South area strategic plan
System capacity planning project
Aurora Energy

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Contents

Executive summary

The long term plan for the South area recommends the continuation of the existing zone substation strategy, with the future Kingston 33 kV injection point expected to provide sufficient capacity to the area's zone substations (after installation of third transformers) for the scope of the study. Several new zone substations are proposed to address load growth in the area including Blackman's Bay and Margate.

The ten year plan for South recommends the establishment of a new zone substation at Blackman's Bay to deload the Kingston and Brown's Rd substations, and the replacement of ageing transformers at Kermandie terminal substation to meet capacity requirements.

The five year plan for South examines the distribution networks of the five existing substations (including the Browns Rd zone substation) and the impact of the proposed zone substation at Blackman's Bay. Proposed distribution feeder works in the area include load transfers between Electrona feeders to deload 33272, load transfers between Knights Rd feeders to deload 30608 and a new feeder from Kermandie substation as part of the transformer replacement project.

The planning philosophy section proposes that Aurora review the ratings of 33 kV cables and 33/11 kV transformers with a view to implementing cyclic, emergency and short-time ratings. This would result in higher capacity from existing and future plant, increase the flexibility of the system and defer system limitations. The planning philosophy also recommends that Aurora investigate the use of 11 kV capacitor banks at zone substations, and where appropriate, establish new capacitor banks to defer transformer upgrades and reduce system losses.

This report is part of a series covering the eleven planning areas in the state of Tasmania. References are made in this report to others in the series which cover adjacent planning areas. An overarching summary document was compiled to highlight the important outcomes and recommendations from each area in the study.

Report reference	Planning area
0	System capacity planning project summary
1	Tamar area strategic plan
2	North Coast area strategic plan
3	North West area strategic plan
4	Hobart West area strategic plan
5	Hobart East area strategic plan
6	**South area strategic plan**
7	Sorell area strategic plan
8	East Coast area strategic plan
9	North East area strategic plan
10	Central area strategic plan
11	West Coast area strategic plan

1. Introduction

Aurora Energy (Aurora) engaged Aurecon (formerly Connell Wagner) to undertake a network system capacity planning study covering the eleven planning areas in the state of Tasmania. A report will be produced for each of the eleven planning areas and will include a long term strategic plan, a ten year plan and a five year plan.

Each area report contains a summary of the planning area, describing the geographical region encompassed, the existing electrical infrastructure and the local council plans as well as Aurora and Transend's committed and proposed works for the area. A load forecast is then presented, with a discussion of the magnitude and location of expected load growth, followed by a discussion of the resulting limitations at each substation. The long term strategic plan, ten year plan and five year plan are then presented.

1.1 Background

Aurora is the distribution network service provider of mainland Tasmania, supplying more than 1 GW peak load through its high voltage network in 2008. Transend is the transmission network service provider of Tasmania.

The Aurora HV distribution system consists mainly of 22 and 11 kV feeders, with the connection point generally on the load side of the feeder circuit breakers at Transend's terminal substations. Aurora also owns several 33/11 kV zone substations and 33 kV feeders, which are supplied by Transend's 110/33 kV substations.

This report has been prepared for Aurora and its intent is to review Aurora's short and long term network requirements, however it is understood that Transend is impacted by the recommendations contained within. Therefore all efforts have been made to perform the study in consultation with Transend, and consideration has been given to Transend's future vision and network security standards.

1.2 Methodology

The methodology used to carry out the planning study is outlined below.

To begin with, data was reviewed for each of the planning areas including:

- Annual planning reports from Transend and Aurora
- Known developments and constraints
- The existing network configuration (using Webmap)
- Load models and load transfer capacity
- Transformer refurbishment program (Aurora)
- Schematics of Aurora and Transend substations
- Joint planning studies and regulatory test reports
- Council plans and residential strategies for all of the Tasmanian councils (where available)

The load model for each planning area was then refined into smaller growth areas, with each area allocated medium or high growth based on land availability, council plans for the area and information from Aurora on growth hot spots and point loads. This process resulted in a load forecast for each planning area which fell between the medium and high growth forecasts provided by Aurora, with load growth biased towards those areas (and hence substations) where high growth is expected. This forecast is considered the high growth forecast for this study, with the medium and low forecasts being those provided by Aurora.

For the purposes of the long term strategic plan and ten year plan it was decided to use the high growth forecast to determine the timing of limitations. This conservative approach was taken to ensure that Aurora is prepared should a higher than expected forecast eventuate. The five year plan is intended to be used by Aurora for its short-term planning, including regulatory submission for relevant projects, and therefore needs to be as accurate as possible. As a result, the five year plan uses the medium growth forecast to determine the timing of limitations.

The long term strategic plan was produced by projecting the high growth load forecast out to the year 2050 and performing a high level review of the resulting limitations. Substation capacity and condition were the primary limitations considered at this stage, as distribution network limitations are difficult to forecast and can largely be addressed independently of major substation projects. The introduction of new voltage levels and phasing out of non-standard voltage levels were examined at this time. The recommendations considered to address the resulting limitations included load transfers, transformer refurbishment or replacement to increase capacity, installation of additional transformers and switchgear and the establishment of new substations.

