Area Plan

Western Sydney Priority Growth Area

Asset Strategy and Planning

April 2018

Endeavour Energy

REVIEW AND APPROVAL SCHEDULE

Responsibility	Position	Name	Signature	Date
Author	Network Planning Engineer	Deepak Sahay		
Reviewed	Capacity Planning Manager	Jason Lu		
Endorsed	Manager Asset Strategy and Planning	Peter Langdon		

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1.0 EXECUTIVE SUMMARY

This report outlines the investment needs and strategy to accommodate the development of an estimated 11,200 hectares of employment lands within the recently defined Western Sydney Priority Growth Area (WSPGA). This priority area encompasses the region referred to as the Broader Western Sydney Employment Area (BWSEA) and also includes the northern part of the former South West Sector Growth Area.

In March 2013 the NSW Government released the "Draft Metropolitan Strategy for Sydney: To 2031" report. It identifies nine key areas known as "city shapers" which will be developed to meet the housing and job needs for the Sydney area. One of the city shapers that has been identified is the Western Sydney Employment Area.

The Western Sydney Priority Growth Area covers the suburbs of Eastern Creek, Erskine Park, Kemps Creek, Luddenham, Badgerys Creek and Bringelly. It extends from M4 in the North to Bringelly Rd in the South and The Northern Rd in the West to the M7 in the East.

It is expected that when fully developed beyond 2046, some 650MVA of load will be added to the Endeavour Energy network. This is in addition to developments outlined in the South West Priority Growth Area (SWPGA) Plan.

The need to continue engagement with various stakeholders, including the NSW Department of Planning & Environment, the Greater Sydney Commission, RMS, TransGrid, developers and landowners, is highlighted as critical for the acquisition of line corridors and zone substation sites.

In summary, the following recommendations are made:

- The proposed ultimate network topology outlined within this report be carried forward as the basis for further planning within the Western Sydney Priority Growth Area. This strategy will require investment staged over the next two decades. Individual projects based on the principles outlined in this report will be developed separately and funding sought for each of these projects at the appropriate level and time.
- Projects to be completed in the 2020-2024 regulatory period with an associated real FY19 cost of $104 Million include:
    - Establishment of Austral ZS in interim configuration
    - Purchase of a site for Rossmore ZS
    - Purchase of a site for North Rossmore ZS
    - Purchase of a site for North Bringelly ZS
    - Establishment of the Southpipe ZS and associated transmission feeders
    - Establishment of the Science Park ZS and associated transmission feeders
    - Establishment of a Broader Western Sydney Employment Lands ZS and associated transmission feeders. It is anticipated that this new zone substation will be established in developer landholdings within the Elizabeth Drive Corridor Precinct in the ultimate layout.
- Projects to be completed in the 2025-2029 regulatory period with an associated real FY19 cost of $151 Million include:
    - Connection works associated with the Kemps Creek Bulk Supply Point
    - Establishment of Rossmore ZS (commence construction)
    - Establishment of North Bringelly ZS
    - Augmentation of Bringelly ZS
    - Conversion of Kemps Creek ZS to 132kV
    - Augmentation of Luddenham ZS
    - Establishment of Austral ZS in permanent configuration
    - Establishment of the second Broader Western Sydney Employment Lands ZS (Commence construction). It is anticipated that this new zone substation will be within the Sydney University Landholdings in the Elizabeth Drive Corridor
- Continue Joint Planning with TransGrid on the establishment of the 132kV switching station and on the later establishment of the 330/132kV Kemps Creek BSP.
- Engage in discussions with the Department of Planning and Environment to ensure that zone substation sites and line corridors are included in the development of master plans for Western Sydney Priority Growth Area Sector precincts.

- Continue discussions with the Department of Planning and Environment on an ongoing basis to ensure that Endeavour Energy's long term plan for the establishment of major infrastructure is in line with projected development timing.

2.0 Introduction

The aim of this report is to establish a supply strategy for the Western Sydney Priority Growth Area (WSPGA). Figure 1 below shows the outline of the WSPGA. This growth area includes the area that was previously referred to as the Broader Western Sydney Employment area (BWSEA) and the northern part of the former South West Growth Sector. These former boundaries are illustrated in Figure 2.

While precincts have not been formally established, the area includes the proposed Western Sydney Airport and 'precincts' identified in previous studies and advice received from planning authorities. These are indicated in the next section.

Throughout this report there are occasions where Endeavour Energy may use the term "transmission" to describe some sub-transmission assets due to internal naming convention, however it does not own and operate "transmission" network assets as per the definition in the National Electricity Rules.

This area plan also includes the Western Sydney Employment Area identified in Figure 1.

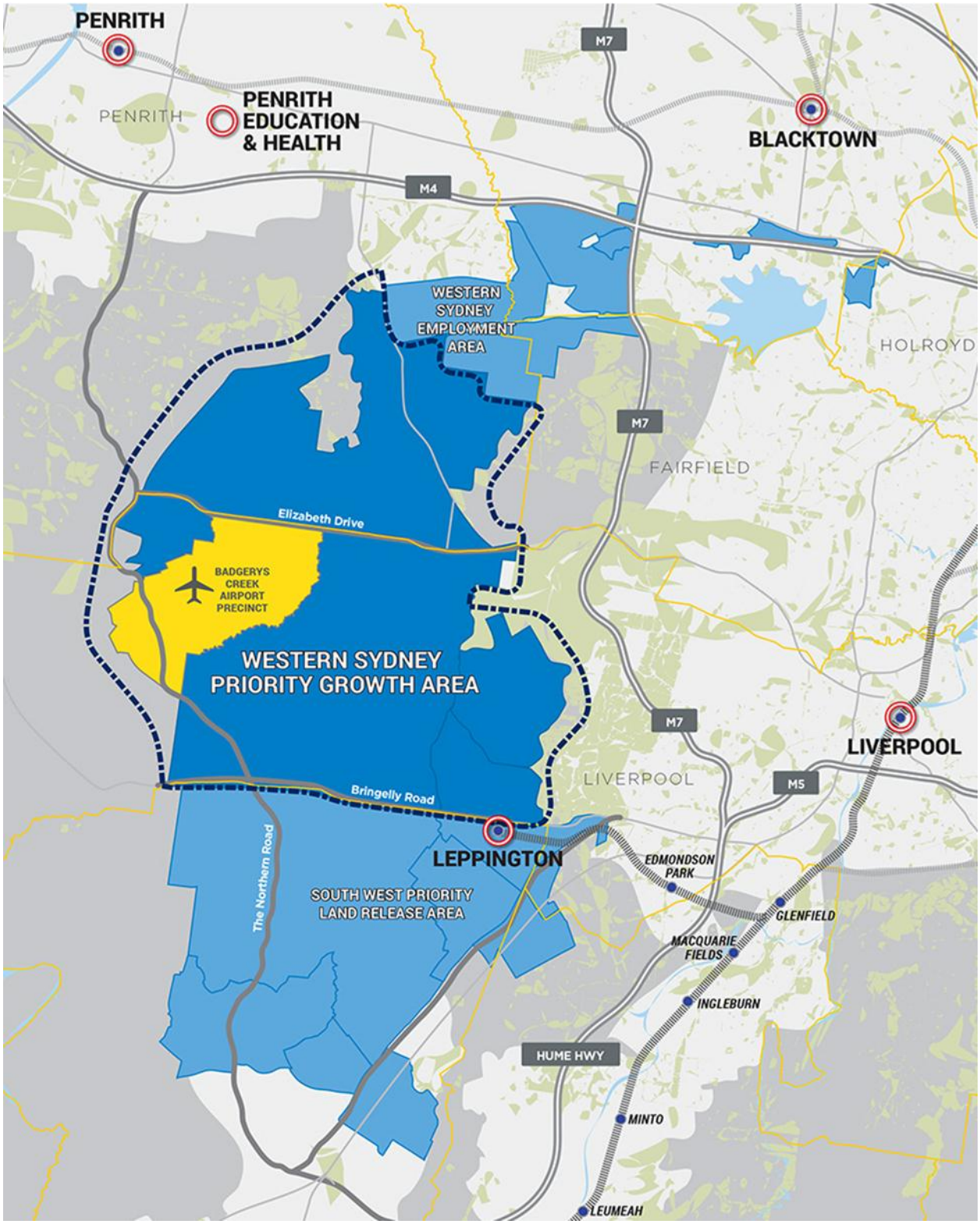


Figure 1 - Western Sydney Priority Growth Area and Western Sydney Employment Area

