PR656 - Electricity Supply for the East Leppington & Leppington Precincts Network Investment Options Report

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Electricity Supply for the East Leppington and Leppington Precincts – PR656
Network Investment Options Report

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1 Executive Summary

This document proposes the augmentation of South Leppington Zone Substation (ZS) to provide electricity supply to the East Leppington and Leppington precincts. The zone substation will supply Willowdale, Emerald Hills, Gledswood Hills, Varroville, Leppington precinct and the most southern portion of the North Leppington precinct. These areas have a combined yield of 14,310 residential dwellings with a diversified load of 45MVA.

- **The total (nominal sum) cost of the recommended project is $26.1M**
- **The present value of capital outlay over the asset life is estimated to be $25.3M**
- **The net market benefit of the project is estimated to be $28.8M**

South Leppington ZS was originally established in 2014 as an interim supply solution to meet an urgent capacity need for this part of the South-West Growth Sector and allow deferral of capex. The substation was established with a single permanent 132/11kV transformer, a portable control building with four 11kV feeder circuit breakers and a single 132kV feeder. The future augmentation to a permanent substation would be undertaken in a subsequent Stage 2 project.

The network requirement date for augmentation is when the distribution back-up capacity of 10MVA is exceeded^. This is the spare capacity in the 11kV network from adjacent zone substations which would be used to supply the full station load during an outage of South Leppington ZS. This occurs in 2018 with a *forecast* load of 11.8MVA increasing to 18.7MVA by 2020 and 26.3MVA by 2022. Endeavour Energy has processed 5,300 lot/dwelling approvals to 30th March 2017 representing 21MVA. Actual dwelling construction and occupation will lag approvals by approximately 12-18 months.

There is a risk of negative press and shareholder dissatisfaction if electricity supply to this rapidly growing region is compromised. The augmentation of South Leppington ZS is the next phase of the development of electricity infrastructure for this part of the South-West Growth Sector in accordance with established long term strategy.

This NIO report will address the network need whilst examining the overall strategy for the area.

Demand management and local generation were not considered feasible to meet the supply requirements of the forecast growth based on the published Screening Report. One substation build option with four 132kV feeder sub-options have been considered as follows:

- **Option 1:** Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder route 1 from Bringelly ZS.
- **Option 2:** Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder route 2 from North Leppington ZS via 9L4 easement.
- **Option 3:** Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder route 3 from North Leppington ZS via 9LY easement.
- **Option 4:** Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder route 4 from Smeaton Grange SS / Denham Court TS.

^ The augmentation is required by 2018 when the supply security limit will be exceeded by 24% and more critically in 2019 when this increases to 63%. By 2020 the substation load exceeds the supply security limit by 120%.

An evaluation of the cost of build options has identified **Option 1 – Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder from Bringelly ZS** addresses the long term network need. Endeavour Energy is carrying out an environmental assessment in accordance with the Environmental Planning and Assessment Act 1979. The final outcome will be determined following consideration of submissions to the RIT-D Draft Project Assessment Report and the outcomes of the environmental assessment and associated community consultation.

2 Introduction

The driver for the capital works is to provide adequate and secured long term electricity supply to the East Leppington and Leppington precincts including Willowdale and the adjacent developments of Emerald Hills and Gledswood Hills which form part of the South-West Priority Growth area.

This NIO report investigates four options available to implement the project and makes recommendations on the preferred option. The options have been assessed with reference to the medium and long term strategy for the 132kV network in the South West Priority Growth Area Area and Network Configuration standard SDI501.

This document comprises the following:

- A discussion of the regulatory context in which this project will be carried out;
- A description of existing supply limitations in the area under consideration;
- Discussion of the Planning or Supply Security Standards applicable to a network of the scale under consideration;
- An assessment of the ultimate electrical load expected to be realised when the area has become fully developed and matured;
- A description of options considered to be appropriate to meet the long term forecast demand profile of the area;
- A discussion of the technical and environmental considerations taken into account when assessing the available options;
- A discussion of the application of the Regulatory Investment Test for Distribution (RIT-D) evaluation on each of the two options, in accordance with Section 5.17.1(c) of the National Electricity Rules.

3 Context

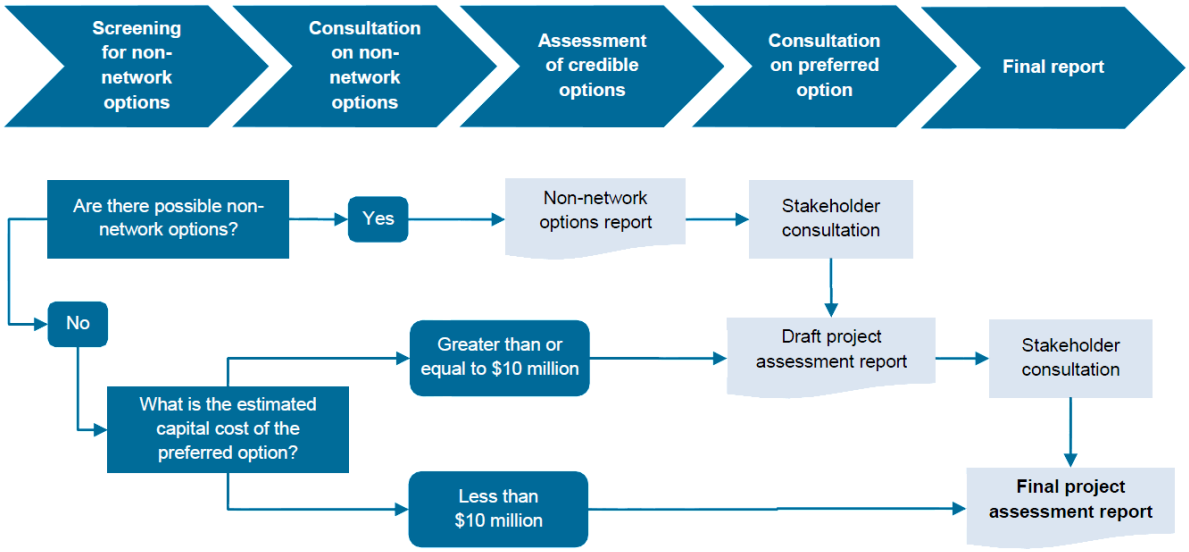
In proposing the installation of new large distribution assets, there is a backdrop of relevant regulatory considerations to be satisfied. These include the following:

3.1 National Electricity Rules Requirements

Endeavour Energy is registered with AEMO as a "Distribution Network Service Provider" under the National Electricity Rules (NER) and consequently all of its assets are deemed to be distribution assets. As a result, Endeavour Energy's operations are governed by the NER and Chapter 5 Part B, Network Planning and Expansion, is particularly relevant. Endeavour Energy is also subject to a regulatory determination by the Australian Energy Regulator (AER) which sets the capital expenditure funding limit for Endeavour Energy over the relevant regulatory period. For Endeavour Energy to be able to recover capital expenditure through future revenues and for expenditure on a project to be included as part of the AER regulated expenditure, Endeavour Energy must demonstrate prudency of investment.

The AER has, as required by section 5.17 of the NER, published the Regulatory Investment Test for Distribution (RIT-D) as well as the RIT-D Application Guidelines. The RIT-D Application Guidelines state, unless specified exemptions apply a project with a potential credible option costing $5 Million or more must be declared as a RIT-D project and be subject to the RIT-D process. The RIT-D process is summarized in the figure below.

Overview of the RIT-D process



3.2 Code of Practice for Authorised Network Operators and the Environmental Planning and Assessment Act 1979

The *NSW Code Practice for Authorised Network Operators* (ANO) *2015* (the Code) and the *Environmental Planning and Assessment Act 1979* (the Act) provides the statutory planning framework for environmental assessment and approval of works to be undertaken by an ANO.

The Act defines two approval processes depending on whether a proposal, or components of it, is considered an "Activity" (Part 5 of the Act) or a "Development" (Part 4 of the Act).

The Code requires an ANO to classify its proposals into one of six possible assessment classes. The Code applies to Assessment Class 3, 4, 5 and 6 proposals only.

Class 3:- requires the preparation of a Summary Environmental Report (SER) refers to projects which are expected on a reasonable basis to be minor and neither extensive or complex.

Class 4:- requires the preparation of an REF and refers to projects which are expected on a reasonable basis to have impacts which go beyond minor, can be extensive and/or complex and at the discretion of the ANO be a project for which it is deemed appropriate to prepare, such as a project which may generate considerable public interest.

Class 5:- refers to projects as defined in Class 4 above, but also require the preparation of a Species Impact Statement (SIS).

Class 6:- refers to projects which are "likely to significantly affect the environment" and therefore an EIS is required.

On 14 June 2017 Endeavour Energy was transacted and became an ANO. Meaning Endeavour Energy is now a privately managed network business in accordance with the *Electricity Networks Assets (Authorised Transactions) Act 2015,* and is subject to "*The Code of Practice for Authorised Network Operators"* gazetted in September 2015 under Clause 244k of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). The Code is deemed to be in force until it is revoked or varied in accordance with the EP&A Regulation.

The NSW Government has prescribed the ANOs as a "prescribed Determining Authorities" for the purposes of Part 5 Section 111A of the EP&A Act and the definition of "public authority" under section 4(1) of that Act.

This prescription allows an ANO to be a Part 5 Determining Authority for the purposes of an electricity transmission or distribution network.

While Part 5 Activities do not require development consent under Part 4 of the EP&A Act, consideration of an Activity's environmental impact is required under Section 111 of that Act. This

is accompanied by Section 112, which requires an EIS to be prepared if an Activity is likely to likely to significantly affect the environment.

The Authorised Transactions Act inserted Division 9 into Part 14 of the EP&A Regulation. Clause 244K in Division 9 provides that The Code may make provision for or with respect to the exercise by an ANO of its functions under Part 5 Section 111 of the EP&A Act in respect of *"an activity for the purposes of a transacted electricity transmission or distribution network".*
These words are defined non-exhaustively in Clause 244J as including:-
…….activities (within the meaning of Part 5 of the EP&A Act), for any one or more of the following purposes:-

a) Development for the purposes of the construction, maintenance or operation of a transacted electricity transmission or distribution network
b) Geotechnical investigations relating to a transacted electricity transmission or distribution network
c) Environmental management and pollution control relating to a transacted electricity transmission or distribution network
d) Access for the purposes of the construction, maintenance or operation of a transacted electricity transmission or distribution network
e) Temporary construction sites and storage areas, including batching plants, the storage of plant and equipment and the stockpiling of excavated material.

As a Determining Authority an ANO can assess and self-determine Activities that are not likely to significantly affect the environment and are conducted for and on behalf of the ANO for the purposes of electricity transmission or distribution.

By virtue of an ANO's status under the Infrastructure SEPP, certain activities will be subject to Part 3, Division 5, Subdivision 1 - *Electricity Transmission or Distribution Networks* - of the Infrastructure SEPP for the purposes of development connected with electricity transmission or distribution.
These are outlined below:-
Under "Clause 41 Development permitted without consent"
(1) "Development for the purpose of an electricity transmission or distribution network may be carried out by or on behalf of an electricity supply authority or public authority without consent on any land….." excluding land reserved under the National Parks and Wildlife Act.
The Infrastructure SEPP's definition of an "electricity transmission or distribution network" includes the following components:

(a) Above or below ground electricity transmission or distribution lines (and related bridges, cables, conductors, conduits, poles, towers, trenches, tunnels, ventilation and access structures)

(b) Above or below ground electricity kiosks or electricity substations, feeder pillars or transformer housing, substation yards or substation buildings……..

The aim of this Policy is to facilitate the effective delivery of infrastructure across the State through increased regulatory certainty, improved efficiency and flexibility in the location of infrastructure and service facilities, while still providing adequate stakeholder consultation.

Since this project can be classified as an “Activity” under Part 5, Endeavour Energy therefore will not be required to submit a Development Application to the relevant Council/s (since Development Applications are assessed under Part 4 of the EP&A Act). However, the relevant Council/s will be given written notice of the intention to carry out the proposed works and Endeavour Energy will consider any response received from the Council/s.

In view of the above, this project will be assessed as a Class 4 Proposal under the Code.

Since this project is classified as an activity in accordance with Part 5 of the EP&A Act 1979, it must also be assessed under Clause 228(2) of the Environmental Planning and Assessment Regulation 2000.

3.3 Electromagnetic Fields

Electromagnetic fields are managed according to Endeavour Energy’s Network Asset Design Policy 9.2.5. Extended public exposure on premises other than roadways, such as easements and other reserves should not exceed magnetic flux density and electric field strengths of 100μT and 5kV/m respectively. Shielding of magnetic fields may be required where these levels may be exceeded.

4 Background

4.1 General

South Leppington ZS was established in 2014 to provide urgently needed distribution capacity for the East Leppington precinct of the South-West Growth Sector and the adjacent developments of Emerald Hills and Gledswood Hills. The substation was established with minimal elements including 1 x 45MVA transformer, 4 x 11kV feeder circuit breakers and 1 x 132kV feeder providing a non-firm capacity of 45MVA but with an operational limit of 10MVA which could be back-up by the surrounding distribution network of neighbouring zone substations.

The East Leppington precinct will yield 6,445 dwellings and is progressing at a rapid pace with 3,441 residential lots and a shopping centre processed by Endeavour Energy since 2012 – refer to Table 2. This represents a load of 14.6MVA of the potential 24MVA which is expected to appear on South Leppington ZS by summer 2020 as homes are established and occupied.

The adjacent residential development of Emerald Hills and Gledswood Hills are concurrently developing with an ultimate yield of 1,350 dwellings and 515 dwellings respectively. A total of 975 lots/dwellings have been processed for these two areas representing a load of 3.9MVA of the potential 7.5MVA.

The adjacent Leppington precinct which was rezoned in 2016 and encompasses the area directly opposite South Leppington ZS along Camden Valley Way will yield up to 9,900 dwellings of which 6,000 of these and representing 21MVA will be supplied from South Leppington ZS.

The combined area within the South Leppington ZS service catchment has a forecast station load of 55MVA supplying 14,310 dwellings and two shopping centres.

South Leppington ZS will need to have a minimum firm capacity of 45MVA to service ongoing development beyond the current 2,500 dwelling/10MVA limitation of the existing “interim” configuration.

Table 1 shows the summer forecast for South Leppington ZS.

Table 1 – Official Load Forecast for South Leppington Zone Substation (MVA) 2016-2027

Year #	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Demand (MVA)	4.2	6.0	11.8	14.7	18.7	22.7	26.3	29.2	31.2	32.5	33.2	34.5
Firm Capacity* (MVA)	10.0	10.0	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.0
Load at Risk (MVA)	0	0	2.3	5.7	10.2	14.7	18.8	22.2	24.7	26.5	27.7	29.5

Year 2017 refers to summer 2016/17 and is the actual recorded load data

*Firm capacity is reduced by 0.5MVA per year from 2018 which is equivalent to 125 new homes being connected to the distribution network providing the back-up to South Leppington ZS

Table 2 - Processed Development for South Leppington Zone Substation							
CAM	Reference	Units	Town Houses	Homes	kVA	Approved	
URS7660	Dwyer Rd Leppington Precinct	0		212	848	2017	
URS7661	George Rd Leppington Precinct	0		213	852	2017	
ENL2718	Ingleburn Rd Leppington	0		33	132	2016	
ENL2738	Park Rd Leppington	0		37	148	2016	
URS16006	Gledswood Hills			67	268	2015	
URS16007	Gledswood Hills			67	268	2015	
URS16008	Gledswood Hills			67	268	2015	
URS15160	Stage 1A Emerald Hills	0		73	292	2015	
URS15161	Stage 1B Emerald Hills	0		91	364	2015	
URS15162	Stage 1C Emerald Hills	0		117	468	2015	
URS17243	Stage 2 Emerald Hills	0		142	568	2015	
URS18347	Stage 4 Emerald Hills	0		119	476	2016	
URS18348	Stage 5 Emerald Hills	0		126	504	2017	
URS18350	Stage 6 Emerald Hills	0		106	424	2017	
URS19325	Camden Valley Way East Leppington	0		85	340	2017	
URS17306	Denham Court Rd East Leppington			58	232	2015	
URS17307	Denham Court Rd East Leppington			27	108	2015	
URS15879	Stage 1 St Andrews Rd East Leppington			106	424	2015	
URS15880	Stage 2 St Andrews Rd East Leppington			79	316	2015	
URS15881	Stage 3 St Andrews Rd East Leppington			30	120	2015	
URS13579	Stage 1A Willowdale			47	188	2013	
URS14082	Stage 1B Willowdale			37	148	2013	
URS14083	Stage 1C Willowdale			41	164	2013	
URS14084	Stage 1D Willowdale			41	164	2013	
URS14085	Stage 1E Willowdale			44	176	2013	
URS14086	Stage 1F Willowdale			50	200	2013	
URS14087	Stage 1G Willowdale			49	196	2013	
URS14088	Stage 1H Willowdale			45	180	2013	
URS14089	Stage 1I Willowdale			25	100	2013	
URS14919	Stage 2A Willowdale			51	204	2014	
URS14920	Stage 2B Willowdale			45	180	2014	
URS14921	Stage 2C Willowdale			23	92	2014	
URS14922	Stage 2D Willowdale			32	128	2014	
URS14923	Stage 2E Willowdale			38	152	2014	
URS14924	Stage 2F Willowdale			61	244	2014	
URS14925	Stage 2G Willowdale			53	212	2014	
URS15138	Stage 3A Willowdale			36	144	2014	
URS15139	Stage 3B Willowdale			38	152	2014	
URS15140	Stage 3C Willowdale			40	160	2014	
URS15141	Stage 3D Willowdale			41	164	2014	
URS15142	Stage 3E Willowdale			54	216	2014	
URS16205	Stage 6 Retirement Village Willowdale			268	1072	2015	
URS16397	Stage 5A Willowdale		74		259	2015	
URS17108	Stage 5B & 5C Willowdale		67		234.5	2015	
URS17109	Stage 5C1 Willowdale		60		210	2016	
URS16753	Stage 7A Willowdale			52	208	2016	
URS16754	Stage 7B Willowdale			48	192	2015	
URS15525	Stage 8A Willowdale			72	288	2014	
URS15526	Stage 8B Willowdale			39	156	2014	
URS15527	Stage 8C Willowdale			91	364	2014	
URS16146	Stage 9A Willowdale			85	340	2015	
URS16147	Stage 9B Willowdale			111	444	2015	
URS14168	Stage 9C Willowdale			83	332	2015	
URS16764	Stage 14 Willowdale			100	400	2016	
URS17612	Stage 15A Willowdale			142	568	2016	
URS17613	Stage 15B Willowdale			121	484	2016	
URS17614	Stage 15C Willowdale			44	176	2016	
URS17615	Stage 15D Willowdale			51	204	2016	
URS17616	Stage 15E Willowdale			59	236	2016	
URS17617	Stage 15F Willowdale			37	148	2017	
UCL8209	Shopping Centre - Willowdale				970	2016	
URS19199	Stage 16A Willowdale			60	240	2017	
URS19201	Stage 16C Willowdale			56	224	2017	
URS19202	Stage 16D Willowdale			48	192	2017	
URS19203	Stage 16E Willowdale			63	252	2017	
URS19214	Stage 11A Willowdale			62	248	2017	
URS19215	Stage 11B Willowdale			62	248	2017	
URS19216	Stage 11C Willowdale			56	224	2017	
URS19217	Stage 11D Willowdale			61	244	2017	
URS19218	Stage 11E Willowdale			65	260	2017	
URS19219	Stage 11F Willowdale			28	112	2017	
	Existing non-urban			900	3600		
	Proposed load transfer to North Leppington ZS			-315	-1260	2018	
TOTALS		**0**	**201**	**5295**	**22.9**	**MVA**	
Firm Capacity					10.0	MVA	
Load at Risk				3213	12.9	MVA	
Willowdale			201	3240	14.6		
Emerald Hills				774	3.1		
Other	Combined areas Leppington and Gledswood Hills			696	2.8		
Existing	Non-urban			900	3.6		
Transfer	Load transfer to North Leppington ZS			-315	-1.3	2019	
TOTALS		**0**	**201**	**5295**	**22.9**		**5496**

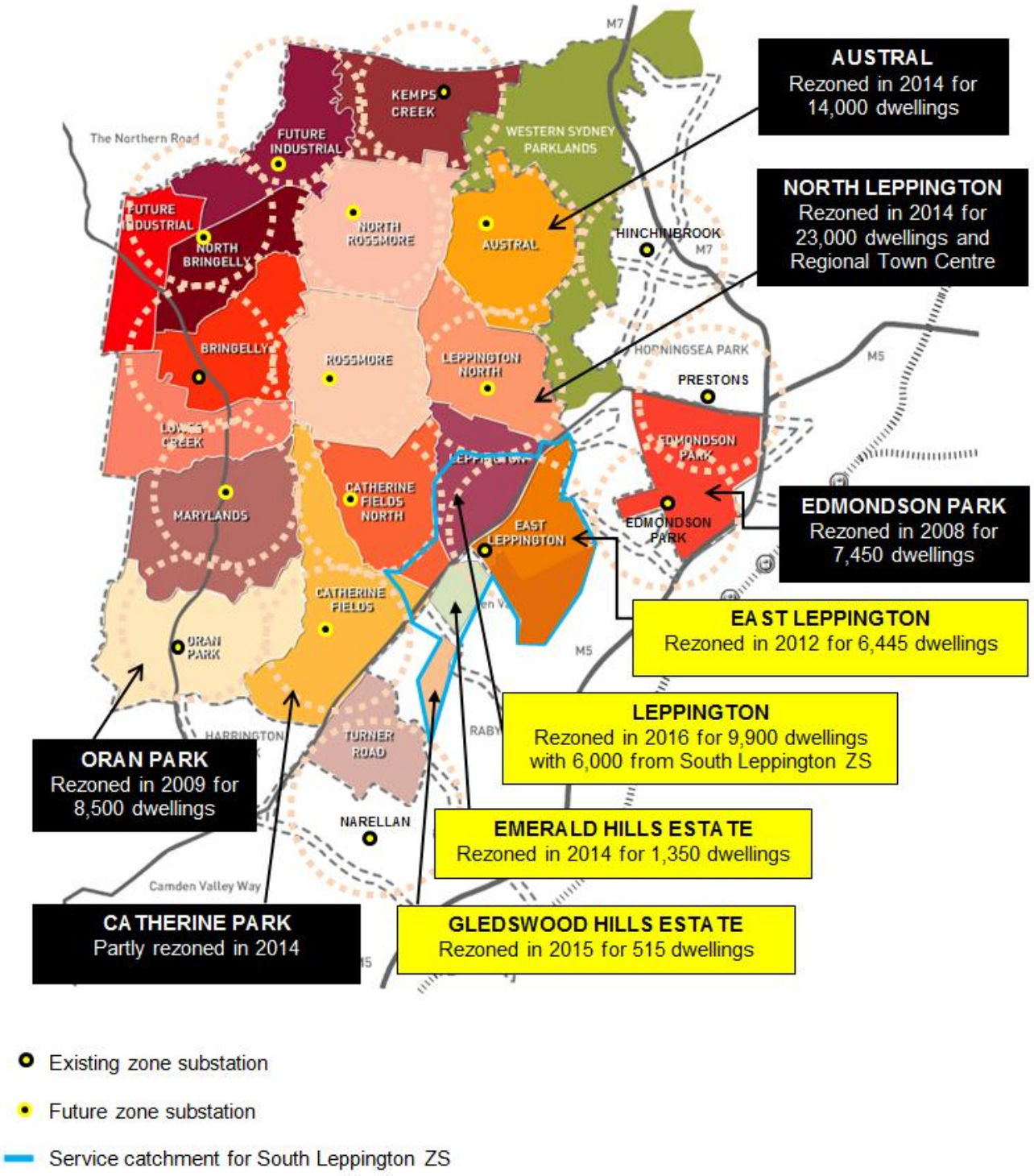


Figure 1 – South West Growth Sector showing the South Leppington ZS service catchment area

Refer to Figure 2 for the South Leppington Zone Substation study area showing all the areas being supplied from the zone substation.

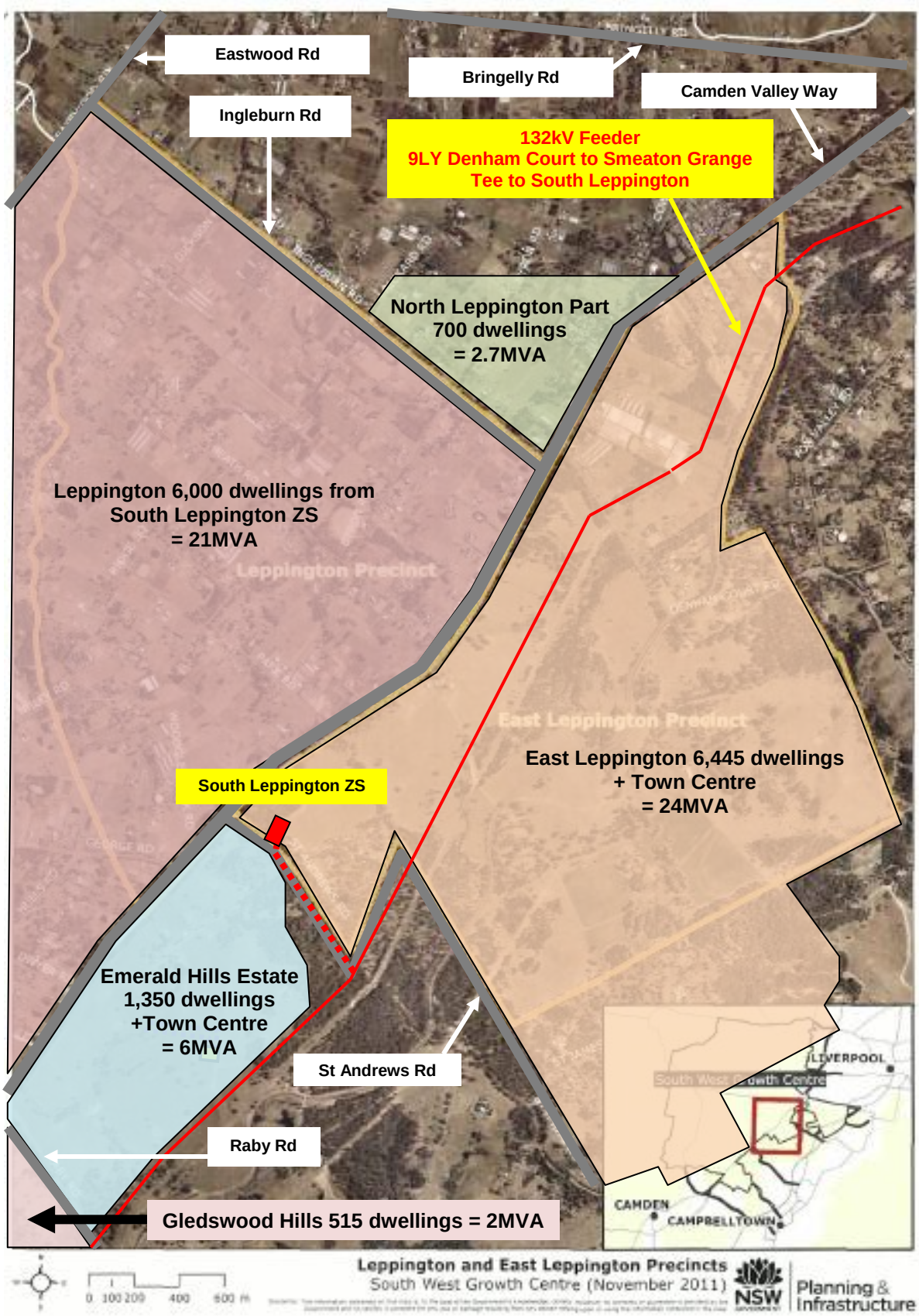


Figure 2 – South Leppington Zone Substation Study Area

A Statement of Network Need (SNN) was prepared for this project and is shown in Appendix 1.

4.2 Network Constraints

4.2.1 Existing Network - South Leppington Zone Substation

This substation was established as an interim supply solution for the East Leppington precinct *(Willowdale)* with a portable control building comprising four 11kV feeder circuit breakers. It was fitted with one 45MVA transformer in its permanent position and is supplied by a single teed 132kV feeder cable from feeder 9LY Denham Court TS to Smeaton Grange SS.

Although this substation has a 45MVA transformer, the 11kV distribution back-up capacity available from the adjacent zone substations is 10MVA. South Leppington ZS has an imposed planning limit of 15MVA to limit the load at risk (LAR) in this area to a maximum of 5MVA *(equivalent to 1,250 homes*). Augmentation to the permanent zone substation comprising two transformers, two 132kV feeders and four sections of 11kV switchboard in a permanent control building was stated as the next stage of progression for South Leppington ZS by NIO Report PR429. The augmentation would secure the electricity supply to this area which will grow to 14,310 residential dwellings and two shopping centers.

In the present *interim* configuration, South Leppington ZS would suffer a total outage if either the 132kV feeder or the 45MVA transformer tripped out under fault conditions. This configuration also means that maintenance on any of the single elements that make up the primary supply to the substation cannot be performed once station load exceeds 10MVA. This will occur in 2018.

During a total outage on South Leppington ZS, the 11kV distribution network of neighboring zone substations will be relied upon to restore supply to approximately 2,500 homes. These 11kV feeders have limited capacity which will progressively decrease as development normally supplied by the same *(back-up)* feeders increases. Therefore the situation will become worse as the region continues to develop resulting in a reduced back-up capacity for South Leppington ZS and an increasing load at risk.

The progression of residential development within the South Leppington ZS service catchment area has resulted in the double-feeder termination of the four 11kV feeder circuit breakers with eight feeder cables. This action has been taken to ensure ongoing development is connected to the appropriate feeder cable that would otherwise ultimately be established from the permanent substation. This avoids overloading fewer cables in the lead up prior to augmentation and establishes the distribution network in its final and ultimate configuration in accordance with the HV overlay for the precinct. The augmentation of South Leppington ZS would then involve transferring these eight feeder cables from the interim switchboard over to individual circuit breakers of the new permanent switchboard.

Analysis reveals that the four 11kV feeder circuit breakers on the interim switchboard will have the following loads after all processed applications have been connected. The substation load will exceed the 10MVA back-up limitation by 350%.

Figure 3 and 4 show the existing South Leppington ZS site plan and the portable control building.

