher** end of the range over the recent years ; and
- a high demand scenario, where existing customer demand and growth proceeds at a level that we consider most likely and it assumes that the level of embedded generation is at the **lowest** end of the range over the recent years.

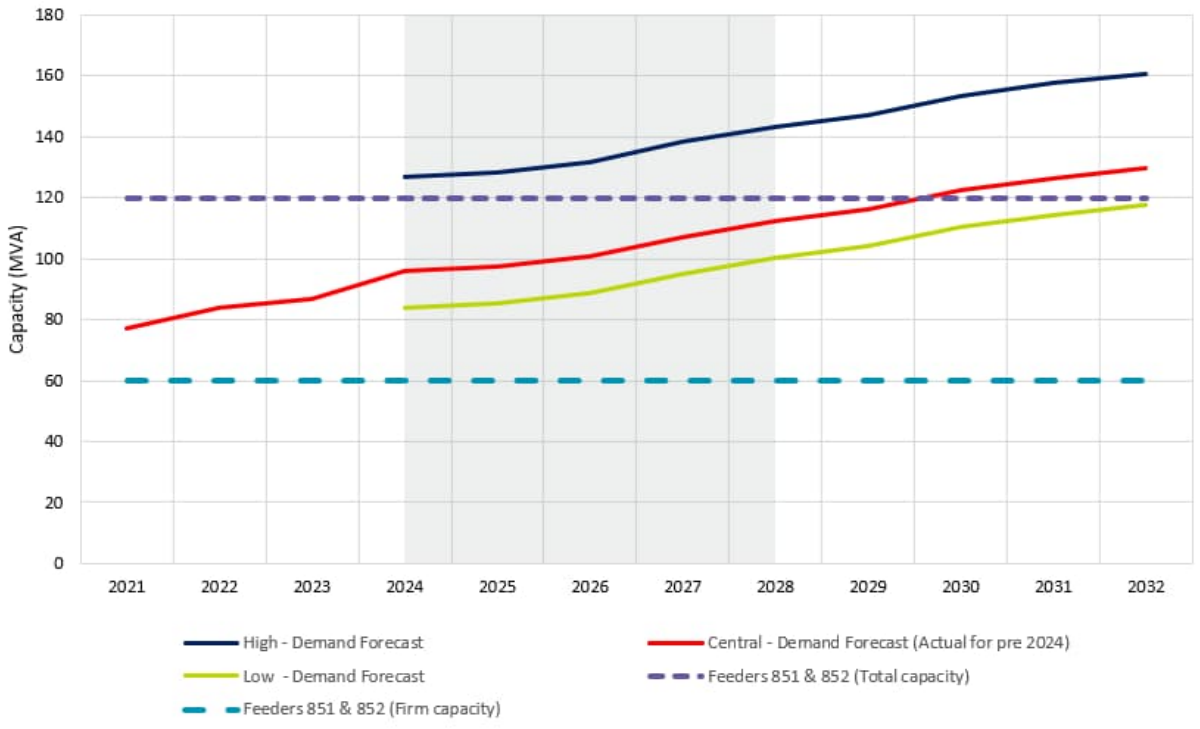
The demand forecast for the Southern Macarthur Growth Area is shown below in Table 3. It shows our three demand scenarios, the capacity of the network based on the 66kV feeders and the load at risk for each of the demand forecast scenarios. The load at risk is determined in relation to the firm capacity of the two 66kV feeders. The 2024 forecast value was the actual value for the summer 2023/24.

Table 3 – Southern Macarthur Growth Area Demand Forecast including the High, Central and Low scenarios

Summer Demand Forecast 2024-2032 (MVA)	2024	2025	2026	2027	2028	2029	2030	2031	2032
High forecast		128.2	131.5	138.2	143.1	147.2	153.4	157.5	160.4
Central forecast	96.0	97.2	100.5	107.2	112.1	116.2	122.4	126.5	129.4
Low forecast		85.2	88.5	95.2	100.1	104.2	110.4	114.5	117.4
	2024	2025	2026	2027	2028	2029	2030	2031	2032
Feeders 851 & 852 (Total capacity)	120	120	120	120	120	120	120	120	120
Feeders 851 & 852 (Firm capacity)	60	60	60	60	60	60	60	60	60
Load at risk (High)	66.9	68.2	71.5	78.2	83.1	87.2	93.4	97.5	100.4
Load at risk (Central)	35.9	37.2	40.5	47.2	52.1	56.2	62.4	66.5	69.4
Load at risk (Low)	23.9	25.2	28.5	35.2	40.1	44.2	50.4	54.5	57.4

Figure 4 below shows the central, low and high demand forecast scenarios and the 66kV supply capacity of the existing Southern Macarthur area. The actual peak demand on the 66kV supply network is provided for the years prior to 2024 on the central demand forecast graph. The actual peak demand for the area has been above the firm capacity for the 66kV supply for a number of years. This situation has been closely monitored by Endeavour Energy in the interests of balancing the supply security to the area for customers and the capital investment required.

Figure 4 – Southern Macarthur Growth Area Demand Actual and Forecast 2021-2032



3.3.2 Existing network

The Southern Macarthur area of the Endeavour Energy network uses a 66kV subtransmission network to supply customers via zone substations at Appin, Maldon, Tahmoor and Wilton. There are also major customers in the area that take supply directly from the 66kV network. Some of the major customers in the area also have their own embedded generation and export electricity into the network. The 66kV network consists of two major overhead feeders that are constrained in their capacity to provide supply to the area. These feeders are the long route overhead feeders 851 and 852.

Figure 5 below shows a simplified line diagram of the Southern Macarthur Growth area and the 66kV network that supplies the area.

Figure 5 – Simplified line diagram of the Southern Macarthur Growth Area (66kV network)