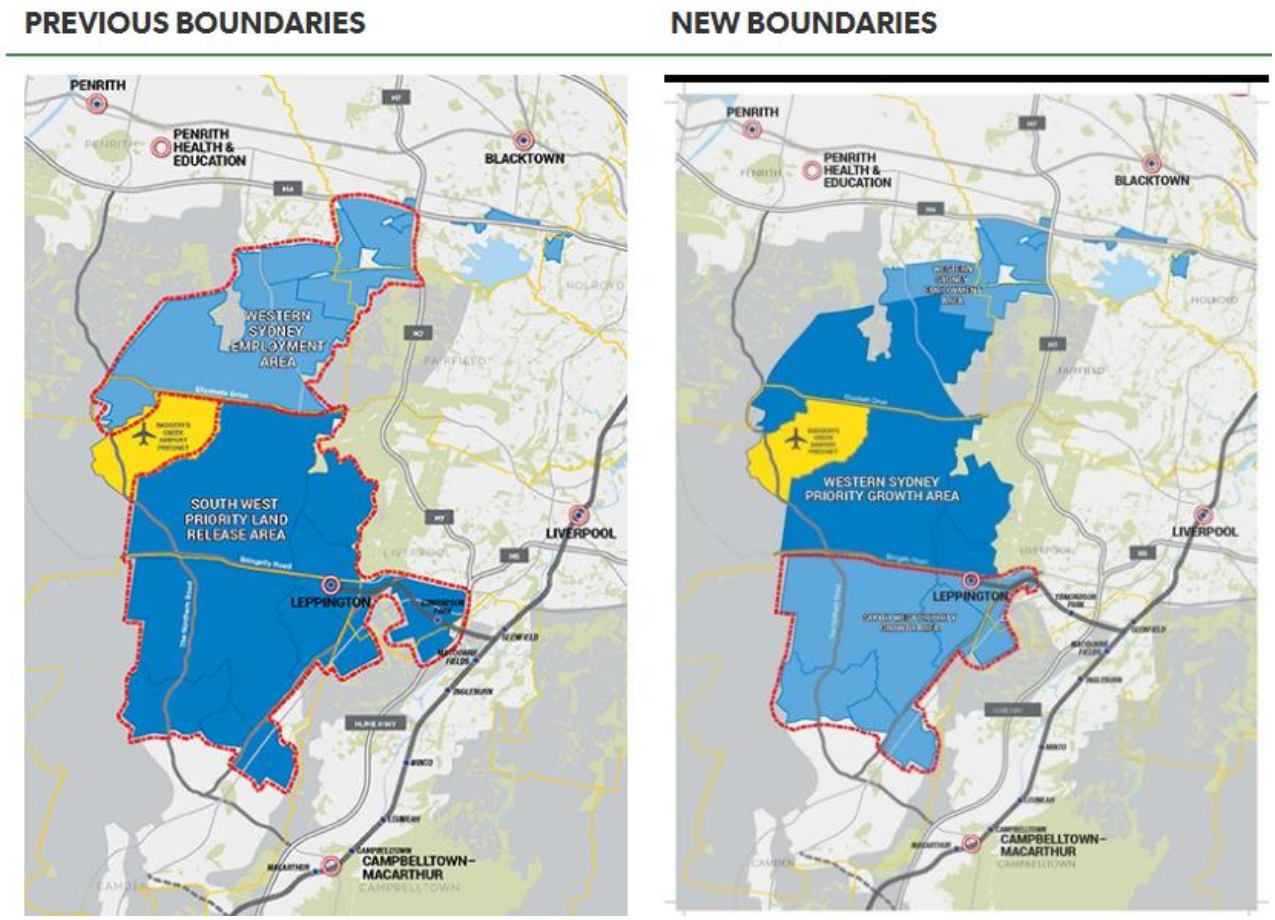


Figure 2 - Boundaries of the former BWSEA and the new Western Sydney Priority Growth Area

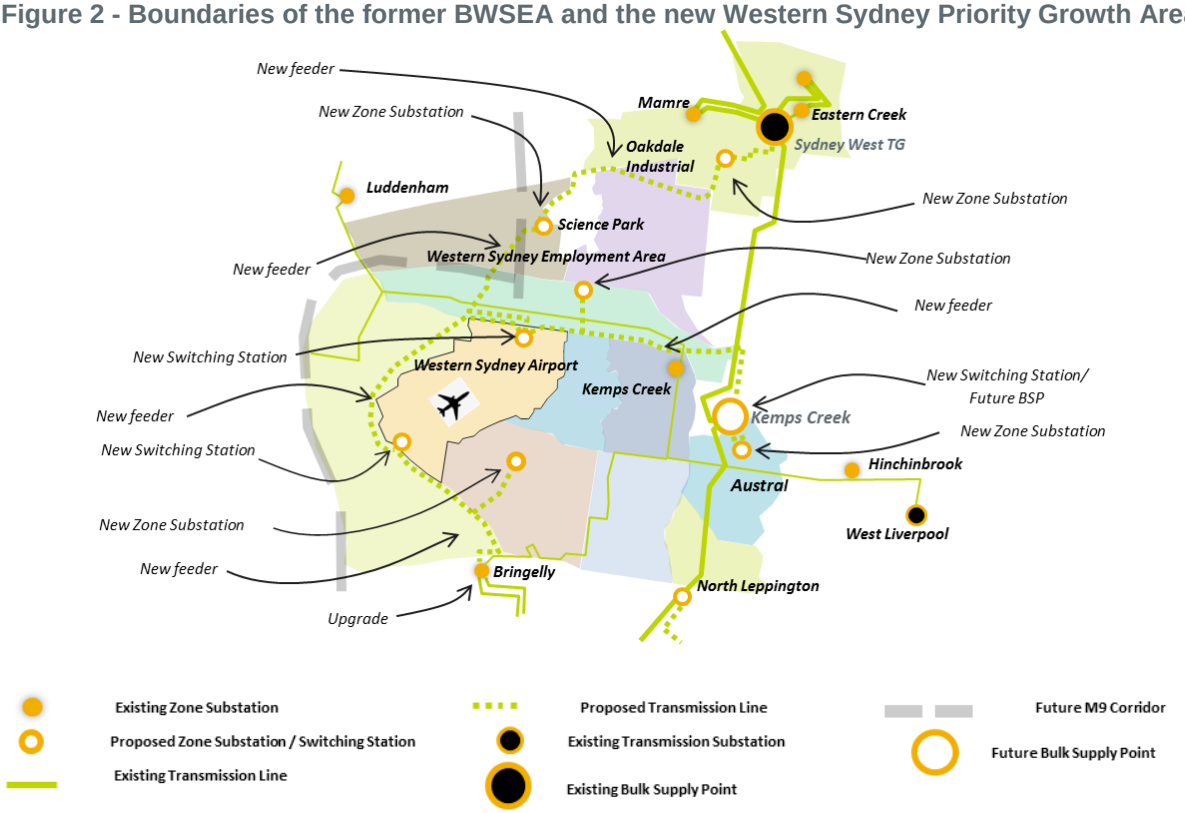


Figure 3 - Western Sydney Priority Growth Area Plan

2.1 Related Area Plans

This Western Sydney Priority Growth Area (WSPGA) Plan shares common elements of the network strategy with the current South West Priority Growth Area (SWPGA) Plan and a previously published Blacktown Area Study Report.

A revised South West Priority Growth Area Plan was published in March 2018. The document requires a number of 132/11kV zone substations to be established in its ultimate configuration. Some of these are in various stages of completion. The Plan relies on two 132kV injection points, Macarthur BSP and a new (yet to be approved) 132kV injection point at the existing Transgrid 500/330kV Kemps Creek Substation. The ultimate configuration is shown in Figure 4.

In 2008 the Blacktown Area Study Special Report Study No. S454 was published. The area study investigated options to supply the original WSEA and identified the need for four zone substations, the existing Eastern Creek ZS, Mamre ZS, North Eastern Creek ZS and a new Archibold ZS. This area is being absorbed within this area plan. Of these three substation have already been established. The proposed Oakdale Southpipe ZS will replace Archbold ZS in the strategy and its location moves south of Sydney West BSP.

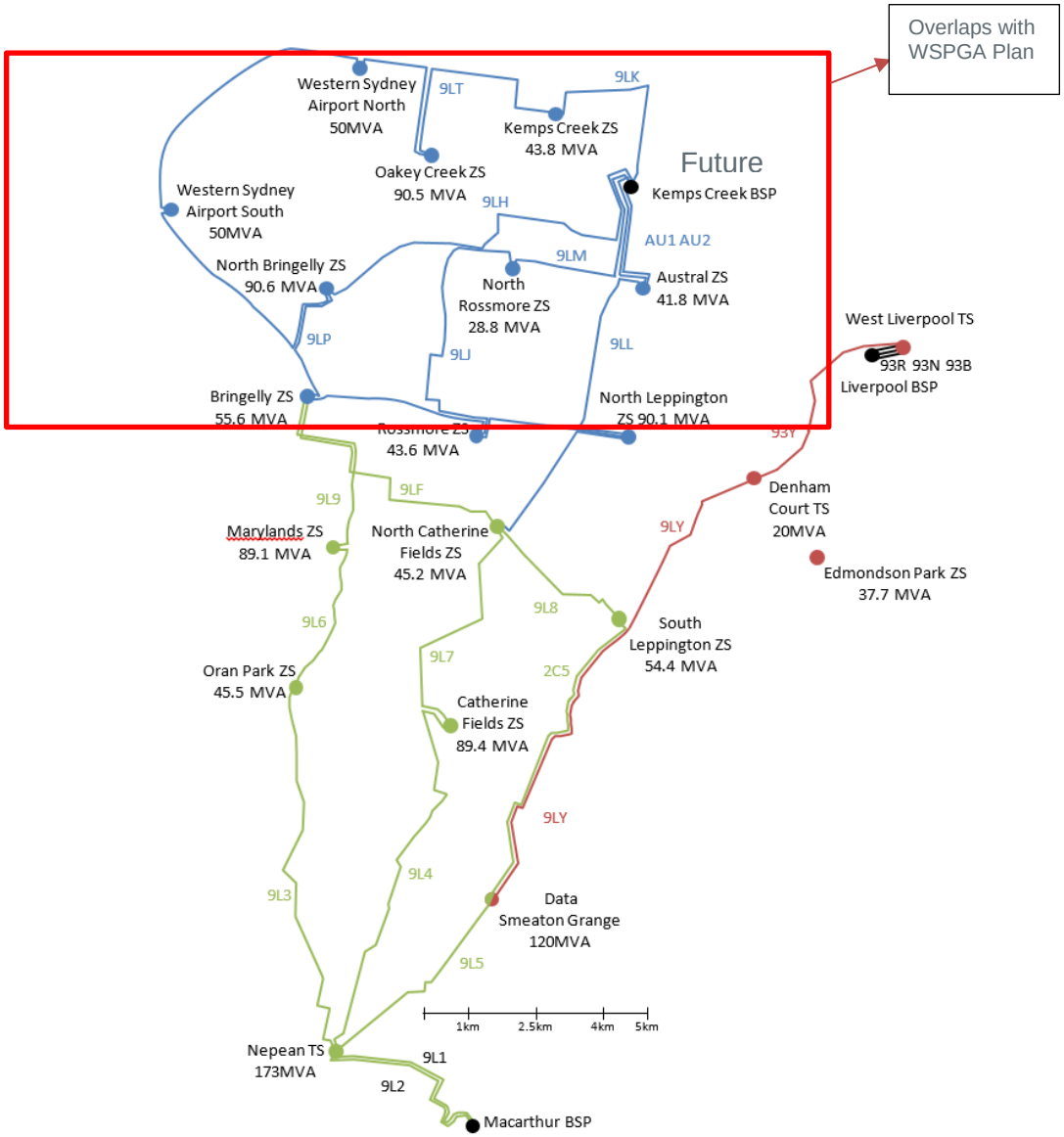


Figure 4 - South West Priority Growth Area Plan

3.0 Western Sydney Priority Growth Area Precincts

3.1 Broader Western Sydney Employment Area

The NSW Government released "A Plan for Growing Sydney" in December 2014 and an extension of the "Draft Metropolitan Strategy for Sydney to 2031" report which was released in March 2013. The most significant change from the Draft Strategy is the inclusion of the plans for the second Sydney Airport at Badgerys Creek, and identifies this as the single largest infrastructure catalyst for employment growth in the history of Western Sydney.