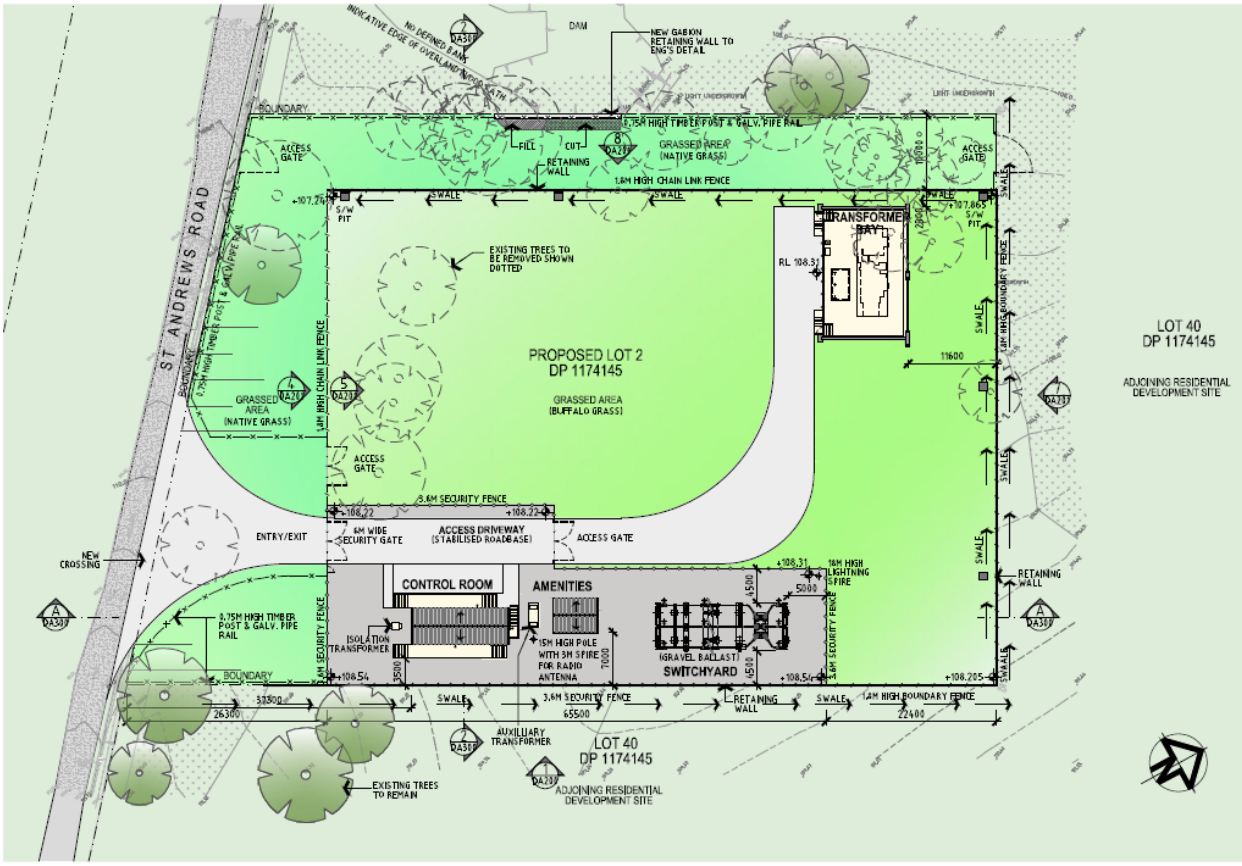


Figure 3 – South Leppington *(Interim)* Zone Substation

Figure 4 South Leppington Portable Control Building

Table 3 - SOUTH LEPPINGTON ZONE SUBSTATION 11kV FEEDER LOAD FORECAST				
No.	**CB ID No.**	**Feeder Name**	**Load (Amps / MVA)**	**Homes**
1	**SL1142**	**Heath Rd & Emerald Hills No.1**	**441 / 8.4**	**2,100**
	SL1142A	Heath Rd	223 / 4.3	1,075
	SL1142B	Emerald Hills No.1	218 / 4.1	1,025
2	**SL1112**	**George Rd & Willowdale No.1**	**473 / 9.0**	**2,250**
	SL1112A	George Rd	215 / 4.1	1,025
	SL1112B	Willowdale No.1	258 / 4.9	1,225
3	**SL1122**	**St Andrews Rd & Willowdale No.2**	**498 / 9.5**	**2,375**
	SL1122A	St Andrews Rd	246 / 4.7	1,175
	SL1122B	Willowdale No.2	252 / 4.8	1,200
4	**SL1132**	**Tunnel St & Navigator St**	**430 / 8.2**	**1,783 + Shops**
	SL1132A	Tunnel St	218 / 4.1	783 + Shops
	SL1132B	Navigator St	212 / 4.0	1,000
5	**SL1512**	**Transformer No.1**	**1,842 / 35.0**	**8,508 + Shops**

The 11kV circuit breakers are rated at 630A and will require overcurrent protection settings to be increased from 400A to 500A as a result of the double terminated feeders. The ideal limit for each of the four circuit breakers was 2.5MVA so not to exceed the 10MVA back-up limitation. However residential development in this area is progressing at an unprecedented and accelerated rate with each feeder cable expected to have over 4MVA by 2020 resulting in up to 9.5MVA on each circuit breaker – *see Table 1 - Load Forecast and Table 3 - 11kV Feeder Loads Forecast*.

This situation would expose 25MVA of load or up to 6,250 homes at risk of an extended supply outage due to the inability to provide adequate back-up. At a more local level an outage of a single 11kV feeder circuit breaker would take out approximately 8MVA of load or 2,000 homes until supply is restored from manual field switching. This scenario would be reduced to 4MVA or 1,000 homes after augmentation with one feeder per circuit breaker and faster restoration times attributed to less switching required to restore supply to half as many customers.

4.3 Potential for Growth

A study of the service catchment area of South Leppington ZS has estimated a potential electrical demand of 55MVA - refer to the modified forecast in Table 4. Development in the Willowdale Estate and Emerald Hills Estate continues whilst a new development front is commencing in the adjacent Leppington precinct. It is expected a total of 14,310 new dwellings will be established in the combined service area over a 20-25 year period. The existing rural residential and commercial load will decline as new residential development spreads across the region.

Table 2 previously showed the approved development to be connected to South Leppington ZS up to March 2017. Enquiries for the 600 lots in Varroville have not been received and are not included in the table.

Table 4 – MODIFIED FORECAST for SOUTH LEPPINGTON ZONE SUBSTATION

Growth	2018	2019	2020	2021	2022	2023	2024	2025	2029	2033	2037
Existing Rural	3.6	3.6	3.6	3.6	3.6	3.6	3.0	2.9	2.1	1.4	0.6
East Leppington	6.2	7.4	9.0	11.0	12.8	14.3	15.4	16.2	19.4	22.6	24.0
Emerald Hills	0.9	1.5	2.2	2.6	3.4	3.8	4.0	4.2	5.0	5.4	5.4
Leppington	0.9	1.8	3.0	4.1	5.3	6.4	7.6	8.7	13.2	17.6	21.0
Gledswood Hills	0.1	0.4	0.7	1.0	1.3	1.6	1.9	2.1	2.1	2.1	2.1
Total Load	**11.7**	**14.7**	**18.5**	**22.3**	**26.4**	**29.7**	**31.9**	**34.1**	**41.8**	**48.0**	**53.1**
Available 11kV back-up capacity∞	9.5	8.0	7.0	6.0	5.5	5.0	4.5	4.0	3.0	3.0	3.0
Load at Risk	**2.2**	**6.7**	**11.5**	**16.3**	**20.9**	**24.7**	**27.4**	**30.1**	**38.8**	**45.0**	**50.1**

∞ Back-up capacity will diminish over time as the 11kV feeders from adjacent zone substations supply development growth within their respective normal supply areas. The forecast is based on the Do Nothing option.

4.4 Network Strategy

Endeavour Energy has developed a long-term supply strategy for the South West Sector with up to 13 zone substations planned to service 15 precincts and a number of new 132kV sub-transmission feeders whilst making use of the existing network between Sydney West BSP, Macarthur BSP and Liverpool BSP. Ultimately the strategy calls for the establishment of the Kemps Creek BSP with a 132kV output for Endeavour Energy. Refer to Figures 5a & 5b and Table 5.

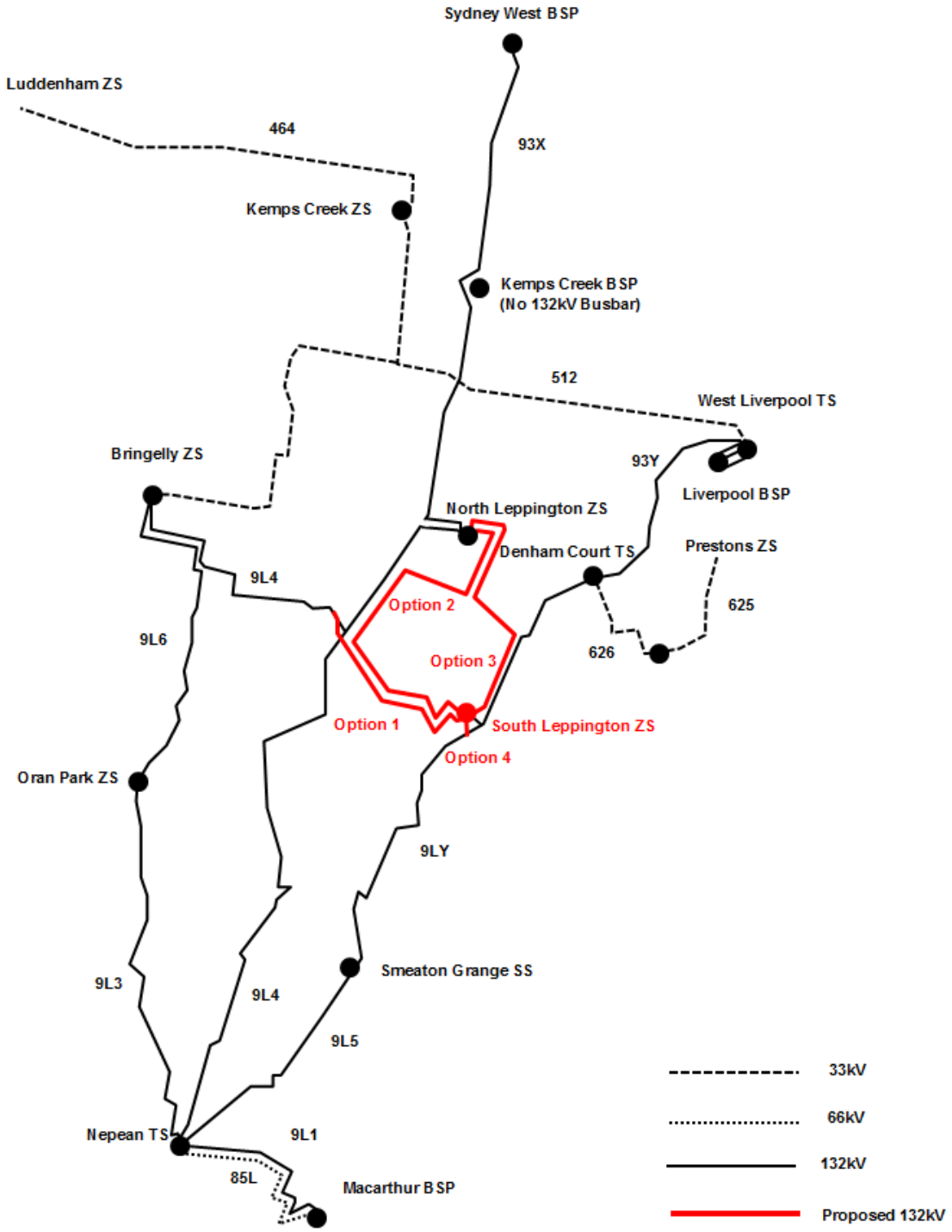


Figure 5a – Existing Network with Augmented South Leppington ZS and 132kV Feeder Options

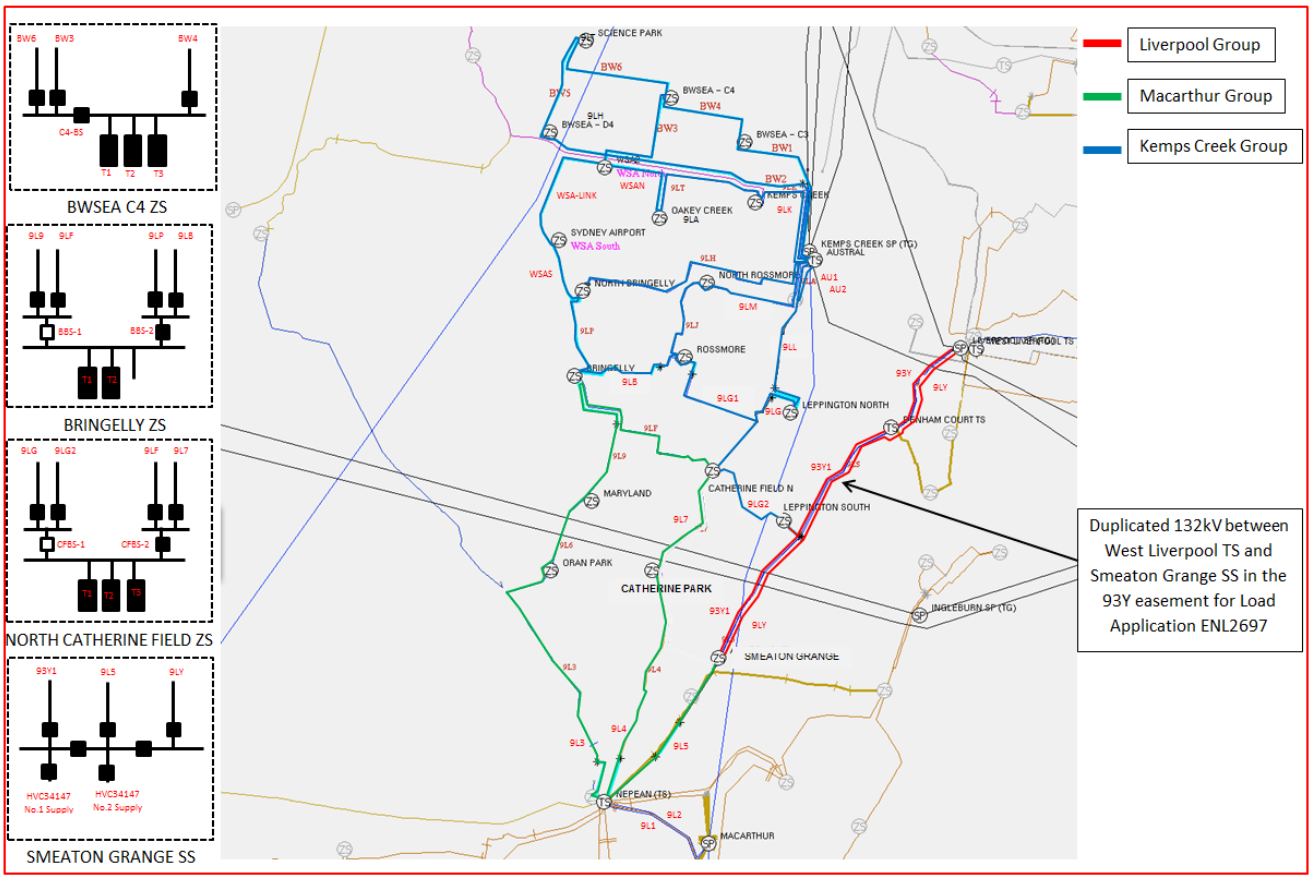


Figure 5b – Ultimate Network Strategy for the South-West Growth Sector
(Including Western Sydney Airport and Smeaton Grange HVC)

Table 5 - Bulk Supply Point Loads with future Kemps Creek BSP			
Bulk Supply Point	**Firm Capacity (MVA)**	**South West Sector (MVA)**	**Ultimate Load (MVA)**
Kemps Creek	750/900[1]	440[4]	882[6]
Liverpool	750/900[1]	150[5]	780[2]
Macarthur	375/450[1]	263	454[3]
Total	**1,875**	**853**	**2,116**

[1] Rating allows for 120% cyclic rating of a 375MVA transformer. [2] Load is the sum of the South West Sector load and the expected ultimate load on Liverpool BSP from West Liverpool TS, Liverpool TS, Denham Court TS and Abbotsbury ZS. [3] Sum of the South West Sector load and the expected ultimate load at Nepean TS. [4] Excludes Western Sydney Airport. [5] Includes Smeaton Grange HVC. [6] Includes Broader Western Sydney Employment Land and Western Sydney Airport

Endeavour Energy assessed one build option in the initial major project of PR429 which established South Leppington ZS. Due to long lead times associated with the delivery of a permanent standard zone substation, the project established an interim configuration. The substation comprised of one relocatable control building and temporary 132kV outdoor switchgear supplied by a single 132kV underground feeder and a single 45MVA transformer. It was designed to provide faster start-up capacity for the East Leppington precinct and recommended the permanent assets to be established by Stage 2 major project PR656 subject to network need.

Major Project PR656 will establish the Stage 2 works and is discussed as follows.

STAGE 2: Augment South Leppington Zone Substation to a Permanent Standard

This project establishes a standard design control building, four 11kV switchboard sections and adds a second 132/11kV 45MVA transformer, a second 132kV feeder and removes the existing portable control room and temporary 132kV outdoor switchgear. The existing 132/11kV 45MVA Transformer No.1 and existing 132kV feeder 9LY will be retained in the permanent configuration.

Estimated cost with 132kV Feeder Option 1 is $26.1 million

Estimated cost with 132kV Feeder Option 2 is $31.8 million

Estimated cost with 132kV Feeder Option 3 is $29.9 million

Estimated cost with 132kV Feeder Option 4 is $21.1 million

Option 1 with a cost of $26.1 million is the preferred solution to meet the network need.

4.5 Environmental Issues

Environmental issues likely to impact on augmenting the electricity supply to the East Leppington precinct and surrounding estates and mitigating forecast load at risk include:

- Visual impacts associated with the augmentation of South Leppington ZS.
- The management of increased transformer noise.
- Construction of the second 132kV feeder.
- The increased public exposure to electromagnetic fields (EMF) due mainly to the installation of a substation into the area and management of the public perception of the issues associated with this.

The project will be managed to comply with all aspects of the Environmental Planning and Assessment Act 1979.

Relevant stakeholders will be identified and managed in accordance with corporate stakeholder management and communications policies.

4.6 Asset Age and Condition

This project will establish new assets and only retain the existing 45MVA transformer and associated bund and sound walls. All other assets serving as temporary measures will be removed. Some 11kV conductors within the influence of the proposed augmented zone substation will require augmentation due to inadequate conductor fault level rating caused by increasing the fault level at South Leppington ZS. The overhead network will ultimately be converted to underground by the progression of urban residential development (URD) over the next 20 years.

4.7 Network Reliability

4.7.1 11kV Network

The 11kV network capacity in the East Leppington Precinct is suitable for a limited amount of new housing. There are eight (8) 11kV feeders emanating from four circuit breakers of the South Leppington ZS supplying the residential areas of Willowdale, Emerald Hills, Gledswood Hills and Leppington. This means there are two (2) 11kV feeders per circuit breaker which are planned to be separated and re-terminated onto individual circuit breakers in the final arrangement after augmentation of the zone substation. The eight feeders have been developed into the new housing estates as they have progressed and will ultimately supply approximately 1,000 dwellings each, up from 300 dwellings each due to the 10MVA substation back-up limit.

The network has been configured so cross-zone ties and cross-feeder ties provide sufficient avenues for back-up switching of the existing rural residential area and the new pockets of urban development during contingencies or planned outages. These however are not robust enough to deal with a forecast load of greater than 10MVA which is equivalent to 2,500 homes. Endeavour Energy has processed over 3,300 new residential lots and the Willowdale Shopping Centre since June 2013. The staggered construction and occupation of homes will see the limit of 2,500 dwellings or 10MVA reached by the end of 2018.

4.7.2 132kV Network

South Leppington ZS is currently supplied by one underground 132kV cable which is tee-connected to overhead feeder 9LY. Supply is from either feeder 93Y from West Liverpool TS via Denham Court TS or from feeder 9L5 from Nepean TS via Smeaton Grange SS depending on network configuration.

It is proposed to extend the 132kV network from either 93X or 93Y to provide the second feeder and N-1 supply security to South Leppington ZS. Depending on the preferred option, a change-over scheme may or may not be implemented.

There were ten (10) incidents reported on 132kV feeder 93Y between April 2007 and Jan 2016. Four of these were classified as “unknown cause” and one was attributed to physical interference to the conductors caused by the South West Rail Link construction. Supply was restored promptly by protection and automation schemes. There have been no further incidents on 93Y since. *(Information courtesy of Network Performance Review – Endeavour Energy)*

There were eight (8) incidents reported on 132kV feeder 93X between May 2008 and Jan 2017. Five of these were classified as “unknown cause”, two to storm and one was attributed to physical interference to the conductors by a developer’s excavation equipment. Supply was restored promptly by protection and automation schemes. There have been no further incidents on 93X since. *(Information courtesy of Network Performance Review – Endeavour Energy)*

5 Project Design Requirements

Based on the identified network constraints and the context the project is to be carried out, the following factors have been identified as key to meeting the project purpose. All of these factors need to be addressed for each identified option, and the ideal project outcome is intended to satisfy all of these requirements:

- **Supply Security** – ensuring customers receive the supply security level detailed in Endeavour Energy planning standards.

- **Financial / Economic Feasibility** – to ensure requirements of the NER RIT-D process are met.

- **Demand Growth** – to ensure the preferred solution continues to be appropriate into the future, given forecast levels of demand growth.

- **Long Term Network Strategy** – the solution must support and be supported by the long-term plan for network development in the South West Growth Sector.

- **Environmental Feasibility** – to ensure the project does not result in a worse environmental impact than currently exists. Where this is not possible, the project must aim to minimise the additional environmental impact.

- **Technical Suitability** – all relevant design standards must be met.

- **Network Utilisation** – the solution proposed makes the best use of the existing capacity of the network.

- **Network Safety** – the proposed solution does not present any future safety issues for operations and maintenance personnel or members of the public. It addresses any identified current safety concerns.

6 Options

6.1 Do Nothing

The “Do Nothing” option will not change the risk profile in the Leppington and East Leppington precincts and specifically the unserviceable development of 8,565 new residential dwellings above the firm limit of the existing substation. It also carries with it significant risks of negative press and NSW Government dissatisfaction if Endeavour Energy is unable to meet supply requirements for this priority growth area.

The load forecast on South Leppington ZS indicates it will exceed the firm substation capacity of 10MVA by the end of the 2018 calendar year. The substation will not be able to service further load growth in the area. If nothing is done, South Leppington ZS would be expected to supply over 14,000 dwellings with a forecast load of 55MVA in its current (interim) configuration. This is technically unachievable and requires new infrastructure works to be undertaken to meet this large need for capacity.

The Do Nothing option will therefore not be considered further.

6.2 DM Option

Electricity Distributors in NSW operate under the licence requirement (under the NSW Electricity Supply Act 1995) to investigate non-network alternatives to network augmentation for specific capital expenditure projects. The National Electricity Rules (NER) requires Distribution Network Service Providers (DNSP) to investigate non-network (demand management) options by utilising a thorough consultation process as part of planning for major network upgrades.

The NER calls for a regulatory investment test for distributors (RIT-D) process to be used in identifying the solution delivering the highest net market benefit in removing the network limitation. A “screening test” is performed for all network limitations where the most expensive credible option is greater than $5 million.

South Leppington ZS - Stage 2 Augmentation is planned to occur when the distribution back-up capacity from adjacent zone substations is exceeded. This will occur in 2018 with a forecast load of 11.8 MVA. This capacity will progressively reduce over time as new development occurs within other precincts normally supplied by the back-up network.

Endeavour Energy has processed 5,300 lot/dwelling approvals since 2014 representing 21MVA. About 1,600 dwellings have been connected with the remainder expected to be connected over the next 24 months. The development of the precincts has been accelerated to produce higher numbers in the initial stages. This accelerated development cannot be adequately serviced from the existing interim South Leppington ZS or the 11kV back-up network. South Leppington ZS is planned to service approximately 14,310 dwellings and two shopping centres which are proposed to be connected over the next 20 years.

The feasibility of a non-network option was investigated. For a non-network option to be successful it would need to reduce sufficient demand to allow existing capacity to supply the new release areas and in turn defer the augmentation of the interim South Leppington ZS. Demand

reduction would need to target the existing customer base on South Leppington ZS and the 11kV back-up network supply areas.

A demand reduction of 11.7MVA is needed to be obtained by 2020 on the interim South Leppington ZS for a one year deferral and 16.7 MVA by 2021 for a two year deferral of the substation augmentation. Analysis identified that there was a potential of 2.6 MVA demand reduction from the existing customer base. This fell short of the required 11.7 MVA demand reduction target by summer 2019/20 for a one year deferral and 16.7 MVA for a two year deferral.

The demand reduction will need to be initiated up to 5 to 6 times a year on a pre-emptive basis, based on the 2018 summer. The number of DR events will quickly increase to 16 events in 2019 and 53 events in 2020. The duration of the demand reduction will also increase from a four hour to a six hour period during the same time. This meant that temporary demand reduction initiatives were not likely to be economic given the large the number of events and duration required.

As a result of the Demand Management Feasibility Study it was concluded that there is insufficient opportunity to obtain the required demand reduction to defer the augmentation of the interim South Leppington ZS. A Screening Report was published to document the non-network investigations and submissions invited from interested parties that may have an alternate view.

6.3 Local Generation

The demand reduction analysis does not consider any large embedded generation options as this is primarily a residential development and is subject to noise and other environmental restrictions.

6.4 Utilising the Existing Network

The 11kV distribution network servicing the Leppington and East Leppington precincts and surrounding release areas is comprised of eight (8) feeders double terminated onto four circuit breakers from South Leppington ZS. There are cross-zone ties to neighbouring zone substations Edmondson Park, Bow Bowing, Bringelly, Prestons and Narellan.

There is no opportunity to off-load any substantial customer load to adjacent parts of the network due to committed network capacity to ongoing development in other precincts supplied by the adjacent zone substations. Some capacity could be utilised from the proposed North Leppington ZS distribution network after June 2019 but this will progressively decrease as the Leppington Town Centre begins to consume all available distribution capacity from the new substation.

The following diagram shows the existing network supplied from the nearest zone substations including South Leppington ZS.

The proposed service catchment area for South Leppington ZS is shown in Appendix 11 Technical Specification *(see last page of this report).*

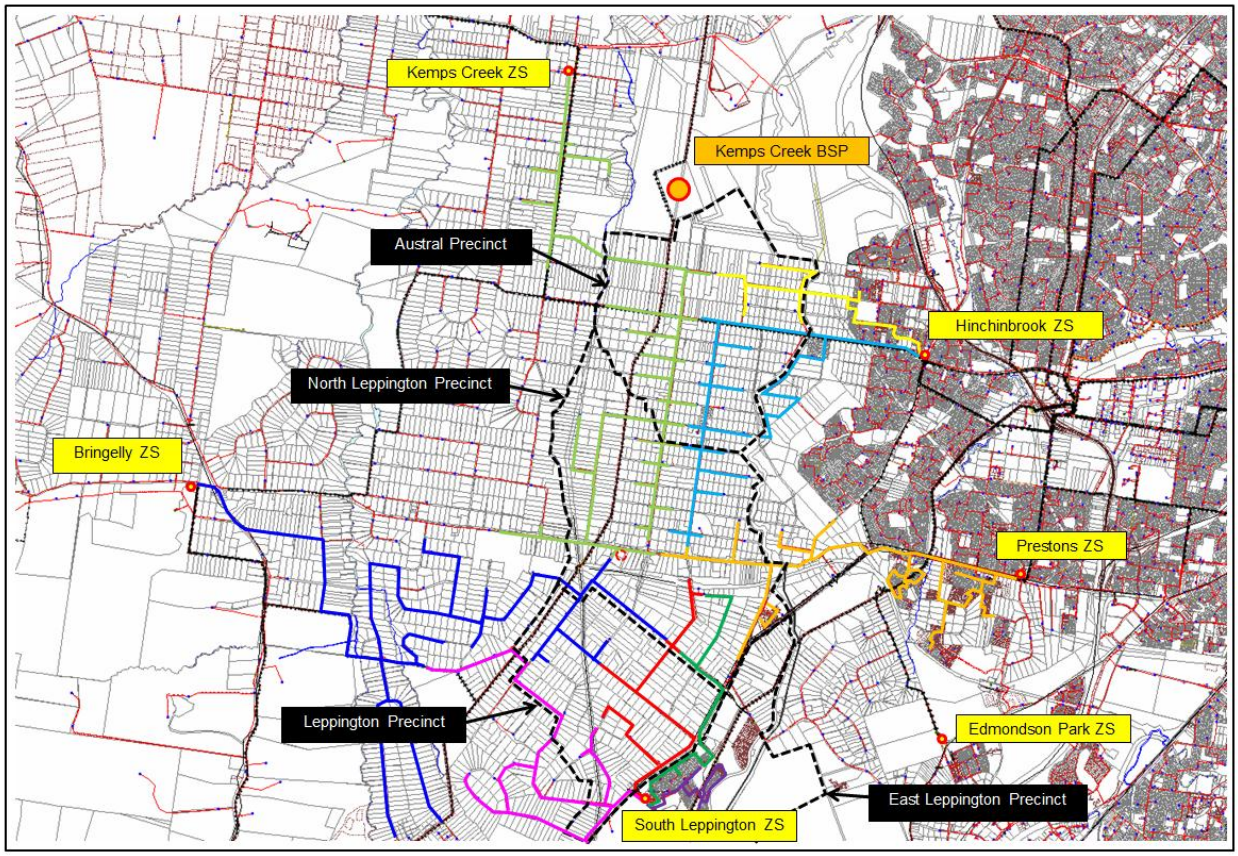


Figure 6 – Existing Distribution Network

6.5 Build Options

There is only one main build option being examined which establishes the permanent zone substation replacing the interim portable solution that was originally established to provide start up capacity for up to five years. This is known as South Leppington ZS - Stage 2 but has four sub-options for the second 132kV feeder. Due to the four feeder options there are four options being compared.

6.6 Scope of Work

6.6.1 Zone Substation - Augment South Leppington 132/11kV Zone Substation

Replace the portable substation with a permanent control building, four 11kV switchboard sections and one additional 45MVA transformer. The substation shall be established as an indoor design on the same Endeavour Energy owned site in St Andrews Rd, Willowdale. The augmented substation will receive a second 132kV supply to provide N-1 supply security and the existing eight 11kV feeders will be transferred to the new switchboard. This option will be carried out in one stage including the removal of the temporary assets – refer to Figure 7.

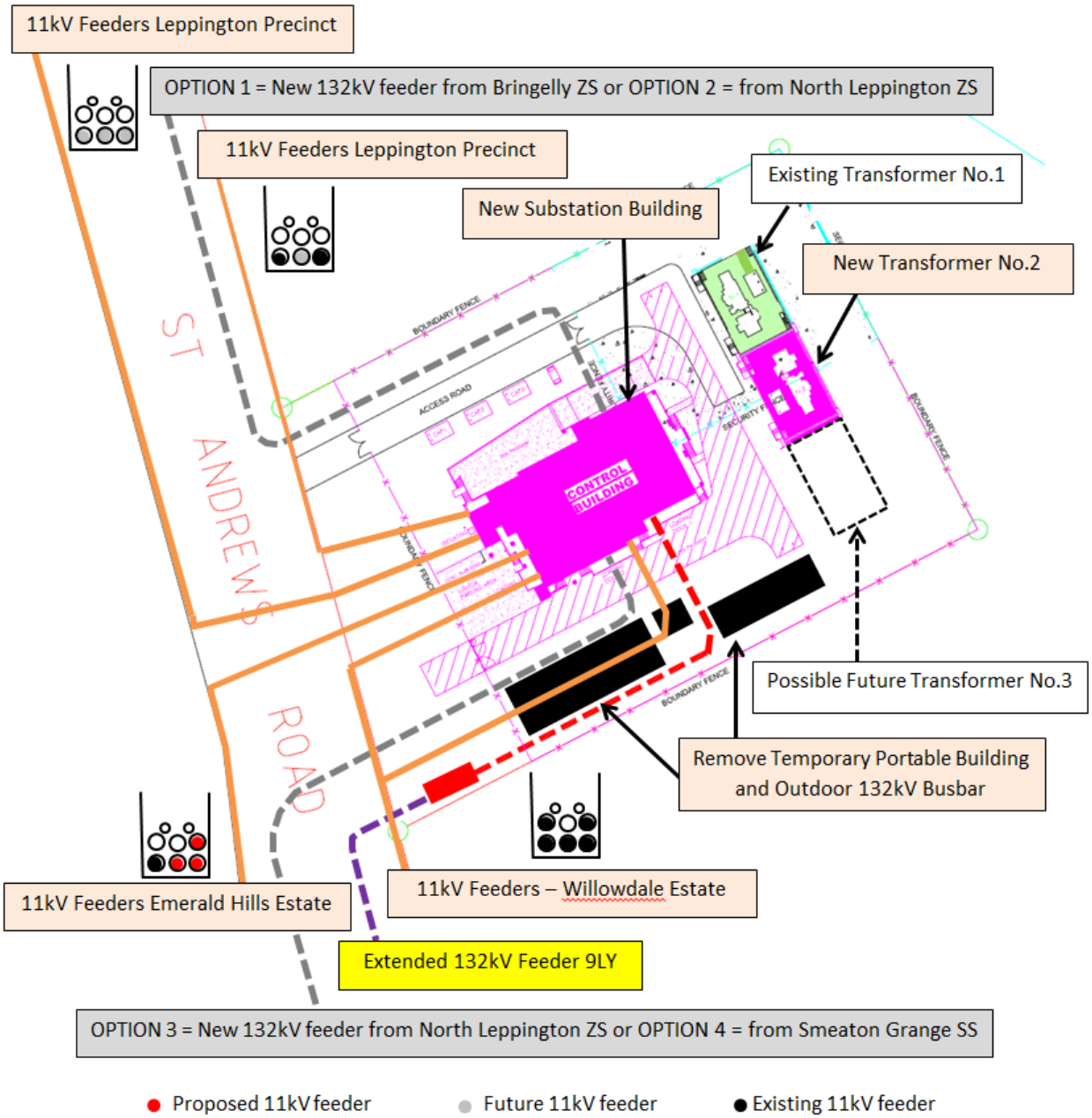


Figure 7 – Preliminary Substation Layout of South Leppington Zone Substation

6.6.2 132kV Feeder Options to South Leppington ZS

The following diagram shows four options for the second 132kV supply to South Leppington ZS.