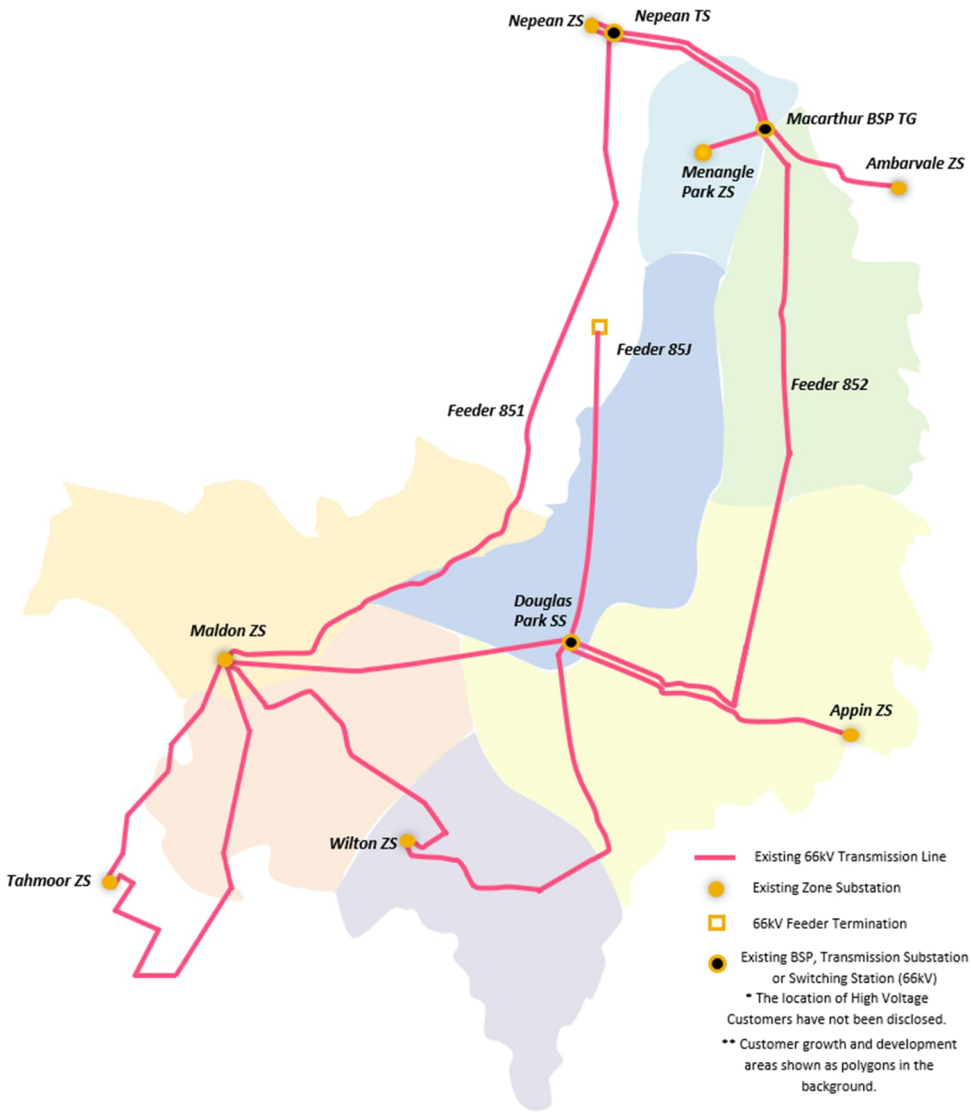
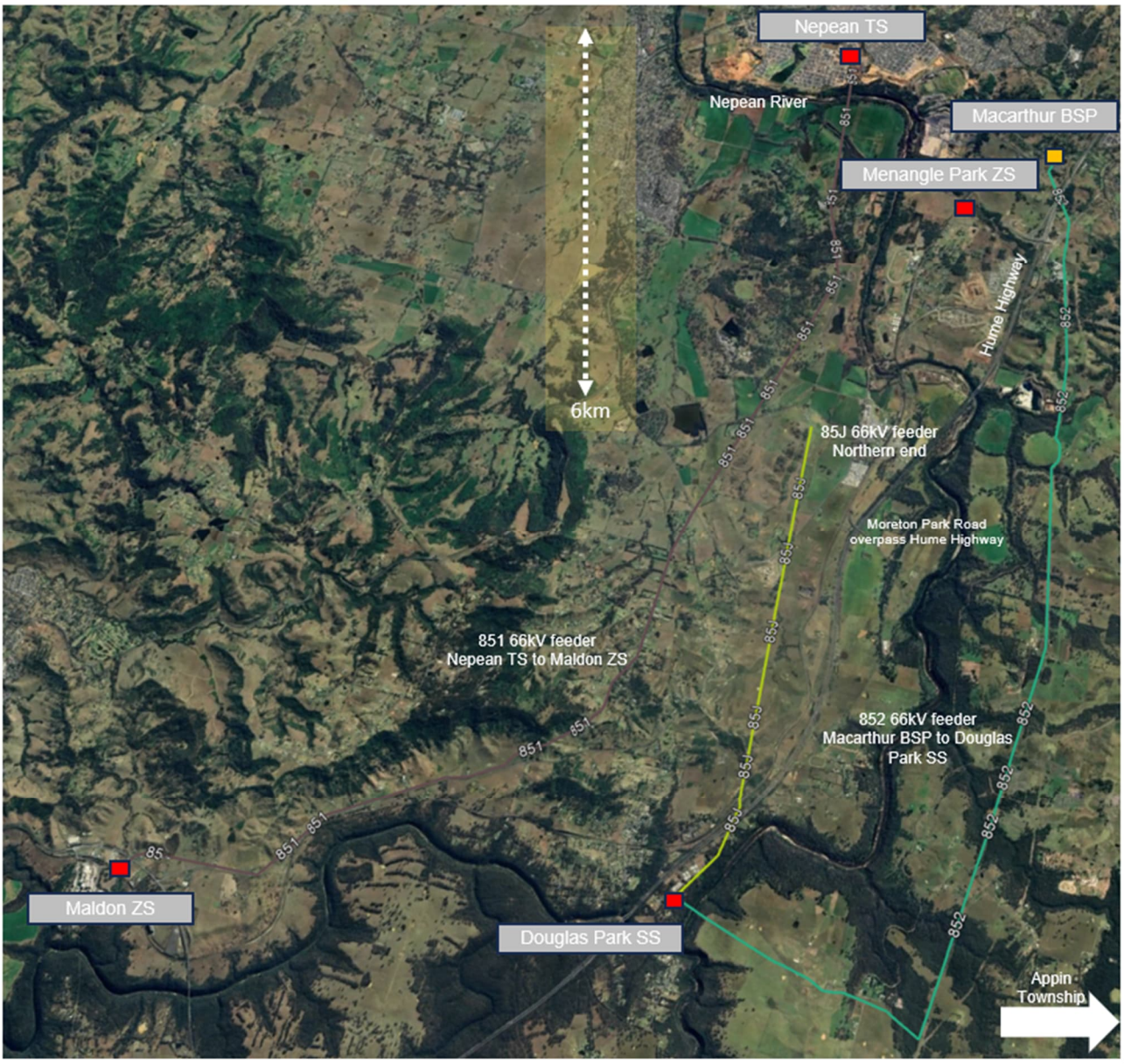


Figure 6 below shows an aerial view of the key existing assets in the Southern Macarthur area. It shows the location of the major substations, supply point and major 66kV feeders. It also shows the location of the Nepean River, Hume Highway and the Moreton Park Road overpass of the Hume Highway to provide orientation of the area. It includes a "6km indicator" to provide distance sensibility to understanding the existing network. The aerial view excludes our 11kV and Low Voltage network to focus on the 66kV network that is the constraint we are addressing in our analysis.

Figure 6 – Aerial view of key existing assets in the Southern Macarthur area



3.3.3 Expected unserved energy if action is not taken

The existing 66kV network supplying the Southern Macarthur is limited in its ability to meet the supply needs of the area. The summer peak demand has exceeded the firm capacity of the network for a number of years and the situation has been monitored and disclosed in our Distribution Annual Planning Reports. The constraint on the 66kV network is an N-1 constraint and the probability of an outage on one of the two feeders has been used to determine the expected unserved energy.

Figure 7 below presents the expected unserved energy if no action is taken under each of the three demand forecasts. We have included the prior years 2021,2022 and 2023 and show the respective expected unserved energy values for those years. There were no abnormal unserved energy events over those years and both feeders 851 and 852 performed with no significant unplanned outages.

Figure 7 – Expected unserved energy under the three demand forecast scenarios (if no action is taken)

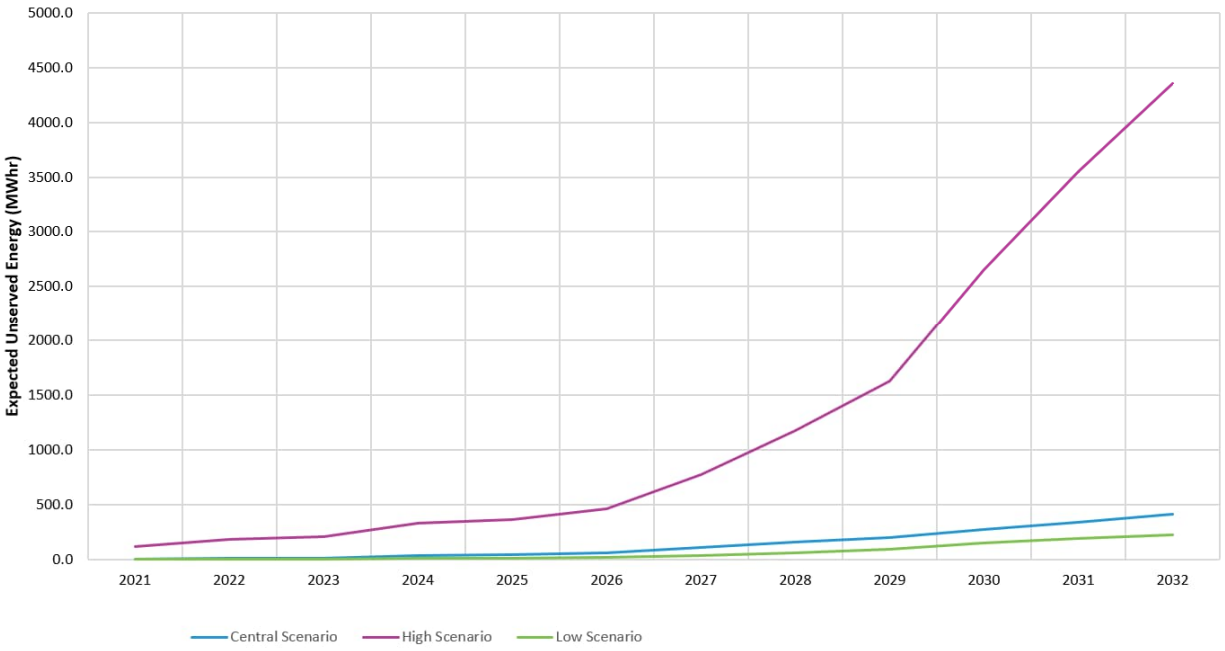


Table 4 below is a summary of the network contingency analysis conducted to determine the expected unserved energy if no action is taken.