In November 2016, the Greater Sydney Commission released a draft amendment to update "A Plan for Growing Sydney". This included the announcement of the Western Sydney Deal which describes the vision of Sydney becoming a metropolis of three cities – the Eastern City which largely exists today, the Central City built around Parramatta by 2036 and finally the vision for an "Aerotropolis" referred to as the "Western City" by 2056. This was confirmed in the March 2018 release of the plan "A Metropolis of Three Cities – the Greater Sydney Region Plan". Refer to Figure 5.

Further details on the Western City are being progressively released by the Commission. It is expected that planning details for the Western Sydney City will be based on previous work carried out by the Department of Planning. This area plan is based on previous work associated with the Broader Western Sydney Employment Area and modified as appropriate in response to announcements since then. A structure plan (Figure 6) was released in March 2018. Figure 7 outlines the infrastructure commitments announced for the Western Sydney Airport and surrounding areas.

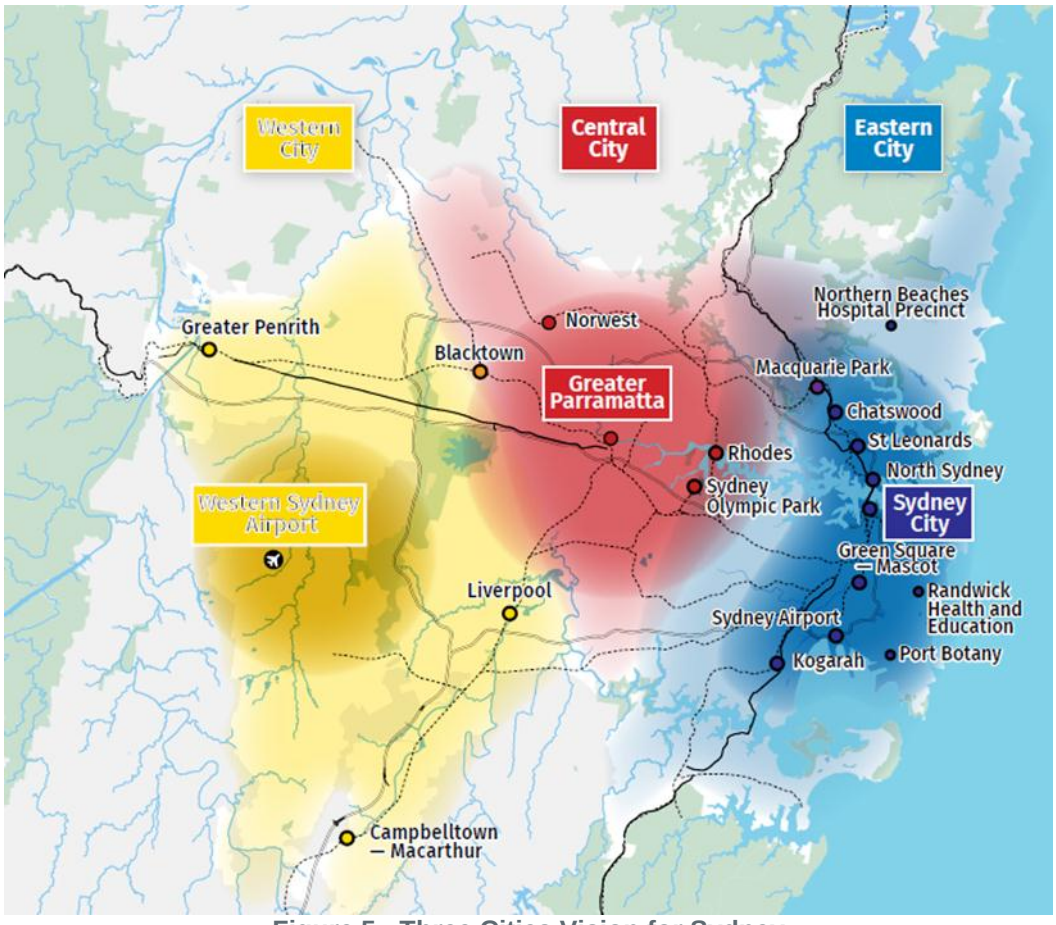


Figure 5 - Three Cities Vision for Sydney

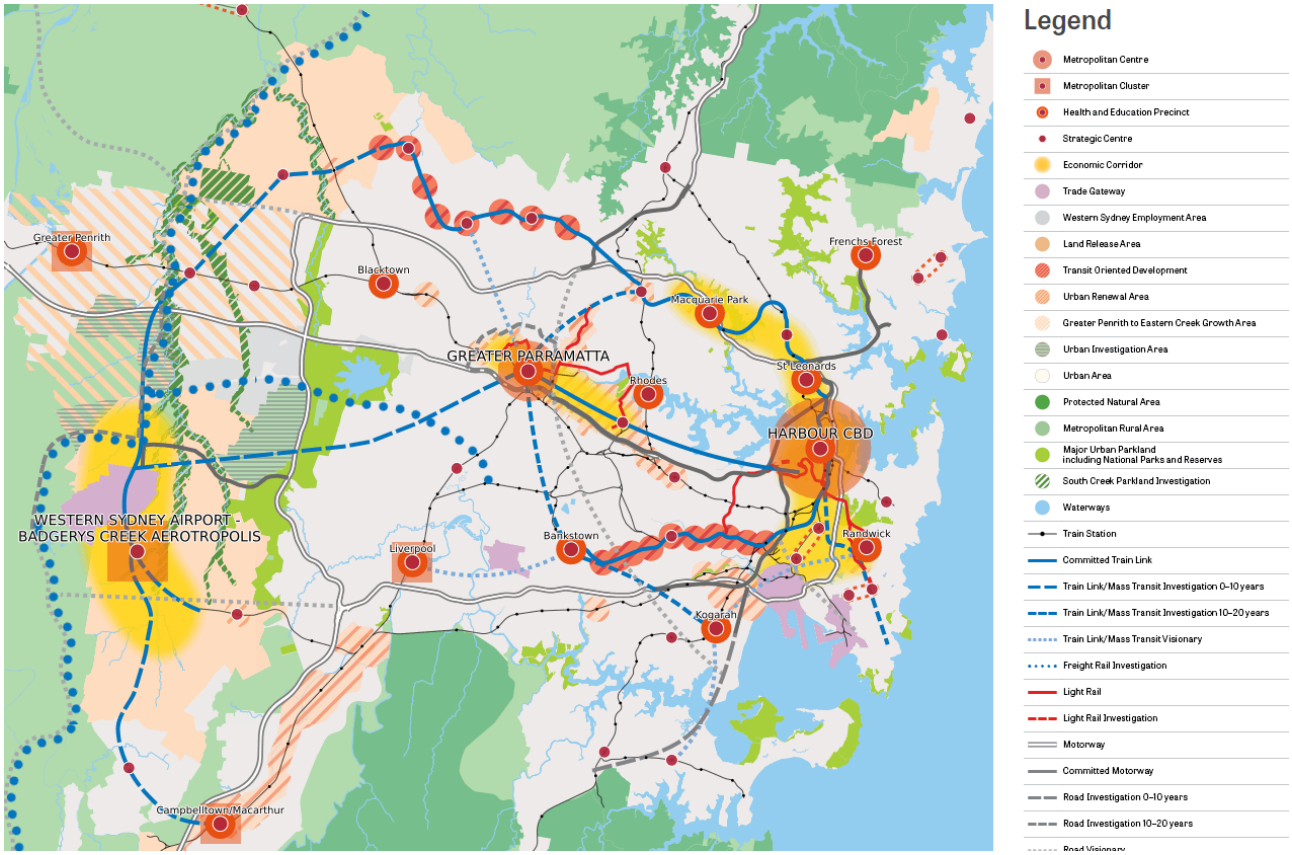


Figure 6 - Structure Plan for Greater Sydney

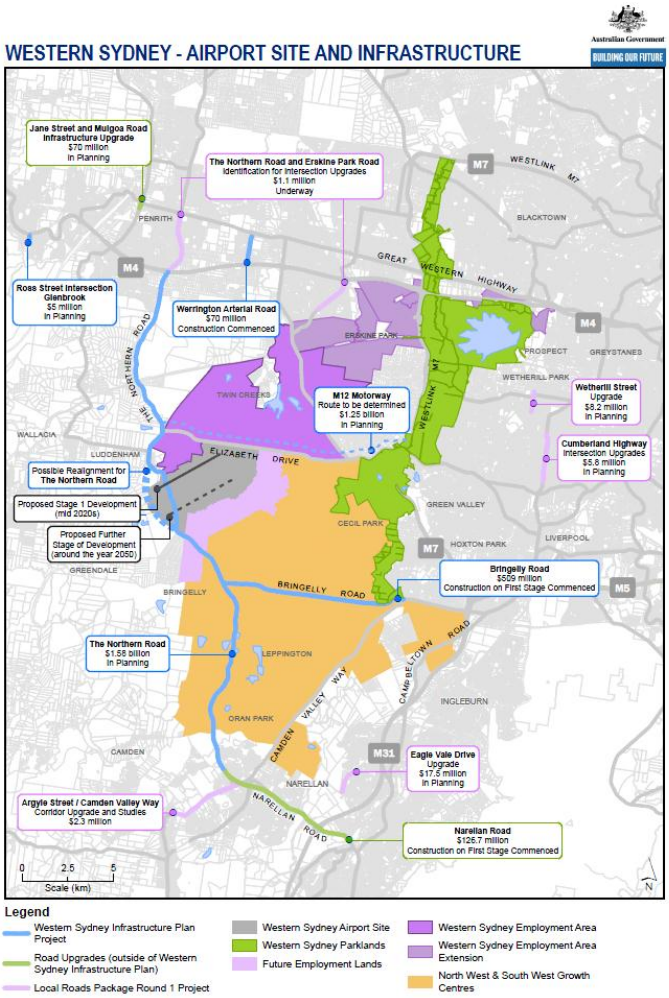


Figure 7 - Western Sydney Airport and related Infrastructure Commitments

The NSW government engaged consultants GHD who produced a potential development profile in 2014 which adopted the philosophy of development progressing from existing Western Sydney Employment Area (WSEA). Notably, at the time this work was done, the Western Sydney Airport had not been announced. Development drivers have changed considerably since this time.