The recommended projects which fell within the period from 2012 to 2022 were then examined in greater detail in the ten year plan. An options analysis was undertaken by comparing the technical and financial implications of the recommended option against several other feasible options. The project drivers were also examined in greater detail, with distribution network limitations such as feeder loading and reliability considered at this stage.

The five year plan focused on the distribution works required within the period from 2012 to 2017. An analysis of each of the existing and new substations was completed to determine feeder limitations in the five year period. The medium growth substation forecast provided by Aurora was combined with historical feeder loading data from 2009 to produce a five year forecast for all distribution feeders in the Aurora network. A number of projects were proposed which included works as part of the substation projects identified in the ten year plan and new projects based on the analysis of feeder loading. A brief justification for the new feeder projects has been included and DINIS studies were completed as applicable. A section has been included to discuss the ultimate configuration of the substation areas and the impact on the ultimate plan by any works completed in the five year period.

For each area, a report was compiled including the long term strategic plan, ten year plan and five year plan. An overarching summary document was compiled to highlight the important outcomes and recommendations from each area in the study.

1.3 Assumptions

A list of some of the general assumptions made for the study is outlined below.

- Direct connected customers were not included in the original load models. However, where the direct connected load affects the substation, an estimated block load has been incorporated into the substation load to determine the capacity limitation.
- The UES 2008 forecast has been used for all load models. The high and medium growth rates for smaller areas in the substation supply areas have been assumed based on existing feeder configuration, land availability, council plans for the area and information from Aurora on growth hot spots and point loads.
- Draft historical feeder loadings were used for the long term strategic and ten year plans. Revised feeder loadings were provided prior to the commencement of the five year plan and the new figures were incorporated to ensure feeder limitations were accurately determined.
- All committed proposed projects up to 2012 are assumed to be completed for this study
- The assumed substation limitation is load above firm capacity
- Transformer asset life as advised by Aurora is 40 years for zone substations and 45 years for terminal substations. For the purpose of this report, it is assumed that actual transformer life is extended by approximately 5 years due to the regular condition assessments and transformer loading under normal conditions.

- The four-hour emergency ratings for transformers is based on 1.2 x normal capacity. It has been assumed that remote switching can be completed within four hours.
- Substation general arrangements were not available during the study and it has been assumed that there is space for the proposed upgrades outlined in the long term strategic plan
- The long term strategy does not take into account individual distribution feeder capacity or voltage drop. This has been further reviewed in the five year plan.
- ESI regulations have been taken into consideration where applicable
- Basic costing was provided by Aurora and Transend and any additional assumptions made are shown in Appendix A
- An NPV analysis has been completed for each of the ten year proposed projects. It should be noted that a cost benefit analysis has not been undertaken
- Demand side initiatives have not been considered in this study. Any feasible demand side initiatives that are identified as part of a separate review will in some cases defer or alleviate identified capital expenditure. The focus of this review is to identify network constraints and determine appropriate network solutions.

2. Area background

The South planning area includes the Kingston area South of Hobart, Bruny Island and the Huon valley.

Figure 2-1 provides a geographic view of the area under study.

Figure 2-1 South planning area geographical view

South is considered a high growth area, recording growth rates of greater than 4% pa for the past three years. In particular, the coastal areas including the towns of Kingston, Blackmans Bay, Margate and Electrona are expected to continue to experience significant commercial and residential development.

The remainder of the planning area consists predominantly of light farming and forestry load.

2.1 Existing infrastructure

The substations within the South planning area are listed in Table 2-1.

Table 2-1 Terminal substations in the South planning area

Substation	Number of transformers	Transformer MVA	Transformer primary voltage	Transformer secondary voltage	Number of feeders
Electrona	2	25 MVA	110 kV	11 kV	7 distribution
Kermandie	2	10 MVA	110 kV	11 kV	4 distribution
Kingston	2	35 MVA	110 kV	11 kV	12 distribution
Knights Rd	2	20 MVA	110 kV	11 kV	6 distribution

As outlined above, distribution within this planning area is at 11 kV.

2.2 Council areas and restrictions

The South planning area includes the Kingborough and Huon valley councils.

Kingborough Council

The Kingborough Council has advised that land will continue to be released to the West of Kingston and Blackmans Bay, and around Margate, but will be mostly utilised by 2021. Further population increases are to be addressed by infill and higher density development. Medium and higher density development will focus on bus trunk routes.

Huon Valley Council

The predominant industries in the Huon Valley area are aquaculture and fishing, forestry, agriculture and tourism. The Huon Vale Council has expressed desire to contain growth to existing settlements.

2.3 Approved and proposed works

The following approved and proposed projects have been identified in the Aurora program of works. For the purpose of this report is assumed that these projects will be commissioned by 2012.