Table 4 – Network contingency analysis for the Southern Macarthur Growth Area for determining expected unserved energy

Contingency Scenario	Identified Asset	Description
1	Loss of 66kV feeder 851 from Nepean TS to Maldon ZS	The loss of feeder 851 in either a planned or unplanned interruption to supply would result in the feeder 852 having to supply the demand of the area. During the summer period the continuous rating of feeder 852 is 60 MVA. Both feeders 851 and 852 are overhead lines and their rating is determined by the ambient air temperature. During the peak demand period over summer, the loss of feeder 851 would result in feeder 852 becoming overloaded and risk damaging the conductor and potentially causing it to lose its strength and fall to the ground or into an adjacent phase causing a risk to public safety including fire. Feeder 851 being an overhead line is exposed to lightning strikes and wind damage. The feeder is located in a well maintained easement and is protected from potential vehicle impacts to poles for example.
2	Loss of 66kV feeder 852 from Macarthur BSP to Douglas Park SS	The loss of feeder 852 in either a planned or unplanned interruption to supply would result in the feeder 851 having to supply the demand of the area. During the summer period the continuous rating of feeder 851 is 60 MVA. Both feeders 851 and 852 are overhead lines and their rating is determined by the ambient air temperature. During the peak demand period over summer, the loss of feeder 852 would result in feeder 851 becoming overloaded and risk damaging the conductor and potentially causing it to lose its strength and fall to the ground or into an adjacent phase causing a risk to public safety including fire. Feeder 852 being an overhead line is exposed to lightning strikes and wind damage. The feeder is located in a well maintained easement and is protected from potential vehicle impacts to poles for example.

4.0 Proposed options to meet the identified need

We have identified four credible network options for augmenting supply to the Southern Macarthur growth area. All four options involve augmenting the 66kV supply to the area. The network options are:

- Option 1 – Establishment of a new 66kV Feeder connecting Nepean TS to 85J.
- Option 2 – Establishment of a new 66kV Feeder connecting Nepean TS to 85J and includes a deviation to the existing Menangle Park Zone Substation.
- Option 3 – Establishment of a new 66kV Feeder connecting Macarthur BSP to 85J.
- Option 4 - Augmentation of the existing 66kV Feeders 851 and 852.

These network options are summarised in Table 5.

Table 5 – High level summary of the four network options considered for the Southern Macarthur growth area .

Network Option	Summary Description	Cost
Option 1 Establishment of a 66kV Feeder connecting Nepean TS to 85J.	• Establish a new 66kV feeder into the Southern Macarthur area supplied from the Nepean Transmission Substation. • Provide connection of the new feeder to Nepean TS at the northern end and to the feeder 85J approximately 7km north of Douglas Park SS at the southern end.	**$7.5M**
Option 2 Establishment of a 66kV Feeder connecting Nepean TS to 85J and include a deviation to the Menangle Park ZS.	• Establish a new 66kV feeder into the Southern Macarthur area supplied from the Nepean Transmission Substation. • Provide connection of the new feeder to Nepean TS at the northern end and to the feeder 85J approximately 7km north of Douglas Park SS at the southern end. • Provide a deviation to the feeder to the Menangle Park ZS location.	**$10.5M**
Option 3 Establishment of a new 66kV feeder connecting Macarthur BSP to 85J	• Establish a new 66kV feeder into the Southern Macarthur area supplied from the Macarthur bulk supply point. • Provide connection of the feeder to Macarthur BSP at the northern end and to the feeder 85J approximately 7km north of Douglas Park SS at the southern end. • Acquire required easements for the section near Macarthur BSP where Endeavour Energy does not already have suitable easements for the proposed feeder route and provide a rail crossing for the proposed feeder.	**$14.0M**
Option 4 Augment existing 66kV feeders 851 and 852	• Augment the existing Feeder 851 from Nepean TS to Maldon ZS by rebuilding the line to increase its capacity. • Augment the existing Feeder 852 from Macarthur BSP to Douglas Park Switching Station by rebuilding the line to increase its capacity.	**$20.0M**

The cost estimates of the network options are for the capital cost estimated for each option. The estimated on going operating cost of the network options is 0.4% per annum of the capital cost. This covers the incremental increase in operational, maintenance and inspection costs. For example, a $1,000 capital investment would result in a $4 per annum operating cost.

4.1 Option 1 – Establish a 66kV feeder from Nepean TS to 85J

This network option involves the establishment of a new 66kV feeder to supply the Southern Macarthur area with the feeder having a route length of 6.2km from Nepean TS and to the northern end of the feeder 85J. The feeder 85J is from the Douglas Park Switching Station.

This new feeder would utilise the easement and line route of an existing 11kV line and an out of service 33kV line. The easement is well maintained and would require no costs for acquisition.

The proposed new feeder would be connected at Nepean TS where there is an existing feeder bay available. This option would provide a closed loop feeder between the Nepean TS and Douglas Park SS and increase supply capacity to the Southern Macarthur area.

The proposed 66kV feeder connection Nepean TS to Douglas Park SS would have a summer rating of 72 MVA and provide a third 66kV feeder into the currently constrained Southern Macarthur Area.

The estimated cost of this network option is $7.5M and would result in an increase of the firm capacity rating of the 66kV network from 60 MVA to 120 MVA. This network option would be commissioned by 30 November 2025.

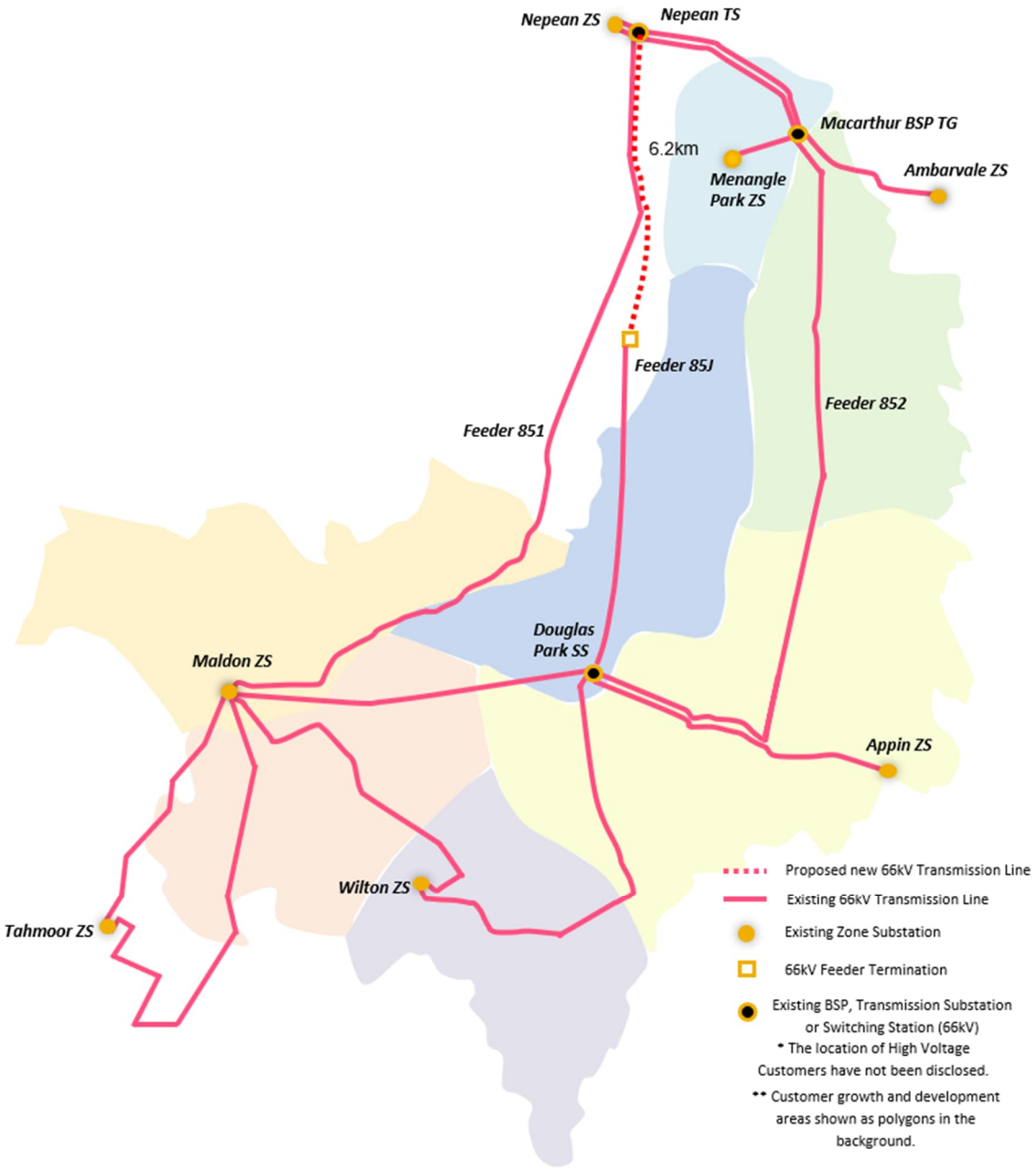
Table 6 below shows the feeder route length for the Network Option 1.

Table 6 – Network Option 1 – Augmentation Feeder Route Length

Feeder Connection Termination points for this option	Proposed Route Length (km)
Nepean Transmission Substation to the northern end of feeder 85J approximately 7km north of the Douglas Park Switching Station.	6.2

Figure 8 below shows a simplified single line diagram for the proposed Network Option 1.