For the purpose of this Area Plan, Endeavour Energy has divided the Western Sydney Priority Growth Area into a number of precincts based early consultation with the Developers, Department of Planning and Environment and the Greater Sydney Commission. As land use plans for the area develop, these plans will be updated and revised. However, the overall supply strategy is not expected to materially change.

Precinct	Estimated Developable Area (ha)
Existing WSEA	1750
Badgerys Creek	707
Science Park	753
Mamre Road	612
Elizabeth Drive Corridor	519
South Creek North	309
Kemps Creek	476
Rossmore	535
Agriculture and Agribusiness	1776
Western Sydney Airport	1200
Austral	522
North Leppington WSPGA only	784
Total	**9,943**
WSEA only	**1,750**
WSPGA only	**8,193**

4.0 Network Need

4.1 Network Capacity

Typical load densities for industrial and residential land have been used to derive an ultimate demand profile for the Western Sydney Priority Growth Area as well as the original Western Sydney Employment Area which is not officially part of the WSPGA. The total undiversified forecast demand for the WSPGA is shown in Table 3 below.

Precinct	Employment Lands Demand MVA	Residential Demand MVA	Total MVA
Existing WSEA	210	0	210
Badgerys Creek	16	26	42
Science Park	84	10	94
Mamre Road	73	0	73
Elizabeth Drive Corridor	62	0	62
South Creek North	37	0	37
Kemps Creek	23	54	78
Rossmore	13	102	115
Agriculture and Agribusiness	107	0	107
Western Sydney Airport	60	0	60
Austral	2	46	48
North Leppington WSPGA only	26	28	55
Total	**714**	**266**	**980**
WSEA only	**210**	**0**	**210**
WSPGA only	**504**	**266**	**770**

Zone Substation (Existing firm capacity)	Supplying Precinct (% allocated to ZS)	Total New Load (MVA)	Ultimate ZS Load (MVA)	Unserviceable Load (MVA)
Eastern Creek ZS (45MVA)	Mamre Road (50%)	37	116	71
Bringelly ZS (19MVA)	Badgerys Creek (100%)	211	222	203
	Rossmore (100%)			
	Agriculture Agribusiness (50%)			
Kemps Creek ZS (25MVA)	Kemps Creek (100%)	237	264	239
	South Creek North (100%)			
	Elizabeth Drive Corridor (100%)			
	Western Sydney Airport (100%)			
Luddenham ZS (15MVA)	Science Park (100%)	148	162	147
	Agriculture Agribusiness (50%)			
Mamre ZS (90MVA)	Mamre Road (50%)	37	105	15
North Eastern Creek ZS (45MVA)	WSEA Remainder	42	62	17
South Leppington (0MVA)	Austral & Leppington North	132	186	132
Total		**842**	**1117**	**824**

Table 1 - Zone Substation, Precincts, Ultimate Loads

Table 1 illustrates that there is insufficient capacity to supply the precincts within the Western Sydney Priority Growth area. Some of the shortfall in capacity can be provided with the augmentation of the existing substations such as augmentation of Bringelly Zone Substation and augmentation of Kemps Creek Zone Substation to 132kV.

4.2 Renewal Needs

The existing zone substations that provide supply in the area and their age and renewal needs of is summarised below in Table 2. The table shows that there are limited renewal needs in the area and these needs have minimal impact on determining the ultimate supply strategy for increased capacity.

Zone Substation	Current age of the asset (years)	Condition comments
Bringelly ZS	31	Currently no renewal needs
Eastern Creek ZS	14	Currently no renewal needs
Horsley Park ZS	52	Auxiliary switchgear being replaced. No other short term renewal needs.
Kemps Creek ZS	50	Recently refurbished. Currently no renewal needs
Luddenham ZS	56	Auxiliary switchgear and 11kV circuit breaker trucks scheduled for replacement within the next five years.
Mamre ZS	17	Currently no renewal needs, third 45MVA transformer installed under PR559.
North Eastern Creek	12	Currently no renewal needs

Table 2 - Renewal Needs

5.0 Study Design Considerations

Most of the existing electricity infrastructure in the study area is of a light, rural nature and is limited in its ability to supply any load arising from development of the Western Sydney Priority Growth Area. Major infrastructure will need to be established prior to developments being completed, particularly the Western Sydney Airport and developments that will support the airport. It may not be possible to provide supplies to initial phases of development from the existing infrastructure.

Due to the difficulties in establishing overhead electricity infrastructure, particularly high capacity lines, the following basic design considerations have been used in the determination of a suitable network topology:

a) Lines should be to the current Endeavour Energy standards, namely single pole lines with line post insulators using a single conductor wherever possible.
b) Mesh 132kV is preferred, but changeover schemes are acceptable.
c) The use of standard capacity overhead feeders will allow standard underground installations where required.
d) Existing lines and easements should be used wherever practicable. Feeder 93X (Sydney West to Nepean tee Bringelly) traverses part of the development area to the east. In addition, parts of 33kV feeder 512 (Kemps Creek to Luddenham tee Bringelly) are constructed at 132kV and should be used for this purpose where possible.

The use of 11kV as the distribution voltage. Although a majority of the existing 11kV in the area is of light, rural design, there are enough assets in place to make any conversion to an alternative distribution voltage difficult, involving complex changeover procedures and possibly lengthy and multiple interruptions to customers

6.0 Existing Supply Arrangements

6.1 Description of the network

Endeavour Energy is supplied in this region at 132kV from primarily from Transgrid owned Bulk Supply Points at Sydney West and Macarthur. The 132kV feeder 93X that runs between Sydney West BSP and Nepean TS in the Macarthur system runs along the eastern fringe of the Western Sydney Priority Growth Area. In addition to this, 33kV Feeder 512 runs through the area from West Liverpool TS to Bringelly ZS, with a tee to Kemps Creek ZS. Feeder 465 is another 33kV feeder in the area that runs between Luddenham ZS and Kemps Creek ZS, with a tee to North Warragamba ZS. Both 33kV feeders are already constrained.

The original WSEA or Precinct A, where development is already underway, is serviced by Eastern Creek ZS, Mamre ZS and North Eastern Creek ZS. The closest existing zone substations to the expanded WSPGA are Bringelly ZS, Kemps Creek ZS and Luddenham ZS. These zone substations are on either the Eastern, Western or Southern border of the expanded WSPGA.

Figure 8 below shows the existing transmission and sub transmission network surrounding the WSPGA area and the location of existing zone substations. Also shown are the Transgrid feeders traversing the WSPGA and the surrounding Transgrid Bulk Supply Points. The WSPGA region is currently serviced by a very sparse 33kV network which feeds a weak rural 11kV distribution network. The existing network cannot service the significant step change in loads that will materialise because of the rezoning and developments surrounding the Western Sydney Airport.

The network in the area has the following characteristics:

- The network presently serves a mixture of mainly rural residential and some industrial areas;
- The network includes :
    - Three 33/11kV zone substations around the perimeter of the BWSEA area (Luddenham, Horsley Park and Kemps Creek ZSs) supplying existing non-BWSEA loads;
    - One hybrid 132/11 33/11kV zone substation (Bringelly ZS) also at the perimeter of the WSPGA supplying existing non-WSPGA loads
    - Three 132/11kV zone substations (Mamre, Eastern Creek, North Eastern Creek ZSs) all of which are concentrated around existing Precinct A;
- The network is comprised mainly of overhead lines operating at 132kV (with some underground cables) close to precinct A and 33kV mainly overhead but with some underground cables;