Kingston terminal substation 33 kV connection point and Browns Rd zone substation

The load on Kingston terminal substation currently exceeds its N-1 rating. A joint planning study between Aurora and Transend is in progress and is expected to recommend the installation of 2 x 110/33 kV transformers at Kingston terminal substation, as well as the establishment of a new Browns Rd zone substation by 2012.

The proposed works will deload the Kingston and Sandy Bay substations, and provide 11 kV transfer capacity between the Hobart-West and South planning areas.

Kingston area 11 kV reinforcement

This project reinforces the 11 kV network from Electrona substation to the Kingston urban area in order to defer the 33 kV connection point at Kingston terminal substation.

Knights Rd new 11 kV feeder

This project installs an additional 11 kV feeder from Knights Rd substation to deload the existing Knights Rd 11 kV network.

Knights Rd- Electron 110 kV transmission line replacement

The existing Knights Rd – Electrona 110 kV transmission line is 68 years old and is deemed to be at the end of its serviceable life. Transend are proposing to replace the existing line with a new line on new steel poles in 2011.

3. Load forecast

The South planning area has experienced growth above 4% per year for the past three years, and is considered one of the growth hotspots in the state. In particular, the coastal areas including the towns of Kingston, Blackmans Bay, Margate and Electrona are expected to continue to experience significant commercial and residential development.

The long term medium growth rate from the Aurora forecast is approximately 2.7% for the South planning area. Blanket load growth above this rate is considered unlikely, however higher growth is likely in certain areas.

The Kingborough and Huon valley councils have indicated that the majority of future growth will be through infill of existing settlements rather than the release of new land. The exception to this is land to be released to the west of Kingston, Blackmans Bay and Margate.

As a result, to produce a conservative load forecast high growth has been applied to these areas, with medium growth applied to the remainder of the planning area.

The resulting 40 year load forecast and firm ratings for substations of the South planning area are provided in Figure 3-1.

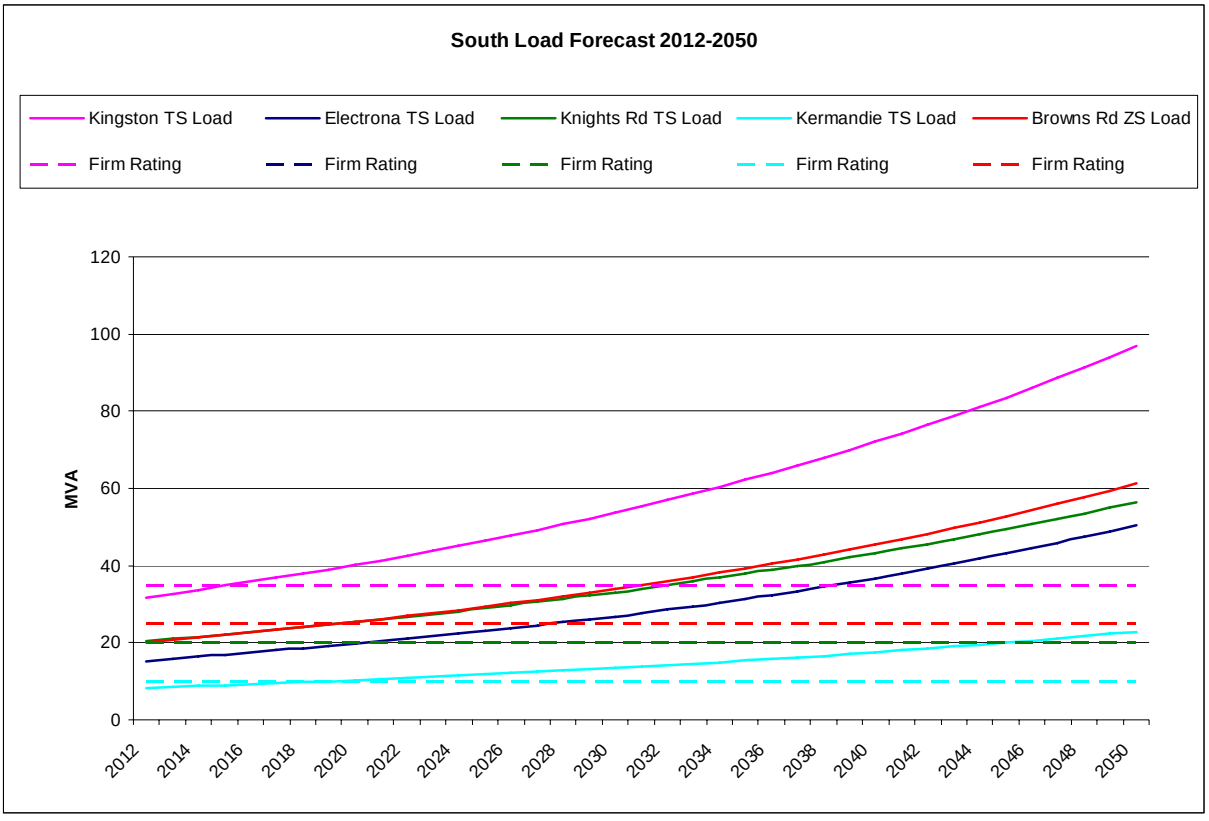

Figure 3-1 South existing load forecast 2012-2050

Figure 3-2 provides a geographic view of the resulting load distribution in 2012 and 2050.