Figure 8 – Network Option 1 – Establishment of new 66kV feeder from Nepean TS to Douglas Park SS by connecting new mains to the northern end of feeder 85J and connect to Nepean TS



4.2 Option 2 – Establish a 66kV feeder from Nepean TS with a deviation to Menangle

This network option involves the establishment of a new 66kV feeder to supply the Southern Macarthur area with the feeder having a route length of 10.2km from Nepean TS and to the northern end of the feeder 85J. The proposed option would include a 4.0km route length diversion to the location of the existing Menangle Park Zone Substation. This would be a dual circuit 2km deviation requiring 4km of new mains. Option 2 has the scope of works of Option 1 with the addition of the diversion to the Menangle Park area.

This new feeder would utilise the easement and line route of an existing 11kV line and an out of service 33kV line. The easement is well maintained and would require no costs for acquisition.

The proposed new feeder would be connected at Nepean TS where there is an existing feeder bay available. This option would provide a closed loop feeder between the Nepean TS and Douglas Park SS and increase supply capacity to the Southern Macarthur area. The option also includes the benefit of providing supply capacity to the Menangle Park area and provides a higher level of supply security by increasing the possible supply paths to the Southern Macarthur area.

The proposed 66kV feeder from Nepean TS to Douglas Park SS would have a summer rating of 72 MVA and provide a third 66kV feeder into the currently constrained Southern Macarthur Area.

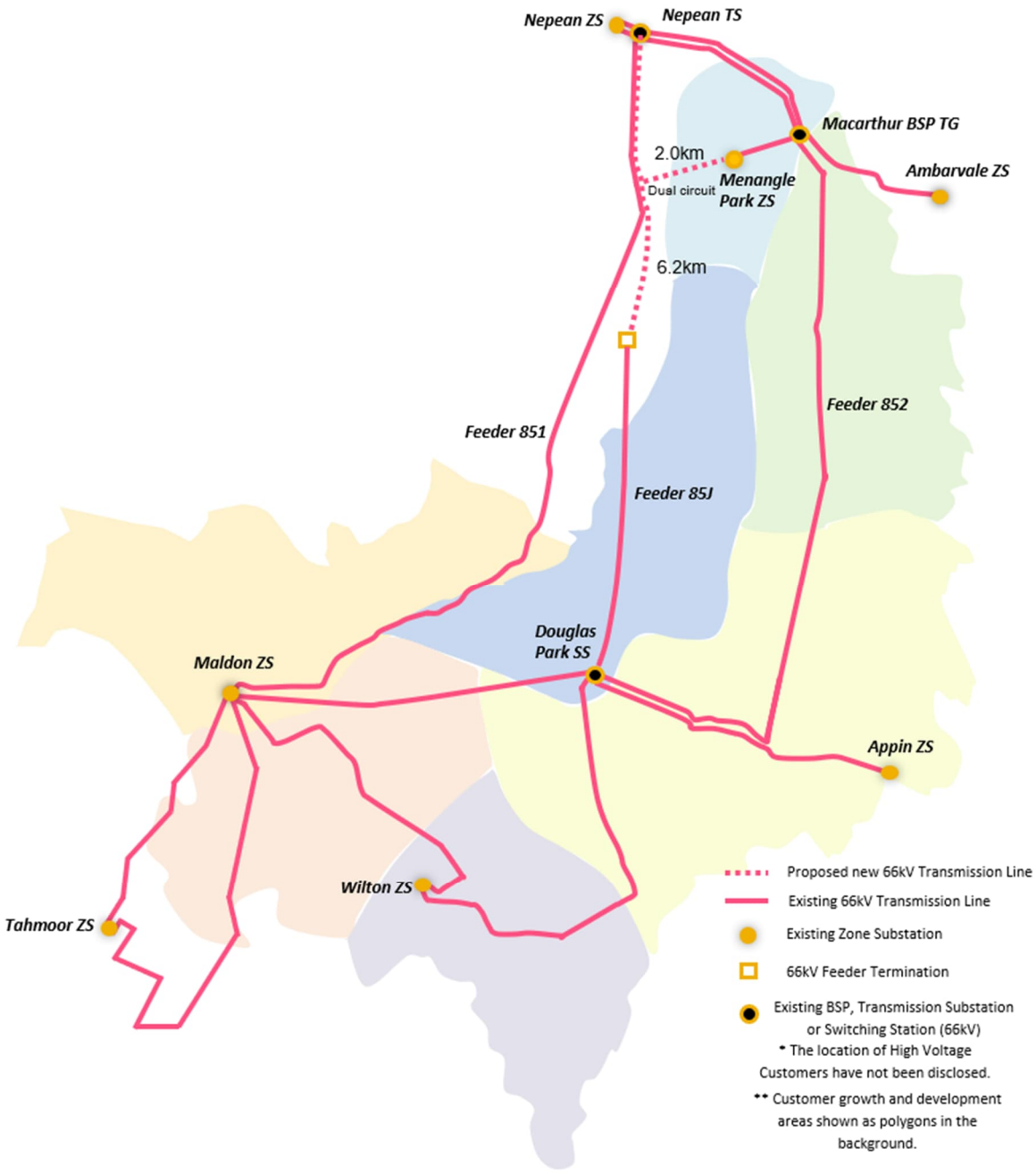
The estimated cost of this network option is $10.5M and would result in an increase of the firm capacity rating of the 66kV network from 60 MVA to 120 MVA. This network option would be commissioned by 30 November 2025.

Table 7 below shows the feeder route length for the Network Option 2. Figure 9 shows a simplified single line diagram for Network Option 2.

Table 7 – Network Option 2 – Augmentation Feeder Route Length

Feeder Connection Termination points for this option	Proposed Route Length (km)
Nepean Transmission Substation to the northern end of feeder 85J approximately 7km north of the Douglas Park Switching Station.	6.2
Deviation to Menangle Park ZS.	4.0
Total.	**10.2**

Figure 9 – Network Option 2 – Establishment of a new 66kV feeder from Nepean TS to Douglas Park SS including a deviation to the Menangle Park ZS and connecting to the northern end of feeder 85J



4.3 Option 3 – Establishment of a 66kV feeder connecting Macarthur BSP to 85J

This network option involves the establishment of a 66kV feeder to supply the Southern Macarthur area with the feeder having a route length of 6.3km from Transgrid's Macarthur BSP to the northern end of the feeder 85J.

The proposed feeder would be connected at Transgrid's Macarthur BSP and have a line route that would pass near the Menangle Park ZS location and then use the existing line route of the out of service 33kV line to connect to feeder 85J.

This network option would include provision of a new 66kV feeder bay and switchgear at Macarthur BSP as Transgrid have advised that there is no existing feeder bay for this proposed connection. The estimated cost of this connection is included in the cost of this network option. The line route from Macarthur BSP to Menangle Park ZS would require land acquisition for easement purposes and include a rail crossing in the route from the Transgrid substation at Macarthur and the existing Menangle Park Zone Substation. These costs have been included in the cost estimate for this option.

The network option would have a summer rating of 72 MVA and provide a third 66kV feeder into the currently constrained Southern Macarthur Area.

The estimated cost of this network option is $14.0M and would result in an increase of the firm capacity rating of the 66kV network from 60 MVA to 120 MVA. This network option would be commissioned by 30 November 2025.