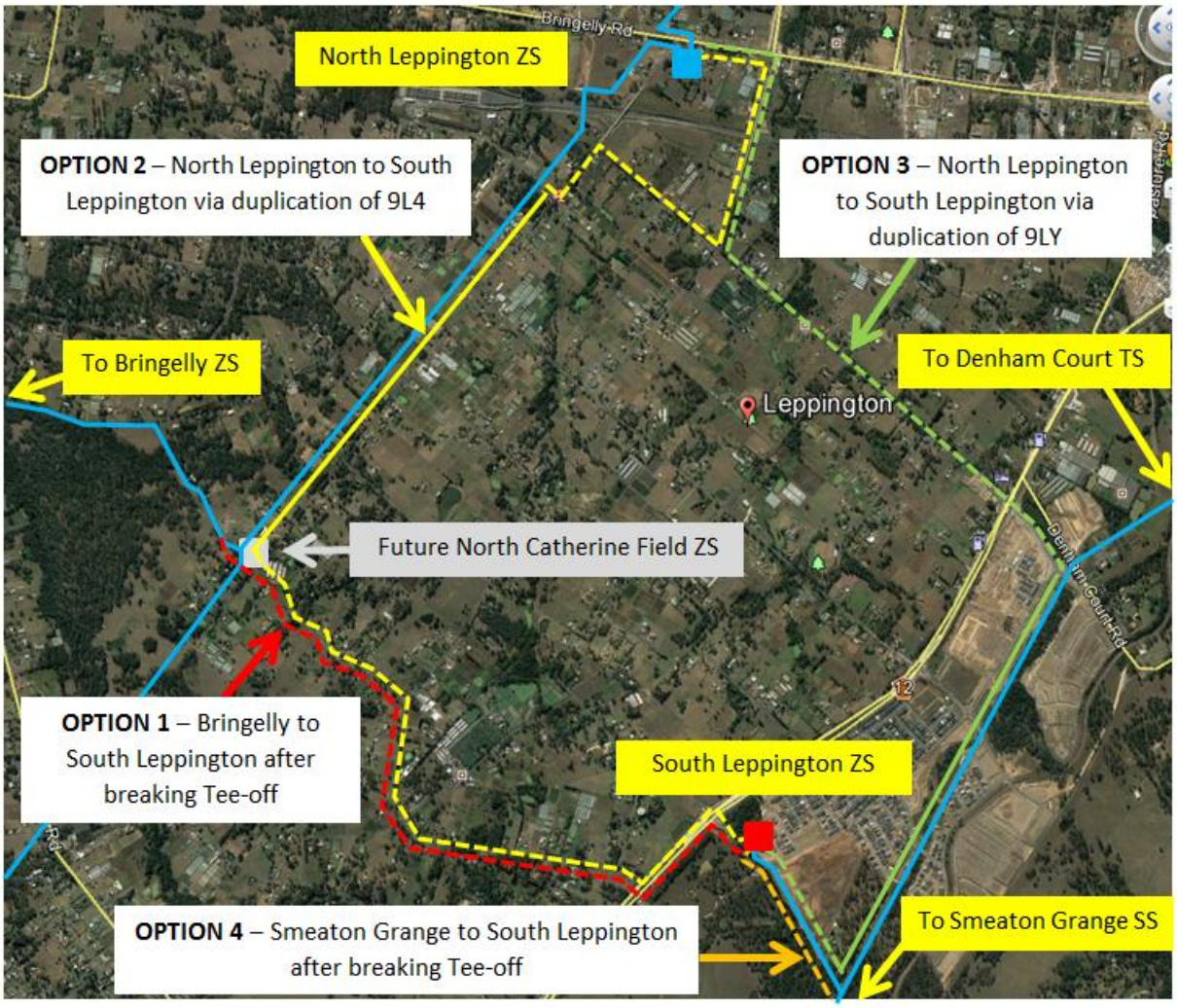


Figure 8 – 132kV Sub-transmission Supply for South Leppington Zone Substation

6.6.3 Distribution Network

There will be three new 11kV feeders established as part of the augmentation of South Leppington ZS to make the newly installed substation capacity accessible in all directions within the service catchment area.

Additional 11kV feeders will be established as needed during the progressive development of the surrounding areas over the next 20 years with an ultimate number of between 12 -15 feeders.

The South Leppington ZS load is expected to peak at between 45MVA – 55MVA representing between 100% -120% utilisation of assets within 20-25 years. The substation may need to be expanded to 90MVA firm capacity and provisions have been made for this potential need which would result from a higher density residential rezoning and new precincts being released within reach of South Leppington ZS.

The proposed distribution network for South Leppington ZS is shown in Figure 9.

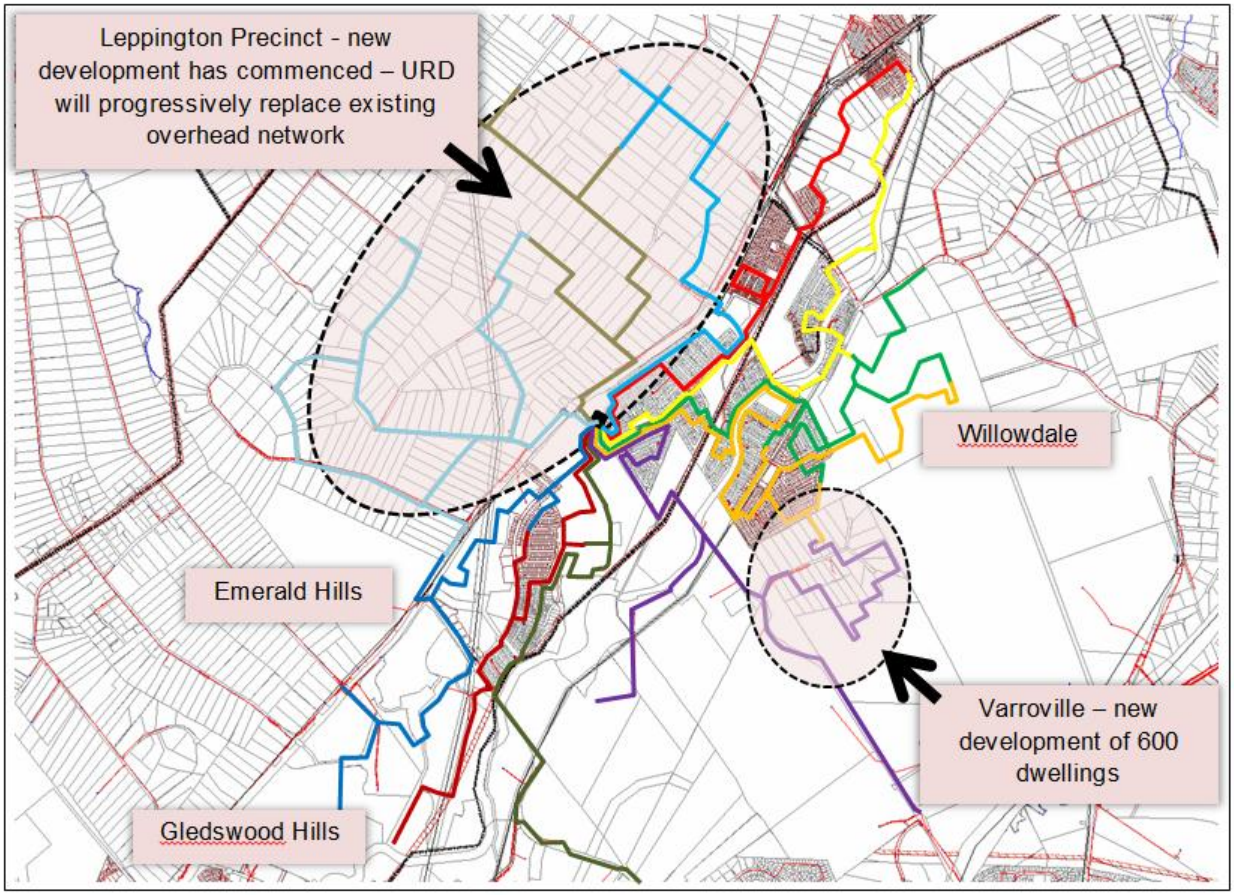


Figure 9 - Proposed 11kV Distribution Network from South Leppington Zone Substation

The 11kV feeders supplying the Leppington precinct will progressively be undergrounded by URD development which will establish the permanent network from South Leppington ZS.

The post augmentation load transfers proposed from adjacent zone substations to South Leppington ZS are shown below.

Table 6 - Proposed Load Transfers				
From Zone Substation	**From Transmission Substation / BSP**	**To Zone Substation**	**To Transmission Substation / BSP**	**Amount (MVA)**
North Leppington	Sydney West	South Leppington	Nepean / Macarthur	Nil
Edmondson Park	West Liverpool / Liverpool			Nil
Prestons				Nil
Bringelly	Nepean / Macarthur			Nil
Narellan				1.5
Total Load to be Transferred				**1.5^**

^The load transfer represents approximately 395 homes in the Gledswood Hills area.

6.6.4 Protection of the 132kV Sub-Transmission Network

As the South-West Growth Sector expands and new zone substations are established, protection of the 132kV network will be upgraded to provide acceptable performance, public safety, asset protection and supply security by meeting critical clearance times required by the NER.

A communication network is required to be established for South Leppington ZS as follows.

132kV Feeder Option 1 – Bringelly to South Leppington

1. Extend communication link **OP0244** from Smeaton Grange SS to the new control building.
2. Extend communication link **OP0246** from Denham Court TS to the new control building.
3. Install communication link **OP0248**

132kV Feeder Option 2 – North Leppington to South Leppington via duplication of 9L4

1. Extend communication link **OP0244** from Smeaton Grange SS to the new control building.
2. Extend communication link **OP0246** from Denham Court TS to the new control building.
3. Install communication link **OP0248**

Same as Option 1

132kV Feeder Option 3 - North Leppington to South Leppington via duplication of 9LY

1. Extend communication link **OP0244** from Smeaton Grange SS to the new control building.
2. Extend communication link **OP0246** from Denham Court TS to the new control building.

132kV Feeder Option 4 – Smeaton Grange to South Leppington

1. Extend communication link **OP0244** from Smeaton Grange SS to the new control building.
2. Extend communication link **OP0246** from Denham Court TS to the new control building.

Same as Option 3

Refer to Figure 10 for the proposed communication network.

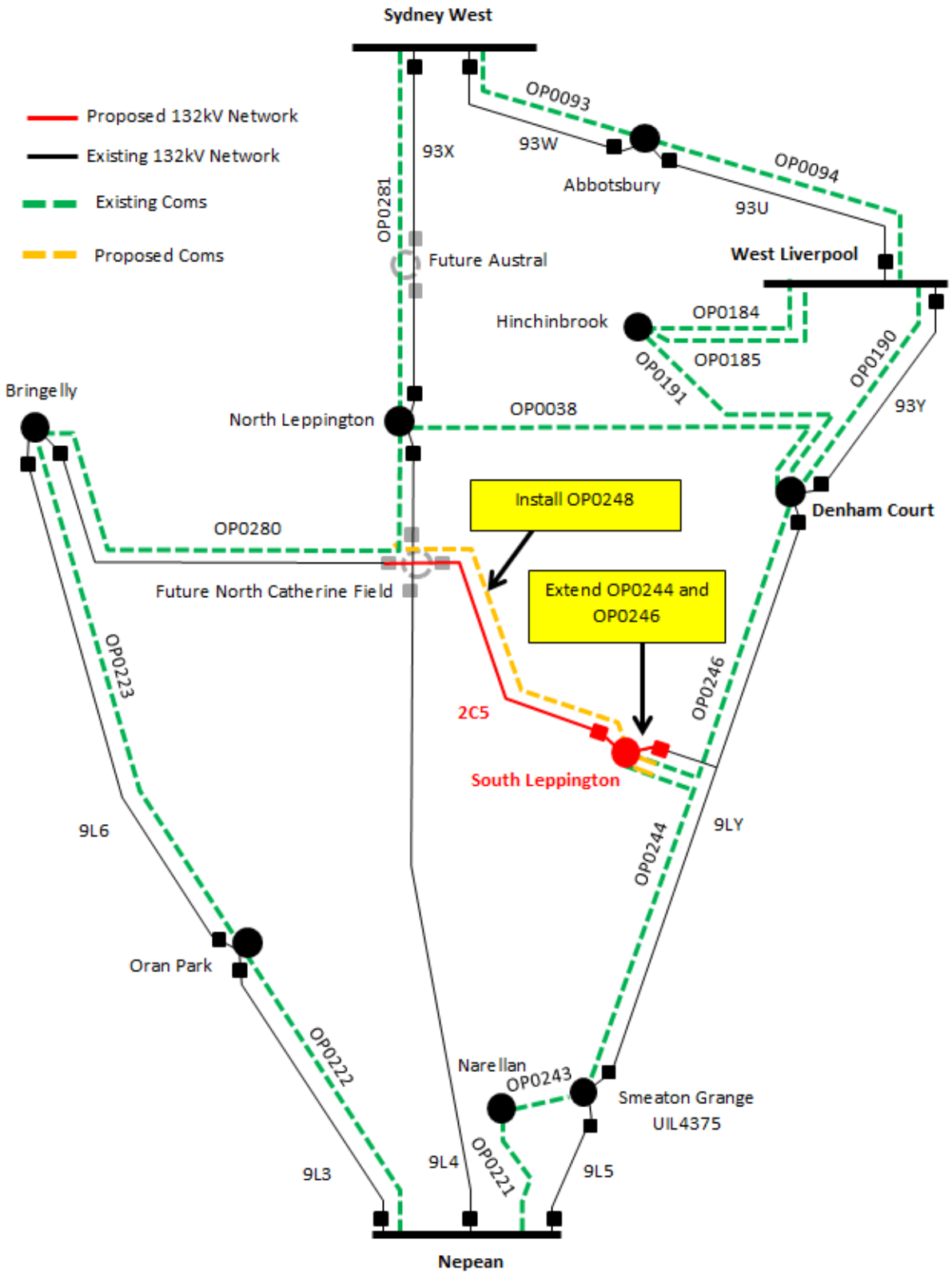


Figure 10 – Communication Network for South Leppington Zone Substation

Undertaking 132kV feeder Option 1, the augmented South Leppington ZS will be supplied from Macarthur BSP/Nepean TS by meshed network 9L3, 9L6, 9L5, 9LY and 2C5.

Undertaking 132kV feeder Option 2, the augmented South Leppington ZS will be supplied from Macarthur BSP/Nepean TS by meshed network 9L3, 9L4, 9L5, 9L6, 9LY and 2C5.

Undertaking 132kV feeder Option 3, the augmented South Leppington ZS will be supplied from Macarthur BSP/Nepean TS by meshed network 9L3, 9L4, 9L5, 9L6, 9LY and 2C5.

Undertaking 132kV feeder Option 4, the augmented South Leppington ZS will be supplied from Liverpool BSP/West Liverpool TS via Denham Court TS by 132kV feeders 93Y and 9LY.

6.6.5 Communication Repatching Work

PR656 South Leppington – Stage 2 will reinstate communication links OP0244 and OP0246 between Smeaton Grange SS and Denham Court TS.

The Protection Engineer will confirm protection settings required for NER compliance and communication repatching.

Due to network configuration and operational alterations proposed by major project **PR656,** a review will occur for the following sites;

9538 West Liverpool Transmission Substation

9585 Nepean Transmission Substation

9616 Bringelly Zone Substation

9624 Sydney West Bulk Supply Point

9759 Denham Court Transmission Substation

9766 South Leppington Zone Substation

9768 Oran Park Zone Substation

9778 North Leppington Zone Substation

9781 Smeaton Grange Switching Station

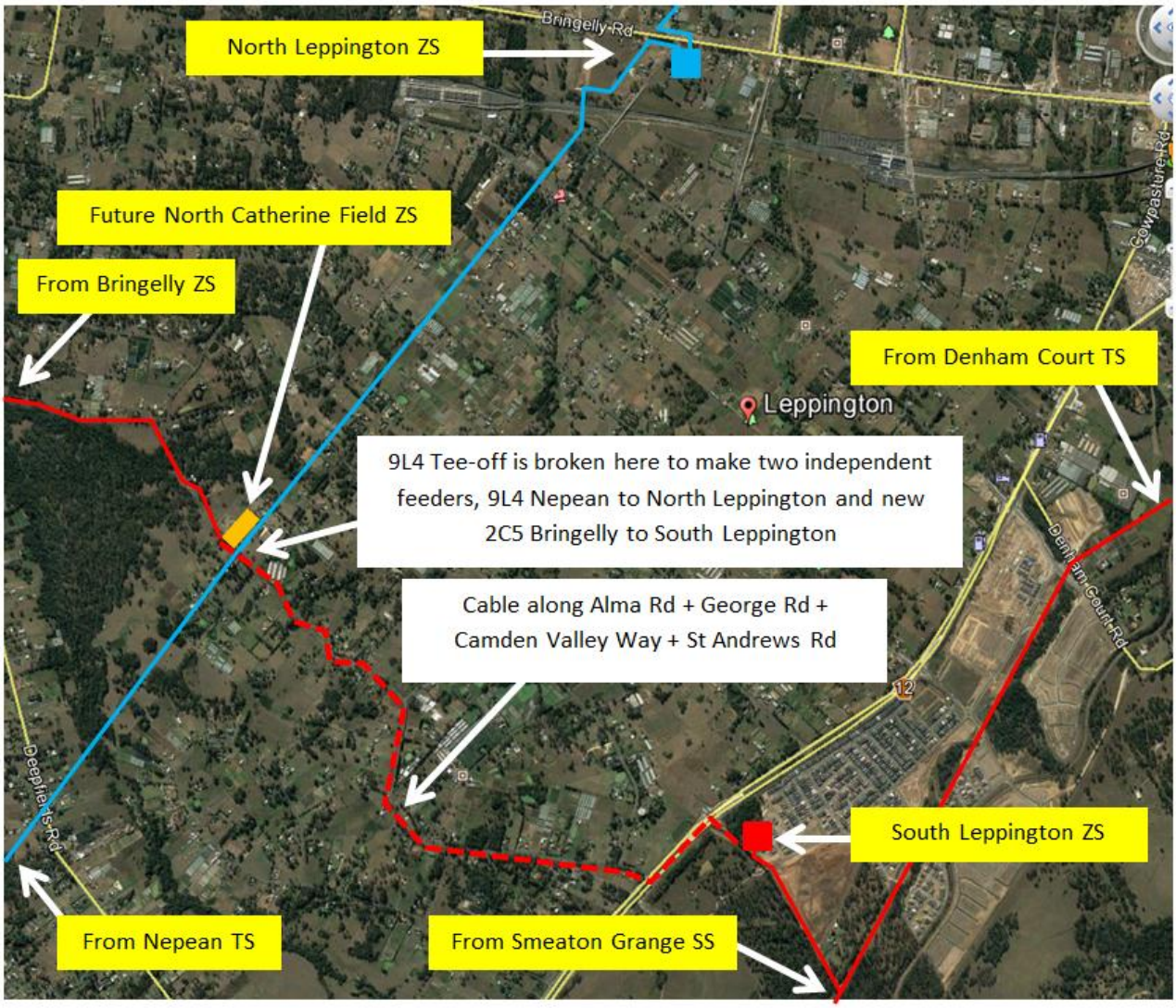
Option Comparison

Four 132kV feeder route options were assessed against the objectively measurable service standards discussed in Section 5.

The options were investigated and compared based on their technical suitability and ability to meet the long-term strategy for the South West Sector as well as total project costs, constructability, delivery times and environmental assessments.

Option 1 – Proposes the extension of 132kV feeder from Bringelly ZS to South Leppington ZS via Alma Rd, George Rd, Camden Valley Way and St Andrews Rd.

Estimated total cost is $26.1M + $1.9M contingency = $28M

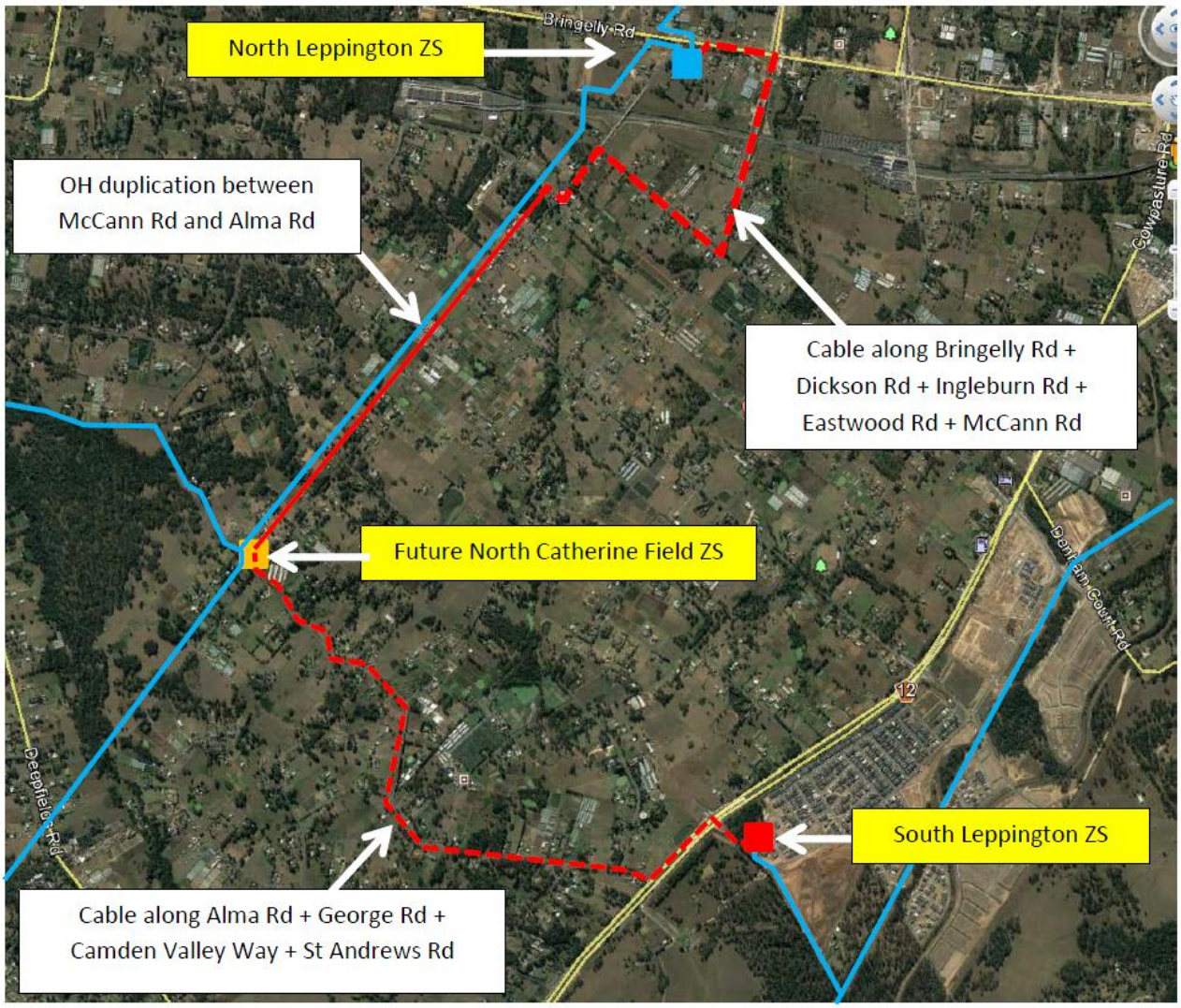


OPTION 1 – Cable extension from existing OH

This option removes the 9L4 tee-off to Bringelly ZS and extends the 132kV from Bringelly ZS to South Leppington ZS. Feeder 9L4 remains direct from Nepean TS to North Leppington ZS.

<u>Option 2</u> – Proposes the establishment of a 132kV feeder from North Leppington ZS to South Leppington ZS via the existing 30m wide easement for feeder 9L4. A 132kV circuit breaker is required at North Leppington ZS for this option. It is proposed to install a cable along Bringelly Rd (using ducts installed as part of the Bringelly Rd upgrade), Dickson Rd (using the railway bridge ducts installed as part of the SW-Rail Link), Ingleburn Rd, Eastwood Rd and McCann Rd to a new UGOH termination pole. Then duplication of the 132kV overhead using concrete monopole structures with vertical outward facing stand-off insulators between McCann Rd and Alma Rd is proposed. Finally a 132kV cable installed from a second new UGOH termination pole at the North Catherine Field ZS site along Alma Rd, George Rd, Camden Valley Way and St Andrews Rd to South Leppington ZS.

Estimated total cost is $31.8M + $ 2.5M contingency = $34.3M

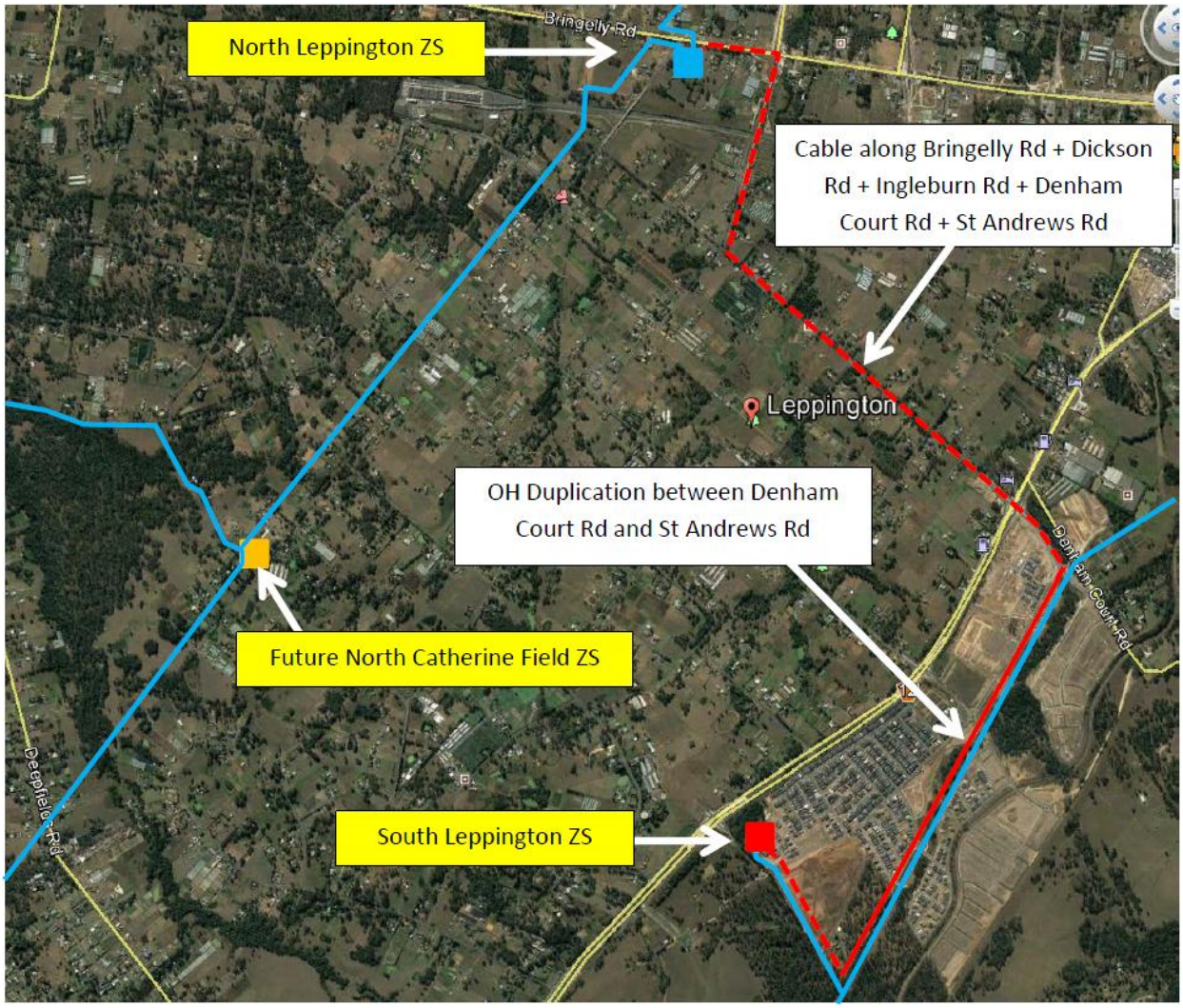


OPTION 2 – Cable and OH Duplication via North Catherine Field Site

Future reconfiguration of the network would utilise one of the duplicated lines to supply Rossmore ZS heading west. Any duplicated section not required to supply Rossmore ZS would be bonded to the adjacent line in lieu of dismantling.

<u>Option 3</u> – Proposes the establishment of a 132kV feeder from North Leppington ZS to South Leppington ZS via the existing 30m wide easement for feeder 9LY. A 132kV circuit breaker is required at North Leppington ZS for this option. It is proposed to install a cable along Bringelly Rd (using ducts installed as part of the Bringelly Rd upgrade), Dickson Rd (using the railway bridge ducts installed as part of the SW-Rail Link), Ingleburn Rd and Denham Court Rd to a new UGOH termination pole. Then duplication of the 132kV overhead using concrete monopole structures with vertical outward facing stand-off insulators between Denham Court Rd and St Andrews Rd is proposed. Finally a 132kV cable installed from a second new UGOH termination pole and along St Andrews Rd to South Leppington ZS.