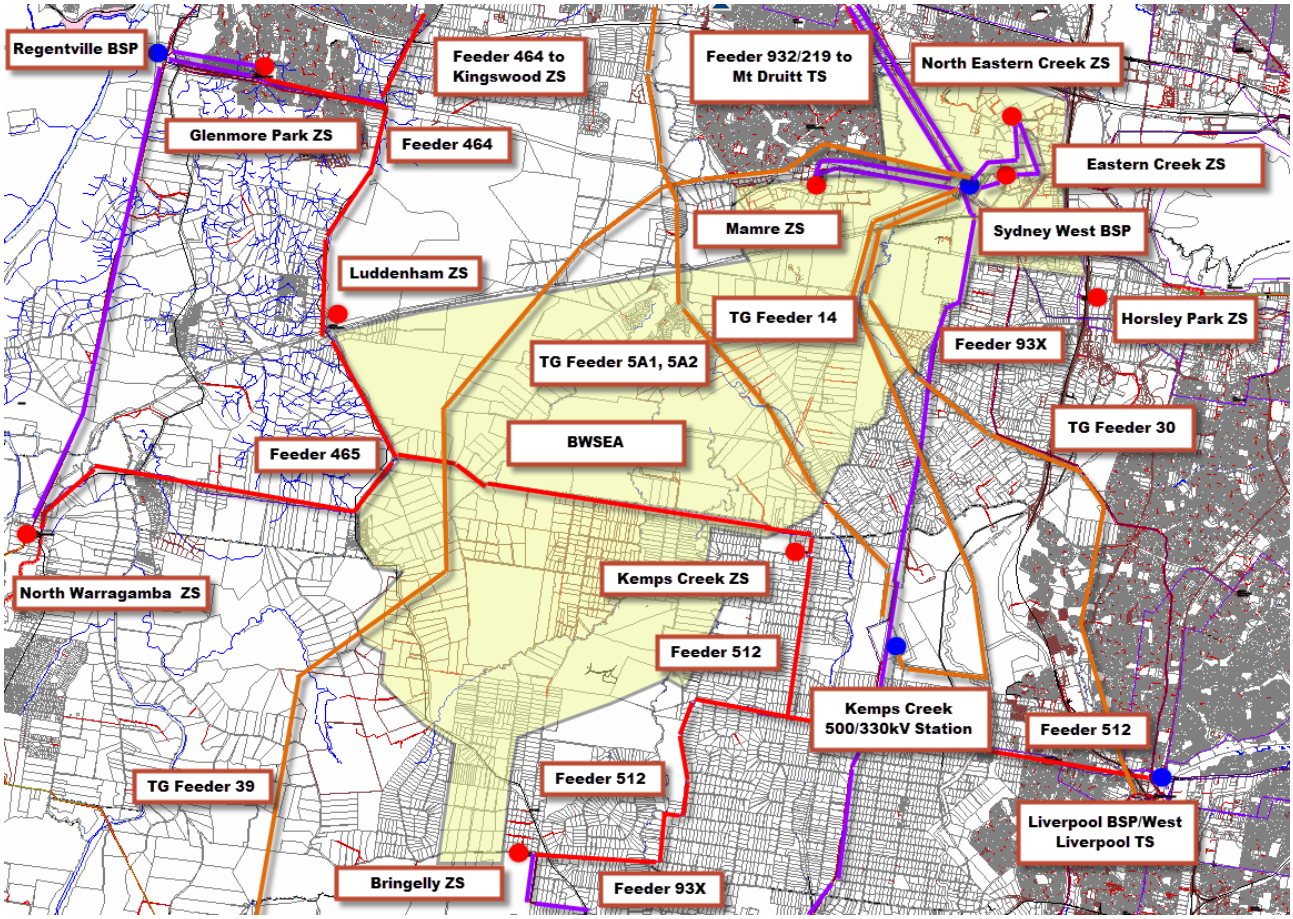


Figure 8 Transmission/Sub Transmission Network Surrounding WSPGA

6.2 Sub-transmission Feeder Capacities

Table 3 shows each sub-transmission line in the area along with the contingency demand and the associated rating.

Feeder	Voltage (kV)	Rating (MVA)	Contingency Load (MVA)
93X	132	200	103.9
465 Luddenham ZS to Tee	33	21	24
465 Tee to Kemps Creek ZS	33	21	24
512 Tee Kemps Creek ZS	33	21	26

Table 3 - Existing 132kV and 33kVFeeder Ratings

6.3 Substation capacities

Table 4 below shows the zone substations that supply the WSPGA, their transformer arrangements and their firm nameplate capacities.

Zone Substation	Voltage (kV)	Transformer arrangement	Firm transformer nameplate capacity (MVA)
Bringelly ZS	132/11, 33/11	1 x 25MVA, 1 x 19MVA	19
Eastern Creek ZS	132/11	2 x 45MVA	45
Horsley Park ZS	33/11	2 x 25MVA	25
Kemps Creek ZS	33/11	2 x 25MVA	25
Luddenham ZS	33/11	2 x 15MVA	15
Mamre ZS	132/11	3 x 45MVA	90
North Eastern Creek	132/11	2 x 45MVA	45

Table 4 Zone Substation Capacities

Table 5 below shows the TransGrid owned bulk supply points that supply the network surrounding BWSEA, their transformer arrangements and their firm capacities.

Bulk Supply Point	Voltage (kV)	Transformer arrangement	Firm transformer capacity* (MVA)
Liverpool BSP	330/132kV	3 x 375MVA	800
Regentville BSP	330/132kV	2 x 375MVA	400
Sydney West BSP#	330/132kV	5 x 375MVA	1600
Macarthur	330/132kV, 330/66kV	1 x 330/132kV 375MVA 1 x 330/66kV 250MVA	250

Table 5 Bulk Supply Point Configuration and Capacities

Note:* TransGrid have advised that the 375MVA transformers are capable of supplying 400MVA under contingency conditions.

6.4 Operational issues

There are a number of operational constraints that apply to the WSPGA area network. Some of these constraints will need to be addressed in the options considered:

- Luddenham ZS is supplied normally from Regentville TS through a 132/33kV transformer at Glenmore Park ZS by feeder 464. During an outage of feeder 464 Luddenham ZS is supplied by feeder 512 West Liverpool TS to Kemps Creek ZS tee Bringelly ZS.
- North Warragamba ZS is supplied by 132kV 937 under normal conditions with a changeover to feeder 465 under an outage of feeder 937.
- Kemps Creek ZS is supplied normally by feeder 512 with a changeover to feeder 465 under an outage of feeder 512.
- Bringelly ZS is supplied normally from feeder 93X with a changeover to feeder 512 under an outage of feeder 93X.
- Transformer one of Kingswood ZS is supplied by feeder 464 during summer peak periods.
- Mt Druitt TS is supplied normally from Sydney West BSP. However, feeder 933 is set up to supply Mt Druitt TS Transformer No 3 after the first forecast hot day of each season, to prepare for possible loss of feeder 932. Feeder 936 will supply Mt Druitt TS Transformer No 1 on detected overload on feeder 939; however during peak summer periods transformer three is supplied from Regentville BSP (through Penrith TS busbar) to manage the potential load at risk under an outage of feeder 932.

7.0 Demand Management Strategy

In accordance with *Company Policy 9.2.8 Demand Management*, Endeavour Energy investigates demand management (DM) options for all major projects meeting the criteria as stipulated in the National Electricity Rules (NER) Chapter 5 Part B – Network Planning & Expansion. The Rules state all distribution network limitations with a credible network option greater than $5 million must be screened for non-network (demand management) options and, if feasible, investigate non-network alternatives via a RIT-D consultation process.

The screening test is applied to ascertain whether it is feasible to expect the number and type of electricity customers driving the identified electricity network limit will respond to demand management initiatives. Generally, demand management can be effective in deferring network augmentation where demand growth is organic as part of normal customer behaviour. Where the area is a substation “green field” site, demand management has to change the demand of future customers to be effective. This is the case with the WSPGA, which mainly consists of the conversion of rural lands to urban and industrial use. Demand management will not avoid the need to establish or augment electricity assets in order to supply the WSPGA but may have the potential to defer future network augmentation.

Demand management’s ability to postpone the need to augment the electricity network in the future depends on the type of demand management program and the uptake by customers. Programs may be either permanent or temporary demand reducing initiatives. Permanent demand reduction is preferred in the early stages of the program where temporary demand reduction initiatives may be utilised as the peak demand is approaching network capacity limits. Examples of temporary demand reducing initiatives include peak time rebate and air conditioning cycling in the residential sector and load curtailment programs in the industrial/commercial sectors. Permanent demand reduction initiatives may include dynamic pricing in the residential sector and efficient appliances and lighting in the industrial/commercial sectors.

8.0 Recommended Supply Strategy

Various supply arrangements were considered in this study. Options included both 132kV and 33kV sub-transmission arrangements to supply the expected ultimate demand of the WSPGA. As there is very little existing transmission infrastructure servicing this area, careful consideration has been given to the timelines associated with the Western Sydney Airport and the practical orderly and progressive development of the transmission network to service the surrounding regions. This section will outline the aspects of the favoured option.

8.1 Initial Supplies

Initial supply to the airport for the purposes of commencement of construction works is available from Kemps Creek Zone Substation. Minor development in areas close to the Kemps Creek Zone Substation in the Elizabeth Drive Corridor may be possible through distribution supplies from Kemps Creek ZS. Initial supplies into the existing WSEA precinct from Eastern Creek ZS are now already facing constraints and will be relieved by the construction of Southpipe ZS. Initial supplies immediately to the South and East of the airport site will be difficult without further investments.

8.2 Proposed Network Topology

Given the anticipated load of the Western Sydney and South West Priority Growth Area, and the geographical spread of this load across the various precincts, a network topology has been developed to service the development by best utilising the existing assets. Further, the proposed network is broadly based on the design requirements of Section 5.0 and Endeavour Energy’s Network Configuration Standard.

The recommended strategy needs to link with the South West Priority Growth Area strategy as there are elements common to both.