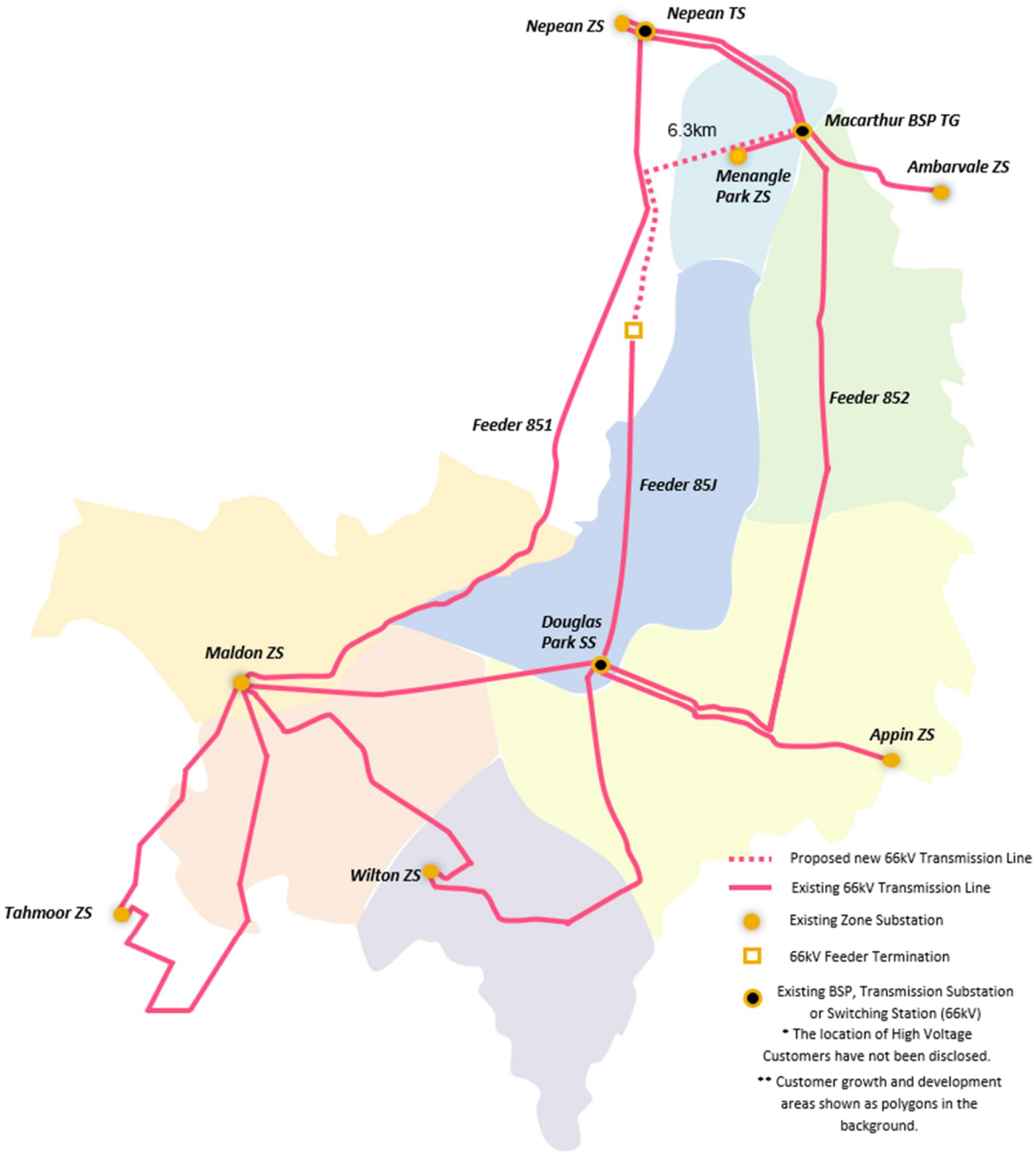
Table 8 below shows the feeder route length for Network Option 3.

Table 8 – Network Option 3 – Augmentation Feeder Route Length.

Feeder Connection Termination points for this option	Proposed Route Length (km)
Macarthur BSP to the northern end of feeder 85J approximately 7km north of the Douglas Park Switching Station.	6.3

Figure 10 below shows a simplified single line diagram for Network Option 3.

Figure 10 – Network Option 3 – New feeder from Macarthur BSP to Douglas Park SS by installing new mains to connect to the existing northern end of feeder 85J.



4.4 Option 4 – Augment existing 66kV feeders 851 and 852

This network option would involve the augmentation of both feeders 851 and 852 to increase their supply capacity. Both of these feeders would be augmented to a higher summer rating of 72 MVA from their existing 60MVA summer rating.

This option would involve replacing the existing conductor with a higher rated conductor and rebuild the existing wood pole support structures to a contemporary concrete pole design. This would use the existing line routes of both of the feeders and would therefore require no additional easements. There would also be minimal connection works because the existing feeder bays and switchgear would be used.

The scheduling of construction works for this network option would be more complex than for the other network options due to outage constraints on both of the feeders. The construction works would require scheduling to complete rebuilding each of the feeders separately and the outage on each line being limited to off peak periods of the year most likely the periods (April/May and September/October) due to both of them being required to be in service during the peak summer and winter periods. This would require the augmentation works to mobilise and demobilise for each construction period.

The construction works under this network option would also elevate network reliability and security risk during the construction period because any unplanned outage of the in-service feeder would result in loss of supply to the area.

The route length of feeder augmentation is given in the following Table 9.

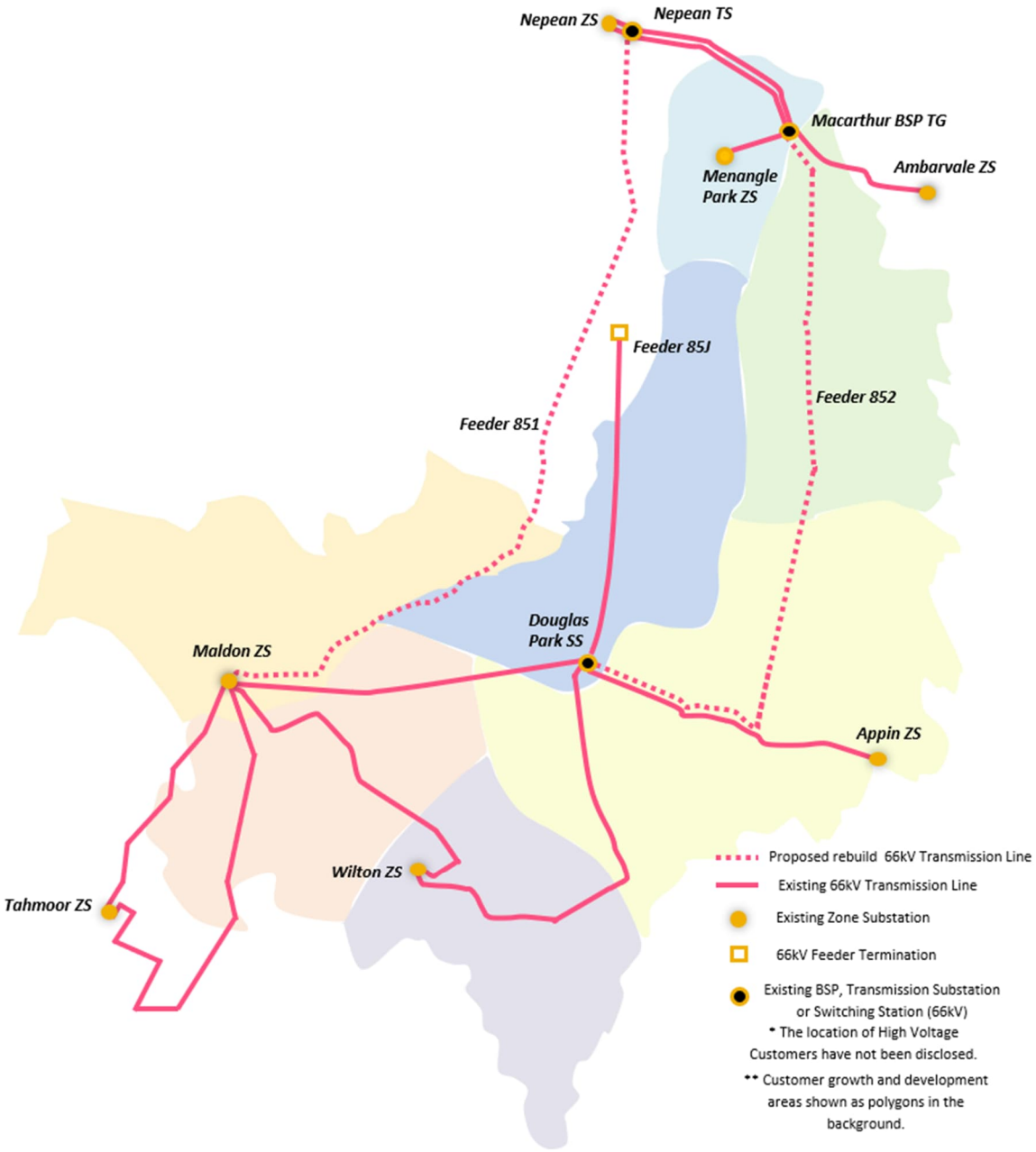
Table 9 – Network Option 4 – Augmentation Feeder Route Length

Feeder	Route Length Augmentation (km)
851 Nepean TS to Maldon ZS	18.3
852 Macarthur BSP to Douglas Park SS	17.4
Total	**35.7**

The estimated cost of this network option is $20.0M and would result in an increase of the firm capacity rating of the 66kV network from 60 MVA to 72 MVA and be commissioned by 30 November 2025.

Figure 11 below shows the simplified line diagram for Network Option 4.

Figure 11 – Network Option 4 – Rebuild feeders 851 and 852 to augment supply capacity to the Southern Macarthur growth area



4.5 Options considered but not progressed

Endeavour Energy considered a number of options that we have not progressed further. These options and our reasoning for not progressing them further are summarised in Table 10.