Estimated total cost is $29.9M + $2.3M contingency = $32.2M



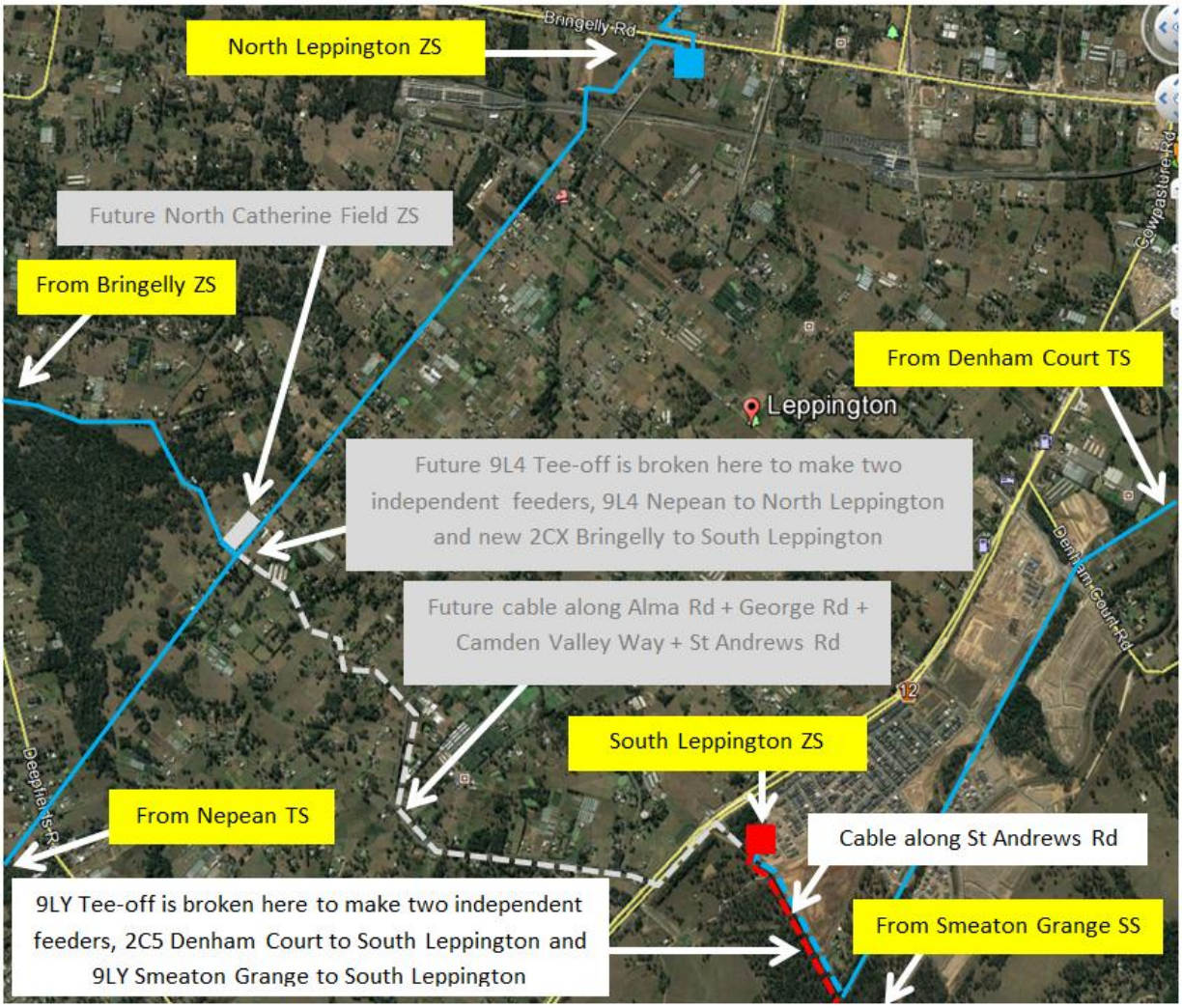
OPTION 3 – Cable and OH Duplication via Alternate Route

There are two additional obstacles associated with this option including acquisition of a second easement for the proposed 132kV cable in St Andrews Rd and the consultation and approval process for crossing the Jemena gas pipeline adjacent to feeder 9LY. Selection of this option would need to factor in the lengthy time penalty associated with achieving this.

Future reconfiguration of the network would utilise one of the duplicated lines to supply the Smeaton Grange Switching Station directly from West Liverpool TS.

Option 4 – Proposes a second 132kV cable from existing feeder 9LY which would create a feed into South Leppington ZS from Nepean TS via Smeaton Grange SS and a feed from West Liverpool TS via Denham Court TS. This option conflicts with Endeavour Energy Substation Design Instruction (SDI) 501 *Transmission Network Configuration* in that it moves away from the ringed network model and results in three substations on radial change-over schemes. It is normal for a single substation to be on a change-over scheme on its own but not three substations each on change-over schemes and relying on the same interdependent network. This option does not satisfy operational and security requirements at multiple 132kV installations.

Estimated total cost is $21.1M + $1.4M contingency = $22.5M



OPTION 4 – Cable Extension of 9LY from Smeaton Grange SS

There are two additional obstacles associated with this option including acquisition of a second easement for the proposed 132kV cable in St Andrews Rd and the consultation and approval process for crossing the Jemena gas pipeline adjacent to feeder 9LY. Selection of this option would need to factor in the lengthy time penalty associated with achieving this for a second time.

The four 132kV feeder options are directly compared in Table 8 – *Comparison of Options* in section 7.4.

6.7 Technical Considerations

A number of technical factors were considered for the preferred option.

Fault Levels and Protection Communication Pilots

Fault levels on the 132kV and 11kV busbars have been calculated and are within the maximum fault levels recommended in SDI 501 *Transmission Network Configuration.* The calculated fault levels for South Leppington ZS are shown in Appendix 3.

An earthing study will be carried out to assess management of fault currents at South Leppington ZS and the associated 132kV sub-transmission network. Protection inter-tripping will be required for the following;

Feeder route **Option 1** between South Leppington ZS and Bringelly ZS

Feeder route **Option 2** between South Leppington ZS and North Leppington ZS

Feeder route **Option 3** between South Leppington ZS and North Leppington ZS

Feeder route **Option 4** between South Leppington ZS, Denham Court TS & Smeaton Grange SS

Duplicated protection and communication is required to provide full redundancy protection.

Step and Touch Potential

Where concrete poles are required on the line to obtain top loading strength, any hazardous step and touch potentials that may exist on the poles under fault conditions can be managed to safe levels (Refer ESAA C(b) 1-2003 Section 11) by adequately earthing affected poles.

This project will involve the erection of concrete poles on the 132kV sub-transmission network for two of the 132kV feeder route sub-options. Any step and touch potentials will be managed accordingly.

Reliability

There are no perceived reliability issues expected from the implementation of recommendations proposed by this NIO report.

6.8 Environmental Consideration

The proposed build option to establish the permanent 132/11kV zone substation at the existing temporary South Leppington ZS site will have an impact on the local environment.

An environmental assessment shall be carried out in accordance with statutory requirements outlined in section 3.2 of this report. The assessment will encompass the range of technologies being considered for this proposal. Endeavour Energy shall engage independent consultants as required to assist in this process and will consult with affected community and other stakeholders in carrying out the environmental assessment.

Preliminary environmental assessment comments are attached as Appendix 9. This assessment provides preliminary advice and guidance on matters relating to augmentation of the ZS to a permanent ZS facility, including consideration of stakeholder perceptions as well as minimising the impact of the substation and feeders. In taking the advice and recommendations of the

preliminary environmental assessment, and incorporating these into the design and construction of the project, this option for a 132kV indoor/11kV indoor zone substation at South Leppington is considered to be achievable from an environmental perspective.

6.8.1 Electromagnetic Fields

South Leppington ZS is ultimately forecast to reach a station load of 45MVA. This project proposes to establish a second 132kV supply to the existing zone substation. As a result approximately 3,800m of new underground 132kV cable will be installed along St Andrews Rd, Camden Valley Way, George Rd and Alma Rd under feeder Option 1. Figure 15 indicates the EMF level expected for a load of 45MVA when measured at 1m above ground level and at various distances from the proposed cable.

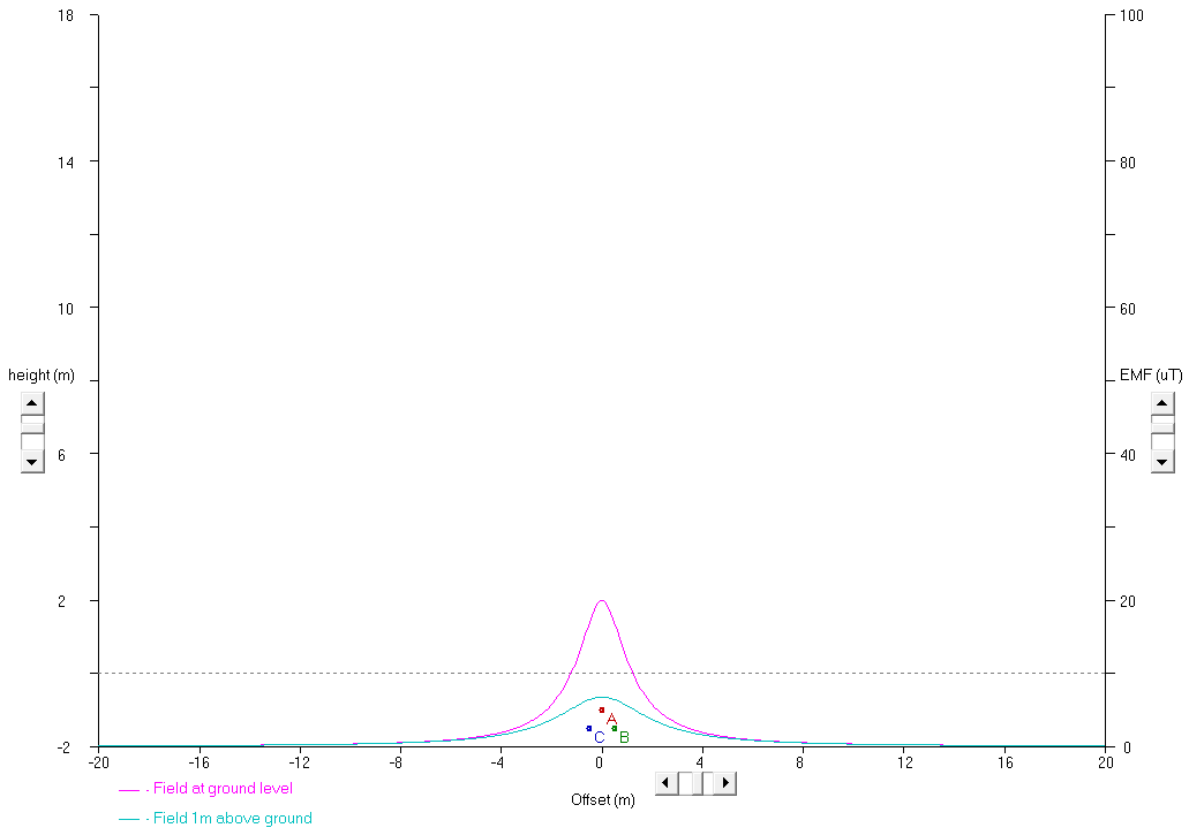


Figure 15 – Underground feeders to South Leppington ZS

South Leppington ZS will be connected to Bringelly ZS by new feeder 2C5 forming a meshed network from Nepean TS via Oran Park ZS, Bringelly ZS and Smeaton Grange SS – refer to SLDs in Appendix 2.

The results show for a forecast load of 45MVA, a 132kV underground cable will produce an EMF level of 70mG in the vicinity of the cable. During a contingency scenario associated with other parts of the network which could see a cable load of up to 170MVA, an EMF level of 130mG is expected in the vicinity of the cable. The expected EMF levels are no greater than between 3.5% to 12.5% of the recommended maximum level of 2000mG (200uT) assigned by the Australian Radiation Protection and Nuclear Safety Agency [ARPANSA] from guidelines set by the World Health Organisation.

6.8.2 Stakeholder Management

A number of stakeholders may be affected by this project. Their needs and issues need to be managed so that the project will not be adversely affected. A preliminary stakeholder management plan has been prepared and is included in Appendix 10.

The plan recommends community consultation be undertaken in parallel with the environmental assessment to address any concerns from the public and other stakeholders, providing feedback, in addition to a media release and website information to be made available. Briefings with the local MP and possibly the Minister for Energy will be required. Endeavour Energy will use various ways to consult with the community including newsletters, face to face visits and briefings, newspaper advertisements as well as project information on the website. The key external stakeholders identified include: Local residents and businesses, Liverpool City Council, Camden City Council, Campbelltown Council, State Member for Liverpool, NSW Minister for Energy, NSW Minister of Planning and Infrastructure and Local Media.

Once the project is approved, a comprehensive stakeholder assessment will be undertaken and a community engagement plan drafted and updated throughout the life of the project with key communication materials supporting the planned works such as key messages, communication timetable to stakeholders, media releases, fact sheets and website information including Q&As.

With the approach recommended in the plan, it is suggested the selected technically feasible option can be achieved.

6.9 Financial Evaluation and Regulatory Investment Test for Distribution (RIT-D)

A RIT-D evaluation was carried out for the proposed options and a Draft Project Assessment Report has been prepared. Details of the evaluation include calculations of the following parameters:

- Capital Expenditure (Not including land) ($)
- Net Market Value (NPV) ($)

A summary of the RIT-D analysis for the options are shown in Appendix 8. Cost estimates for the four options are shown in Appendix 4, Appendix 5, Appendix 6 and Appendix 7.

The purpose of the Regulatory Test for Distribution is specified in NER clause 5.17.1(b) as:

> *"The purpose of the regulatory investment test for distribution is to identify the credible option that maximises the present value of the net economic benefit to all those who produce, consume and transport electricity in the National Electricity Market (the preferred option). For the avoidance of doubt, a preferred option may, in the relevant circumstances, have a negative net economic benefit (that is a net economic cost) where the identified need is for reliability corrective action."*

Clause 5.17.3(a) of the NER states a RIT-D proponent must apply the regulatory test for distribution to a RIT-D project except in circumstances where (among others):

"(2) the estimated capital cost to the Network Service Providers affected by the RIT-D project of the most expensive potential credible option to address the identified need is less than $5million (as varied in accordance with a cost threshold determination."

As such, the RIT-D is applicable to this project. The four options are directly compared in the following table.

Table 7: Options Cost Comparisons				
	OPTION 1 **Augment South Leppington + 132kV Feeder Route 1**	**OPTION 2** **Augment South Leppington + 132kV Feeder Route 2**	**OPTION 3** **Augment South Leppington + 132kV Feeder Route 3**	**OPTION 4** **Augment South Leppington + 132kV Feeder Route 4**
Total CPI indexed Capital outlay (sum of nominal cash flows)#	26.1	31.8	29.9	21.1
Total Capital Outlay ($m)^ (sum of real cash flows)	25.3	30.8	28.9	20.4

These amounts represent the funding sought for each option by taking into account the years in which expenditure is expected to occur.

^ These amounts are used for RIT-D analysis and exclude contingency amounts and CPI.

6.10 Option Comparison

An assessment of the build options is shown in the following table.

Table 8: Comparison of Options				
PROJECT REQUIREMENT	**OPTION 1**	**OPTION 2**	**OPTION 3**	**OPTION 4**
Supply Security - provides long term N-1 supply security for East Leppington and Leppington precincts.	**Yes**	**Yes**	**Yes**	**Yes**
Licence Condition Compliance – 11kV distribution feeders controlled to planning limits for normal load current and voltage regulation.	**Yes**	**Yes**	**Yes**	**Yes**
Financial / Economic Feasibility – satisfies the RIT-D	**Yes**	**No**	**No**	**No**
Demand Growth – provides long term capacity needs for precinct development.	**Yes**	**Yes**	**Yes**	**Yes**
Long Term Network Strategy – solution will support the ultimate South West Sector Strategy.	**Yes**	**Yes**	**No**	**No**
Environmental Feasibility – design minimises additional impact.	**Yes**	**No**	**No**	**Yes**
Technical Suitability – design standards met.	**Yes**	**Yes**	**Yes**	**No**
Network Utilisation – best use of existing network and capacity.	**Yes**	**No**	**No**	**No**
Network Safety – does not present future safety issues for operations and maintenance personnel or members of the public.	**Yes**	**Yes**	**Yes**	**Yes**

6.11 Preferred Option

The RIT-D test establishes Option 1 - Augment South Leppington ZS with 132kV Feeder Route 1 maximises the Net Market Benefits. Option 1 is therefore the preferred option under the RIT-D.

Option 1 also provides the best overall solution to the identified design requirements and network need and is therefore also the technically preferred option.

All works associated with this option will be in accordance with SDI 501 *Transmission Network Configuration* unless specified otherwise. A site specific technical specification is included in Appendix 11.

7 Conclusion

Endeavour Energy has identified long-term network constraints for the Leppington and East Leppington precincts. One build option with four *(132kV feeder)* sub-options to address the constraints has been investigated with Option 1 meeting all technical and economic requirements.

Load transfers, demand management and local generation cannot address the identified constraints due to the type and magnitude of ongoing residential development within the study area.

A RIT-D evaluation of the cost of the build options and comparison of technical considerations has identified Option 1 - *Augment South Leppington Zone Substation with 132kV Feeder Route 1,* meets all project requirements and satisfies the NER requirements for RIT-D Draft Project Assessment.

This option will be finalised based upon responses to the RIT-D Draft Project Assessment Report and the outcomes of the environmental assessment conducted for this project. A Final RIT-D Project Assessment Report will then be prepared.

Appendices

Appendix 1	Statement of Network Need (SNN)
Appendix 2	Build Option 1 - Proposed Single Line Diagrams
Appendix 3	Fault Level Calculations
Appendix 4	Cost Estimate for Feeder Option 1
Appendix 5	Cost Estimate for Feeder Option 2
Appendix 6	Cost Estimate for Feeder Option 3
Appendix 7	Cost Estimate for Feeder Option 4
Appendix 8	Summary of RIT-D Analysis for PR656 South Leppington Zone Substation
Appendix 9	Preliminary Environmental Assessment
Appendix 10	Preliminary Stakeholder Management Plan
Appendix 11	Detailed Technical Specification and Distribution Works Items – Preferred Option

Memorandum

To	Capacity Planning Manager	File no	South Leppington ZS
From	Joe Degabriele – Capacity Planner	Date	16 March 2017
Subject	**Augmentation of South Leppington ZS** - Statement of Network Need No.PR656		
Copies	Manager Asset Strategy & Planning		

Background

South Leppington ZS was established to supply the East Leppington precinct in 2014. The substation has an interim layout comprising a portable control building with four 11kV feeder circuit breakers and a single *(permanent)* 45MVA transformer supplied by a single 132kV underground cable from a Tee-off on feeder 9L5.

The Willowdale Estate which makes up the majority of the East Leppington precinct is progressing rapidly with 3,240 residential lots and a shopping centre processed for connection to the network since June 2013 with a forecast load of 14.6MVA. The area is planned for an ultimate 6,445 dwellings representing a load of 25MVA. There are currently 985 completed and occupied dwellings with an estimated load of 3.9MVA.

South Leppington ZS also supplies the Emerald Hills Estate situated south of the zone substation and the Leppington precinct situated across Camden Valley Way. The Emerald Hills Estate is planned for a total of 1,350 dwellings with 774 residential lots processed for connection to the network with a forecast load of 2.8MVA since January 2015. The Leppington precinct is planned for 9,900 dwellings of which approximately 6,000 are proposed to be supplied from South Leppington ZS. There are currently three developer enquiries totalling 521 dwellings with a forecast load of 2MVA within the Leppington precinct.

In addition to the above, South Leppington ZS also supplies the Gledswood Hills residential area planned for 515 dwellings. A total of 201 dwellings have been processed for connection with a forecast load of 0.8MVA. There will also be 1,300 dwellings supplied in the south-east extremity of the North Leppington precinct with a forecast load of 5.2MVA.

The combined areas will result in a total station load of 55MVA for South Leppington Zone Substation. Endeavour Energy has processed a total of 5,496 new lots/dwellings and shopping centre with a combined load of 20.6MVA.

The study area is shown in Diagram 1 and approved development since June 2013 in Table 1.

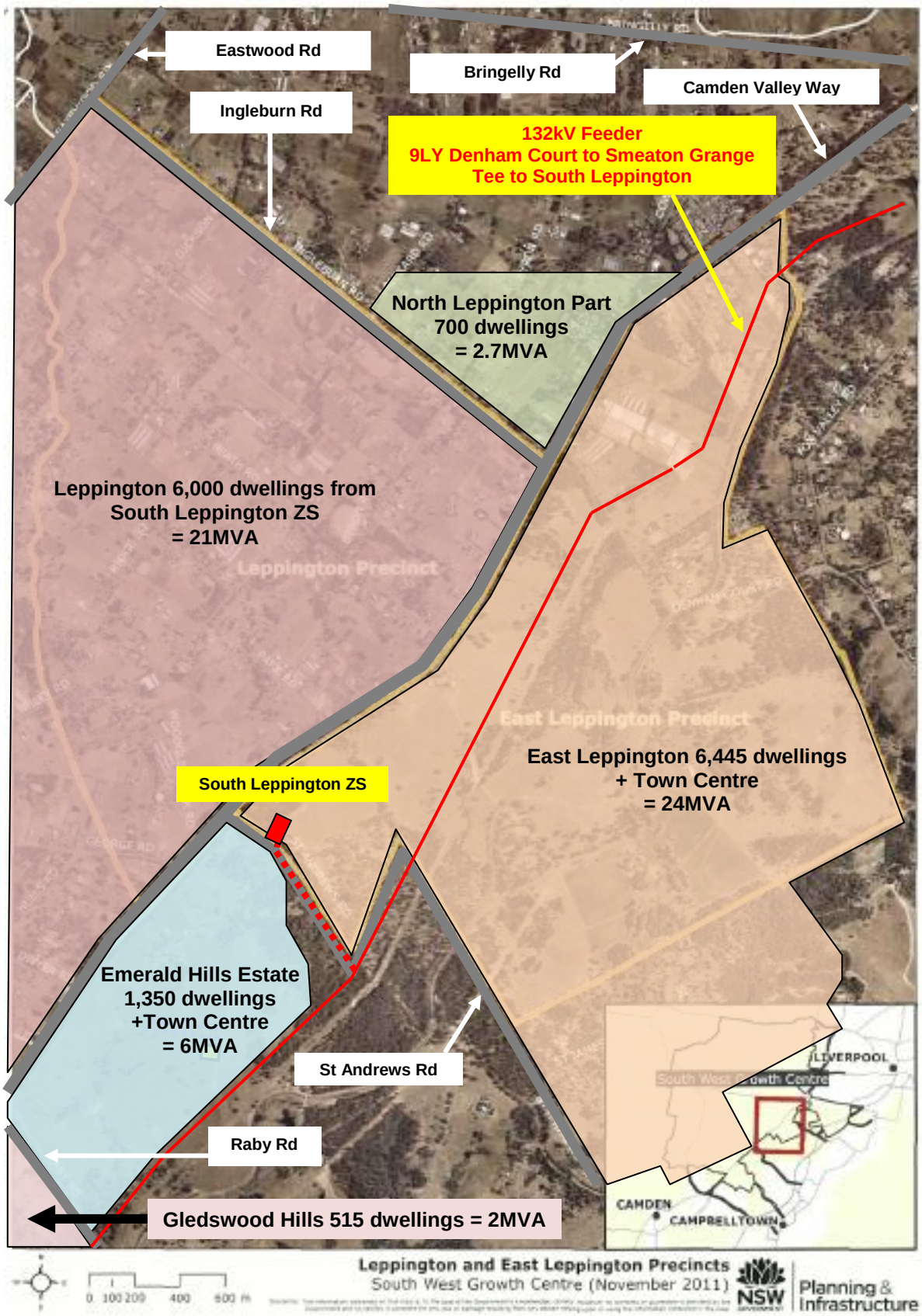


Table 1 - Processed Development for South Leppington Zone Substation							
CAM	Reference	Units	Town Houses	Homes	kVA	Approved	
URS7660	Dwyer Rd Leppington Precinct	0		212	848	2017	
URS7661	George Rd Leppington Precinct	0		213	852	2017	
ENL2718	Ingleburn Rd Leppington	0		33	132	2016	
ENL2738	Park Rd Leppington	0		37	148	2016	
URS16006	Gledswood Hills			67	268	2015	
URS16007	Gledswood Hills			67	268	2015	
URS16008	Gledswood Hills			67	268	2015	
URS15160	Stage 1A Emerald Hills	0		73	292	2015	
URS15161	Stage 1B Emerald Hills	0		91	364	2015	
URS15162	Stage 1C Emerald Hills	0		117	468	2015	
URS17243	Stage 2 Emerald Hills	0		142	568	2015	
URS18347	Stage 4 Emerald Hills	0		119	476	2016	
URS18348	Stage 5 Emerald Hills	0		126	504	2017	
URS18350	Stage 6 Emerald Hills	0		106	424	2017	
URS19325	Camden Valley Way East Leppington	0		85	340	2017	
URS17306	Denham Court Rd East Leppington			58	232	2015	
URS17307	Denham Court Rd East Leppington			27	108	2015	
URS15879	Stage 1 St Andrews Rd East Leppington			106	424	2015	
URS15880	Stage 2 St Andrews Rd East Leppington			79	316	2015	
URS15881	Stage 3 St Andrews Rd East Leppington			30	120	2015	
URS13579	Stage 1A Willowdale			47	188	2013	
URS14082	Stage 1B Willowdale			37	148	2013	
URS14083	Stage 1C Willowdale			41	164	2013	
URS14084	Stage 1D Willowdale			41	164	2013	
URS14085	Stage 1E Willowdale			44	176	2013	
URS14086	Stage 1F Willowdale			50	200	2013	
URS14087	Stage 1G Willowdale			49	196	2013	
URS14088	Stage 1H Willowdale			45	180	2013	
URS14089	Stage 1I Willowdale			25	100	2013	
URS14919	Stage 2A Willowdale			51	204	2014	
URS14920	Stage 2B Willowdale			45	180	2014	
URS14921	Stage 2C Willowdale			23	92	2014	
URS14922	Stage 2D Willowdale			32	128	2014	
URS14923	Stage 2E Willowdale			38	152	2014	
URS14924	Stage 2F Willowdale			61	244	2014	
URS14925	Stage 2G Willowdale			53	212	2014	
URS15138	Stage 3A Willowdale			36	144	2014	
URS15139	Stage 3B Willowdale			38	152	2014	
URS15140	Stage 3C Willowdale			40	160	2014	
URS15141	Stage 3D Willowdale			41	164	2014	
URS15142	Stage 3E Willowdale			54	216	2014	
URS16205	Stage 6 Retirement Village Willowdale			268	1072	2015	
URS16397	Stage 5A Willowdale		74		259	2015	
URS17108	Stage 5B & 5C Willowdale		67		234.5	2015	
URS17109	Stage 5C1 Willowdale		60		210	2016	
URS16753	Stage 7A Willowdale			52	208	2016	
URS16754	Stage 7B Willowdale			48	192	2015	
URS15525	Stage 8A Willowdale			72	288	2014	
URS15526	Stage 8B Willowdale			39	156	2014	
URS15527	Stage 8C Willowdale			91	364	2014	
URS16146	Stage 9A Willowdale			85	340	2015	
URS16147	Stage 9B Willowdale			111	444	2015	
URS14168	Stage 9C Willowdale			83	332	2015	
URS16764	Stage 14 Willowdale			100	400	2016	
URS17612	Stage 15A Willowdale			142	568	2016	
URS17613	Stage 15B Willowdale			121	484	2016	
URS17614	Stage 15C Willowdale			44	176	2016	
URS17615	Stage 15D Willowdale			51	204	2016	
URS17616	Stage 15E Willowdale			59	236	2016	
URS17617	Stage 15F Willowdale			37	148	2017	
UCL8209	Shopping Centre - Willowdale				970	2016	
URS19199	Stage 16A Willowdale			60	240	2017	
URS19201	Stage 16C Willowdale			56	224	2017	
URS19202	Stage 16D Willowdale			48	192	2017	
URS19203	Stage 16E Willowdale			63	252	2017	
URS19214	Stage 11A Willowdale			62	248	2017	
URS19215	Stage 11B Willowdale			62	248	2017	
URS19216	Stage 11C Willowdale			56	224	2017	
URS19217	Stage 11D Willowdale			61	244	2017	
URS19218	Stage 11E Willowdale			65	260	2017	
URS19219	Stage 11F Willowdale			28	112	2017	
	Existing non-urban			900	3600		
	Proposed load transfer to North Leppington ZS			-315	-1260	2018	
TOTALS		**0**	**201**	**5295**	**22.9**	**MVA**	
Firm Capacity					10.0	MVA	
Load at Risk				3213	12.9	MVA	
Willowdale			201	3240	14.6		
Emerald Hills				774	3.1		
Other	Combined areas Leppington and Gledswood Hills			696	2.8		
Existing	Non-urban			900	3.6		
Transfer	Load transfer to North Leppington ZS			-315	-1.3	2019	
TOTALS		**0**	**201**	**5295**	**22.9**		**5496**

Network Need

South Leppington ZS has a non-firm station capacity of 45MVA but due to its 'N' security of supply configuration of single transformer and single 132kV feeder, the firm distribution capacity is 10MVA. This however will progressively decrease as new development within adjacent precincts is normally supplied by the back-up network thus reducing the back-up capacity. The limitation is dictated by the distribution network capacity available from adjacent zone substations during a complete outage on South Leppington ZS. This capacity will be exceeded in Summer 2017/18 as shown in Table 2.

Table 2 – Official Load Forecast for South Leppington Zone Substation (MVA) 2015-2026

Year #	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Demand (MVA)	6.0	11.8	14.7	18.7	22.7	26.3	29.2	31.2	32.5	33.2	34.5	35.8
Firm Capacity* (MVA)	10	9.5	9.0	8.5	8.0	7.5	7.0	6.5	6.0	5.5	5.0	4.5
Load at Risk (MVA)	0	2.3	5.7	10.2	14.7	18.8	22.2	24.7	26.5	27.7	29.5	31.3

The forecast indicates the station load will exceed the firm back-up capacity provided by the 11kV networks of Bow Bowing ZS, Edmondson Park ZS, Narellan ZS and Prestons ZS in 2018. By 2020 the forecast load at risk (LAR) will be in excess of 10MVA and equivalent to approximately 2,500 dwellings.

The approved connection of 5,496 lots/dwellings and the Willowdale Shopping Centre with a combined load of 20.6MVA together with an existing non-urban load of 3.6MVA and a load transfer proposed for 2019 of -1.3MVA represents a station load of 22.9MVA. This means South Leppington ZS has the equivalent of the 2023 forecast load already approved to date.

New capacity is required prior to 2020 when approximately 2,500 homes are at risk of not being serviced during an outage of South Leppington ZS.

Other Issues

The planned commissioning of North Leppington ZS in 2019 will provide limited back-up to South Leppington ZS via the existing rural network between the two zone substations. This will occur as the network is reconfigured to bring the initial North Leppington distribution network on line but will cut off 11kV ties between Prestons ZS and South Leppington ZS in the process. The distribution back-up capacity to South Leppington ZS will generally remain at 10MVA subject to new development taking up back-up capacity.

On the 10th January 2017, Endeavour Energy received customer enquiry ENL2763 for the development of 14,917 apartments and 136,000m2 of commercial and educational floor space within one of the four quadrants of the Leppington Town Centre. Development will be staged over a 10 year period commencing in late 2017. This application has an estimated diversified load of 49MVA and will be supplied from North Leppington ZS. This will significantly reduce the back-up capability from North Leppington ZS resulting in a further reduced firm capacity for customers supplied from South Leppington ZS.

Recommendation

Based on the forecast load growth and LAR shown in Table 2, it is recommended that a NIO team be formed to investigate options to deliver the capacity required to supply continued development in the East Leppington and Leppington Precincts. Your agreement or otherwise is sought in regard to the recommendation.