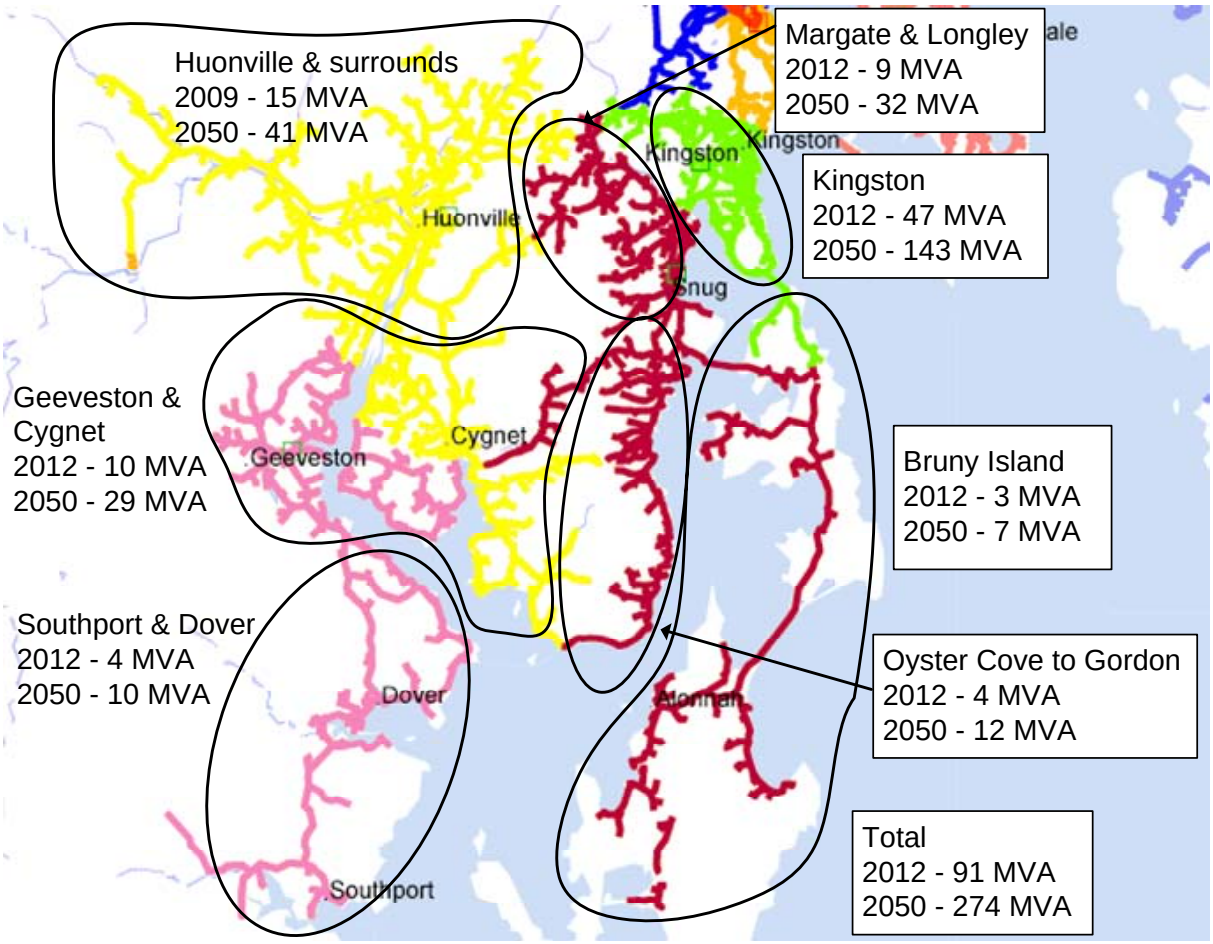

Figure 3-2 South geographic load forecast 2012-2050

4. Limitations

4.1 Electrona terminal substation

Electrona terminal substation is equipped with 2 x 25 MVA 110/11 kV transformers, providing a firm capacity of 25 MVA. The transformers at Electrona were installed in 2008.

The load at Electrona is forecast to exceed firm capacity in 2028.

4.2 Kingston terminal substation

Kingston terminal substation is equipped with 2 x 35 MVA 110/11 kV transformers, providing a firm capacity of 35 MVA. An additional 2 x 60 MVA 110/33 kV transformers are to be installed at Kingston in 2012.

The 11 kV load at Kingston is forecast to exceed firm capacity in 2016.

The 33 kV load at Kingston is not forecast to exceed firm capacity within the period of study.

The 110/11 kV transformers at Kingston were installed in 1980.

4.3 Knights Rd terminal substation

Knights Rd terminal substation is equipped with 2 x 20 MVA 110/11 kV transformers, providing a firm capacity of 20 MVA.

The load at Knights Rd terminal substation is forecast to exceed firm capacity in 2012.