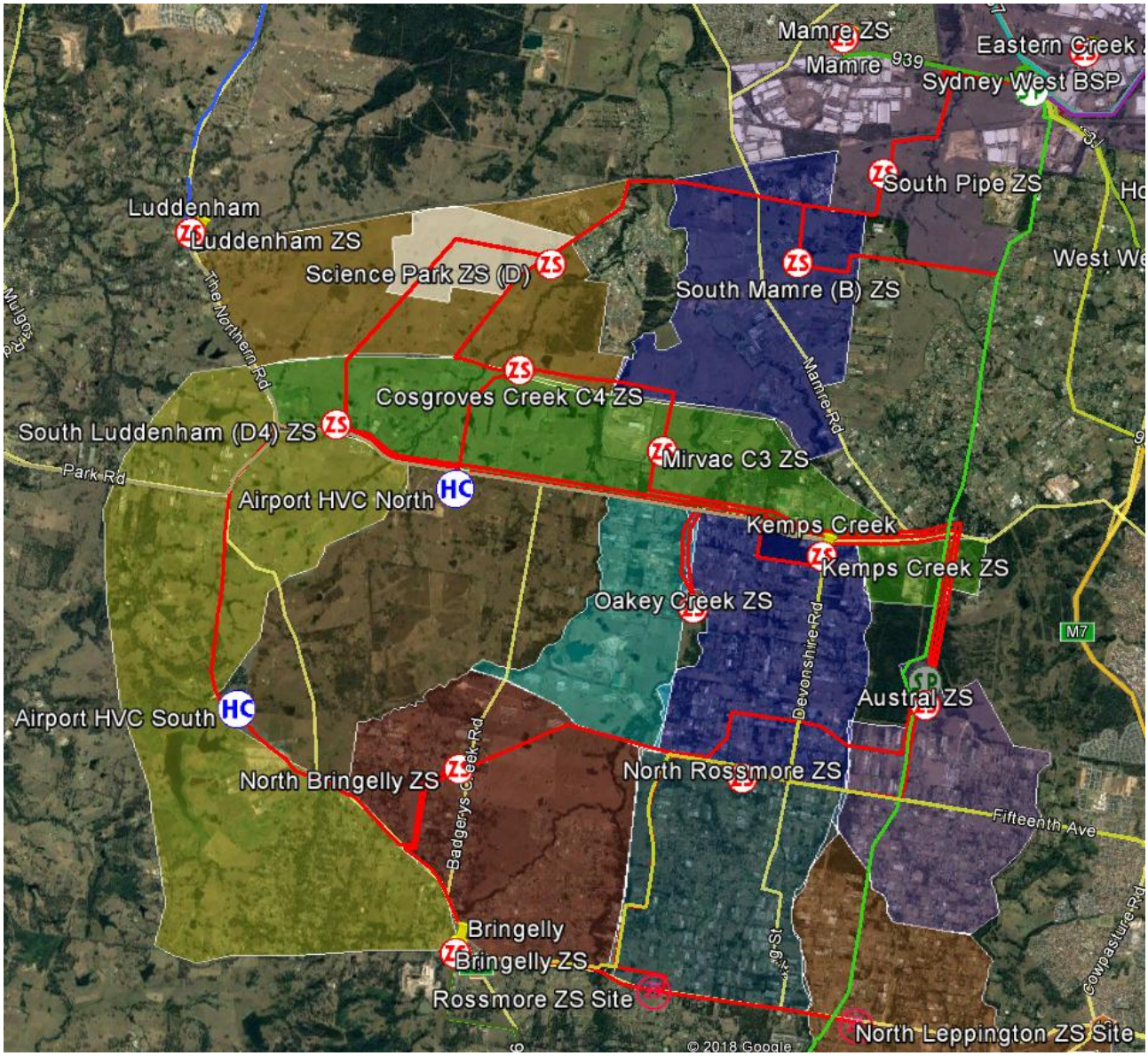


Figure 9 - Proposed Ultimate Network Topology

Substation	Configuration	Year Required	Real Cost FY19 ($M)
2020-2024 Regulatory Period – Non Airport Works			
Rossmore ZS	Site Purchase	2024	3.0
North Rossmore ZS	Site Purchase	2023	3.0
North Bringelly ZS	Site Purchase	2024	3.5
Kemps Creek SS	4 bay Switching Station	2023	By TransGrid
Austral ZS (Interim)	1 x 15MVA	2021	2.4
Southpipe ZS	2 x 45 MVA 132/11kV Tx 3 TR FDR	2022	19.7
Southpipe ZS	132kV Feeder from Sydney West BSP	2022	7.6
Science Park ZS	2 x 45 MVA 132/11kV Tx 3 TR FDR	2022	19.7
Science Park ZS	132kV Feeder from Southpipe ZS	2022	20.8
Mirvac ZS (BWSEA #1)	132kV Feeder from Kemps Creek SS	2024	19.7
Mirvac ZS (BWSEA #1)	2 x 45 MVA 132/11kV Tx 3 TR FDR	2024	3.8
Total			**$103.2**

Substation	Configuration	Year Required	Real Cost FY19 ($M)
2020-2024 Regulatory Period – Airport Works			
WSA South	132kV Feeder from Kemps Creek BSP	2024	10.6
WSA North	132kV Feeder from Kemps Creek BSP	2024	10.8
WSA Link	132kV Feeder from WSA North to WSA South	2024	17.2
WSA North SS	Indoor 132kV Switching Station	2024	8.5
WSA South SS	Indoor 132kV Switching Station	2024	8.5
Bringelly ZS	132kV Upgrade	2024	5.7
Total			**61.3**

Substation	Configuration	Year Required	Real Cost FY19 ($M)
2025-2029 Regulatory Period			
Kemps Creek BSP	2 x 375 MVA330/132kV Tx 8 TR FDR	2028	By TransGrid
Kemps Creek BSP	Connection works	2028	4.3
Rossmore ZS	2 x 45 MVA 132/11kV Tx 3 TR FDR	2030	10.0
North Bringelly ZS	3 x 45 MVA 132/11kV Tx 3 TR FDR	2028	22.1
Bringelly ZS	2 x 45 MVA 132/11kV Tx 3 TR FDR	2028	20.7
Kemps Creek ZS	2 x 45 MVA 132/11kV Tx 2 TR FDR	2026	29.7
Luddenham ZS	2 x 35 MVA 33/11kV Tx 3 TR FDR	2026	17.1
Austral ZS	2 x 45 MVA 132/11kV Tx 3 TR FDR	2026	22.6
Cosgroves Creek ZS (Sydney Uni) WSEA #2	2 x 45 MVA 132/11kV Tx 3 TR FDR	2029	24.5
Total			**$151.0**

Substation	Configuration	Year Required	Real Cost FY19 ($M)
>2030 Regulatory Periods			
South Mamre ZS	Site Purchase	2030	3.5
Rossmore ZS	2 x 45 MVA 132/11kV Tx 3 TR FDR	2031	10.7
North Rossmore ZS	2 x 45 MVA 132/11kV Tx 3 TR FDR	TBD	20.7
North Rossmore ZS	132 kV Feeders	TBD	24.6
South Mamre ZS	3 x 45MVA 132/11kV 3 TR FDR	TBD	20.7
South Mamre ZS	132kV Feeders	TBD	3.2
Oakey Creek	Site Purchase	TBD	3.5
Oakey Creek	3 x 45MVA 132/11kV 2 TR FDR	TBD	20.7
Oakey Creek	132kV Feeder Connections	TBD	9.1
South Luddenham ZS	3 x 45MVA 132/11kV 3 TR FDR	TBD	20.7
South Luddenham ZS	132kV Feeder Connections	TBD	23.8
Cosgroves Creek ZS (Sydney Uni) WSEA #2	132kV Feeder Connections	2029	6.5
Luddenham ZS	33kV Feeders	TBD	TBD
Total			**$167.7**

8.2.1 Bulk Supply Point

TransGrid had established Macarthur BSP for the purposes of supplying growth in the South West Priority Growth Area. However, Macarthur BSP will not have sufficient capacity to manage all new development in the South West and Western Sydney Priority Growth Areas, noting that Macarthur BSP will also supply the Greater Macarthur South Area (at 66kV). Initial supply from Sydney West BSP will be utilised prior to construction of a Bulk Supply Point to service the area. A future shortfall in BSP capacity is projected due to the loads being connected within the WSPGA and SWPGA.

Table 6 - BSP Capacity and Demand Outlook

Bulk Supply Point	Firm Capacity	2027	2037	2047	2047+
Liverpool	800	476	517	538	549
Macarthur 132kV TX	400	309	436	484	532
Regentville	400	306	306	306	306
Sydney West	1600	1366	1614	1937	2342

It has been established through joint planning with TransGrid that a 132kV switching station will initially be established at TransGrid's Kemps Creek 500/330kV substation in anticipation of later turning this substation into a 132kV bulk supply point for Endeavour Energy. This switching station will allow spare capacity within the Sydney West Bulk Supply point to be utilised to the point where a new bulk supply point is required. A bulk supply point will be required by the late 2020s.

However, due to developments in the WSPGA and SWPGA there is a requirement to develop the 132kV network that will supply the zone substations in these priority growth areas. The establishment of a 132kV switching station at Kemps Creek will facilitate the development of the 132kV network.

The following bulk supply point works are required as part of this strategy.

- Establish 132KV switching station at Kemps Creek Substation
- Establish 330/132kV bulk supply point at Kemps Creek Substation

8.2.2 Zone Substations

The following zone substation works are required to service the Western Sydney Priority Growth Area developments:

- Upgrade Kemps Creek ZS to 132/11kV
- Augment Luddenham ZS
- Establish Southpipe ZS
- Establish South Mamre ZS (Location B)
- Establish Science Park ZS (Location D)
- Establish Mirvac ZS (Location C3)
- Establish Cosgroves Creek (Sydney Uni) ZS (Location C4)
- Establish South Luddenham ZS (Location D4)
- Establish Oakey Creek ZS (Rename to South Creek ZS)
- Establish North Bringelly ZS
- Establish North Rossmore ZS
- Establish Austral ZS

The following zone substations works are shared with the South West Priority Growth Area Plan.

- Upgrade Bringelly ZS to full 132/11kV
- Establish Rossmore ZS

Two of the new zone substations, Southpipe ZS and later the South Mamre ZS, are to be supplied at 132kV from the Sydney West BSP network as an extention to the developments already occurring in the Western Sydney Employment Area (WSEA). The option of supplying the Sydney Science Park ZS from Sydney West is also available and is likely to proceed as part of the Science Park development.

Two of the existing zone substations (Bringelly and Kemps Creek) are supplied, or backed up, at 33kV and will be augmented and converted to 132kV at an appropriate time.

The reconstruction of feeder 465 which occurs under the South West Sector strategy is extended to the airport HVC and beyond to South Luddenham ZS. A second 132kV feeder from Kemps Creek BSP to Cosgroves Creek ZS and South Luddenham ZS is also established, resulting in two transmission lines on Elizabeth Dr. A third feeder to be built as the road network develops, runs to the Mirvac Zone Substation from Kemps Creek and continues on to Cosgroves Creek

The ultimate loads on each zone substation have been estimated in Table 7 below.

Zone Substation	Precincts Supplied	Percentage	MVA	Ultimate Load MVA	Planned Configuration
Southpipe ZS	Existing WSEA	0.2	42	42	2 x 45 MVA
South Mamre ZS	Existing WSEA	0.2	42	101	3 x 45 MVA
	Mamre Road	0.8	59		
Kemps Creek ZS	Kemps Creek	0.35	27	40	2 x 45 MVA
	Elizabeth Drive Corridor	0.2	12		
Luddenham ZS	Science Park	0.1	9	44	3 x 25 MVA
	Other Loads outside of WSPGA		35		
Science Park ZS	Science Park	0.5	47	47	2 x 45 MVA
Mirvac (WSEL) ZS	Elizabeth Drive Corridor	0.5	31	46	2 x 45 MVA
	Mamre Road	0.2	15		
Cosgroves Creek (Sydney Uni) ZS	Elizabeth Drive Corridor	0.2	12	41	3 x 45 MVA
	Science Park	0.3	28		
South Luddenham ZS	Science Park	0.1	9	85	3 x 45 MVA
	Elizabeth Drive Corridor	0.1	6		
	Agriculture and Agribusiness	0.65	69		
Oakery Creek ZS	South Creek North	1	37	76	3 x 45 MVA
	Kemps Creek	0.5	39		
North Bringelly ZS	Badgerys Creek	1	42	52	3 x 45 MVA
	Agriculture and Agribusiness	0.1	11		
North Rossmore ZS	Rossmore	0.4	46	63	2 x 45 MVA
	Kemps Creek	0.15	12		
	Austral	0.1	5		
Austral ZS	Austral	0.9	43	55	2 x 45 MVA
	Rossmore	0.1	12		
North Leppington	North Leppington	1	54	102	3 x 45 MVA
	Rossmore	0.1	12		
	Other Loads outside of WSPGA	1	36		
Bringelly ZS	Agriculture and Agribusiness	0.25	27	56	2 x 45 MVA
	Other Loads outside of WSPGA		29		
Rossmore ZS	Rossmore	0.4	46	56	2 x 45 MVA
	Other Loads outside of WSPGA		10		

Table 7. ZS ultimate loads

.