Prepared by

Joseph Degabriele
Capacity Planner
Asset Strategy & Planning

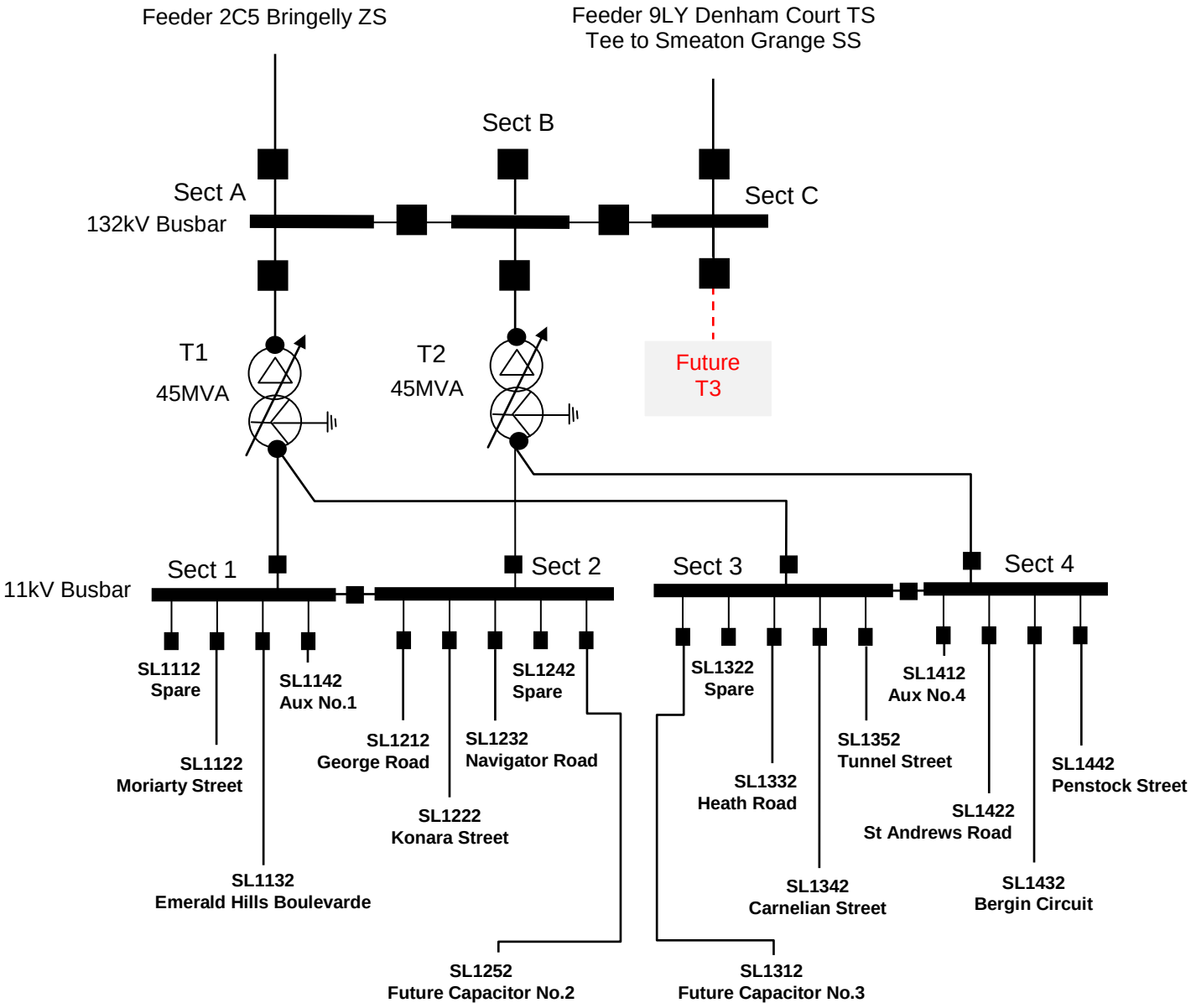
Endorsed by

Deepak Sahay
Act Capacity Planning Manager
Asset Strategy & Planning

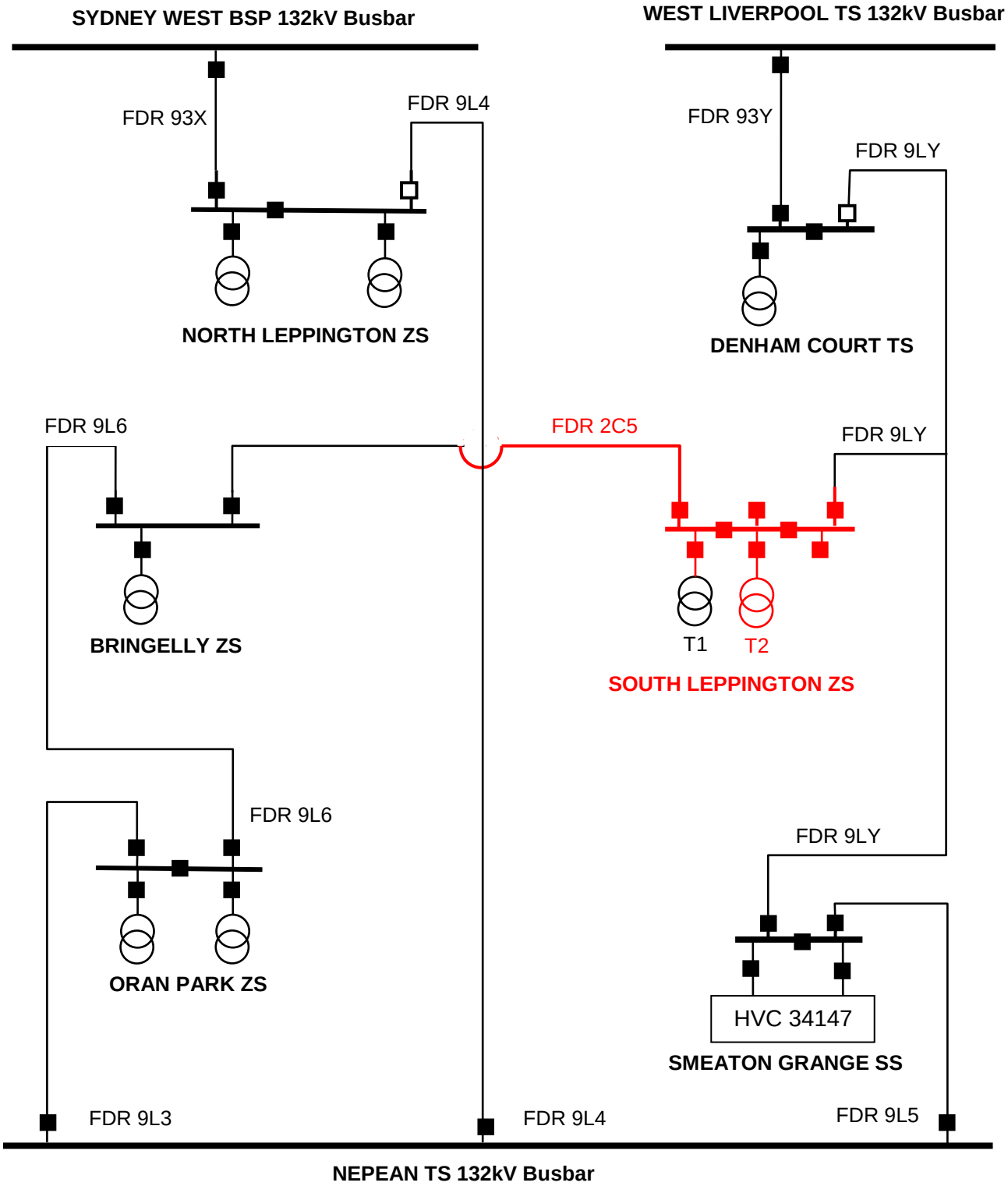
Appendix 2 Proposed Single Line Diagram

The following are the proposed single line diagrams (SLD) for the132/11kV South Leppington Zone Substation and 11kV distribution feeders.

SINGLE LINE DIAGRAM – 132/11kV SOUTH LEPPINGTON ZONE SUBSTATION



SUB-TRANSMISSION SINGLE LINE DIAGRAM – OPTION 1



Appendix 3 Fault Level Calculations

Fault levels at South Leppington, Oran Park and Bringelly have been calculated as follows:

Table A3-1: Details of System Fault Levels on 132kV Busbar and 11kV Busbar

	Transmission Substation 132kV Busbar			
	3 Phase-Earth Fault Level		1 Phase-Earth Fault Level	
	kA	MVA	kA	MVA
West Liverpool TS (from Liverpool BSP)	18.7	4275	22.5	5144
Nepean TS (from Macarthur BSP)	10.0	2286	10.5	2400
	South Leppington ZS 132kV Busbar			
	3 Phase-Earth Fault Level		1 Phase-Earth Fault Level	
	kA	MVA	kA	MVA
Supplied from Liverpool BSP	9.9	2263	8.6	1966
Supplied from Macarthur BSP	7.4	1692	6.7	1532
	South Leppington ZS 11kV Busbar With 2 x Transformers			
	3 Phase-Earth Fault Level		1 Phase-Earth Fault Level	
	kA	MVA	kA	MVA
Supplied from Liverpool BSP	11.82	225	12.22	233
Supplied from Macarthur BSP	11.43	218	11.93	227
	Zone Substation 132kV Busbar			
	3 Phase-Earth Fault Level		1 Phase-Earth Fault Level	
	kA	MVA	kA	MVA
Oran Park ZS	7.92	1811	7.57	1731
Bringelly ZS	7.3	1669	6.71	1534
	Zone Substation 11kV Busbar			
	3 Phase-Earth Fault Level		1 Phase-Earth Fault Level	
	kA	MVA	kA	MVA
Oran Park ZS with 2 x transformers	11.53	220	12.0	229
Bringelly ZS with 1 x 132/11kV transformer	10.31	196	10.73	205

The fault levels on the 132kV and 11kV busbars are within the maximum fault levels recommended in *SDI 501 Network Configuration*

Appendix 4 Cost Estimate for Feeder Option 1

Ellipse Login | Load Estimates | Retrieve Actuals | Copy to Project Directory | Clear Log

PROJECT: Project Description:

TOTALS	Work Packet	Labour Cost	Actual	Store Costs	Actual	Plant Costs	Actual	Direct Charge	Actual	Total Costs	Total Actual	Contingency		Reason For Contingency
Planning & Development	1	$ 120,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 120,000	$ -	$ -	0%	
NIOs & PDs	1.1	$ 35,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 35,000	$ -	$ -		
Environmental Requirements	1.2	$ 85,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 85,000	$ -	$ -		
Substation Design	2	$ 86,230	$ -	$ -	$ -	$ -	$ -	$ 590,000	$ -	$ 676,230	$ -	$ 62,787	9%	
Electrical, Mechanical & Civil	2.1	$ 86,230	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 86,230	$ -	$ 2,587		3 % for design modifications
Architect	2.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 250,000	$ -	$ 250,000	$ -	$ 50,000		20% for design modifications
Earthing Design	2.3	$ -	$ -	$ -	$ -	$ -	$ -	$ 340,000	$ -	$ 340,000	$ -	$ 10,200		3 % for design modifications
Project Management	3	$ 468,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 468,000	$ -	$ -	0%	
Substation Procurement/ Subcontract	4	$ 79,575	$ -	$ 48,828	$ -	$ 67,946	$ -	$ 7,373,173	$ -	$ 7,569,522	$ -	$ 38,862	1%	
Major Equipment	4.1	$ -	$ -	$ -	$ -	$ 22,144	$ -	$ 6,147,500	$ -	$ 6,169,644	$ -	$ -		
Minor Equipment	4.2	$ -	$ -	$ 44,188	$ -	$ 34,894	$ -	$ 180,000	$ -	$ 259,082	$ -	$ 38,862		Allow 5% per year for copper & foreign exchange
Steelwork & Busbars/Fittings	4.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Major Equipment Storage	4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 189,825	$ -	$ 189,825	$ -	$ -		
On Site Security	4.5	$ -	$ -	$ -	$ -	$ -	$ -	$ 150,000	$ -	$ 150,000	$ -	$ -		
Landscaping	4.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Control Panels	4.7	$ 53,299	$ -	$ 4,640	$ -	$ 1,435	$ -	$ 35,000	$ -	$ 94,374	$ -	$ -		
SCADA Hardware	4.8	$ 20,004	$ -	$ -	$ -	$ 2,734	$ -	$ 316,450	$ -	$ 339,188	$ -	$ -		
Protection Relays	4.9	$ 6,272	$ -	$ -	$ -	$ 6,739	$ -	$ 354,398	$ -	$ 367,409	$ -	$ -		
Trans Subs Construction	5	$ 1,027,662	$ -	$ 14,686	$ -	$ 33,442	$ -	$ 40,000	$ -	$ 1,115,790	$ -	$ -	0%	
Electrical Works	5.1	$ 518,127	$ -	$ 8,631	$ -	$ 15,824	$ -	$ 40,000	$ -	$ 582,582	$ -	$ -		
Protection & Control	5.2	$ 460,764	$ -	$ -	$ -	$ 13,508	$ -	$ -	$ -	$ 474,273	$ -	$ -		
HV Test	5.3	$ 46,391	$ -	$ -	$ -	$ 3,651	$ -	$ -	$ -	$ 50,042	$ -	$ -		
Metering	5.4	$ 2,380	$ -	$ 6,055	$ -	$ 458	$ -	$ -	$ -	$ 8,893	$ -	$ -		
Trans Mains Construction	6	$ 904,115	$ -	$ 315,544	$ -	$ 126,435	$ -	$ 6,162,817	$ -	$ 7,508,911	$ -	$ 750,891	10%	
Project Management & Design	6.1	$ 252,052	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 252,052	$ -	$ 25,205		
Survey	6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 20,000	$ -	$ 20,000	$ -	$ 2,000		
Civil Works	6.3	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,752,300	$ -	$ 2,752,300	$ -	$ 275,230		
Material Procurement	6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,382,178	$ -	$ 2,382,178	$ -	$ 238,218		
Construction	6.5	$ 652,063	$ -	$ 315,544	$ -	$ 126,435	$ -	$ 141,139	$ -	$ 1,235,181	$ -	$ 123,518		
Restorations	6.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 867,200	$ -	$ 867,200	$ -	$ 86,720		
Distribution Construction	7	$ -	$ -	$ -	$ -	$ -	$ -	$ 635,500	$ -	$ 635,500	$ -	$ 63,550	10%	Allow 10% for rock
Civil & Building Works	8	$ 33,336	$ -	$ 15,396	$ -	$ 104	$ -	$ 6,333,512	$ -	$ 6,382,348	$ -	$ 957,352	15%	Allow 15% for contaminated soil or rock
Additional Costs:	9	$ 45,865	$ -	$ 15,000	$ -	$ -	$ -	$ 745,000	$ -	$ 805,865	$ -	$ 46,000	6%	
Changeover/Preliminaries	9.1	$ -		$ -		$ -		$ 150,000		$ 150,000		$ -		
Outages	9.2	$ 25,865		$ -		$ -		$ -		$ 25,865		$ -		
Decommissioning of Temp ZS	9.3	$ -		$ -		$ -		$ 300,000		$ 300,000		$ 30,000		Allow 10% for unforeseen circumstances
Time clocks and PE cells	9.4	$ -		$ -		$ -		$ 200,000		$ 200,000		$ -		
Remote Protection Upgrades	9.5	$ 20,000		$ 15,000		$ -		$ 45,000		$ 80,000		$ 16,000		Allow 20% for price variations.
Fibre Mods near Nth C Park site	9.6	$ -		$ -		$ -		$ 50,000		$ 50,000		$ -		
	9.7	$ -		$ -		$ -		$ -		$ -		$ -		
	9.8	$ -		$ -		$ -		$ -		$ -		$ -		
	9.9	$ -		$ -		$ -		$ -		$ -		$ -		
Totals		$ 2,764,783	$ -	$ 409,454	$ -	$ 227,927	$ -	$ 21,880,002	$ -	$ 25,282,166	$ -	$ 1,919,443	8%	

Assumed CPI = 2.5%	YEAR					
	1st	2nd	3rd	4th	5th	Total
% Spend	15%	45%	40%	0%	0%	100%
Cost Breakdown	$ 3,792,325	$ 11,376,975	$ 10,112,866	$ -	$ -	$ 25,282,166
CPI	$ -	$ 284,424	$ 505,643	$ -	$ -	$ 790,068

= Assume no CPI for 1st Year

= Only change percentages

Total (inc CPI): $ 26,100,000

Contingency: $ 1,900,000

PR656 South Leppington ZS – Augment South Leppington ZS to 45MVA + Feeder Option 1 from Bringelly ZS

Appendix 5 Cost Estimate for Feeder Option 2

Ellipse Login | Load Estimates | Retrieve Actuals | Copy to Project Directory | Clear Log

PROJECT: Project Description:

TOTALS	Work Packet	Labour Cost	Actual	Store Costs	Actual	Plant Costs	Actual	Direct Charge	Actual	Total Costs	Total Actual	Contingency		Reason For Contingency
Planning & Development	1	$ 120,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 120,000	$ -	$ -	0%	
NIOs & PDs	1.1	$ 35,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 35,000	$ -	$ -		
Environmental Requirements	1.2	$ 85,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 85,000	$ -	$ -		
Substation Design	2	$ 90,011	$ -	$ -	$ -	$ -	$ -	$ 590,000	$ -	$ 680,011	$ -	$ 62,900	9%	
Electrical, Mechanical & Civil	2.1	$ 90,011	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 90,011	$ -	$ 2,700		3 % for design modifications
Architect	2.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 250,000	$ -	$ 250,000	$ -	$ 50,000		20% for design modifications
Earthing Design	2.3	$ -	$ -	$ -	$ -	$ -	$ -	$ 340,000	$ -	$ 340,000	$ -	$ 10,200		3 % for design modifications
Project Management	3	$ 468,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 468,000	$ -	$ -	0%	
Substation Procurement/ Subcontract	4	$ 84,917	$ -	$ 82,140	$ -	$ 75,743	$ -	$ 7,578,124	$ -	$ 7,820,924	$ -	$ 47,806	1%	
Major Equipment	4.1	$ -	$ -	$ -	$ -	$ 23,801	$ -	$ 6,301,300	$ -	$ 6,325,101	$ -	$ -		
Minor Equipment	4.2	$ -	$ -	$ 72,628	$ -	$ 38,531	$ -	$ 180,000	$ -	$ 291,159	$ -	$ 43,674		Allow 5% per year for copper & foreign exchange
Steelwork & Busbars/Fittings	4.3	$ -	$ -	$ 4,292	$ -	$ 1,615	$ -	$ 21,638	$ -	$ 27,545	$ -	$ 4,132		
Major Equipment Storage	4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 194,439	$ -	$ 194,439	$ -	$ -		
On Site Security	4.5	$ -	$ -	$ -	$ -	$ -	$ -	$ 150,000	$ -	$ 150,000	$ -	$ -		
Landscaping	4.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Control Panels	4.7	$ 58,641	$ -	$ 5,220	$ -	$ 1,614	$ -	$ 38,500	$ -	$ 103,976	$ -	$ -		
SCADA Hardware	4.8	$ 20,004	$ -	$ -	$ -	$ 2,830	$ -	$ 318,513	$ -	$ 341,347	$ -	$ -		
Protection Relays	4.9	$ 6,272	$ -	$ -	$ -	$ 7,351	$ -	$ 373,734	$ -	$ 387,357	$ -	$ -		
Trans Subs Construction	5	$ 1,122,397	$ -	$ 15,470	$ -	$ 35,525	$ -	$ 40,000	$ -	$ 1,213,392	$ -	$ -	0%	
Electrical Works	5.1	$ 588,376	$ -	$ 9,415	$ -	$ 17,358	$ -	$ 40,000	$ -	$ 655,149	$ -	$ -		
Protection & Control	5.2	$ 483,976	$ -	$ -	$ -	$ 13,957	$ -	$ -	$ -	$ 497,933	$ -	$ -		
HV Test	5.3	$ 47,665	$ -	$ -	$ -	$ 3,751	$ -	$ -	$ -	$ 51,417	$ -	$ -		
Metering	5.4	$ 2,380	$ -	$ 6,055	$ -	$ 458	$ -	$ -	$ -	$ 8,893	$ -	$ -		
Trans Mains Construction	6	$ 1,739,874	$ -	$ 814,459	$ -	$ 297,700	$ -	$ 10,033,660	$ -	$ 12,885,693	$ -	$ 1,288,569	10%	
Project Management & Design	6.1	$ 319,446	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 319,446	$ -	$ 31,945		
Survey	6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 25,000	$ -	$ 25,000	$ -	$ 2,500		
Civil Works	6.3	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,536,094	$ -	$ 4,536,094	$ -	$ 453,609		
Material Procurement	6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 4,252,566	$ -	$ 4,252,566	$ -	$ 425,257		
Construction	6.5	$ 1,420,428	$ -	$ 814,459	$ -	$ 297,700	$ -	$ -	$ -	$ 2,532,587	$ -	$ 253,259		
Restorations	6.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,220,000	$ -	$ 1,220,000	$ -	$ 122,000		
Distribution Construction	7	$ -	$ -	$ -	$ -	$ -	$ -	$ 635,500	$ -	$ 635,500	$ -	$ 63,550	10%	Allow 10% for rock
Civil & Building Works	8	$ 34,465	$ -	$ 15,830	$ -	$ 104	$ -	$ 6,345,642	$ -	$ 6,396,041	$ -	$ 959,406	15%	Allow 15% for contaminated soil or rock
Additional Costs:	9	$ 18,106	$ -	$ -	$ -	$ -	$ -	$ 600,000	$ -	$ 618,106	$ -	$ 30,000	5%	
Changeover/Preliminaries	9.1	$ -		$ -		$ -		$ 100,000		$ 100,000		$ -		
Outages	9.2	$ 18,106		$ -		$ -		$ -		$ 18,106		$ -		
Decommissioning of Temp ZS	9.3	$ -		$ -		$ -		$ 300,000		$ 300,000		$ 30,000		Allow 10% for unforeseen circumstances
Time clocks and PE cells	9.4	$ -		$ -		$ -		$ 200,000		$ 200,000		$ -		
	9.5	$ -		$ -		$ -		$ -		$ -		$ -		
	9.6	$ -		$ -		$ -		$ -		$ -		$ -		
	9.7	$ -		$ -		$ -		$ -		$ -		$ -		
	9.8	$ -		$ -		$ -		$ -		$ -		$ -		
	9.9	$ -		$ -		$ -		$ -		$ -		$ -		
Totals		$ 3,677,770	$ -	$ 927,899	$ -	$ 409,071	$ -	$ 25,822,926	$ -	$ 30,837,667	$ -	$ 2,452,231	8%	

Assumed CPI = 2.5%	YEAR					
	1st	2nd	3rd	4th	5th	Total
% Spend	15%	45%	40%	0%	0%	100%
Cost Breakdown	$ 4,625,650	$ 13,876,950	$ 12,335,067	$ -	$ -	$ 30,837,667
CPI	$ -	$ 346,924	$ 616,753	$ -	$ -	$ 963,677

= Assume no CPI for 1st Year
= Only change percentages

Total (inc CPI): $ 31,800,000

Contingency: $ 2,500,000

PR656 South Leppington ZS – Augment South Leppington ZS to 45MVA + Feeder Option 2 from North Leppington ZS via 9L4

Appendix 6 Cost Estimate for Feeder Option 3

Ellipse Login | Load Estimates | Retrieve Actuals | Copy to Project Directory | Clear Log

PROJECT: Project Description:

TOTALS	Work Packet	Labour Cost	Actual	Store Costs	Actual	Plant Costs	Actual	Direct Charge	Actual	Total Costs	Total Actual	Contingency		Reason For Contingency
Planning & Development	1	$ 120,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 120,000	$ -	$ -	0%	
NIOs & PDs	1.1	$ 35,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 35,000	$ -	$ -		
Environmental Requirements	1.2	$ 85,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 85,000	$ -	$ -		
Substation Design	2	$ 90,011	$ -	$ -	$ -	$ -	$ -	$ 590,000	$ -	$ 680,011	$ -	$ 62,900	9%	
Electrical, Mechanical & Civil	2.1	$ 90,011	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 90,011	$ -	$ 2,700		3 % for design modifications
Architect	2.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 250,000	$ -	$ 250,000	$ -	$ 50,000		20% for design modifications
Earthing Design	2.3	$ -	$ -	$ -	$ -	$ -	$ -	$ 340,000	$ -	$ 340,000	$ -	$ 10,200		3 % for design modifications
Project Management	3	$ 468,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 468,000	$ -	$ -	0%	
Substation Procurement/ Subcontract	4	$ 84,917	$ -	$ 82,140	$ -	$ 75,743	$ -	$ 7,578,124	$ -	$ 7,820,924	$ -	$ 47,806	1%	
Major Equipment	4.1	$ -	$ -	$ -	$ -	$ 23,801	$ -	$ 6,301,300	$ -	$ 6,325,101	$ -	$ -		
Minor Equipment	4.2	$ -	$ -	$ 72,628	$ -	$ 38,531	$ -	$ 180,000	$ -	$ 291,159	$ -	$ 43,674		Allow 5% per year for copper & foreign exchange
Steelwork & Busbars/Fittings	4.3	$ -	$ -	$ 4,292	$ -	$ 1,615	$ -	$ 21,638	$ -	$ 27,545	$ -	$ 4,132		
Major Equipment Storage	4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 194,439	$ -	$ 194,439	$ -	$ -		
On Site Security	4.5	$ -	$ -	$ -	$ -	$ -	$ -	$ 150,000	$ -	$ 150,000	$ -	$ -		
Landscaping	4.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Control Panels	4.7	$ 58,641	$ -	$ 5,220	$ -	$ 1,614	$ -	$ 38,500	$ -	$ 103,976	$ -	$ -		
SCADA Hardware	4.8	$ 20,004	$ -	$ -	$ -	$ 2,830	$ -	$ 318,513	$ -	$ 341,347	$ -	$ -		
Protection Relays	4.9	$ 6,272	$ -	$ -	$ -	$ 7,351	$ -	$ 373,734	$ -	$ 387,357	$ -	$ -		
Trans Subs Construction	5	$ 1,122,397	$ -	$ 15,470	$ -	$ 35,525	$ -	$ 40,000	$ -	$ 1,213,392	$ -	$ -	0%	
Electrical Works	5.1	$ 588,376	$ -	$ 9,415	$ -	$ 17,358	$ -	$ 40,000	$ -	$ 655,149	$ -	$ -		
Protection & Control	5.2	$ 483,976	$ -	$ -	$ -	$ 13,957	$ -	$ -	$ -	$ 497,933	$ -	$ -		
HV Test	5.3	$ 47,665	$ -	$ -	$ -	$ 3,751	$ -	$ -	$ -	$ 51,417	$ -	$ -		
Metering	5.4	$ 2,380	$ -	$ 6,055	$ -	$ 458	$ -	$ -	$ -	$ 8,893	$ -	$ -		
Trans Mains Construction	6	$ 1,684,324	$ -	$ 675,454	$ -	$ 280,111	$ -	$ 8,355,602	$ -	$ 10,995,491	$ -	$ 1,099,549	10%	
Project Management & Design	6.1	$ 391,946	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 391,946	$ -	$ 39,195		
Survey	6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 25,000	$ -	$ 25,000	$ -	$ 2,500		
Civil Works	6.3	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,185,908	$ -	$ 3,185,908	$ -	$ 318,591		
Material Procurement	6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 3,385,178	$ -	$ 3,385,178	$ -	$ 338,518		
Construction	6.5	$ 1,292,378	$ -	$ 675,454	$ -	$ 280,111	$ -	$ 199,916	$ -	$ 2,447,859	$ -	$ 244,786		
Restorations	6.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,559,600	$ -	$ 1,559,600	$ -	$ 155,960		
Distribution Construction	7	$ -	$ -	$ -	$ -	$ -	$ -	$ 635,500	$ -	$ 635,500	$ -	$ 63,550	10%	Allow 10% for rock
Civil & Building Works	8	$ 34,465	$ -	$ 15,830	$ -	$ 104	$ -	$ 6,345,642	$ -	$ 6,396,041	$ -	$ 959,406	15%	Allow 15% for contaminated soil or rock
Additional Costs:	9	$ 18,106	$ -	$ -	$ -	$ -	$ -	$ 600,000	$ -	$ 618,106	$ -	$ 30,000	5%	
Changeover/Preliminaries	9.1	$ -		$ -		$ -		$ 100,000		$ 100,000		$ -		
Outages	9.2	$ 18,106		$ -		$ -		$ -		$ 18,106		$ -		
Decommissioning of Temp ZS	9.3	$ -		$ -		$ -		$ 300,000		$ 300,000		$ 30,000		Allow 10% for unforeseen circumstances
Time clocks and PE cells	9.4	$ -		$ -		$ -		$ 200,000		$ 200,000		$ -		
	9.5	$ -		$ -		$ -		$ -		$ -		$ -		
	9.6	$ -		$ -		$ -		$ -		$ -		$ -		
	9.7	$ -		$ -		$ -		$ -		$ -		$ -		
	9.8	$ -		$ -		$ -		$ -		$ -		$ -		
	9.9	$ -		$ -		$ -		$ -		$ -		$ -		
Totals		$ 3,622,220	$ -	$ 788,894	$ -	$ 391,482	$ -	$ 24,144,868	$ -	$ 28,947,465	$ -	$ 2,263,211	8%	

Assumed CPI = 2.5%	YEAR					
	1st	2nd	3rd	4th	5th	Total
% Spend	15%	45%	40%	0%	0%	100%
Cost Breakdown	$ 4,342,120	$ 13,026,359	$ 11,578,986	$ -	$ -	$ 28,947,465
CPI	$ -	$ 325,659	$ 578,949	$ -	$ -	$ 904,608

= Assume no CPI for 1st Year

= Only change percentages

Total (inc CPI): $ 29,900,000

Contingency: $ 2,300,000

PR656 South Leppington ZS – Augment South Leppington ZS to 45MVA + Feeder Option 3 from North Leppington ZS via 9LY

Appendix 7 Cost Estimate for Feeder Option 4

Ellipse Login | Load Estimates | Retrieve Actuals | Copy to Project Directory | Clear Log

PROJECT: Project Description:

TOTALS	Work Packet	Labour Cost	Actual	Store Costs	Actual	Plant Costs	Actual	Direct Charge	Actual	Total Costs	Total Actual	Contingency		Reason For Contingency
Planning & Development	1	$ 120,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 120,000	$ -	$ -	0%	
NIOs & PDs	1.1	$ 35,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 35,000	$ -	$ -		
Environmental Requirements	1.2	$ 85,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 85,000	$ -	$ -		
Substation Design	2	$ 86,230	$ -	$ -	$ -	$ -	$ -	$ 590,000	$ -	$ 676,230	$ -	$ 62,787	9%	
Electrical, Mechanical & Civil	2.1	$ 86,230	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 86,230	$ -	$ 2,587		3 % for design modifications
Architect	2.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 250,000	$ -	$ 250,000	$ -	$ 50,000		20% for design modifications
Earthing Design	2.3	$ -	$ -	$ -	$ -	$ -	$ -	$ 340,000	$ -	$ 340,000	$ -	$ 10,200		3 % for design modifications
Project Management	3	$ 468,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 468,000	$ -	$ -	0%	
Substation Procurement/ Subcontract	4	$ 79,575	$ -	$ 48,828	$ -	$ 67,946	$ -	$ 7,373,173	$ -	$ 7,569,522	$ -	$ 38,862	1%	
Major Equipment	4.1	$ -	$ -	$ -	$ -	$ 22,144	$ -	$ 6,147,500	$ -	$ 6,169,644	$ -	$ -		
Minor Equipment	4.2	$ -	$ -	$ 44,188	$ -	$ 34,894	$ -	$ 180,000	$ -	$ 259,082	$ -	$ 38,862		Allow 5% per year for copper & foreign exchange
Steelwork & Busbars/Fittings	4.3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Major Equipment Storage	4.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 189,825	$ -	$ 189,825	$ -	$ -		
On Site Security	4.5	$ -	$ -	$ -	$ -	$ -	$ -	$ 150,000	$ -	$ 150,000	$ -	$ -		
Landscaping	4.6	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Control Panels	4.7	$ 53,299	$ -	$ 4,640	$ -	$ 1,435	$ -	$ 35,000	$ -	$ 94,374	$ -	$ -		
SCADA Hardware	4.8	$ 20,004	$ -	$ -	$ -	$ 2,734	$ -	$ 316,450	$ -	$ 339,188	$ -	$ -		
Protection Relays	4.9	$ 6,272	$ -	$ -	$ -	$ 6,739	$ -	$ 354,398	$ -	$ 367,409	$ -	$ -		
Trans Subs Construction	5	$ 1,027,662	$ -	$ 14,686	$ -	$ 33,442	$ -	$ 40,000	$ -	$ 1,115,790	$ -	$ -	0%	
Electrical Works	5.1	$ 518,127	$ -	$ 8,631	$ -	$ 15,824	$ -	$ 40,000	$ -	$ 582,582	$ -	$ -		
Protection & Control	5.2	$ 460,764	$ -	$ -	$ -	$ 13,508	$ -	$ -	$ -	$ 474,273	$ -	$ -		
HV Test	5.3	$ 46,391	$ -	$ -	$ -	$ 3,651	$ -	$ -	$ -	$ 50,042	$ -	$ -		
Metering	5.4	$ 2,380	$ -	$ 6,055	$ -	$ 458	$ -	$ -	$ -	$ 8,893	$ -	$ -		
Trans Mains Construction	6	$ 1,369,033	$ -	$ 166,619	$ -	$ 90,552	$ -	$ 1,273,863	$ -	$ 2,900,067	$ -	$ 290,007	10%	
Project Management & Design	6.1	$ 205,799	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 205,799	$ -	$ 20,580		
Survey	6.2	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,000	$ -	$ 5,000	$ -	$ 500		
Civil Works	6.3	$ 745,908	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 745,908	$ -	$ 74,591		
Material Procurement	6.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 603,407	$ -	$ 603,407	$ -	$ 60,341		
Construction	6.5	$ 417,326	$ -	$ 166,619	$ -	$ 90,552	$ -	$ 368,256	$ -	$ 1,042,753	$ -	$ 104,275		
Restorations	6.6	$ -	$ -	$ -	$ -	$ -	$ -	$ 297,200	$ -	$ 297,200	$ -	$ 29,720		
Distribution Construction	7	$ -	$ -	$ -	$ -	$ -	$ -	$ 635,500	$ -	$ 635,500	$ -	$ 63,550	10%	Allow 10% for rock
Civil & Building Works	8	$ 33,336	$ -	$ 15,396	$ -	$ 104	$ -	$ 6,333,512	$ -	$ 6,382,348	$ -	$ 957,352	15%	Allow 15% for contaminated soil or rock
Additional Costs:	9	$ 15,519	$ -	$ -	$ -	$ -	$ -	$ 550,000	$ -	$ 565,519	$ -	$ 30,000	5%	
Changeover/Preliminaries	9.1	$ -		$ -		$ -		$ 50,000		$ 50,000		$ -		
Outages	9.2	$ 15,519		$ -		$ -		$ -		$ 15,519		$ -		
Decommissioning of Temp ZS	9.3	$ -		$ -		$ -		$ 300,000		$ 300,000		$ 30,000		Allow 10% for unforeseen circumstances
Time clocks and PE cells	9.4	$ -		$ -		$ -		$ 200,000		$ 200,000		$ -		
	9.5	$ -		$ -		$ -		$ -		$ -		$ -		
	9.6	$ -		$ -		$ -		$ -		$ -		$ -		
	9.7	$ -		$ -		$ -		$ -		$ -		$ -		
	9.8	$ -		$ -		$ -		$ -		$ -		$ -		
	9.9	$ -		$ -		$ -		$ -		$ -		$ -		
Totals		$ 3,199,355	$ -	$ 245,529	$ -	$ 192,044	$ -	$ 16,796,048	$ -	$ 20,432,976	$ -	$ 1,442,558	7%	

Assumed CPI = 2.5%	YEAR					
	1st	2nd	3rd	4th	5th	Total
% Spend	15%	45%	40%	0%	0%	100%
Cost Breakdown	$ 3,064,946	$ 9,194,839	$ 8,173,190	$ -	$ -	$ 20,432,976
CPI	$ -	$ 229,871	$ 408,660	$ -	$ -	$ 638,531

= Assume no CPI for 1st Year

= Only change percentages

Total (inc CPI): $ 21,100,000

Contingency: $ 1,400,000

PR656 South Leppington ZS – Augment South Leppington ZS to 45MVA + Feeder Option 4 from Smeaton Grange SS

Appendix 8 Summary of RIT-D Analysis for PR656 South Leppington ZS (New Model)

Definition of a RIT-D project

A RIT-D project is defined in cl/ 5.10.2 of the NER as a:

(a) Project the purpose of which is to address an identified need identified by a Distribution Network Service Provider, or
(b) Joint planning project that is not a regulatory investment test for transmission (RIT-T) project

Purpose of RIT-D

The purpose of the RIT-D as specified in the NER is to:

..identify the *credible option* that maximises the present value of the net economic benefit to all those who produce, consume, and transport electricity in the *National Electricity Market* (the *preferred option*). For the avoidance of doubt, a *preferred option* may, in the relevant circumstances, have a negative net economic benefit (that is, a net economic cost) where the *identified* need is for reliability corrective action.[1]

The market benefit of a credible option is calculated by comparing the state of the world with the credible option in place with the state of the world in the base case. Hence the RIT-T is an economic test rather than a financial one.

Operation and application of the RIT-D

The broad steps for applying the RIT-D are summarised in the RIT_D Application Guidelines as:

(1) Identify:
   i. a need for investment
   ii. a set of credible options to address the identified need

(2) Identify a set of reasonable scenarios appropriate to the credible options under consideration

(3) Quantify the expected costs of each credible option with consideration of how the expected costs will vary across different reasonable scenarios

(4) Estimate the magnitude of the expected market benefits of each credible option with consideration of how expected market benefits will vary across different reasonable scenarios. Where the RIT-D proponent quantifies market benefits, quantification should occur over a probability weighted range of reasonable scenarios

(5) Rank each credible option by its expected net economic benefit to identify the credible option with the highest expected net economic benefit as the preferred option. In the relevant circumstances, this will require quantifying the expected net economic benefit of each credible option.

In order to calculate the outcomes in the relevant 'state of the world', Endeavour Energy has developed a model which incorporates the key variables that drive market benefits, with particular emphasis on evaluating risks of involuntary load shedding.

[1] NER cl 5.17.1(b)

Market Benefits to be considered

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
- Any other class of market benefit determined to be relevant by the AER

The dominant class of market benefits applicable to this project is addressing the risks associated with involuntary load shedding.

The RIT-D application guidelines currently focus on monetising the risks of interruptions to supply to *connected* customers based on the value of customer reliability (VCR). The RIT-D guidelines currently do not have appropriate mechanisms for monetising the economic risks associated with deriving *unconnected* customers of supply. Endeavour Energy believes that this project predominantly belongs to the category of unconnected customers awaiting supply, as the investment is required in order to provide supply to customers who would otherwise remain unconnected (development would not proceed due to lack of power supply). As a proxy, therefore, Endeavour Energy has employed an upper envelope value of the retail price to for the purpose of monetising the risks of not being able to meet its regulatory obligations of providing connections to the network to customers wishing to get connected. The full VCR value has been used for the purpose of modelling loss of supply to connected customers.

Load at Risk and Value of Expected Unserved Energy[2]

Year	Load At Risk (MVA)	Mean Expected Unserved Energy (Due to an outage) (MWh) (Valued at VCR)	Mean Energy unable to be supplied (No Capacity) (MWh) (Valued at Market Price Cap)
2017	0	0	0
2018	1.8	0.2	0
2019	4.7	1.0	1.0
2020	8.5	3.5	28.7
2021	12.3	8.5	173.2
2022	16.4	16.7	565.1
2023	19.7	26.0	1225.6
2024	21.9	32.7	1860.8
2025	24.1	38.5	2556.3
2026	26.1	44.1	3454.8
2027	28.0	50.3	4671.4

[1] Due to the nature of Monte-Carlo modelling, Expected Unserved Energy Values can change slightly each time the model is run. Hence these values may differ slightly from the values stored in the corresponding Excel file.

Option Costs (not indexed for CPI)

The option costs for the options considered in the RIT-D evaluation are tabled below. The costs differ slightly from the costs outlined in the document as the CPI indexation has been removed from the RIT-D evaluation due to the use of discount rates based on the regulated real WACC (Weighted Average Cost of Capital)

Option	Capital Cost $m
Baseline Risk	$0
Option 1 – Build Stage 2 of zone substation with Bringelly to South Leppington sub-transmission connection	$25.3
Option 2 – Build Stage 2 of zone substation with North Leppington to South Leppington sub-transmission connection via 9L4 easement	$30.8
Option 3 – Build Stage 2 of zone substation with North Leppington to South Leppington sub-transmission connection via 9LY easement	$28.9
Option 4 – Build Stage 2 of zone substation with Smeaton Grange to South Leppington sub-transmission connection and Bringelly to South Leppington link later (not costed)	$20.4

Net Market Benefits (NPV)

The present value of the net market benefits for Options 1 and 4 are tabled below. Options 2 and 3 are similar and address the same risks. These options have not been further considered for RIT-D purposes on the basis that the costs are higher than the other options.

Option 1 has reliability benefits arising from the ability to operate the network in meshed configuration. In contrast, Option 4 has a number of technical issues that need to be overcome. This option requires the construction of the Bringelly to South Leppington link at a later date to align with the South West Sector Strategy that will allow meshed operation of the South West Sector network (to achieve the reliability benefits inherent in Option 1). Whilst the link is not in place, Option 4 will require a non-standard changeover scheme involving three zone substations and carries reliability risks associated with the loss of three zone substations. Based on experience with the reliability of change-over schemes, it has been estimated that there is a 20% risk of failure of the multiple changeover schemes required as part of this option. Consequently, Gross Market Benefits from this option have been reduced by 20%.

The table also outlines the ranking of each of the remaining options derived from probabilistic Monte-Carlo modelling. Costs and market benefits are close for all options considered. Option 1 delivers the maximum net market benefit.

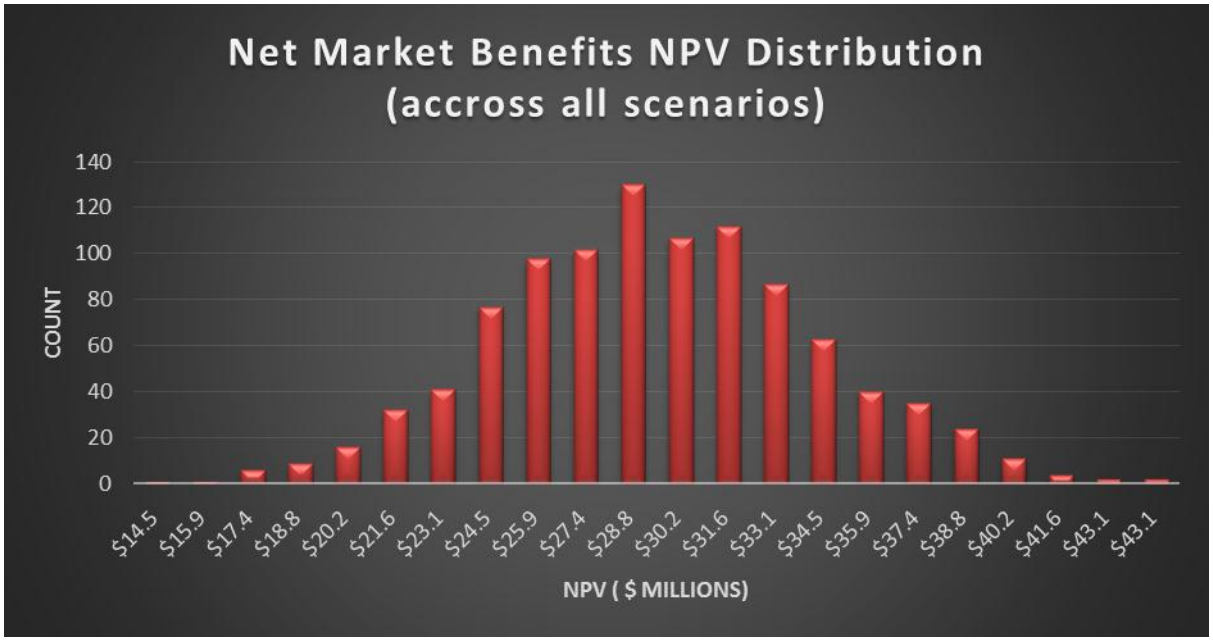
Options	Total Costs (mean, PV, $m)	Gross Market Benefits (mean, PV, $m)	Net Market Benefits (Mean, PV, $m)	Ranking under RIT-D
Do Nothing	0	0	0	3
Option 1 – Build Stage 2 of zone substation with Bringelly to South Leppington sub-transmission connection	$22.5	$51.2	$28.8	1
Option 4 – Build Stage 2 of zone substation with Smeaton Grange to South Leppington sub-transmission connection and Bringelly to South Leppington link later	$18.1	$40.9	$22.8	2

Sensitivity Testing

The probabilistic monte-carlo model takes into account the following sensitivity parameters.

Scenario	
Forecast High	1.5 x base
Forecast Low	0.7 x base
Discount Rate High	Base% + 2%
Discount Rate Low	Base% - 2%
VCR High	Base + 30%
VCR Low	Base – 30%
Capital Cost High	Base +25%
Captial Cost Low	Base -25%

The figure below demonstrates the net market benefits distribution across randomly selected scenarios. The NPV remains positive across all modelled scenarios and indicates no risk of negative market benefits.



Preferred Option

The above analysis supports Option 1 as the RIT-D preferred option. As the preferred option exceeds $10 million, in accordance with the National Electricity Rules, a draft project assessment with these findings will be released for submissions from market participants and interested parties.

Appendix 9 Preliminary Environmental Assessment

Internal Memo

To	Danny Asvestas; Manager Asset Standards and Design Jason Lu; Capacity Planning Manager	**File no**	South Leppington ZS (PR656)
From	Clinton Jurd – Environmental Specialist	**Date**	10 November 2017
Subject	Preliminary Environmental Comments – PR656 Electricity Supply for the East Leppington & Leppington Precincts; Network Investment Options Report		
Copies	Pat Woodbury – Network Environmental Assessment Manager Joseph Degabriele – Capacity Planner		

Preliminary Environmental Comments; PR656 - Electricity Supply for the East Leppington & Leppington Precincts

Permanent South Leppington Zone Substation
The option to establish the permanent South Leppington Zone Substation (ZS) as a two transformer 132kV indoor facility was settled on previously.

The previously determined proposal for the temporary South Leppington ZS facility stated Endeavour Energy's intention to establish a permanent two transformer 132kV indoor ZS on the property, with the capacity to ultimately accommodate a third transformer in the future if and when required.

The permanent ZS will be established to replace the existing temporary ZS facility utilising the existing single transformer and initially adding another transformer.

The second transmission feeder connections or supply to the ZS facility were not finalised at that time and are considered further herein.

The ZS property is now surrounded to the north and east by medium density residential development. Similar residential development is proceeding to the south of the ZS property.

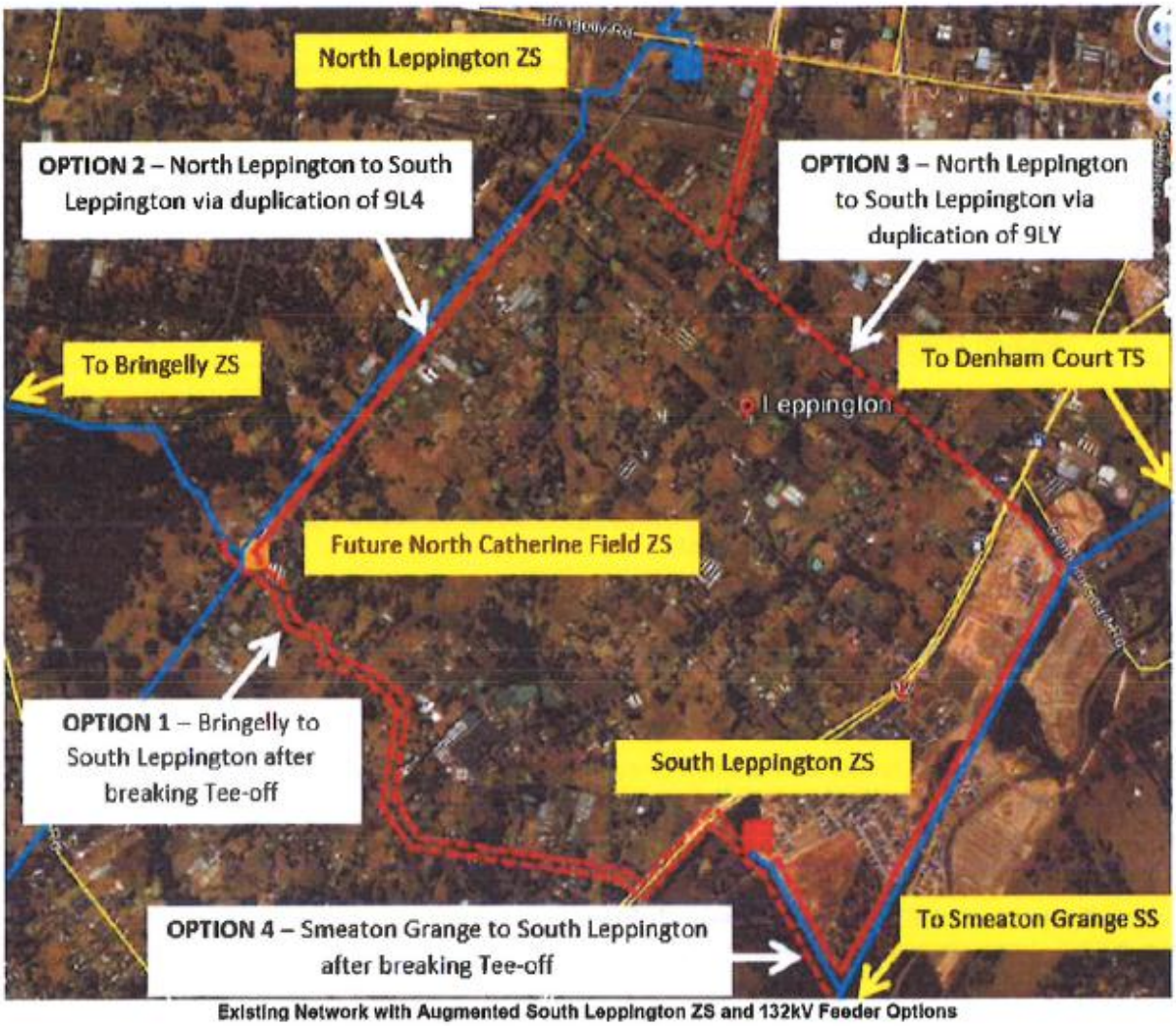
Second Transmission Feeder Connection Options
Four 132kV transmission feeder connection options have been given preliminary assessment consideration herein.

Option 1: Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder route 1 from Bringelly ZS.

Option 2: Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder route 2 from North Leppington ZS via 9L4 easement.

Option 3: Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder route 3 from North Leppington ZS via 9LY easement.

Option 4: Augment South Leppington ZS to 45MVA firm capacity with 132kV feeder route 4 from Smeaton Grange SS / Denham Court TS.



Existing Network with Augmented South Leppington ZS and 132kV Feeder Options

Generic Construction Impacts

The range of potential construction impacts are varyingly synonymous with the four feeder connection options and include noise and potential water pollution that shall be properly considered and effectively managed or mitigated in accordance with Endeavour Energy standards and the relevant legislation.

It is anticipated that the majority of works will be undertaken during normal construction hours. Feeder cable works will be constrained by traffic management aspects.

Preferred second feeder connection discussion

Feeder connection Option 1 configured underground (UG) is the preferred transmission feeder connection option. This option has the least environmental constraints or impacts, whilst maximising use of the existing network and capacity and also supporting the ultimate long term South West Sector Strategy for the network.

Feeder connection Options 2 and 3 are similar in respect of aspects and impacts or constraints. Both options traverse greater distances than Options 1 and 4 and would require configuration UG for all if not the majority of their length. This UG configuration requirement is driven by the existing easement terms restricting the corridor width, such that the existing OH feeder sections require rebuilding as dual circuit sections to provide adequate clearances to each other and the easement boundaries. UG configuration would also be required along the road reserve sections of these feeder route options, as the road side verge or nature strip areas for part of all of the routes sections, could not accommodate the clearance requirements of an OH 132kV feeder, without obtaining easements over adjacent property frontages.

Feeder connection Option 4 has the least potential environmental impacts or constraints due mainly to the reduced feeder length. However, it doesn't support the long term or ultimate South West Sector Strategy for the network and similar to the previously completed feeder connection beyond the

eastern end of St Andrews Road, is likely to involve delayed easement negotiations and terms with key stakeholders.

Feeder connection Option 1 discussion
Undergrounding (UG) is the most viable option for establishing a 132kV feeder asset along St Andrews Road, Camden Valley Way and Alma Road/George Road.

Constructing a new OH 132kV (joint use) asset along Alma Road/George Road would undoubtedly be met with significant community opposition, and would also involve costly and likely lengthy easement negotiations.

Similar projects elsewhere have encountered varyingly significant community opposition and involved complicated, lengthy and costly easement negotiations.

This opposition substantially delayed the design and the assessment process, and thus greatly impacted delivery timing and in some cases significantly changed the final feeder configuration. EE have in the past significantly modified the configuration of feeders or feeder sections in response to community and other stakeholder concerns.

A substantial project contingency would be recommended to accommodate the potential for the construction of the UG option, should OH be pursued in the initial instance.

Establishing such an OH 132kV asset [single sided construction or otherwise] within a 20m wide local rural/residential road reserve could not comply with current EE standards [that require a 25m wide easement/corridor for 132kV OH assets] without the acquisition of numerous individual easements over adjacent property frontages. Easements would be required over up to approximately 25 rural/residential properties or lots for the majority if not the entire 3km route section along George Road/Alma Road. Such negotiations would be time consuming and the easement acquisitions costly. Such costs and time would be better incorporated into pursuing or funding an UG option in the initial instance.

South Leppington ZS discussion
From an environmental risk perspective, the main aspects and impacts or constraints of establishing the permanent South Leppington ZS on the subject property include:

- the potential for opposition to the augmentation of the ZS as a permanent ZS facility from surrounding residents.
  Noting, the temporary ZS was assessed and constructed prior to the establishment of the surrounding residences; and based on recent assessment consultation, carried out for minor works at the temporary ZS facility, there may be a low level of awareness amongst surrounding residents as to the medium to long term plans for development of the ZS.
- Further to the previous point; the potential impacts on visual amenity from the zone permanent ZS facility.
  Noting, the proposed indoor facility will be less visually intrusive than the existing temporary ZS facility; that is being replaced and ultimately removed from the ZS perimeter buffer area.
- noise emissions from additional transformers.
- community perception of EMF emissions from the proposed ZS facility and proposed 132kV underground feeder cables.

An environmental assessment or assessments, including community consultation, shall be carried out in accordance with the Code of Practice for Authorised Network Operators and EP&A Act prior to establishment of the ZS facility and second transmission feeder connection.

The environmental assessment will thoroughly consider and assess the aspects and impacts, and appropriate mitigating measures for the construction and operation of the permanent ZS facility.

Noise Emission Mitigation
An additional modern low noise transformer shall be installed on the ZS property. The additional transformer shall be housed within a noise attenuating fire wall enclosure, similar to and to the south east of the existing transformer arrangement.

A noise impact assessment, commissioned at the time of the assessment of the temporary ZS facility, concluded that noise emissions from the ultimate permanent ZS facility, i.e. a three transformer arrangement, would not cause offensive noise emissions as defined by the Protection of the Environment Operations Act 1997.

The nearest potentially sensitive noise receptors are occupied residences established, subsequent to the temporary ZS, on residential properties directly adjacent to the south eastern boundary of the ZS property.

Landscaping
A buffer reserved for low growing landscape grasses remains along the south eastern ZS property boundary.

This south eastern buffer area is currently being utilised to accommodate the temporary ZS outdoor switch yard and switch room building that will be removed following commissioning of the permanent ZS facility.

The opportunity or scope for planting taller screening trees along this buffer area is limited by the need to ensure the bushfire risk from the nearby bushland area is not exacerbated.

Access
An all-purpose in / out access driveway into the ZS property already exists off St Andrews Road. This will be maintained for the permanent ZS facility.

Your acknowledgement is sought regarding this preliminary environmental assessment for the establishment of the permanent indoor 132/11kV South Leppington ZS, the removal of the existing temporary South Leppington ZS switchyard and control building, and the establishment of a second 132kv transmission feeder connection to the permanent ZS facility. Noting that strictly, from an environmental aspects and impacts perspective, and the subsequent ease of obtaining environmental approval, the order of preference is Option 4 and then Option 1 followed by Options 2 and 3.

10/11/17.

Clinton Jurd
Environmental Specialist
Network Environmental Assessment

Endorsed

10/11/2017

Pat Woodbury
Network Environment Assessment Manager

Approved

10.11.17

Danny Asvestas
Manager Asset Standards and Design

Appendix 10 Preliminary Stakeholder Management Plan

SOUTH LEPPINGTON ZONE SUBSTATION
Community Engagement Approach for NIO-PR656

1 Background

Endeavour Energy has begun an internal assessment on the proposed augmentation of South Leppington Zone Substation (ZS) to ensure a safe and reliable electricity supply for the Leppington and East Leppington precincts.

These precincts are currently serviced by South Leppington ZS which was established in 2014. The 11kV distribution feeders that service the area supply rural residential customers, some commercial premises and market gardening enterprises and an increasing amount of new urban residential development. Load on these feeders will exceed planning and operational limits with the ongoing development.
The key drivers of load growth are:

- 14,310 proposed residential dwellings to be supplied from South Leppington ZS
- Establishment of two shopping centres in the Willowdale Estate and Emerald Hills Estate
- The existing back-up network has a capacity limit of 10MVA or 2,500 homes

The above key drivers are forecast to have a combined load of up to 55MVA noting the back-up of just 10MVA means there will be a 45MVA shortfall in capacity. In order to meet the proposed growth, eliminate load at risk on the electricity network and ensure a good level of reliability, the South Leppington ZS requires augmentation. The following is the preferred option.

1. Establish a 132kV / 11kV indoor (permanent) zone substation on the same site as the existing (interim) zone substation in St Andrews Rd, Willowdale with 132kV feeder Option 1. This is the preferred option for the following reasons:

    a. complies with Endeavour Energy SDI 501 – Transmission Network Configuration for optimal operational reliability
    b. minimises environmental impact with indoor substation and underground feeders
    c. meets long term 132kV strategy for the South West Growth Sector

The establishment of the new South Leppington Zone Substation will involve:

- construction of a new control building for 11kV and 132kV switchboards and auxiliaries
- installation of the second 132/11kV 45MVA power transformer
- removal of the existing portable control building and outdoor switchgear
- development of three new 11kV underground feeders to strengthen the local network
- installation of the second 132kV underground feeder

The following figure depicts the site of the South Leppington Zone Substation and shows the proposed 132kV and 11kV underground cables to enter and exit the substation and the above ground assets to be removed.

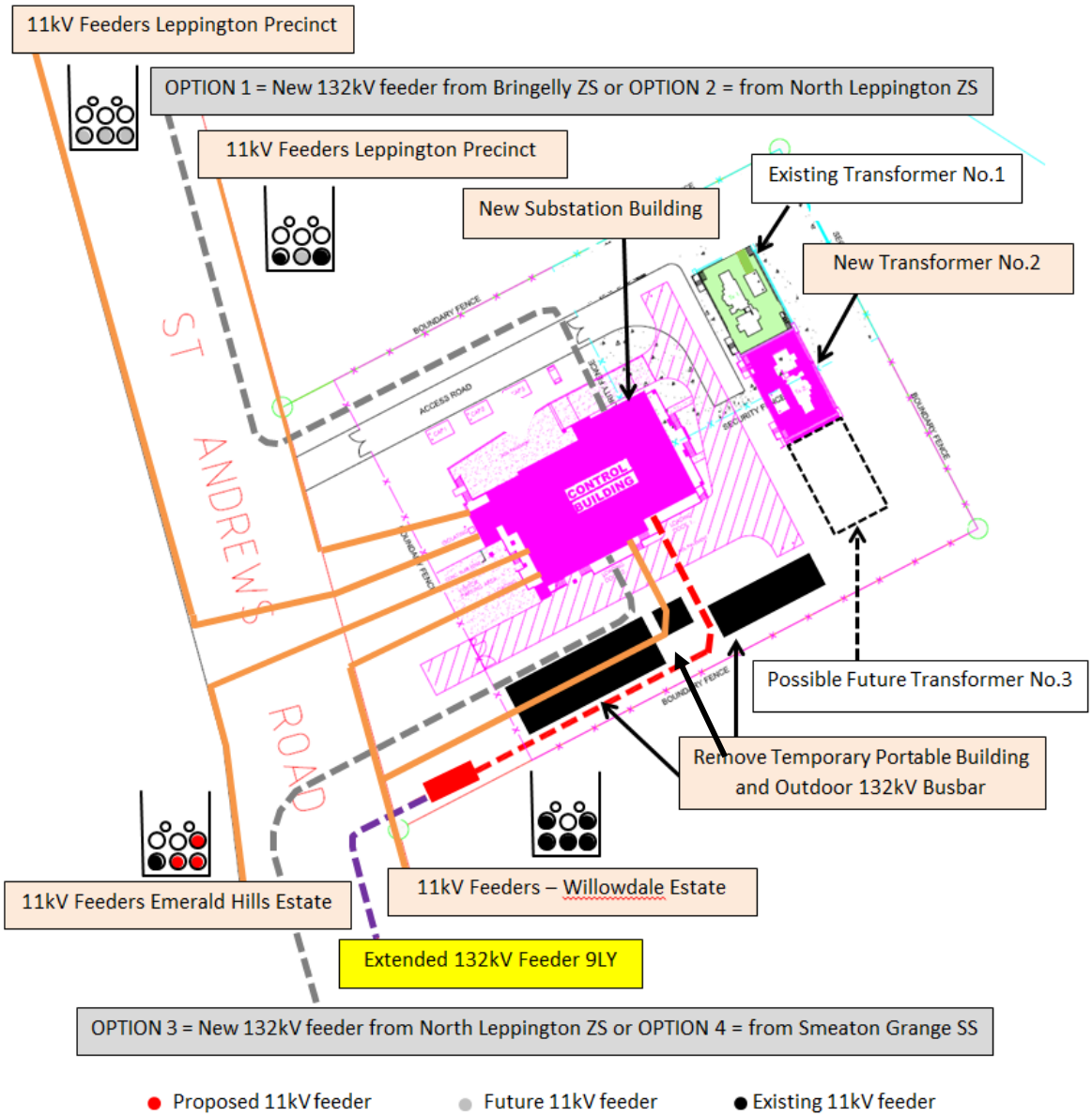


Figure 1 – South Leppington Zone Substation Project Scope

2 Strategic Conclusions

There will be a number of key stakeholders who will need to be consulted regarding the proposed works including:

- Residents, who live around the substation site in St Andrews Rd and Navigator St will need to be consulted regarding the proposed works, especially in reference to traffic impacts and civil construction activity.
- Local State Member for Liverpool
- Liverpool City Council and Camden City Council
- Local road users, who may be impacted by traffic movements.
- NSW Planning for precinct planning purposes.
- Transport for NSW
- NSW Roads and Maritime Services
- Any surrounding businesses
- Landowners potentially impacted by substation construction and associated feeders

3 Strategic Recommendations

Community consultation needs to be undertaken in parallel with the environmental assessment. The community will therefore be involved in the assessment process and can provide feedback and have their concerns considered well in advance of the works' commencement.