Table 10 – Options considered but not progressed

Option	Reason not progressed
Potential Staging of Option 2 to construct the deviation to Menangle Park at a later time	Option 2 could be staged to construct the deviation to Menangle Park ZS at a later time to align to the customer demand in the Menangle Park area. However, there are potentially more beneficial 66kV supply options to the Menangle Park area that may utilise a lower cost supply option from Transgrid's Macarthur BSP where two 66kV feeders could be utilised. We consider it beneficial to assess 66kV supply options to Menangle Park at a later time and in close alignment to the customer need in this area which is currently in an early development stage. We have included Option 2 into this analysis for completeness and show the range of options that we consider as credible, however Option 2 has a higher cost than Option 1 but does not deliver higher benefits mainly due to the demand in the Menangle Park area increasing at a later time, more towards 2030. We expect to explore this option further in our assessment of the future needs for the high growth area at Menangle Park over the next few years. This may result in a separate RIT-D assessment for the Menangle Park Development Area.
Wait for a possible new Bulk Supply Point in the Appin area	Any new Bulk Supply Point (BSP) for the Appin area would be at least several years in the future and be dependent upon Transgrid's decision and timing, however the identified need for Southern Macarthur is urgent and cannot wait for a new BSP to provide an additional 66kV supply to the area. Our network options identified here would complement any new BSP in the Appin area by providing high capacity connection to the large and growing customer base in the area.
132kV conversion of the Southern Macarthur area	The Southern Macarthur area uses a 66kV network. Over the long term, we expect that the possible conversion of the area to 132kV will be economically efficient based on the comparatively lower cost of major equipment including power transformers and the higher energy density provided in transmission for both Transgrid and Endeavour Energy. However, this decision and conversion is likely to be greater than 10 to 20 years into the future. This would also require considerable joint planning with Transgrid and is not credible in meeting the immediate needs of the Southern Macarthur area.

5.0 Modelling & Assumptions

5.1 Assumptions

The RIT-D requires that the preferred option is the credible option that maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the NEM.

The market benefit of a credible option is calculated by comparing the credible option in place with the state of the system in the base case. The emphasis in this situation is differences in the risks of involuntary load shedding.

The market benefits that can be considered under the National Electricity Rules are:

- Changes in voluntary load curtailment (considered a negative benefit);
- Changes in involuntary load shedding and customer interruptions caused by network outages;
- Changes in costs to other parties (timing of new plant, capital costs, operating and maintenance costs);
- Differences in timing of expenditure;
- Changes in load transfer capacity and the capacity of embedded generators to take up load;
- Option value;
- Changes in electrical energy losses; and
- Any other class of market benefit determined to be relevant by the AER.

The time period chosen for the NPV analysis was 30 years.

5.1.1 Energy at risk and expected unserved energy

A core justification for this project is based on the load at risk and the supply reliability and security for the existing customer base. However, there are also major growth plans for the area based on the release of large amounts of land for residential housing

The same VCR value has been applied to the energy at risk values established from the existing customer demand and the future expected customer demand, based on the government's development plans for the Southern Macarthur area. We expect that the customer type composition of the area may change over time with a greater proportion of residential customer demand.

5.1.2 Load profile characteristics

The Southern Macarthur area has a geographically diverse customer base including rural, residential, enterprise and major customers. While the major customers have a predictable and regular pattern of use throughout the year and during the week, the residential customer base is influenced by the air temperature and the use of air conditioning during the summer and particularly on days with a maximum temperature above 30 degrees. The demand for the area is peaky. The peak in demand and demand levels within 10% of the peak demand have a total duration of approximately 48 hours in the year (0.13% of the year has a demand level over 90% of the annual peak demand). Based on our analysis of customer demand, this area has a high peak demand relative to the average demand.

Figure 12 below presents the normalised load duration curve (LDC) for the Southern Macarthur growth area. It shows that the area has a high peak demand that is sustained for a relatively short period of time during the year.

Figure 12 – Normalised LDC for the Southern Macarthur Growth Area based on historical data

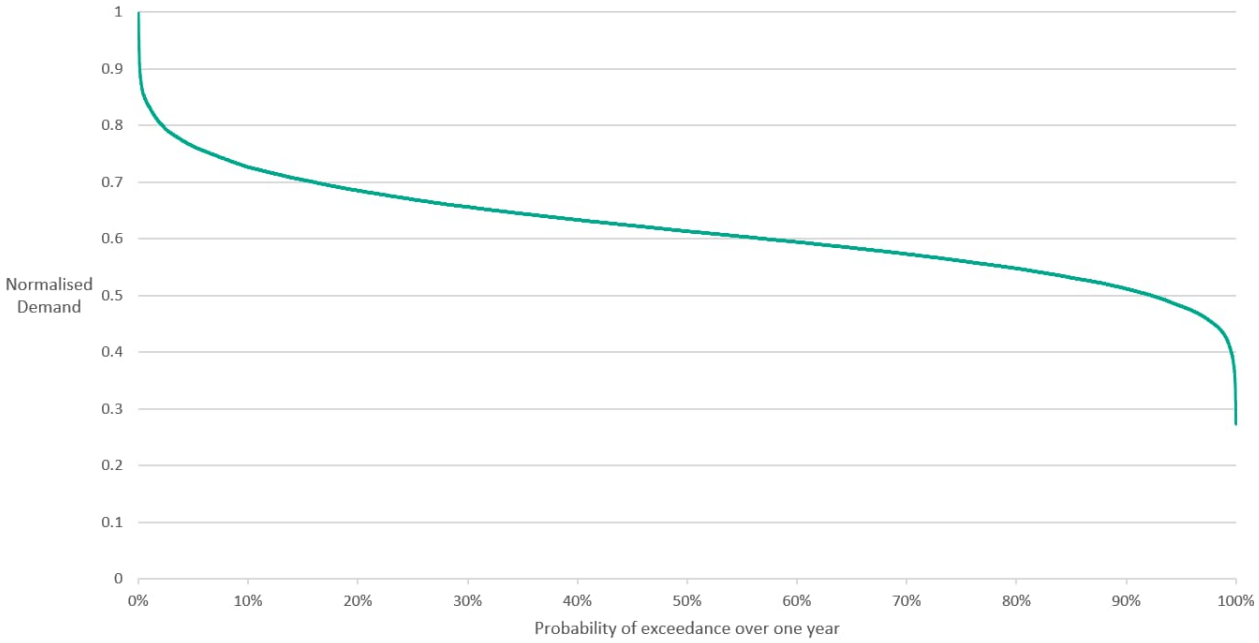


Figure 13 below shows the forecast peak day profile for the area based on historical customer demand data and our projection of demand into the future. It shows the forecast peak day profile for 2024 and 2028 for comparison. The peak time of day is shown to highlight the period from 1pm to 4pm when the customer demand reaches its highest daily level. This is the time of day that is to be targeted for demand reduction, however the demand is above the 60MVA firm capacity for almost the entire day.

Figure 13 – Peak summer day profile for the Southern Macarthur growth area

5.1.3 Value of customer reliability

The value of unserved energy is calculated using the Value of Customer Reliability (VCR). This represents an estimate of the value electricity consumers place on a reliable electricity supply. Endeavour Energy used a VCR of $44,792 per MWh in the evaluation which is based on the 2023 VCR annual adjustment provided by the AER, weighted in accordance with the composition of the agriculture, commercial, industrial and residential demand within the Southern Macarthur area.

The Southern Macarthur area includes a component of industrial demand which consists of mining, building materials manufacturing (mainly cement) and water treatment activities that have a 40% contribution to the demand for the area.

A breakdown of this calculation is provided in Table 11 below.

Table 11 – Composite VCR used in the evaluation

Parameter	Agriculture	Commercial	Industrial	Residential
Demand composition of the Southern Macarthur area	5%	5%	40%	50%
AER VCR	$42,140	$49,540	$70,970	$23,640
Demand weighted VCR ($/MWh)				**$44,792**

5.2 Classes of market benefit considered

5.2.1 Changes in involuntary load shedding

Endeavour Energy has valued reduced involuntary load shedding by reference to our estimate of energy at risk, which is derived from the annual peak demand forecasts and load duration curve.

5.3 Classes of market benefit not considered to be material

The classes of market benefits that are not considered material include:

- Changes in voluntary load curtailment;
- Option value;
- Changes in load transfer capacity;
- Changes in costs to other parties; and
- Changes in electrical losses.

These are further detailed below.

5.3.1 Changes in voluntary load curtailment

Voluntary load curtailment is when customers agree to reduce their demand to address a network limitation in return for a payment. A credible demand side option to enlist such customers to voluntarily reduce demand could lead to a reduction in involuntary load shedding.

Endeavour Energy has not estimated any market benefits associated with changes in voluntary load curtailment as there is insufficient capacity in the existing customer base to deliver sufficient voluntary demand reduction.