Table 8 Load and Source of Supply for BWSEA and South West Sector Zone Substations

Zone Substation	Load (MVA)	Supply Source
South Pipe ZS	42	Sydney West BSP
South Mamre ZS	101	Sydney West BSP
Mirvac ZS	46	Kemps Creek BSP
Cosgroves Creek ZS	41	Kemps Creek BSP
Science Park ZS	47	Kemps Creek BSP
South Luddenham ZS	85	Kemps Creek BSP
Airport HVC	60	Kemps Creek BSP
Kemps Creek ZS	40	Kemps Creek BSP
Oakey Creek ZS	76	Kemps Creek BSP
Bringelly	56	Kemps Creek BSP/Macarthur BSP
North Bringelly	63	Kemps Creek BSP
North Rossmore	63	Kemps Creek BSP
Rossmore	56	Kemps Creek BSP
Austral	55	Kemps Creek BSP

In selecting a ZS site, particularly for a 90MVA ZS, consideration should be given to providing sufficient site frontage such that the cables to be connected to the ZS do not limit the firm capacity. Consideration needs to be given to not just the de-rating resulting from cables within the same ducts bank, but also the de-rating caused by adjacent duct banks.

8.2.3 Sub-transmission Network

The sources of supply for the WSPGA zone substations is Kemps Creek BSP as per the South West Sector Strategy, and Sydney West BSP.

This strategy requires the establishment of four transmission feeders heading north from Kemps Creek BSP. This will require the existing easement from Kemps Creek Substation to Elizabeth Dr to be extended from the present 30m.

The South West Sector strategy relies on establishing initial zone substations using the existing feeder 93X from Sydney West BSP to Nepean TS. The 132kV switching station at Kemps Creek relies on Feeder 93X as a supply source from Sydney West Bulk Supply Point.

The approximate quantity of line works required to address growth in this area as outlined in the proposed network topology are itemised in Appendix 3 and approximated to total 58km.

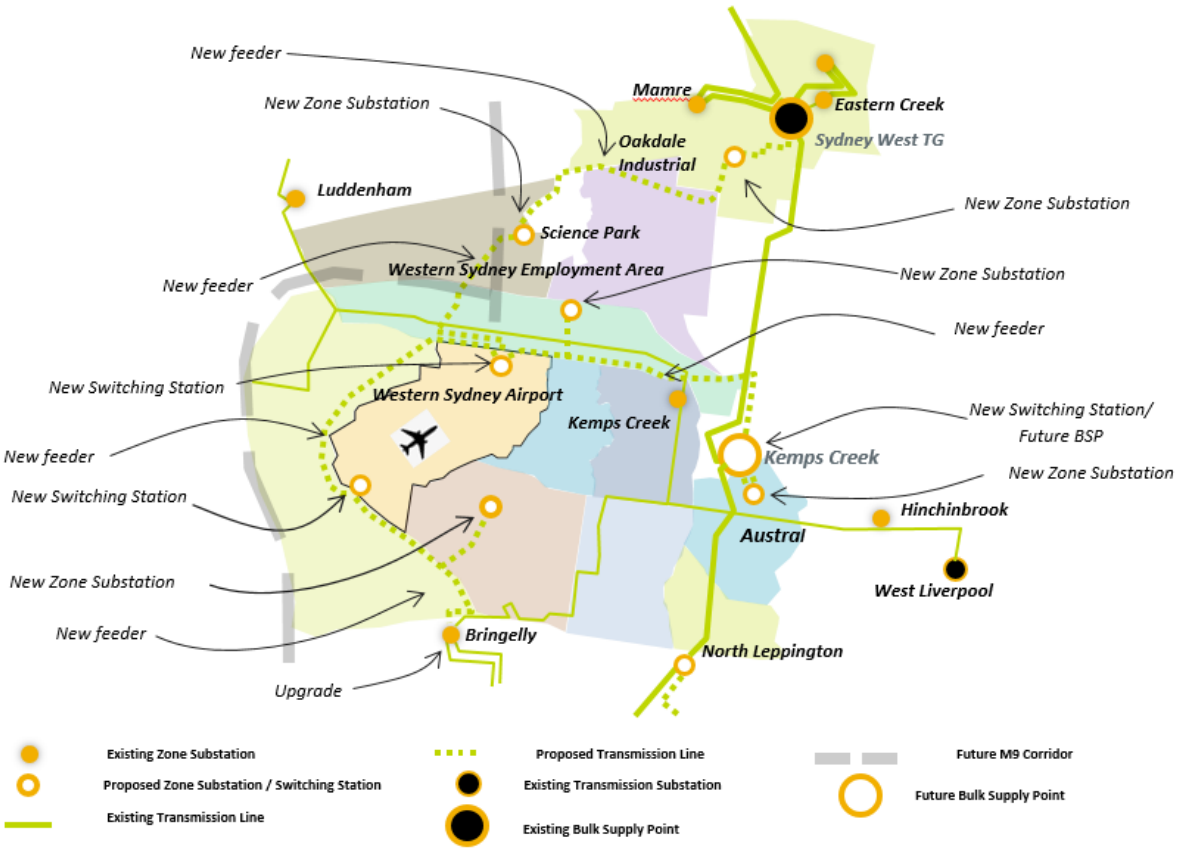
8.3 Potential Issues

The transmission line corridors especially along Elizabeth Drive and areas north of it is a recognised issue.

9.0 Staging

This section proposes network configurations that will allow for the staged implementation of the proposed ultimate network and cater for the expected short and medium-term network needs. It is Endeavour Energy's experience that staging of zone substations in industrial areas does not work as well as it does for zone substations in residential areas due to the large blocks of connecting load in industrial areas. Whereas growth in residential areas is usually incremental and allows Endeavour Energy sufficient time to react to demand growth signals in a 'just in time' approach, the lack of timely capacity being available in industrial lands often leads to stifling of economic growth.

9.1 Short to Medium Term Outlook to FY2024



10.0 Stakeholder Issues

10.1 TransGrid Works

TransGrid are the Transmission Network Provider in NSW. They provide the main grid injection points in the form of Bulk Supply Points that supply Endeavour Energy's network, and, as such, the two organisations conduct joint planning in relation to these connection points. Macarthur BSP was established by TransGrid in 2009 to service growth in the SWPGA and has a firm transformer capacity of 250MVA. Joint planning with TransGrid has identified the need for installation of a 132kV switching station at Kemps Creek by 2023 followed by the establishment of a 132kV grid injection point at a later date. This will continue to be pursued in future joint planning meetings between the two organisations. In addition to the issue of BSPs, some of Endeavour Energy's feeders may need to share easements with Transgrid feeders.

10.2 Roads and Maritime Services (RMS) and Local Road Authorities

Roads and Maritime Services and Local Councils will be packaging works to widen existing roads and construct new roads as precincts in the area develop. Opportunities to provide for future development of the network through installation of ducts and relocation of existing assets will arise and provisions have been made to utilise these opportunities to minimise costs of expanding the network. The widening of the Northern Road has been used as an opportunity to provide for ducts for the 132kV cables to the Airport South HVC.

10.3 Developers and Landowners

In order to obtain the appropriate land to build each zone substation and the corridors for the connecting feeders, it is important that Endeavour Energy is involved in the subdivision planning stage of developments. The manner in which developments take place is important from a land acquisition and corridor development perspective. It is critical that the following issues be considered and addressed where appropriate based on learnings from past experience:

- Endeavour Energy must actively support NSW Planning and Environment in their efforts to coordinate development in areas of fragmented land ownership.

- Early discussions must be held to determine options for incorporating existing and future infrastructure into precinct master plans (involving the NSW Department of Planning and Infrastructure and the Greater Sydney Commission). This should incorporate the need for relocation and the identification of feasible options where required. Zone substation sites and line corridors should be identified on precinct master plans from the outset where appropriate.

- Early strategic acquisition of zone substation sites and sub-transmission line corridors can be advantageous due to lower land prices (pre-rezoning) and fewer environmental constraints (not surrounded by existing residential dwellings). However, the Foreign Investment Review Board (FIRB) now mandates a maximum five year period between the acquisition and development of land by Endeavour Energy. This is a major limitation on any new land acquisition and must be carefully considered during the planning process.

  It is also necessary to compare the cost of easement acquisition for overhead sub-transmission lines versus undergrounding or use of the road reserve.

- Sub-transmission line design and construction has a longer lead time than zone substations due to the ability to secure appropriate line routes. Consideration should be given to lead times and final commissioning dates when issuing projects with significant sub-transmission line design and easement acquisition.

There is a need to have a consistent process by which the necessary properties and line easements can be acquired. The preferred option would be suitable substation locations and line

corridors are identified at an early stage and these included on precinct master plans. As design work on the development proceeds, final details of sites and corridors can be determined in discussions between developers and Endeavour Energy. Upon finalisation of the infrastructure location, Endeavour Energy will make arrangements with developers to acquire the appropriate tenure over the agreed locations.

A significant sensitive area within the WSEA area is the Western Sydney Parkland. This has the potential to create constraints on development and maintenance of the electricity network.

10.4 Environmental Considerations

The construction and upgrading of zone substations and the connecting lines will be assessed under the Environmental Planning and Assessment Act (1979) (the Act). Reviews of Environmental Factors (REFs) will be prepared for all activities and depending on the impacts of the proposals, Environmental Assessments may be required for some of the works and therefore extensive community involvement and community consultation would be required. Depending on the complexity of a project, the Environmental Assessment process can take between 12 – 24 months before environmental approval is obtained and construction of a project can commence. Allowance of sufficient forward planning time is therefore essential. The planning process needs to ensure that electrical infrastructure can be installed in strategic locations and be located adjacent to suitable compatible land uses to minimise the impacts to the environment and the community.

The 132kV feeder easement from Kemps Creek Substation to Elizabeth Dr will need to be doubled from 30m to 60m. This may cause issues as the easement would further encroach into Kemps Creek Nature Reserve.