The transformers at Knights Rd were installed in 1987.

4.4 Kermandie terminal substation

Kermandie terminal substation is equipped with 2 x 10 MVA 110/11 kV transformers, providing a firm capacity of 10 MVA. The transformers at Kermandie were installed in 1962. Transend have indicated that these are likely to be replaced in 2015 with 25 MVA units.

The load at Kermandie terminal substation is forecast to exceed firm capacity in 2019.

4.5 Browns Rd zone substation

Browns Rd zone substation is to be equipped with 2 x 25 MVA 33/11 kV transformers, providing a firm capacity of 25 MVA. The load at Browns Rd is forecast to exceed firm capacity in 2020.

4.6 Knights Rd – Kermandie 110 kV transmission line

The Knights Rd – Kermandie 110 kV transmission line has a winter rating of 53 MVA and supplies Kermandie terminal substation as well as the direct connection customer substation at Huon River. The combined load at Kermandie and Huon River is not forecast to exceed this rating within the period of study.

Taking supply from a single transmission this single transmission line exposes Kermandie to the risk of loss of supply in the event of a feeder fault, and makes maintenance or replacement of the line very difficult. However load at Kermandie is below the ESI 25 MW limit for requiring N-1 security in the Transend 110 kV network.

There is not sufficient transfer capacity to transfer load to adjacent substations in the event of a 110 kV feeder fault.

5. Planning philosophy

For the purposes of this study the planning area has been combined into a group of substations, with members of the group having significant transfer capacity amongst each other. The substations within the group are Kingston terminal substation and Browns Rd zone substation, with future zone substations in the Kingston area included as they are established. It is assumed that a capacity limitation occurs when the group load exceeds the sum of the firm capacities.

Aurora already plans to establish 33 kV injection at Kingston substation by 2012. Thus the obvious approach to network augmentation is to utilise the 110/33 kV capacity via additional 33/11 kV zone substations located in areas of high load density. Due to the limited 33 kV network in the area, and the distance from the neighbouring 33 kV injection points, the installation of 33 kV switchgear and meshed networks has not been proposed for the South planning area.

Consideration has been given to the replacement of ageing assets as efficiently as possible. For example, the Kermandie transformers are expected to require replacement within the next 10 years and it is cost effective to replace the transformers with higher capacity units to defer augmentation elsewhere in the network.

The design of 33 kV cables should be carefully considered with regard to the ultimate load to be supplied. XLPE cables generally have a short-time rating far in excess of the normal capacity (depending on cable installation and prior loading conditions). For example, an XLPE cable that is loaded at half its normal capacity can have a short-time rating of double its normal capacity. The time used in the short time rating would be chosen to allow operators and line crews sufficient time to respond, either by 33 kV switching or 11 kV load transfers to reduce load below the normal rating, and is typically several hours. This allows the 33 kV cables to be loaded well above their normal N-1 rating without risking any loss of load, provided that there is transfer capacity available to reduce load within the nominated short-time rating period following a feeder fault. In the case of multiple 33 kV circuits in a common trench, the cable rating with an adjacent circuit out of service can also be evaluated. This higher rating reduces the quantity of load that needs to be transferred after a feeder fault.

A similar approach can be taken with the rating of transformers. Aurora currently use transformer continuous ratings as the driver for capacity limitations, whereas the cyclical nature of substation load, particularly in predominantly domestic areas, means that significantly higher peak loads can usually be safely accommodated. It is also common practice to define a transformer emergency rating, a slightly higher load at which accelerated ageing of the transformer is possible but is considered an acceptable risk during contingencies. Balancing the accelerated ageing under contingency loading with the reduced ageing rate under normal loading will ensure that the expected service life of the transformer is achieved. As discussed above for 33 kV feeders, short-time transformer ratings may also be employed for transformers to allow time to implement load transfers during contingencies.

While capacitor banks have not been proposed in any particular project in this study, it is generally recommended that the installation of 11 kV capacitor banks at Aurora zone substations be investigated. This would defer substation capacity limitations, while reducing losses in the upstream network and improving the power factor at the substation.

6. Long term strategy

The establishment of Kingston 33 kV injection and Browns Rd zone substation by 2012 addresses the existing limitations in the Kingston area for several years, with the next stage of augmentation, Blackmans Bay zone substation, not required until 2017. This is followed by another zone substation in the Margate area in 2034 and third transformers at Browns Rd and Blackmans Bay in 2040 and 2046 respectively. The existing Kingston 110/11 kV transformer reach their end of life in 2030 and are replaced with higher capacity units at this time, and a third transformer is required at the Kingston 33 kV injection point in 2036.

In the Knights Rd and Kermandie supply area, the replacement of the ageing Kermandie transformers in 2015 allows the Knights Rd capacity limitation to be deferred until 2024, at which time the Knights Rd 110/11 kV transformers reach end of life and are replaced. This addresses all substation limitations in the area until 2040 when load at Kermandie exceeds firm capacity, and load on the Knights Rd-Kermandie 110 kV transmission line exceeds 25 MVA. At this point 110 kV network augmentation is required to meet the ESI 25 MW regulation and augmentation is required at Kermandie to increase firm capacity.