Once the community has been advised of Endeavour Energy's proposal, media interest may follow. Endeavour Energy will issue a media release informing the community of the consultation being undertaken and/or have a media holding statement and responses to questions.

Landscaping to screen the substation is recommended to improve the visual amenity of the site for local residences.

Access to the site is from Camden Valley Way and St Andrews Rd. Steps will need to be taken to mitigate the impact on traffic and the noise and dust generation during construction of the new substation.

The following figure shows the proposed augmented South Leppington ZS after completion of the proposed upgrade.

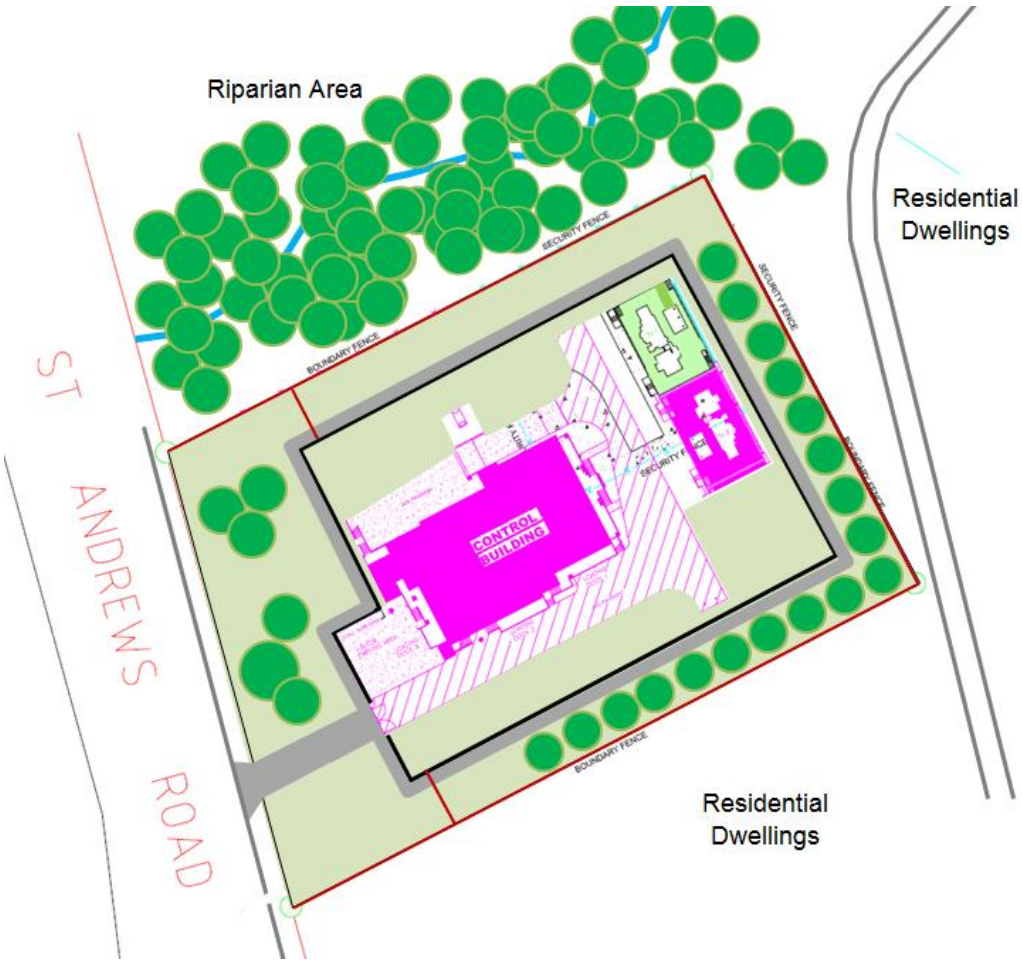


Figure 2 – Preliminary Substation Layout of South Leppington Zone Substation

4 Suggested Approach

NSW Government

The NSW Government will have an interest in the planned works because of its need to ensure infrastructure delivery for the Leppington precinct. When the timing and details of the project are known, briefings with the local MP and possibly the Minister for Energy will be required.

Local community

It is recommended that Endeavour Energy consult local stakeholders in the following ways:

- Seek feedback from stakeholders during the environmental assessment stage
- Distribution of newsletters and/or letters in the lead up to and during construction
- Face to face visits and briefings with adjacent property owners if required
- Information on the project available to interested stakeholders via website
- Advertisements in the local paper
- Issuing media releases at key stages during the project

Local media

Endeavour Energy should proactively brief the local media at the same time information about the project is released to the local community. The Media Relations Manager may consider inviting appropriate journalists to attend individual site tours to explain the planned works and therefore minimise the chance of any misinformation being circulated.

5 Key stakeholders

Internal stakeholders are:

- Endeavour Energy staff involved in the project
- Endeavour Energy's contractors working on the site
- Endeavour Energy staff (via internal communication networks)

Key external stakeholders include:

- Local residents and businesses
- Liverpool City Council
- Camden City Council
- State Member for Liverpool
- Minister for Energy
- NSW Planning & Infrastructure
- Local media
- Landowners including property developers
- Transport for NSW
- NSW Roads and Maritime Services
- Urban Development Institute of Australia

6 Community engagement

Once the project is approved, a comprehensive stakeholder assessment will be undertaken and a community engagement plan drafted. This plan will be updated appropriately throughout the life of the project and includes a number of key communication materials that will be required to support the planned works. They include:

- Key messages about the project
- A communication timetable to key stakeholders
- Media release/s

- Letters
- Newsletters
- Information and Q&As for the website
- Endeavour Energy's community engagement protocols for project staff

Appendix 11 Technical Specification

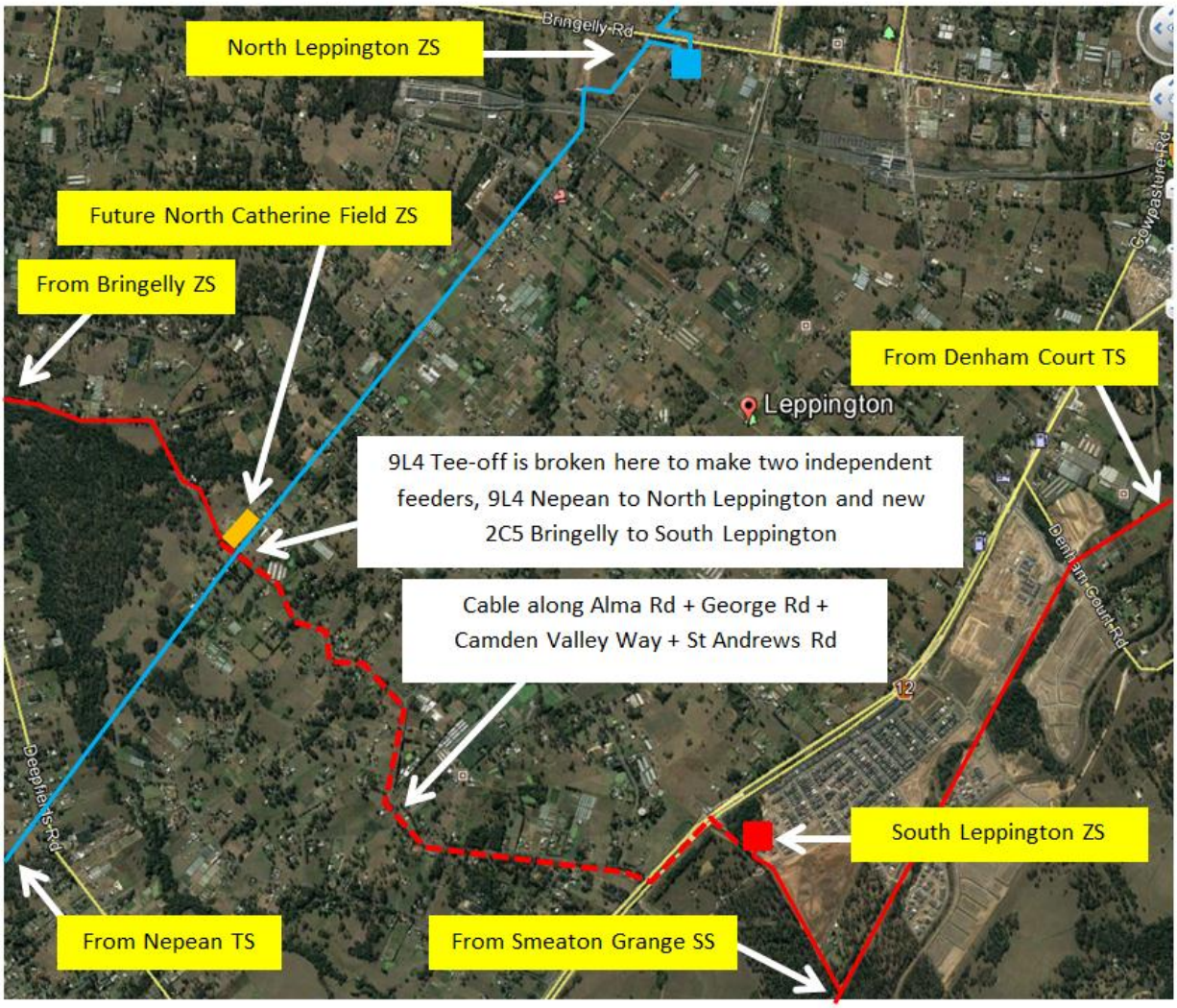
A11.1 Transmission Lines

Primary Supply to South Leppington ZS – From Nepean TS

- South Leppington ZS will be supplied from Nepean TS by a meshed 132kV network comprising of feeders 9L3, 9L5, 9L6, 9LY and 2C5. All feeders will be operated closed avoiding the need for an automated change-over scheme.
- The 9L4 tee-off to Bringelly ZS will be disconnected and extended with 800mm2 Cu XLPE 132kV cable along Alma Rd, George Rd, Camden Valley Way and St Andrews Rd to South Leppington ZS.

Alternate Supply to South Leppington ZS – From West Liverpool TS

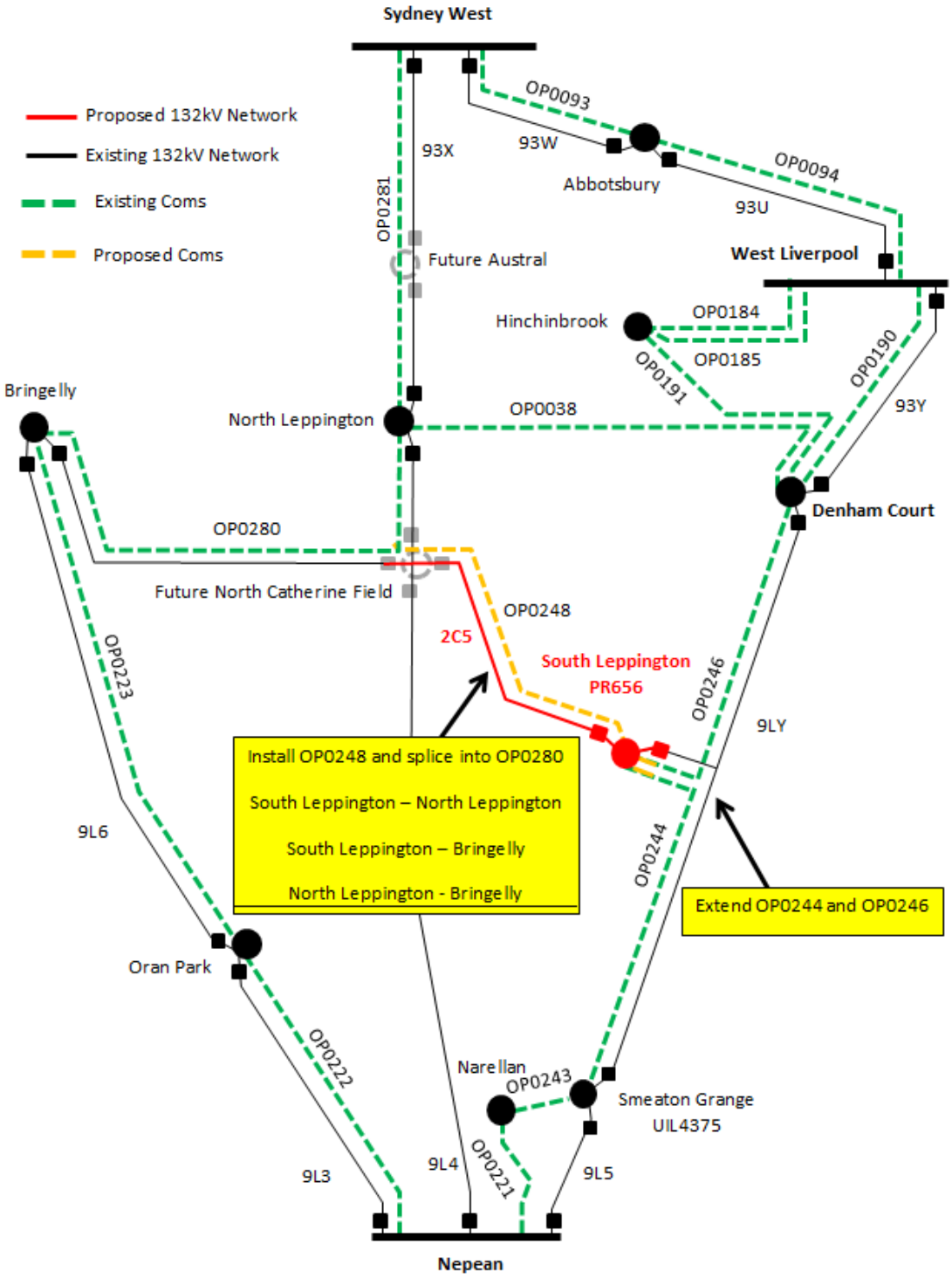
- South Leppington ZS can be supplied from West Liverpool TS by 132kV 93Y via Denham Court TS if required. Refer to Appendix 2 for the SLD.
- The existing 9LY tee-off to South Leppington ZS between Denham Court TS and Smeaton Grange SS will remain.



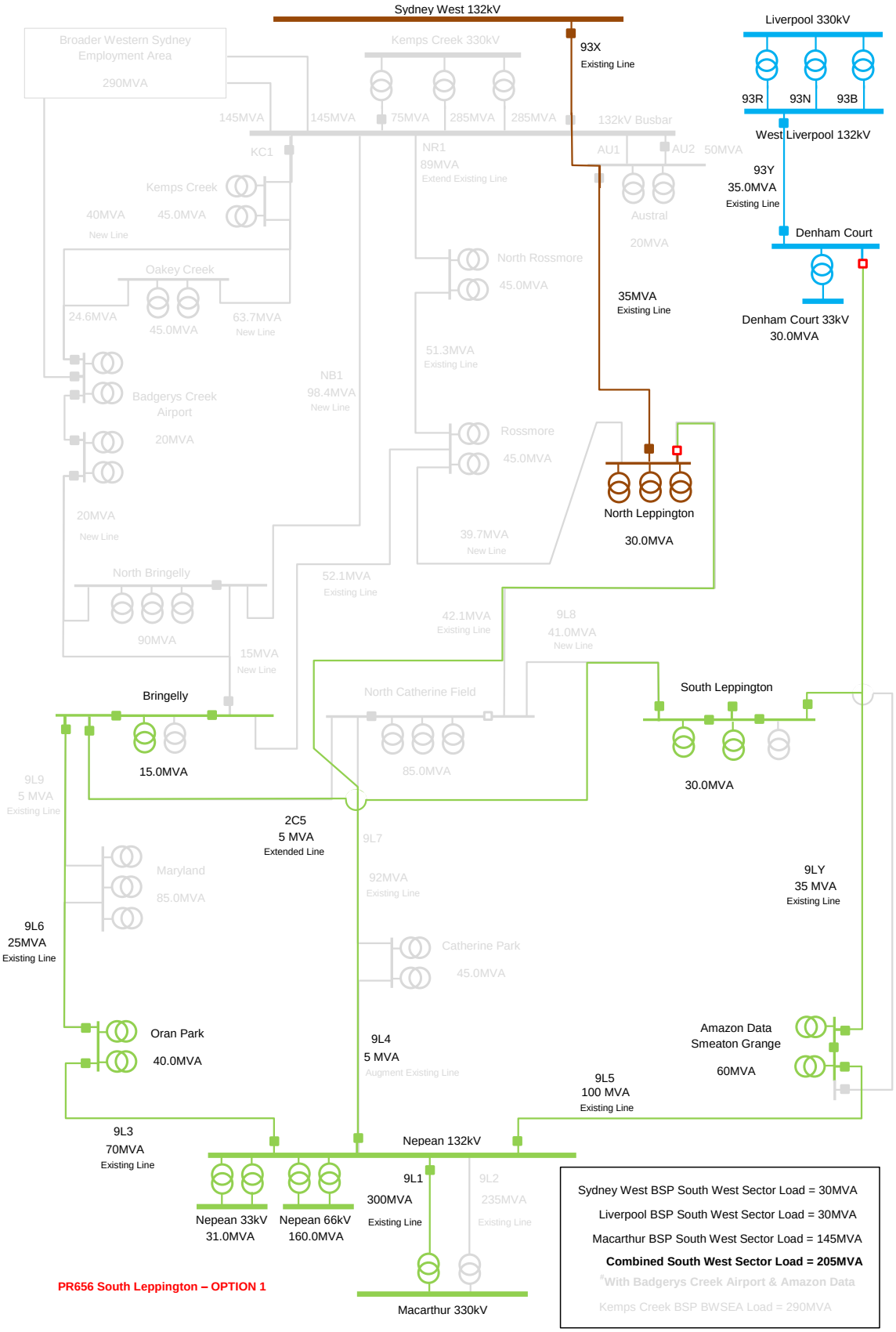
132kV Feeder Extension - Bringelly Zone Substation to South Leppington Zone Substation

Communication Pilots for 132kV Sub-Transmission Network

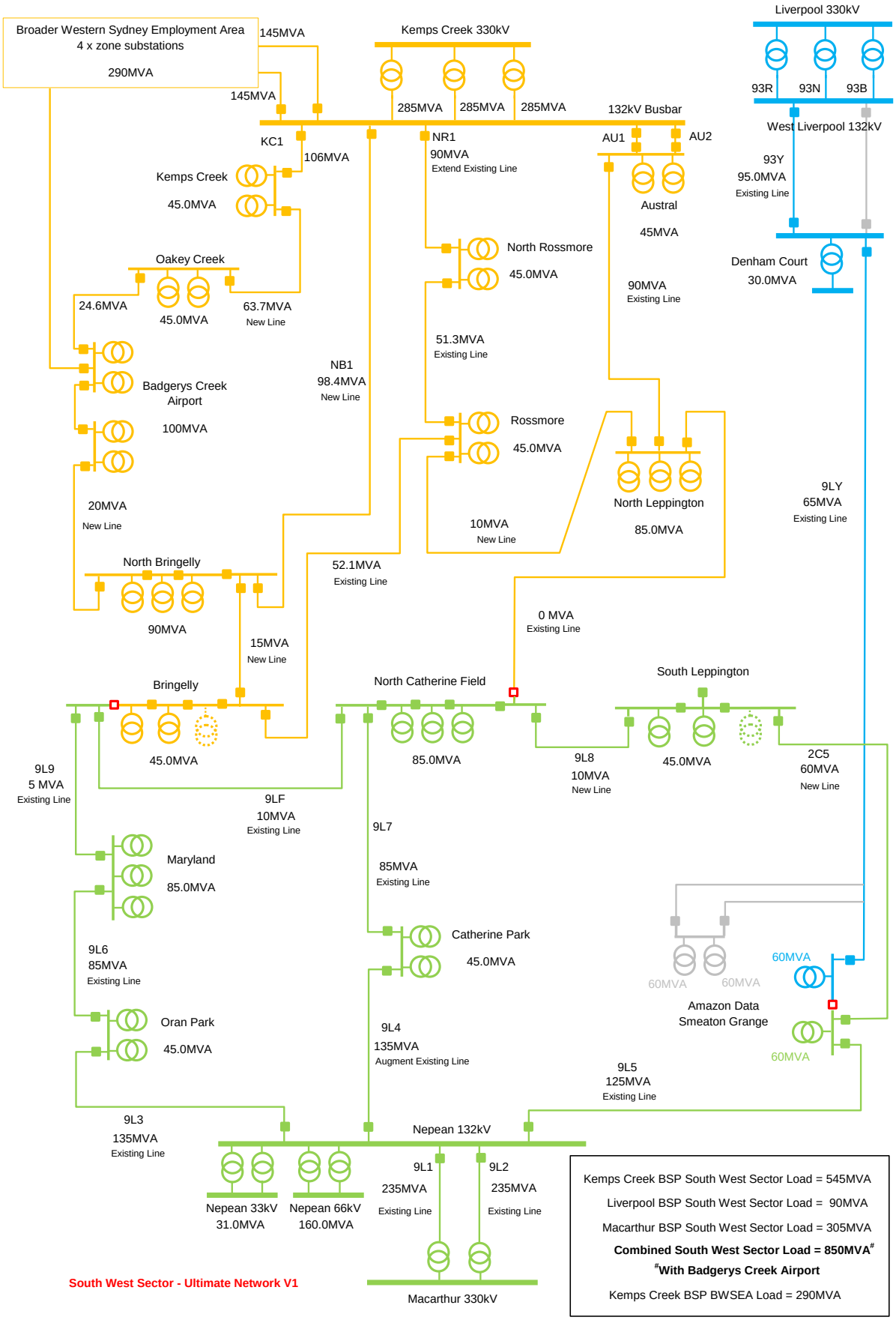
1. Install new communication link **OP0248** and splice into existing **OP0280** creating 72 fibres between South Leppington ZS and Bringelly ZS, 72 fibres between South Leppington ZS and North Leppington ZS and retaining 72 fibres between North Leppington ZS and Bringelly ZS.
2. Re-establish communication links **OP0244** and **OP0246** between South Leppington ZS, Denham Court TS and Smeaton Grange SS.



Communication Network for South Leppington Zone Substation



Proposed 132kV Network by 2020



Proposed 132kV Ultimate Network – South West Sector

A11.2 Substation Works

Establish a new control building to accommodate 11kV and 132kV switchboards and other equipment and apparatus associated with an ultimate three transformer 90MVA zone substation as detailed in Table A and Table B and proposed single line diagrams.

The 11kV switchboard shall be established with four sections forming one straight side of the ultimate six-section switchboard as per SDI 501 - Section 5.3.4.2 Multiple Bus configuration.

There is no AFIC and therefore smart meters and/or analogue *time*-switches/clocks are to be used for load control requirements.

Table A **132/11kV 45/90MVA South Leppington Zone Substation**	
Standard Zone Substation Single Line Diagram	Multiple bus 132/11kV 90MVA with three transformers
Installed Capacity for PR656	90MVA = 2 x 45MVA Transformers
Firm Rating Emergency Firm Rating	45MVA = (100%) 49.5MVA = (110%)
Transformer Details	As per Table B – Transformer Details
Fault Rating of 132kV Elements	40.0kA & curve 1 CB's
Rating of 132kV Feeder CB, Busbar and Bus-section CB	2500A
Number of 132kV Feeder CB's	3
Number of 132kV Bus-section CB's	2
Number of 132kV Bus-sections	3
132kV Transformer CB Rating	2500A
Number of 132kV Transformer CB's	3
Fault Rating of 11kV Elements	20.0kA & curve 1 CB's
11kV Transformer Bus-duct or Cable Rating	2500A
11kV Transformer CB, Busbar and Bus-section CB Rating	2500A
11kV Transformer CB Number	4
11kV Bus-section CB Number	2
11kV Bus-sections	4
11kV Feeder CB Rating	630A
Number of 11kV Feeder CBs	16
Number of 11kV CB's per bus-section and required bus-section arrangement	2 x sections each with 4 x FDRs + 1 x TRF 2 x sections each with 4 x FDRs + 1 x CAP + 1 x TRF
Capacitor Bank capacity	Nil required
SFU Rating^	Nil required – Use Smart Meters
Number of Auto Frequency Injection Cell	Nil required – Use Smart Meters
Auxiliary Busbar	Located in PM Sub / Auxiliary Transformer

Table B 132/11kV 45MVA Transformer Details	
Minimum continuous rating at any voltage tap	2361A @ 11kV = 45MVA
Minimum over- excitation capability	10%
Voltage ratio on nominal tap	132/11kV
Standard tapping range	132kV + (3 x 1.5%) – (17 x 1.5%)/11kV
Minimum pu impedance on 100MVA base at any voltage tap	0.78pu (86.67% - min impedance on Tap 1)
Standard vector group	Dyn1 (Star point of secondary winding earthed)

^ Investigations by the Power Quality Engineer concluded AFIC equipment was causing power quality problems and should cease.

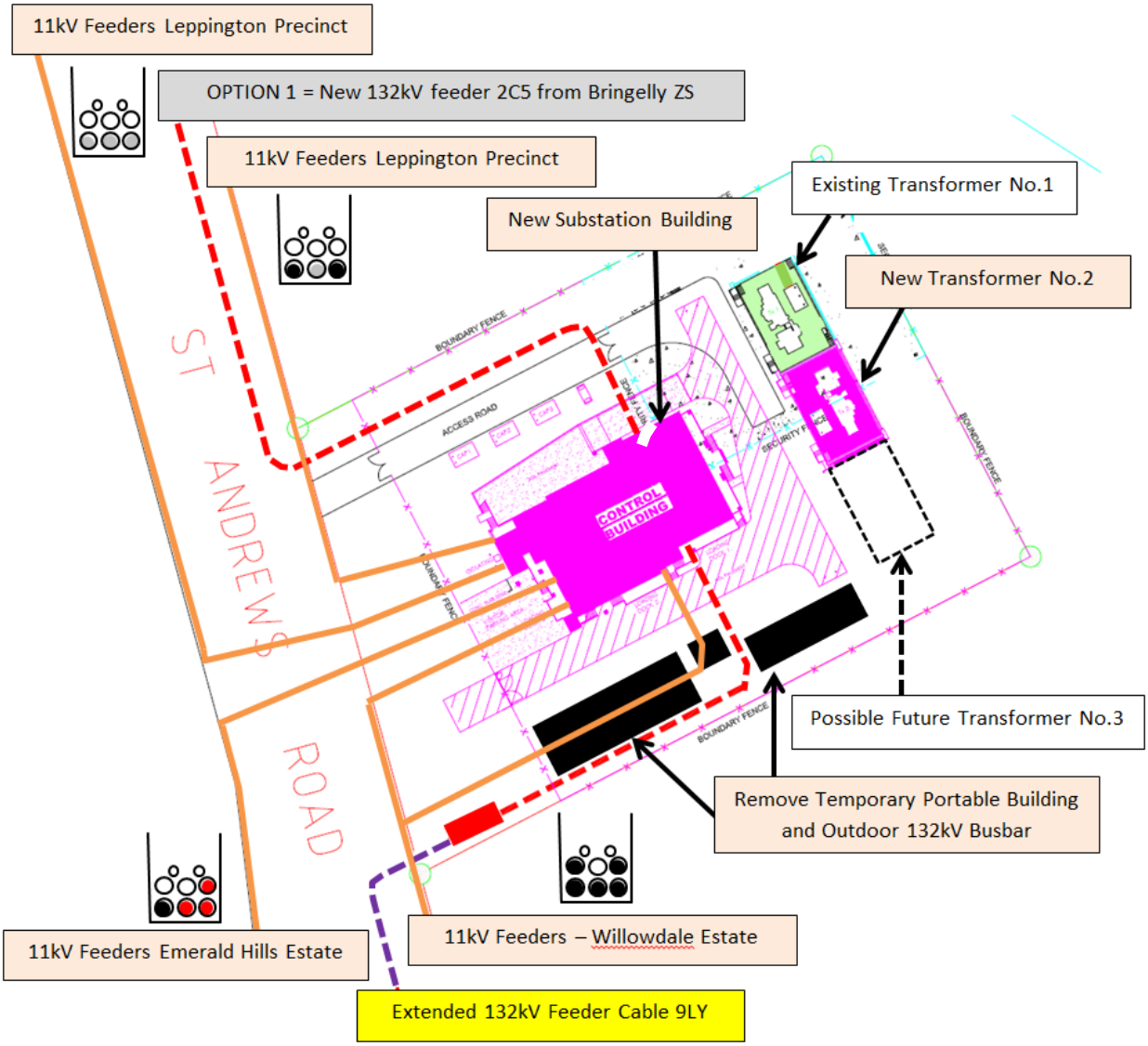
- **Station layout feasibility** – The substation shall comprise of a standard *(simplified)* control building for 11kV and 132kV switchboards and associated auxiliary equipment and batteries and be suitably screened by appropriate landscaping. Transformer noise shall be mitigated by appropriately designed and built-in measures.
- **Protection & SCADA** – Standard Protection & SCADA schemes to be employed for;
  1. 132kV feeder 2C5 South Leppington ZS - Bringelly ZS
  2. 132kV feeder 9LY South Leppington ZS - Denham Court TS - Smeaton Grange SS
  3. Carry out works described in **Section 6.6.4** and **Section 6.6.5** of this report.
  4. Revise protection settings at Bringelly, Oran Park, Smeaton Grange, North Leppington and Nepean TS for meshed operation of the 132kV network. North Leppington will continue on C/O between Sydney West and Nepean, Denham Court will continue on C/O between West Liverpool and Nepean.
  5. Allow for check synchronisation on 132kV feeders at South Leppington ZS.
  6. Allow for potential relay changes or communication card modifications at North Leppington ZS, Bringelly ZS and Nepean TS as may be dictated by attenuation studies on the proposed communication network of the re-arranged 132kV network.
- **Under Frequency Load Shedding** – System Operations Branch shall determine UFLS priorities for 11kV feeders. There are no known hospitals in the service catchment area at this point in time however there is an aged care facility and retirement village in Jamboree Ave, Willowdale supplied by PM Sub 34686 and PM Sub 34687 on feeder SL1232 Navigator St.
- **Float voltage, LDC** – Float voltage shall be set at 10.9kV on the 11kV busbar with an LDC of zero until determined otherwise. 11kV feeders will be up to 3.0km in route length and voltage regulation is expected to be within planning limits with a range of 0.1% at light load to 3.8% at full load.
- **Frequency injection** – Auto Frequency Injection Control (AFIC) will not be established at South Leppington ZS due to power quality investigations concluding this was causing interference with modern household appliances and LED lighting. As a consequence, all

existing customers with off-peak relays for controlled load such as storage hot water tanks will need to be converted to smart meters to retain controlled function and tariff. Compliance to BASIX will result in no new customers requiring AFIC control.

- **Street lighting Control Points** – SLCPs operating on AFIC signal are to be converted to PE cell or Master/Astronomical clock. Refer to Tables D and E below.
- **Capacitor banks** – None required.
- **132kV Duct Provisions**

  132kV feeder 2C5 from Bringelly ZS will traverse along Alma Rd, George Rd, Camden Valley Way and St Andrews Rd from adjacent to feeder 9L4 *opposite the North Catherine Field ZS site* to South Leppington ZS. The new feeder route is 3,800m in length and will be required to be ducted along its full length from the new UGOH termination pole to South Leppington ZS. Additional consultation time with RMS for access and design approvals across and along Camden Valley Way must be factored into lead times for delivery of the new feeder.
- **11kV Duct Provisions**

  11kV feeders will exit the control building into St Andrews Rd and disperse east to Jamboree Ave & Emerald Hills Boulevarde and west to Camden Valley Way via five (5) sets of Type 26 distribution ducts linking up with the existing underground network. Refer to the following diagram for transmission and distribution ducts.
- **Portable Control Room & Temporary 132kV Equipment at South Leppington ZS** Decommission and remove from site.