5.3.2 Option value

Endeavour Energy notes that the AER's view is that option value is likely to arise where there is uncertainty regarding future outcomes, the information that is available in the future is likely to change and the credible options considered by the RIT-D proponent are sufficiently flexible to respond to that change.

Due to the certainty of the Southern Macarthur area being further developed and the existing customer base and their demand, there is little doubt about the need and use of the infrastructure investment and each option is considered equivalent in that respect. Option value has therefore not been considered in the economic analysis.

5.3.3 Changes in load transfer capability

Distribution investments can improve load transfer capacity where a credible option allows end users to gain access to a back-up power supply. This is a market benefit because backed-up power supplies can service end-users in the event of power failure. The preferred option, Option 1, will generally improve load transfer capability by allowing for an additional supply path into the Southern Macarthur area and allow for the potential transfer of load, via the 66kV network, between Macarthur BSP and Nepean TS.

However, we have conservatively set this market benefit to zero due to assumptions required about the 66kV network configuration of Nepean TS. Importantly, none of the options considered provided any additional changes in load transfer capability with Options 1 and 2 probably providing the highest capability.

Immediate changes to load transfer capacity are not considered material for this RIT-D.

5.3.4 Changes in costs to other parties

In this instance, Endeavour Energy has not identified any changes in costs to other parties from developing the credible options identified in this document.

5.3.5 Changes in electrical losses

Endeavour Energy recognises that there would be small changes in the loss profiles for customers across the network due to changes in the network proposed by this project requirement. The impact of the small change in loss profile for these customers is unlikely to have significant impact on the network wide distribution loss factors that will be applicable to these and other customers. These changes are captured as part of the complex annual review of distribution loss factors when more information about customer usage patterns is available. Changes in electrical losses have therefore not been modelled for this RIT-D.

5.4 Scenarios and sensitivities

The central scenario parameters and relevant references in the FPAR are summarised in Table 12.

Table 12 – Central Scenario Parameters and references in the FPAR

Parameter	Central scenario
Maximum demand forecasts	The Central demand forecast provided in Section 3.
Capital costs	Cost Estimates provided in Section 4.
Operating & Maintenance costs	0.4 per cent of capital expenditure per annum.
Value of customer reliability	Section 5.1.3

5.4.1 Demand forecasts

The maximum demand forecasts have been derived from a projection of the customer connection applications and enquiries and the time series forecast is presented in Section 3.

The central scenario has been developed from analysis of the existing customer base and customer connection request information. It is based on:

- An ultimate load forecast for the area based on surface area analysis;
- A timeframe to reach that ultimate load (the estimated time for this precinct to reach maturity is 30 years); and
- A load ramp up rate assumption (which is linear in this instance).

Probabilistic 'load realisation' factors have been applied to the development derived forecast, which in turn is calibrated by the actual connections applications that we receive over time.

5.4.2 Capital costs

Capital cost estimates have been based on the scope of work required for each option and are based on current market pricing for materials, labour and third party contracting. The type of work required for all the options considered can largely be delivered by our internal staff and we have a high degree of confidence on this component of costs. Option 3 includes easement acquisition costs which we have estimated based on recent land acquisition costs in the area.

For sensitivity analysis, these estimates have been varied by ± 25%.

5.4.3 Value of customer reliability

Our analysis adopts the value of customer reliability values published by the AER to calculate the expected unserved energy. The ratio of load types has been estimated and used to calculate the weighted aggregate VCR value and then applied to the energy at risk. Based on the estimated load composition of the subject area, a demand composition weighted VCR value of $44.70 per kWh has been derived and used in the RIT-D analysis. A variation of ±25% has been used for sensitivity testing in accordance with AER guidelines.

5.4.4 Discount rates

The discount rate used in the financial analysis will impact the estimated present value of net market benefits and may affect the ranking of credible options. Endeavour Energy has employed a real, pre-tax discount rate based on the latest AER determination as the low case. For sensitivity analysis, a symmetrical application was used to determine the high case.

5.4.5 Summary of sensitivities and scenarios

We have assessed three alternative future scenarios as part of the NPV assessment, namely:

- a **central scenario** – consisting of assumptions that reflect a central set of variable estimates, which, in our opinion, provides the most likely scenario. We have used the central scenario to determine the preferred option.
- a **high benefit scenario** – reflecting an optimistic set of assumptions which have been selected to investigate an upper bound on reasonably expected market benefits; and
- a **low benefit scenario** – reflecting a number of assumptions that give rise to a lower bound NPV estimate for each credible option, in order to represent a conservative future state of the world.

A summary of the key variables and framework used for each scenario is provided in Table 13 below.

Table 13 – Scenarios used in the Southern Macarthur area NPV assessment

Parameter	Central scenario	High benefits	Low benefits
Capex	Central estimates	-25%	+25%
Demand	Central demand forecast	High demand forecast	Low demand forecast
VCR	Load-weighted AER VCR	+30%	-30%
Discount rate	3.26%	2.22%	4.30%
Maintenance costs	Central estimates	-25%	+25%

6.0 Results of analysis

This section describes the results of the economic assessment for each of the credible options considered in this RIT-D.

6.1 Central case results

Options 1,2 and 3 provide the same level of market benefits because they provide the same level of increased supply capacity to the 66kV network supplying the Southern Macarthur area. Option 4 provides a lower level of market benefits due to it providing only an augmentation of the existing feeders 851 and 852, however the capacity increase of this augmentation is limited to an increase in the capacity of the existing lines and does not provide an additional supply path to the Southern Macarthur area.

Option 2 provides a deviation to the Menangle Park area and although that would provide benefits in terms of improved operational flexibility and would provide an alternate supply to the future Menangle Park growth area, we have taken a conservative approach and we have not included any market benefits for avoid unserved energy in Menangle Park. The Menangle Park and Moreton Park Road areas will mainly require connection capability and 11kV supply capacity and although the proposed 66kV supply deviation would assist, it would not directly provide the market benefits and ensure customer supply when taken in isolation. We intend on conducting future RIT-D studies on the supply to the Menangle Park area that directly addresses the customer needs as the demand forecast for that area becomes clearer and the associated support infrastructure is developed further.

Option 1 has the lowest nominal capex and given that it provides the same level of benefits as the other options will result in it being the preferred option.

Option 3 has a significantly higher level of capex because it is based on a longer route length for the 66kV feeder augmentation and it also includes connection costs at the Macarthur BSP and also some easement acquisition costs for the route from Macarthur BSP to the Menangle Park area on the way to the northern most end of the existing feeder 85J. Option 3 is a higher cost than Option 1 because of the greater route length and the fact that Option 1 uses an existing feeder easement corridor and requires no additional easement acquisition. Option 1 is in the best interests of our customers and has the highest net benefit for the National Electricity Market.

Table 14 – Central case results presents the economic analysis of the options under the central case scenario including the present value of the benefits and costs.

Figure 14 below shows the economic evaluation of the options, using their net benefits (NPV) in a simple graph.

Figure 14 – Economic evaluation (NPV) of the Options

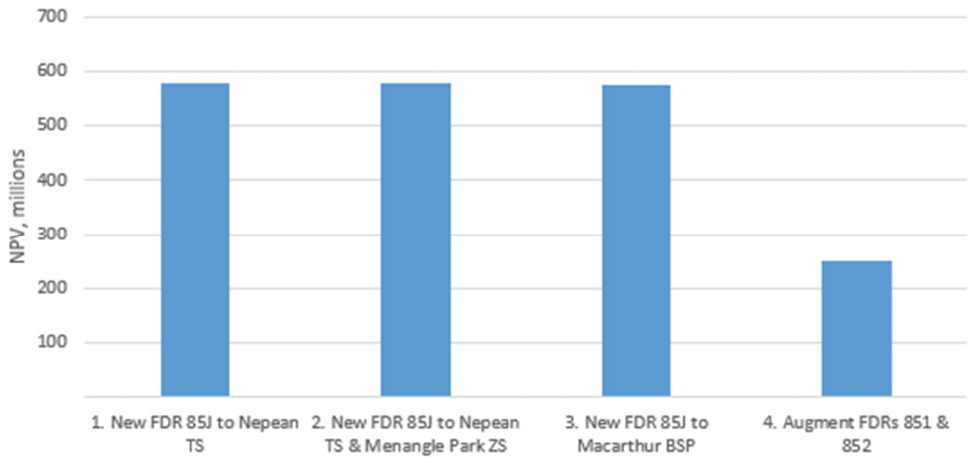


Table 14 – Central case results

Option	Description	Project capex nominal ($M)	PV of market benefits ($M)	PV of costs ($M)	NPV ($M)	Rank
1	Establishment of a 66kV Feeder from Nepean TS to 85J.	7.5	466.3	6.2	460.1	1
2	Establishment of a 66kV Feeder from Nepean TS to 85J and include a deviation to the Menangle Park ZS.	10.5	466.3	8.7	457.6	2
3	Establishment of a 66kV Feeder from Macarthur BSP to 85J.	14.0	466.3	11.6	454.7	3
4	Augment existing 66kV Feeders 851 and 852.	20.0	222.4	16.6	205.8	4

6.2 Sensitivity and scenario assessment

Endeavour Energy has carried out sensitivity analysis in the RIT-D assessment based on variations of key parameters. Specifically, Endeavour Energy has investigated as part of the scenarios change in relation to the:

- Forecast demand, and hence quantity of involuntary load shedding;
- Value of customer reliability;
- Investment costs; and
- Discount rate.