11.0 Recommendation

It is recommended that the following be adopted:

1. The proposed Ultimate Network Topology – (Kemps Creek BSP) outlined within this report be carried forward as the basis for further planning within the Western Sydney Priority Growth Area. Individual projects based on the principles outlined in this report will be developed separately and funding sought for each of these projects at the appropriate level and time.

2. Continue Joint Planning with Transgrid on the establishment of 330/132kV Kemps Creek BSP

3. Engage in discussions with the Department of Planning and Environment to ensure that zone substation sites and line corridors are included in the development of master plans for Western Sydney Priority Growth Area precincts, including the Western Sydney Airport

4. Continue discussions with the Department of Planning and Environment on an ongoing basis to ensure that Endeavour Energy's staging for the establishment of major infrastructure is in line with projected development timing.

It is noted that demand management initiatives and changes in electricity demand may modify the ultimate load of the Western Sydney Priority Growth Area as well as the timing of the required infrastructure. It has, however, been shown that proposed network topology is flexible enough to supply both the high and low residential load scenarios presented within this report with minimal variation in the proposed network topology.

- Projects to be completed in the 2020-2024 regulatory period with an associated real cost of $104 Million include:
    - Establishment of Austral ZS in interim configuration
    - Purchase of a site for Rossmore ZS
    - Purchase of a site for North Rossmore ZS
    - Purchase of a site for North Bringelly ZS
    - Establishment of the Southpipe ZS and associated transmission feeders
    - Establishment of the Science Park ZS and associated transmission feeders
    - Establishment of a Broader Western Sydney Employment Lands ZS and associated transmission feeders. It is anticipated that this new zone substation will be established in the developer landholdings within the Elizabeth Drive Corridor Precinct in the ultimate layout.
- Projects to be completed in the 2025-2029 regulatory period with an associated real cost of $151 Million include:
    - Connection works associated with the Kemps Creek Bulk Supply Point
    - Establishment of Rossmore ZS (commence construction)
    - Establishment of North Bringelly ZS
    - Augmentation of Bringelly ZS
    - Conversion of Kemps Creek ZS to 132kV
    - Augmentation of Luddenham ZS
    - Establishment of Austral ZS in permanent configuration
    - Establishment of the second Broader Western Sydney Employment Lands ZS (Commence construction). It is anticipated that this new zone substation will be within the Sydney University Landholdings in the Elizabeth Drive Corridor

12.0 Appendices

Appendix 1 Precinct Overlay

Appendix 2 Contingency Tables – Ultimate Configuration

A contingency analysis has been completed for the recommended option.

12.1.1 132kV Kemps Creek BSP Contingency Analysis

Table 9 132kV Feeder Loads

Faulty →	Feeder Description	NIL	AU1	AU2	9LL	9LB	9LG	9LH	9LI	9LK	9LM	9LP	9LT	WSAS	WSAN	WSALINK	BW3	BW1	BW4	BW2	BW6	BW5
AU1	Kemps Creek BSP to Austral ZS	67.6	X	124.5	22.2	67.8	71.9	103.0	69.7	67.8	80.8	82.5	71.7	64.5	69.3	67.5	66.9	68.6	67.9	71.1	67.8	67.5
AU2	Kemps Creek BSP to Austral ZS	63.7	123.6	X	20.9	63.9	67.7	97.1	65.7	63.9	76.1	77.7	67.5	60.8	65.3	63.6	63.0	64.6	64.0	67.0	63.8	63.6
9LL	Austral ZS to North Leppington ZS	88.2	80.3	81.1	X	88.5	96.5	156.7	92.3	88.6	113.6	117.0	96.0	82.2	91.5	88.0	86.7	90.1	88.7	94.9	88.4	87.9
9LB	Rossmore ZS to Bringelly ZS	6.4	7.7	7.3	62.6	X	9.4	137.4	50.2	6.0	59.2	58.5	18.4	12.7	10.5	4.6	4.2	8.9	7.3	16.3	6.7	6.1
9LG	North Leppington ZS to Rossmore ZS	8.4	16.0	15.2	96.0	8.0	X	60.9	4.2	8.0	17.2	20.9	1.0	14.1	5.0	8.6	9.8	6.3	7.7	1.8	8.0	8.7
9LH	Kemps Creek BSP to North Bringelly ZS	198.2	202.0	201.6	241.2	199.0	194.4	X	192.6	227.0	238.7	159.8	243.2	163.7	217.3	197.4	190.4	209.4	201.5	236.8	199.9	196.5
9LJ	North Rossmore ZS to Rossmore ZS	53.7	56.0	55.8	80.6	54.0	51.3	123.0	X	54.1	30.0	82.7	61.5	47.7	57.0	53.5	52.3	55.6	54.3	60.4	54.0	53.4
9LK	Kemps Creek BSP to Kemps Creek ZS	209.1	209.9	209.8	217.7	209.2	208.3	211.7	208.6	X	217.1	201.3	46.3	231.3	140.7	211.0	194.1	230.6	215.5	283.0	212.3	205.8
9LM	Kemps Creek BSP to North Rossmore ZS	83.7	86.0	85.8	110.5	84.0	81.3	153.0	30.0	84.1	X	112.7	91.5	77.6	87.0	83.5	82.3	85.6	84.2	90.4	83.9	83.4
9LP	North Bringelly ZS to Bringelly ZS	57.2	62.6	62.0	118.9	58.5	51.7	138.5	48.0	11.0	115.6	X	41.9	69.0	50.7	57.3	59.6	53.4	56.0	44.2	56.6	57.7
9LT	Kemps Creek ZS to Oakey Creek ZS	164.6	165.3	165.3	173.1	164.7	163.8	167.3	164.2	46.2	172.5	156.9	X	186.7	96.7	166.6	149.6	186.0	171.0	237.9	167.8	161.3
WSAS	North Bringelly ZS to Western Sydney Airport South	49.8	48.2	48.4	30.8	49.2	51.5	45.9	53.4	137.3	31.6	66.5	109.8	X	75.3	48.5	39.3	65.0	54.4	101.3	52.1	47.5
WSAN	Oakey Creek ZS to Western Sydney Airport North	70.2	70.9	70.9	78.7	70.3	69.4	73.1	69.9	140.5	78.1	62.5	96.8	92.2	X	72.3	56.0	91.5	76.6	143.2	73.4	67.0
WSA-LINK	Western Sydney Airport North to Western Sydney Airport South	15.5	15.2	15.2	20.5	13.5	16.1	7.8	16.5	92.8	19.6	24.4	66.4	48.2	33.5	X	9.5	26.0	18.6	58.5	16.5	14.6
BW3	WSA North to South Luddenham ZS	34.9	34.2	34.3	27.3	33.9	35.6	28.7	36.7	97.2	27.4	41.7	79.5	19.6	27.1	28.2	X	69.3	45.8	154.4	39.6	30.1
BW1	Kemps Creek BSP to Mirvac ZS	92.0	92.2	92.2	94.5	91.9	91.7	93.0	92.3	122.6	94.2	89.6	117.4	98.4	102.7	92.4	98.9	X	64.3	173.2	89.4	94.7
BW4	Mirvac ZS to Cosgroves Creek ZS	28.2	28.5	28.4	30.8	28.3	28.0	29.3	27.9	57.9	30.6	26.1	53.4	34.8	38.9	29.2	36.0	63.2	X	108.7	25.8	31.0
BW2	Kemps Creek BSP to Cosgroves/Sth Luddenham	203.8	204.4	204.3	211.4	203.7	203.0	206.7	204.0	295.7	210.8	196.7	280.7	223.6	236.4	205.6	225.3	256.6	219.7	X	201.0	206.9
BW6	Cosgroves ZS to Science Park ZS	29.3	29.4	29.4	30.5	29.3	29.2	29.5	29.1	43.3	30.4	28.2	41.2	32.4	34.4	29.5	32.4	21.3	26.9	4.0	X	60.7
BW5	South Luddenham ZS to Science Park ZS	31.4	31.3	31.3	30.2	31.3	31.5	31.0	31.5	17.5	30.2	32.4	19.5	28.3	26.3	31.1	28.2	39.6	33.9	61.9	60.7	X

Appendix 3 Approximate Feeder Works with Kemps Creek BSP

Feeder	From To	Total Works (km)
9LB	Rossmore ZS to Bringelly ZS	4.7
9LG	North Leppington ZS to Rossmore ZS	3.4
9LH	Kemps Creek BSP to North Bringelly ZS	8.9
9LJ	North Rossmore ZS to Rossmore ZS	9.0
9LK	Kemps Creek BSP to Kemps Creek ZS	4.8
9LL	Austral ZS to Leppington North ZS (Exist 93X)	0.0
9LM	Kemps Creek BSP to North Rossmore ZS	4.5
9LP	North Bringelly ZS to Bringelly ZS	4.0
9LT	Kemps Creek ZS to Oakey Creek ZS	4.8
9SPSM	Southpipe ZS to South Mamre ZS (Tee off SCPK)	1.5
9SWSP	Sydney West to South Pipe ZS	4.0
9XX	Fdr 93X tee to South Mamre	3.5
AU1	Kemps Creek BSP to Austral ZS	1.5
AU2	Kemps Creek BSP to Austral ZS	1.5
BW1	Kemps Creek BSP to Mirvac ZS	8.5
BW2_A	Kemps Creek BSP to Tee Cosgroves/South Luddenham	10.5
BW2_B	Tee to Cossgroves ZS	2.1
BW2_C	Tee to South Luddenham ZS	2.1
BW3	WSA North to South Luddenham ZS	2.5
BW4	Mirvac ZS to Cosgroves Creek ZS	4.0
BW5	South Luddenham ZS to Science Park ZS	5.5
BW6	Cossgroves ZS to Science Park ZS	3.2
SCPK	South Pipe ZS to Science Park ZS	7.0
WSA_LINK	WSA North to WSA South	8.2
WSAN	Oakey Creek ZS to WSA North	6.0
WSAS	North Bringelly ZS to WSA South	5.3
TOTAL	**FEEDER WORKS**	**121**
	FEEDER WORKS IN REG PERIOD FY20-24	**58**
	FEEDER WORKS IN REG PERIOD FY25-29	**47**
	FEEDER WORKS IN REG PERIOD FY25-29	**16**