11kV Ducts for South Leppington Zone Substation

A11.3 Distribution Works

- **New 11kV Feeders** *(by Endeavour Energy)* – Establish three (3) 11kV feeders from the new switchboard and connect them into the existing network. Refer to Table C and DWP scope sheet **MHC04373**. Also refer to GIS diagram of South Leppington DWP Works.

  SL1342 Carnelian Street – Install 240Cu XLPE 11kV cable from the new switchboard to STJ on cable from PM Sub 35471.

  SL1432 Bergin Circuit – Install 240Cu XLPE 11kV cable from the new switchboard to STJ on cable from PM Sub 36021.

  SL1442 Penstock Street – Install 240Cu XLPE 11kV cable from the new switchboard to STJ on cable from PM Sub 33564.

- **Network Augmentation** – Augment fault level exceeded conductor, remove fault level exceeded conductor and replace underslung links. Refer to DWP scope sheets **MHC04396**, **MHC04402 and MHC04403.**

- **Customer Load Control** – Convert load control relays and off-peak meters to switchable smart meters or analogue time-switch on existing customers with off-peak hot water. *(Funded in lieu of AFIC).* Refer to Table D.
- **Street Lighting Control** – Convert street light control points (SLCP) that have load control relays to PE cell or astronomical clock. *(Funded in lieu of AFIC).* Refer to Table E.

The post commissioning feeder loads and voltage regulation are shown in Table C

Item No.	Feeder Name	Predicted Initial Load (Amps)	Predicted Initial Load (MVA)	Predicted Voltage Regulation (%)
MHC04373	SL1122 Moriarty Street	120	2.3	3.7
MHC04373	SL1132 Emerald Hills Boulevarde	90	1.71	1.3
MHC04373	SL1212 George Road	150	2.85	3.9
MHC04373	SL1222 Konara Street	120	2.3	3.7
MHC04373	SL1232 Navigator Road	120	2.3	3.7
MHC04373	SL1332 Heath Road	100	1.9	2.8
MHC04373	SL1342 Carnelian Street *(New feeder)*	90	1.71	1.3
MHC04373	SL1352 Tunnel Street	120	2.3	3.7
MHC04373	SL1422 St Andrews Road	90	1.71	1.5
MHC04373	SL1432 Bergin Circuit *(New feeder)*	90	1.71	1.3
MHC04373	SL1442 Penstock Street *(New feeder)*	90	1.71	1.3
Zone Sub	**TOTAL**	**1180**	**22.5#**	

Table C – Proposed 11kV Feeder Loads and Voltage Regulation

Summated peak load of the 11kV feeders is estimated at 22.5MVA however this will translate to a zone substation diversified load of approximately 18MVA.

Table D – Customer Off-Peak Relay Replacement List for South Leppington Zone Substation

SL1122 Moriarty Street	Subs	Customers	Relays	SLCP	Comments
	33551	60	0		
	33835	56	0		
	33882	48	0		
	34648	47	0		
	34700	33	0		
	34701	23	0		
	34702	22	0		
	34912				
	35124				
	35125				
	35126				
	35127				
	35128				
	35129				
	35964				
	35965				
	35966				

SL1132 Emerald Hills Boulevarde	Subs	Customers	Relays	SLCP	Comments
	35237				
	35240				
	35242				
	35243				
SL1212 George Road	**Subs**	**Customers**	**Relays**	**SLCP**	**Comments**
	4785	9	3		
	10621	14	8		
	10622	22	8		
	10623	19	9		
	10624	18	11		
	10625	23	9		
	10630	1	1		
	10809	18	6		
	10810	14	6		
	10841	17	6		
New sub 33083 replaced 10842	10842	3	3		
	10894	13	8		
	11018	5	4		
	11985	13	13		
	12051	10	8		
	12099	2	2		
	22515	12	8		
	23072	6	0		
	25887	15	5		
	26725	2	0		
	27045	13	5		

SL1222 Konara Street	Subs	Customers	Relays	SLCP	Comments
	33037	61	0		
	33072	60	0		
	33550	53	0		
	33555	26	0		
	33560	54	0		
	33829	15	0		
	34064	32	0		
	34065	39	0		
	34066	5	0		
	34067	35	0		
	34068	9	0		
	34957				
	34973				
	35968				

SL1232 Navigator Road	Subs	Customers	Relays	SLCP	Comments
	33038	28	0		
	33071	69	0		
	33474	5	5		
	33565	48	0		
	34686				
	34687				
	34730				
	34731				
	34764				
	34765				
	35806				Shopping Centre
SL1332 Heath Road	**Subs**	**Customers**	**Relays**	**SLCP**	**Comments**
	10617	14	7		
	10618	26	15		
	10619	29	7		
	10620	7	3		
	10651	26	12		
	10969	21	7		
	10973	6	3		
	12062	13	5		
	35993				
SL1342 Carnelian Street	**Subs**	**Customers**	**Relays**	**SLCP**	**Comments**
	3XXXX				Future asset
	3XXXX				Future asset
	3XXXX				Future asset
	35471				
	34553				
	34552	14	0		
	33937				
	34988				
	11840	1	0		
	11848	3	0		
	11844				
SL1352 Tunnel Street	**Subs**	**Customers**	**Relays**	**SLCP**	**Comments**
	1068	8	8		
	8477	3	0		
	28203	11	0		by PR427 North Leppington
	28204	22	0		by PR427 North Leppington
	29269	8	5		
	32400	2	0		
	33069	66	0		
	33070	63	0		
	33472	27	4		
	34056	16	8		
	34269	71	0		
	34811				
	34814				

	35594	4	0		
	35713				
	35915				
	35916				
SL1422 St Andrews Road	**Subs**	**Customers**	**Relays**	**SLCP**	**Comments**
	565	2	0		
	10408	2	2		
	10409	2	1		
	10412	26	16		
	10767	1	0		
	11386	1	1		
	11592	1	0		
	18547	1	0		
	20363	2	0		
	25733	1	0		
	27035	1	0		
	27036	1	0		
	27305	2	0		
	34270	6	0		
	34271	5	0		
	34272	4	0		
	34273				
SL1432 Bergin Circuit	**Subs**	**Customers**	**Relays**	**SLCP**	**Comments**
	590	3	1		
	863	10	4		
	9971	7	1		
	11551	1	1		
	11993	5	3		
	13450	71	53		
	13500	41	16		
	19067	1	0		
	20076	1	0		
	21476	1	0		
	32251	48	0		
	33498	28	0		
	33950				
	33984	11	0		
	33985	15	0		
	34450				
	34451				
	34452				
	35292				
	35472				
	35473				
	36021				
	36022				

SL1442 Penstock Street	Subs	Customers	Relays	SLCP	Comments
	33564	59	0		
	33883	59	0		
	34647	47	0		
	34649	41	0		
	34911				
	35130				
	35961				
	35963				
	35969				
	36025				
	36026				
	36027				
	36028				
	36029				
Total Relays / Locations			**311**		

A list of customer NMIs and addresses will be provided in the Project Definition.

Table E – SLCP List for South Leppington Zone Substation

SLCP Asset Number	Supplied from Sub	Action Required
3130	10412	PE Cell - Install
3268	10809	PE Cell - Install
3497	13450	Master Clock - Install
3516	29980	Master Clock - Install
3958	13500	Master Clock - Install
3959	13501	Master Clock - Install
4410	11736	Master Clock - Install
4469	1082	PE Cell - Install
4756	13567	Master Clock - Install
9239	28203	Master Clock - Install
9416	29269	PE Cell - Install
9417	10973	PE Cell - Install
9449	10620	PE Cell - Install
9451	33083	PE Cell - Install
9462	10751	PE Cell - Install
9463	29505	PE Cell - Install
9483	29549	Master Clock - Install
9722	33037	Master Clock - Install
9735	1068	PE Cell - Install
9750	33083	PE Cell - Install
9812	35594	Master Clock - Install
9816	33474	PE Cell - Install
9820	34056	PE Cell - Install
9821	33472	PE Cell - Install
9926	33937	Master Clock - Existing
9942	33984	Master Clock - Existing
9949	34552	Master Clock - Existing
TOTAL SLCPs / Locations = 27		**14 x PE Cell and 10 x Master Clock**

Zone:	**South Leppington, 9766**	Item No:	**MHC04373**	Amd No:	**0**
Feeder:	**SL1122 – St Andrews Rd**	LG Area:	**CC**		
Location:	**St Andrews Rd, Leppington**	Prepared:	**Joe Degabriele**		

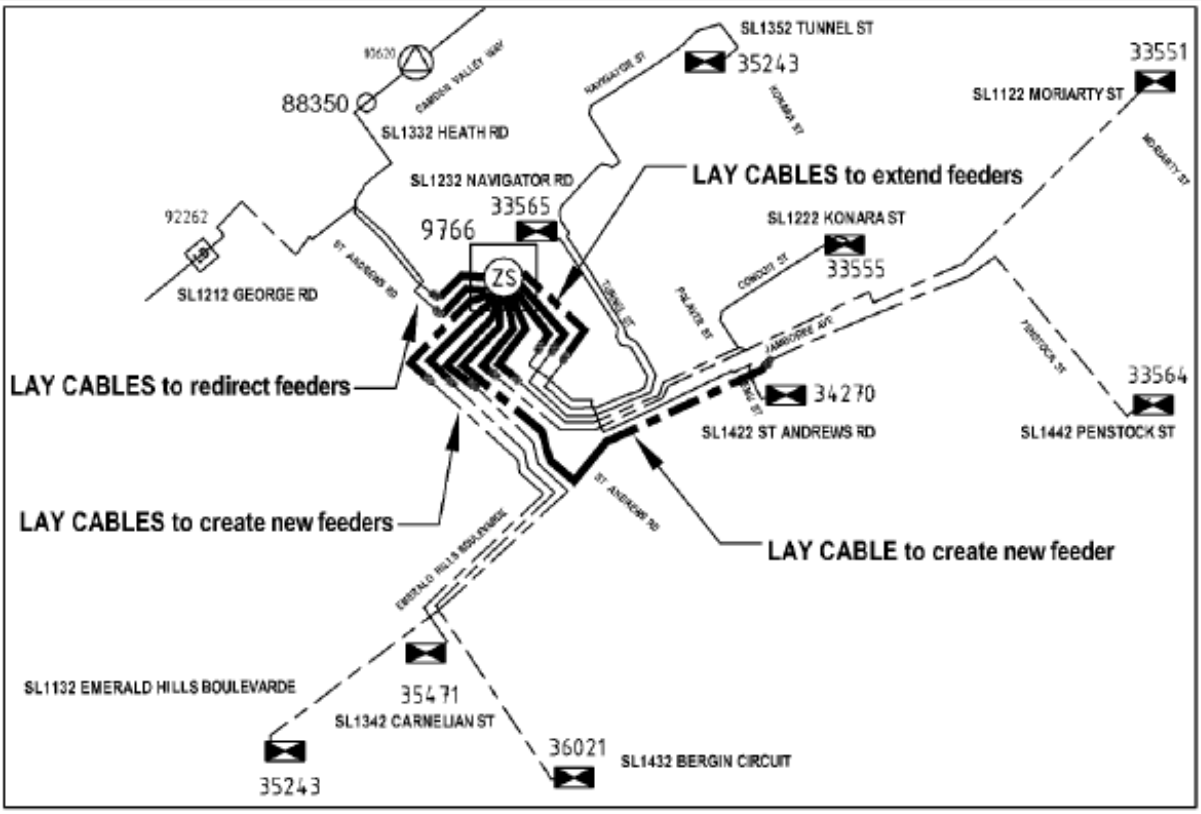
Reason for Works

South Leppington ZS is being augmented and 11kV feeders are required to be extended from the old switchboard to the new switchboard.

Description Of Works	Length (km)
Extend the St Andrews Rd feeder cable from SL1122A to new SL1422 in 240Cu XLPE 11kV cable. Extend the Konara St feeder cable from SL1122B to new SL1222 in 240Cu XLPE 11kV cable.	0.2
Extend the Tunnel St feeder cable from SL1132A to new SL1352 in 240Cu XLPE 11kV cable. Extend the Navigator St feeder cable from SL1132B to new SL1232 in 240Cu XLPE 11kV cable.	0.2
Extend the George Rd feeder cable from SL1112A to new SL1212 in 240Cu XLPE 11kV cable. Extend the Moriarty St feeder cable from SL1112B to new SL1122 in 240Cu XLPE 11kV cable.	0.2
Extend the Heath Rd feeder cable from SL1142A to new SL1332 in 240Cu XLPE 11kV cable. Extend the Emerald Hills Boulevard feeder cable from SL1142B to new SL1132 in 240Cu XLPE 11kV	0.2
Install 240Cu XLPE cable SL1342 and STJ to cable from Sub 35471 creating Carnelian St feeder. Install 240Cu XLPE cable SL1432 and STJ to cable from Sub 36021 creating Bergin Circuit feeder.	0.2
Install 240Cu XLPE cable SL1442 and STJ to cable from Sub 33564 creating Penstock St feeder.	0.4
Estimated Total Project Cost:	**$800,000**

Remarks

The scope of works are designed to transfer 8 x existing 11kV feeders from the South Leppington ZS interim switchboard to the permanent switchboard and estabish three new 11kV feeders.



Asset Strategy & Planning

Zone:	**South Leppington, 9766**	Item No:	**MHC04396**	Amd No:	**0**
Feeder:	**SL1142 – Heath Rd**	LG Area:	**CC**		
Location:	**Rickard Road, Leppington**	Prepared:	**Joe Degabriele**		

Reason for Works

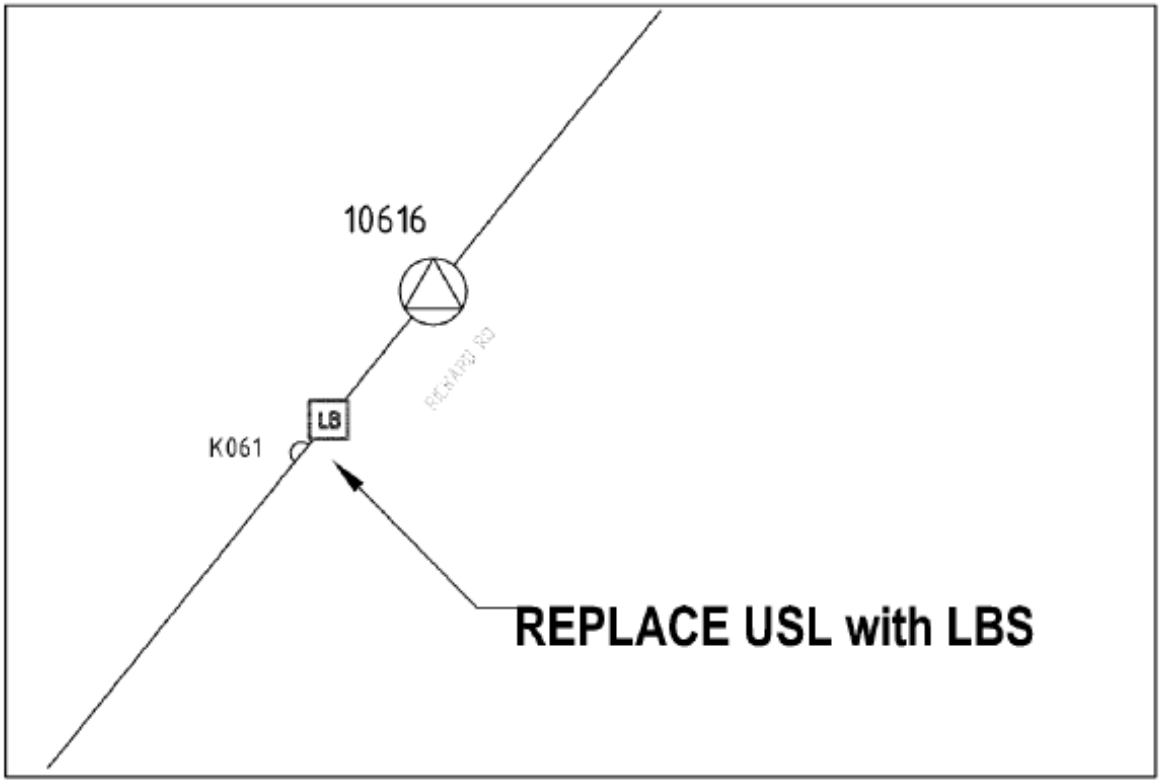
This is the proposed N/O point between North Leppington ZS and South Leppington ZS and is required to be a three phase switch.

Description Of Works	Length (km)
Replace USL K061 with a SCADA Automated Load Break Switch.	

Estimated Total Project Cost: **$36,000**

Remarks

The new load break switch is required to be SCADA enabled in readiness for cross-zone switching.



Asset Strategy & Planning

Zone:	**South Leppington, 9766**	Item No:	**MHC04402**	Amd No:	**0**
Feeder:	**SL1142 – Heath Rd**	LG Area:	**CC**		
Location:	**Park Road, Leppington**	Prepared:	**Joe Degabriele**		

Reason for Works

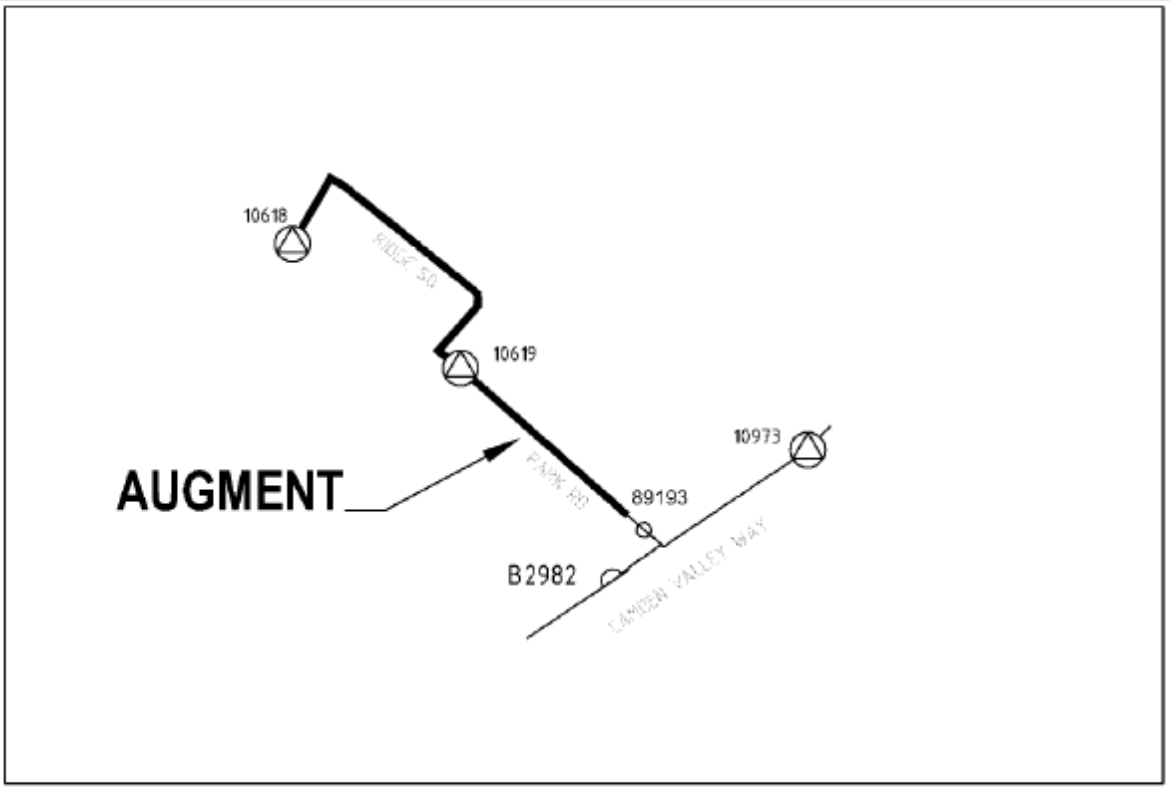
The Protection Engineer has assessed the existing 6/1/3.00ACSR/GZ conductor along Park Rd Leppington to be fault level exceeded and unprotected.

Description Of Works	Length (km)
Augment existing HV conductor to 7/4.5AAC (or equivalent) along Park Road from Camden Valley Way to Pole Sub 10618.	1.4

Estimated Total Project Cost: **$176,000**

Remarks

No URD subdivisions had occurred at the time of drafting the scope of works. Any URD development which has since occurred along Park Road and Ridge Square will be a deduction in length and cost estimate for this augmentation.



Asset Strategy & Planning

Zone:	**South Leppington, 9766**	Item No:	**MHC04403**	Amd No:	**0**
Feeder:	**SL1122 – St Andrews Rd**	LG Area:	**CC**		
Location:	**St Andrews Rd, Willowdale**	Prepared:	**Joe Degabriele**		

Reason for Works

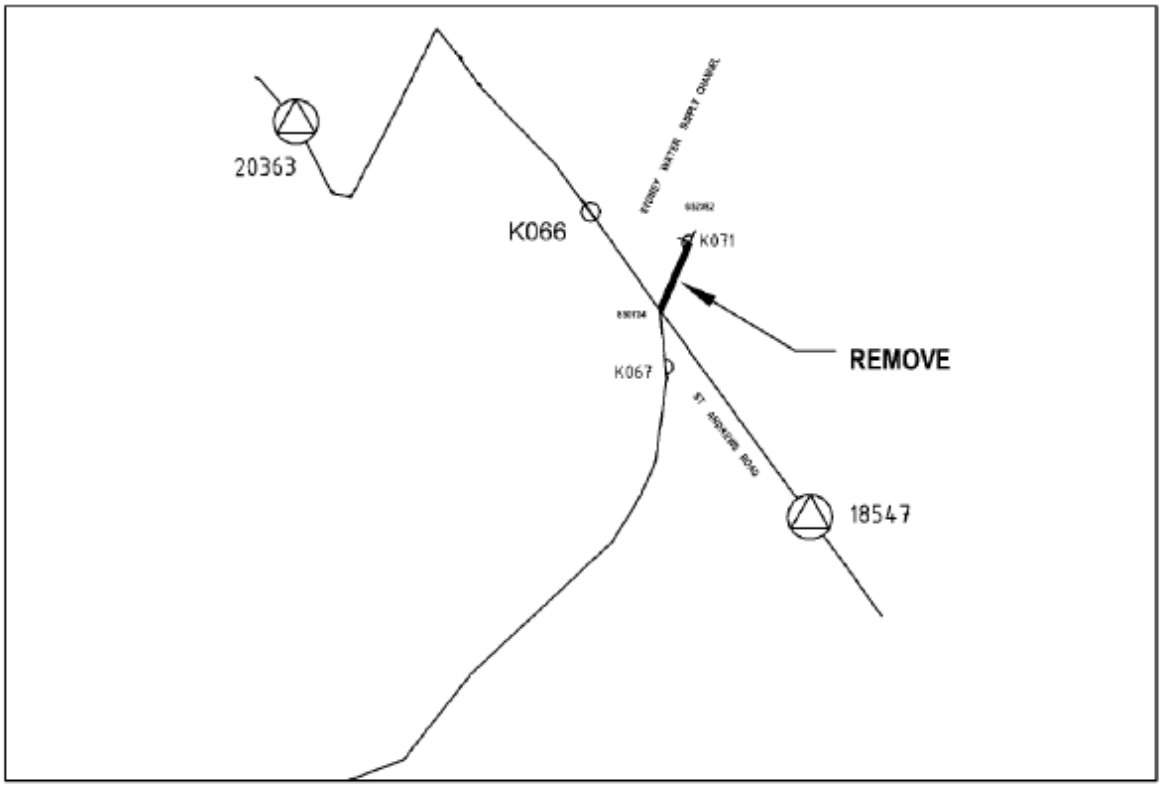
The Protection Engineer has assessed the existing 6//2.50 ACSR/GZ conductor to be fault level exceeded and unprotected.

Description Of Works	Length (km)
Remove existing overhead conductor from 4-way Pole 650704 to termination Pole 652082 and USL K071.	0.07

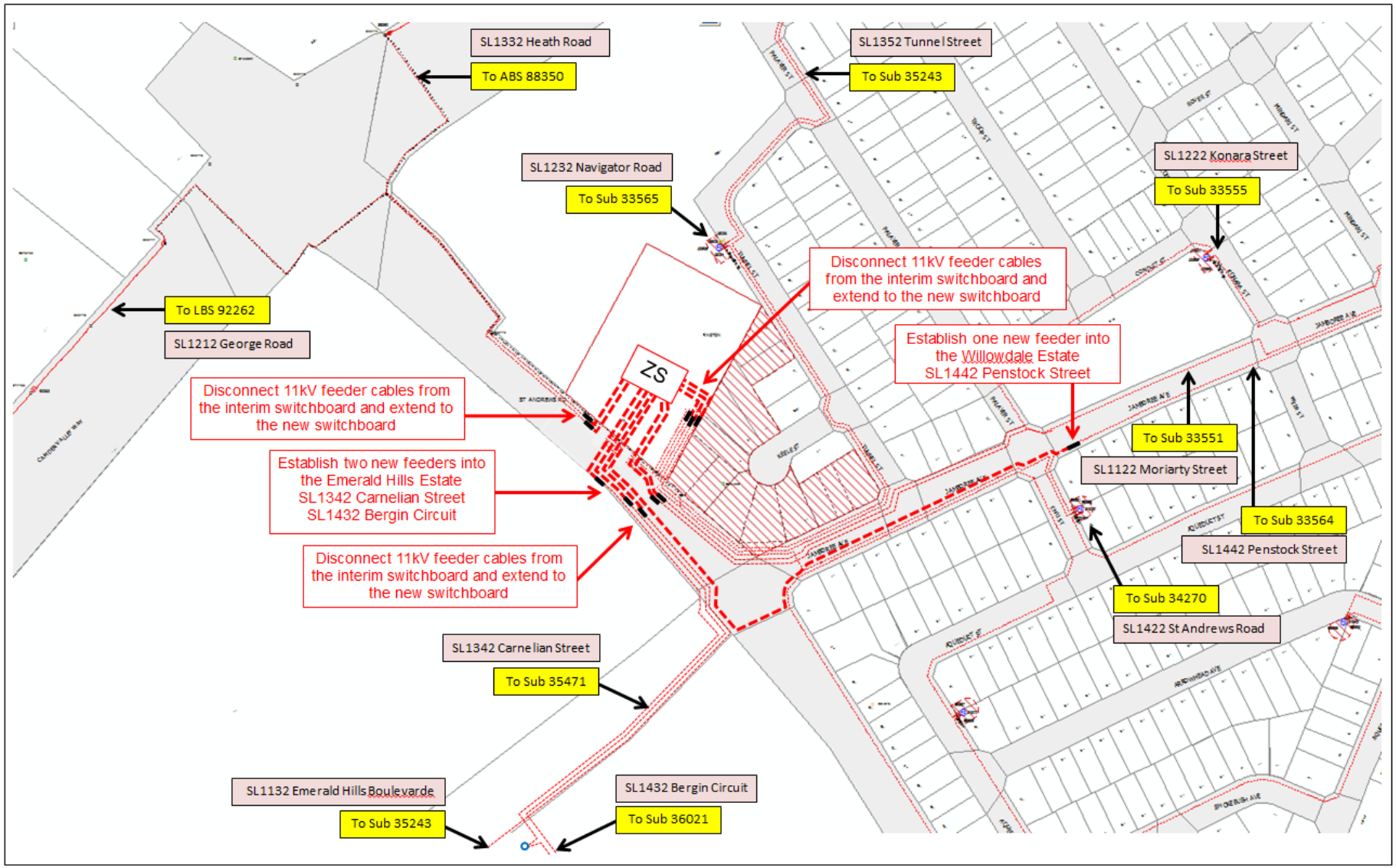
Estimated Total Project Cost: **$0**

Remarks

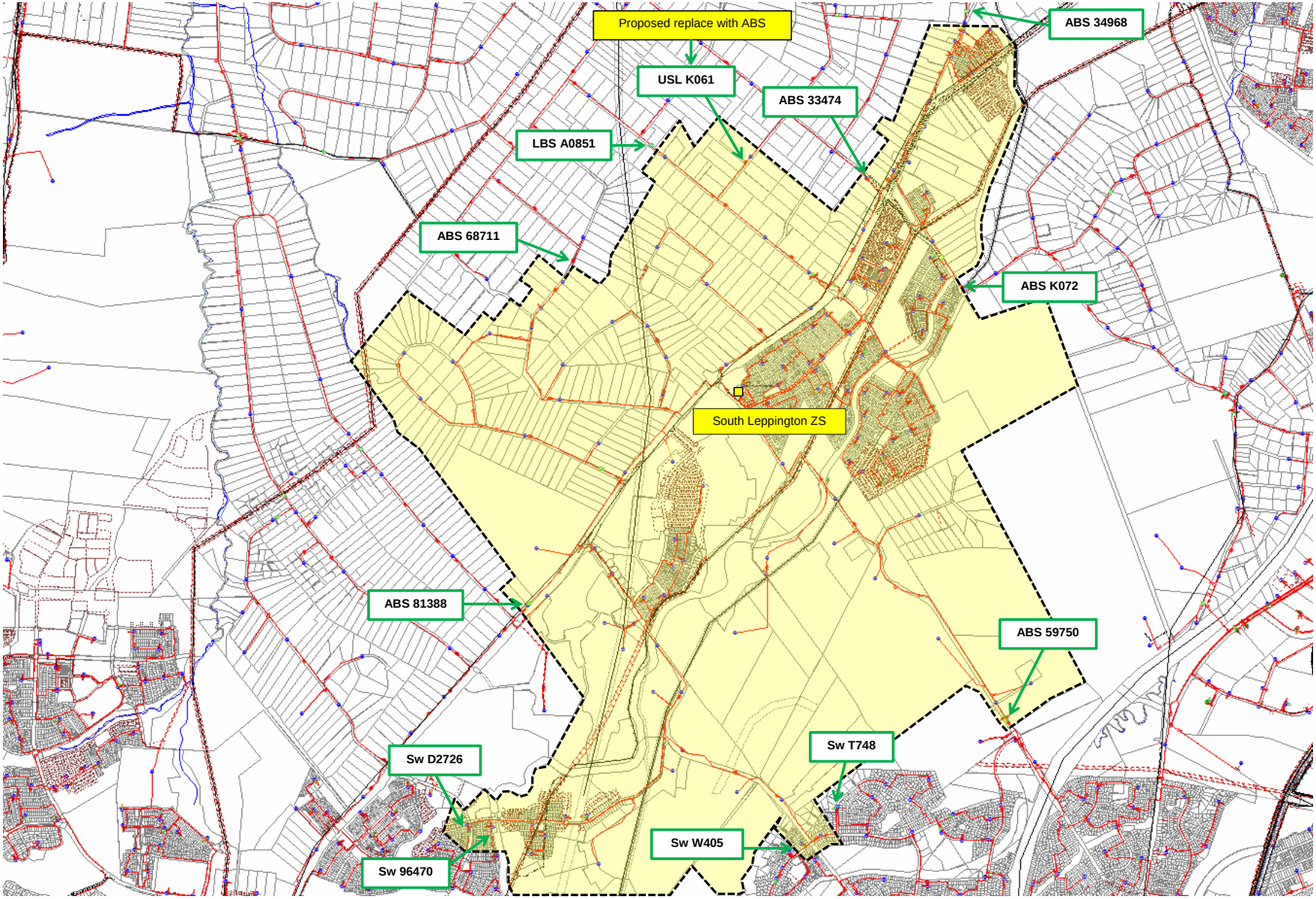
Special access arrangements may apply as adjacent to Sydney Water Supply Channel



Asset Strategy & Planning



PR656 SOUTH LEPPINGTON ZONE SUBSTATION - DWP WORKS



SOUTH LEPPINGTON ZONE SUBSTATION SERVICE AREA – POST PR656