While it is not expected to be required by 2050, the establishment of 33 kV injection at Electrona substation is considered a reasonable future development. This would allow Electrona to supply Margate, thus deloading Kingston, as well as potential future zone substations to the south and north-west of Electrona. Similarly, terminal substations in the vicinity of existing 110 kV lines around Franklin and Longley may be reasonable developments beyond 2050.

The proposed projects for the long term strategy are detailed below.

It should be noted that the projects proposed in this section will require further detailed analysis to confirm their economic and technical feasibility. A regulatory investment test will also be required for those projects where the augmentation component exceeds $1 M (RIT-D) or $5 M (RIT-T).

6.1 Proposed projects

6.1.1 Upgrade Kermandie terminal substation

Load on Kermandie substation is forecast to exceed firm capacity in 2019 and to reach 23 MVA by 2050. The Kermandie transformers are 47 years old and have been recommended for replacement in 2015.

Therefore it is recommended that the existing 2 x 10 MVA transformers be upgraded to 2 x 25 MVA units in 2015. It is also proposed that the Kermandie substation supply area be extended to supply the entire Geeveston and Cygnet area shown in Figure 2-1. This allows Kermandie to deload Knights Rd, which defers the Knights Rd capacity limitation by 10 years. It is likely that 11 kV feeder reinforcement from Kermandie will be required to implement the load transfers, but this is expected to be significantly lower cost than the alternative.

Kermandie substation is forecast to exceed firm capacity again in 2040. To address this limitation it is proposed that the 25 MVA transformers be replaced with 60 MVA units. At this time the second 110 kV Knights Rd-Kermandie transmission line could be justified for N-1 security at Kermandie, as the load will be greater than 25 MVA. The existing towers are double circuit construction which will aid in the construction of the second circuit.

6.1.2 Establish Blackmans Bay zone substation

Kingston terminal substation is forecast to exceed firm capacity in 2017.

Therefore it is recommended that a new zone substation be established in the Blackmans Bay area to deload Kingston in 2017.

Blackmans Bay zone substation will consist of 2 x 25 MVA 33/11 kV transformers, fed from 2 x 33 kV feeders from Kingston 33 kV substation.

It would also be possible to address this limitation by upgrading the existing 2 x 35 MVA transformers at Kingston with 60 MVA units. However this solution would require significant 11 kV reinforcement out of Kingston towards Blackmans Bay, and would also not be efficiently utilising the existing transformers which are nominally end of life in 2030.

6.1.3 Upgrade Knights Rd terminal substation

Load on Knights Rd substation is forecast to exceed firm capacity in 2012 and to reach 56 MVA by 2050.

The Knights Rd transformers are only 22 years old, so to get the maximum utilisation from the existing assets it is preferred that any transformer replacement be deferred as far as possible by transferring load to adjacent substations. This can be accomplished through the transfer of load to Kermandie substation, after its upgrade in 2015. In the years between the Knights Rd overload in 2012 and the Kermandie upgrade in 2015, the limitation at Knights Rd can be accepted, since load remains below the substation cyclic capacity.

To address the subsequent capacity limitation at Knights Rd it is recommended that the existing 2 x 20 MVA transformers be upgraded to 2 x 25 MVA units in 2024. It is also proposed that Knights Rd substation supply area be extended to the east towards Margate, to address capacity limitations at Electrona substation. This has been approximated as a 3 MVA transfer in 2024, however in reality the transfer could be smaller or larger depending on load growth at Electrona substation. It is likely that 11 kV feeder reinforcement from Knights Rd will be required at that time to transfer load from Electrona, but this is expected to be offset by the deferral of the Electrona substation upgrade or an additional zone substation.

6.1.4 Upgrade Kingston terminal substation

The 110/11 kV transformers at Kingston terminal substation are predicted to reach end of life in approximately 2030. The group load on Kingston, Blackmans Bay and Browns Rd is forecast to exceed group firm capacity at approximately the same time.

Therefore it is recommended that the existing 35 MVA units be replaced with 2 x 60 MVA transformers in 2030. The transformers should be installed on the block adjacent to the existing substation site, allowing space for the subsequent installation of a third 110/33 kV transformer on the existing site.

An alternative option would be to establish a new Kingston zone substation on a nearby block, allowing space on the existing site for the installation of the third 110/33 kV transformer. This option also has the benefit that Aurora would have control over the 11 kV injection at Kingston, simplifying the operation of the network and the establishment of future 11 kV feeders. However this option has not been recommended for the following reasons:

- It would bring forward the installation of the third 110/33 kV transformer at Kingston
- The load on the Kingston, Browns Rd and Blackmans Bay substations are all forecast to be close to firm capacity in 2030. Replacing the existing 35 MVA transformers at Kingston with 25 MVA units would result in a deficit in firm capacity, which would require an additional zone substation establishment or upgrade to address
- It is likely to be a more costly option than a simple transformer replacement

Therefore, unless there are significant costs involved in fitting the three 110/33 kV and two 110/11 kV transformers on the existing site, the 110/11 kV transformers are recommended over the 33/11 kV option.