Option 1 is the preferred option under the central and our weighted scenario. Based on the sensitivity and scenario assessment, we have a high level of confidence in the preferred option for the Southern Macarthur area.

Figure 15 – Sensitivity analysis for the discount rate

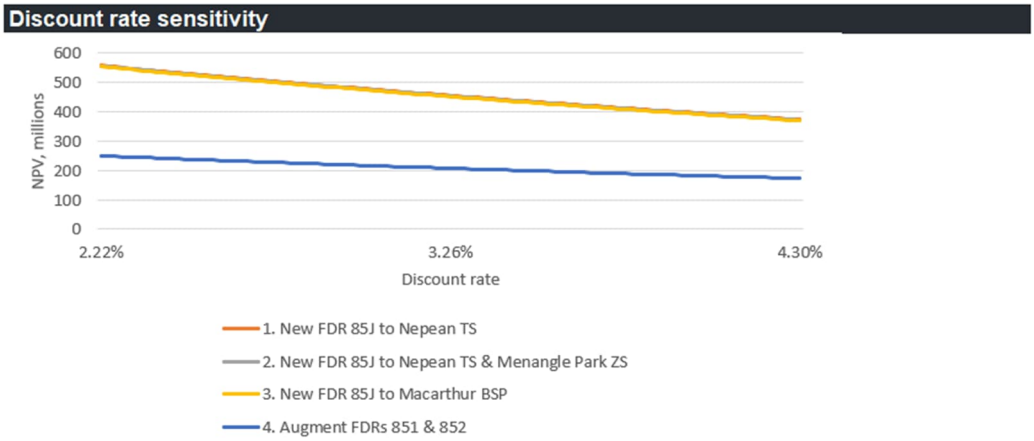


Figure 16 – Sensitivity analysis for capital cost

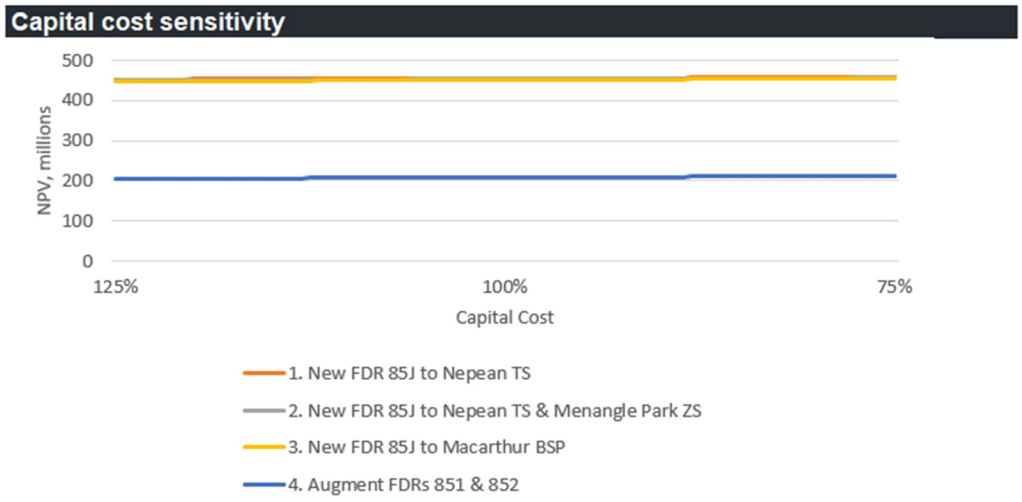
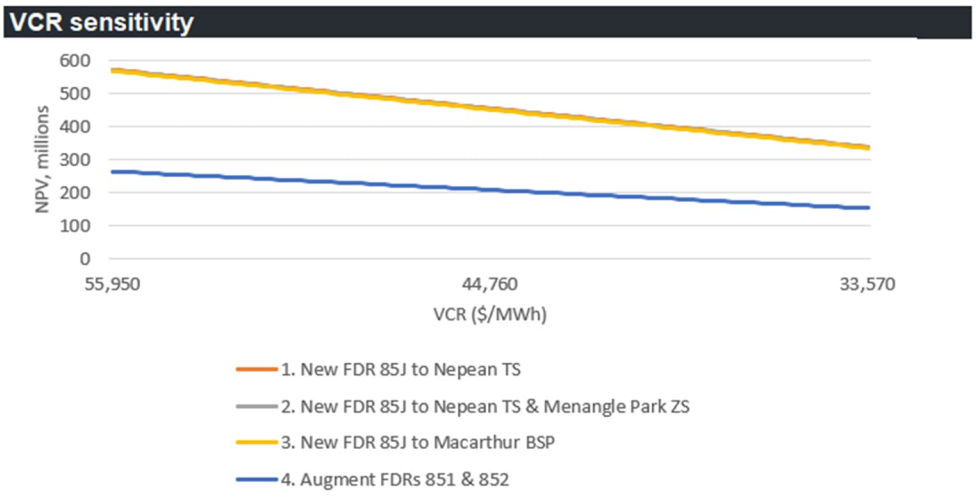


Figure 17 – Sensitivity analysis for the value of customer reliability



6.3 Economic Timing

The economic timing of the preferred option is the point in time when the existing network capacity is insufficient to supply new customers.

The supply to the Southern Macarthur area is insufficient to provide the required level of firm capacity to the existing customer base. The demand forecast shows that based on the existing customer demand, if there were to be an outage to one of the two 66kV feeders (851 or 852) that supply the area, then there would be a loss of supply to customers.

Endeavour Energy has monitored the supply arrangements to the Southern Macarthur area for a number of years and reported on it in our Distribution Annual Planning Report (DAPR). The level of risk to the supply reliability for customers in the area has reached the level that Endeavour Energy believes that it must progress with the preferred option to ensure that supply reliability and supply security is maintained in the Southern Macarthur area. The preferred option is planned to be commissioned by November 2025.

7.0 Conclusion

The Southern Macarthur Growth Area is located in the south-west of Sydney and includes parts of the local government areas of Campbelltown, Camden and Wollondilly. The area is supplied by a 66kV overhead network supplying four zone substations at the village townships of Appin, Maldon, Tahmoor and Wilton and also supplies several major customers in diverse business activities including mining, agriculture, water supply and building materials manufacturing.

The area is planned to grow significantly during the period up to 2040 based on the NSW Government's ***Greater Macarthur 2040 Plan***. The plan outlines the release of residential housing lots, development of new town centres and the release of employment lands. Land use zoning is being changed to support the development of the widespread increase in residential housing in the area. The 66kV electricity supply network will require augmentation to support the forecast increase in electricity demand in the area.

The major development precincts within the Southern Macarthur area include:

- The Menangle Park and Mount Gilead area to include over 15,000 new residential dwellings and 24 hectares of employment land.
- The Wilton area to include over 15,000 new residential dwellings and 300 hectares of employment land.
- The West Appin area to include over 20,000 new residential dwellings and 30 hectares of employment land.

While these developments will not fully mature until 2040 and beyond, the early stages of development will require significant augmentation to the existing electricity supply in the area. The existing 66kV supply to the area is not capable of providing the supply capacity required to support these developments.

Non-network options were sought via our Non-network Options Report and a simultaneous Request for Proposal process from April 2024 to July 2024 and no proposals were received.

During our consultation process for this RIT-D, we received a letter of support for Option 1.

Four options were determined to be credible in providing augmented supply to the Southern Macarthur growth area. These are:

- Option 1 - Establishment of a 66kV feeder connecting Nepean TS to 85J.
- Option 2 - Establishment of a 66kV feeder connecting Nepean TS to 85J via a deviation to Menangle Park.
- Option 3 – Establishment of a 66kV feeder connecting Macarthur BSP to 85J.
- Option 4 – Augment the existing 66kV feeders 851 and 852.

Each of these options were considered in an economic evaluation and Option 1 was selected as the preferred option. Option 1 is also the lowest cost option.

The total cost of this option is estimated to be **$7.5 million** and the construction of the new feeder from Nepean Transmission Substation to the northern end of the existing feeder 85J would commence in 2024/25 with commissioning in 2025/26. We are targeting November 2025 for commissioning of the new feeder.

CONTACT

If you have any comments or enquiries regarding this report, please send them to the **Portfolio Management Office** at: consultation@endeavourenergy.com.au

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Endeavour Energy

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