6.1.5 Establish Margate zone substation

Electrona is forecast to exceed firm capacity in 2034, following the load transfers to Knights Rd.

To address this limitation it is proposed that a zone substation be established in the Margate area to deload Electrona. Margate zone substation will consist of 2 x 25 MVA 33/11 kV transformers, fed from 2 x 33 kV feeders from Kingston 33 kV substation.

Kermandie substation is forecast to exceed firm capacity in the same year, however this limitation may be deferred by several years through load transfers to Electrona after the establishment of Margate. It is likely that 11 kV feeder reinforcement from Electrona will be required at that time to transfer load from Kermandie, but this is expected to be offset by the deferral of the Kermandie upgrade, especially considering the 110 kV reinforcement required as part of that project.

6.1.6 Upgrade Kingston terminal-33kV substation

Kingston terminal 33 kV substation is forecast to exceed firm capacity with the installation of Margate zone substation in 2034, however it is expected that this limitation could be deferred for several years by load transfers from zone substations to Kingston terminal substation.

Therefore it is proposed that an additional 60 MVA 110/33 kV transformer be installed at Kingston in 2036.

6.1.7 Upgrade Browns Rd and Blackmans Bay substations

The group load of Kingston terminal substation and Browns Rd, Blackmans Bay and Margate zone substations is forecast to exceed firm capacity in approximately 2040. The addition of approximately 50 MVA of firm capacity is required in the Kingston area by 2050 to address the forecast load.

To address this limitation it is proposed that a new 25 MVA 33/11 kV transformer be installed at the existing Browns Rd and Blackmans Bay substations, supplied from a new 33 kV feeders from Kingston 33 kV substation.

The upgrades would be required in 2040 and 2046 and the order of the projects would depend on the load development in the respective supply areas.

A new zone substation in the Kingston area would also be a potential solution, however given that the load in the area is quite dense and the existing substations are located in close proximity to each other, it is expected that the upgrade of an existing zone with 11 kV reinforcement would be a lower cost option. Should the new zone substation be justified, it may be possible to install 33 kV switchgear at Browns Rd and Blackmans Bay and supply the new zone by installing a single 33 kV cable from each.

6.2 Summary of proposed works

A summary of the proposed works from 2012 to 2050 in the South planning area is outlined in Table 6-1.

Table 6-1 South project summary

Year	Proposed Project	Proposed Outcomes
2015	Upgrade Kermandie terminal substation	Replace ageing 110/11 kV transformers and increase firm capacity at Kermandie. Load transfers defer capacity limitation at Knights Rd
2017	Establish Blackmans Bay zone substation	Deload Kingston terminal substation
2024	Upgrade Knights Rd terminal substation	Increase firm capacity at Knights Rd. Load transfers from Electrona to Knights Rd to defer Electrona capacity limitation
2030	Upgrade Kingston terminal substation	Replace ageing 110/11 kV transformers and increase firm capacity at Kingston.
2034	Establish Margate zone substation	Deload Electrona and Kermandie substations
2036	Upgrade Kingston Terminal-33kV substation	Increase the capacity of Kingston terminal-33kV substation
2040	Upgrade Kermandie substation and second 110 kV Knights Rd – Kermandie transmission line	Increase firm capacity at Kermandie and provide N-1 on transmission lines
2040	Upgrade Browns Rd zone substation	Increase group firm capacity
2046	Upgrade Blackmans Bay zone substation	Increase group firm capacity

The resulting load forecast curves are given in Figure 6-1 and Figure 6-2.

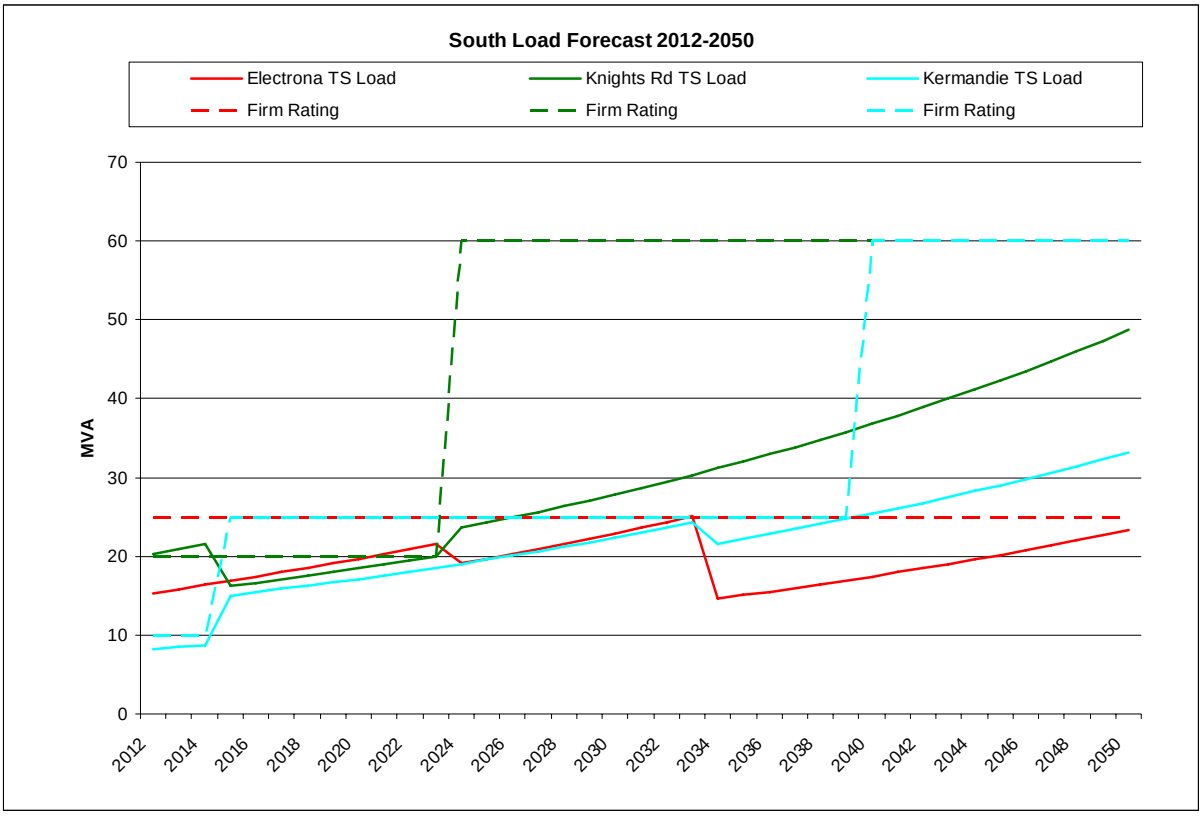

Figure 6-1 South proposed terminal substation load forecast 2012-2050

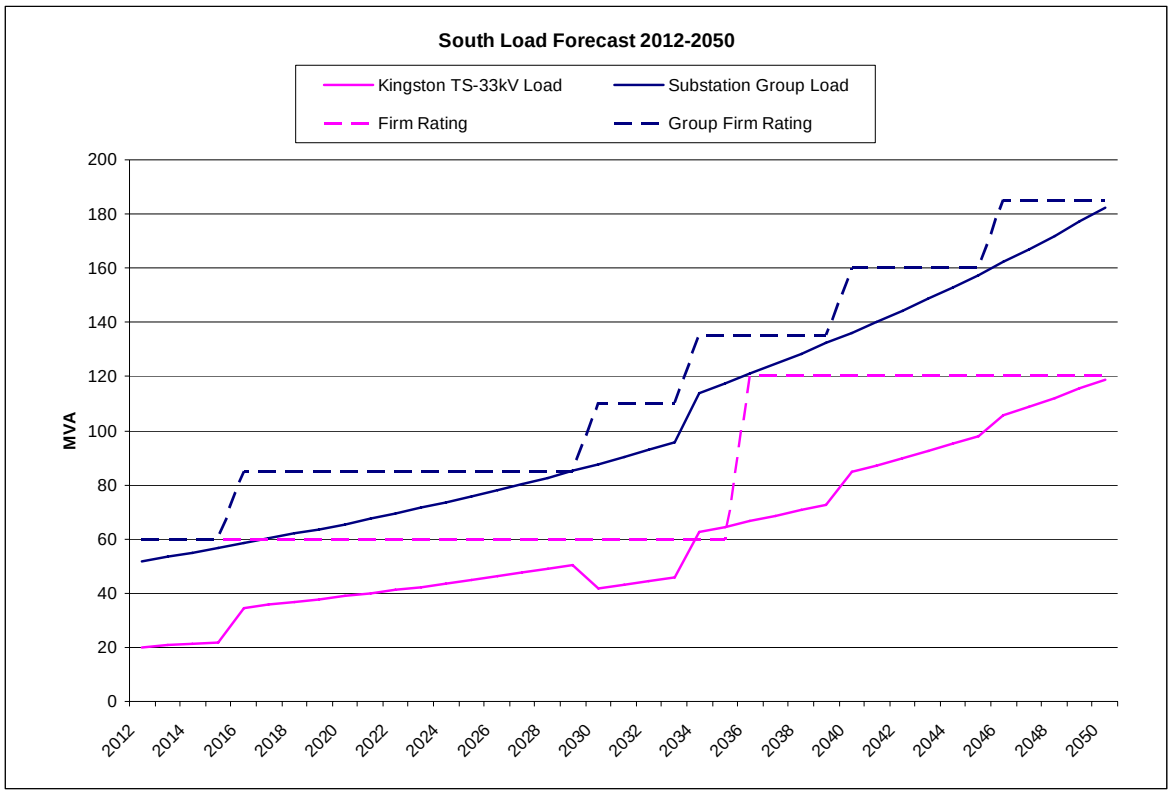

Figure 6-2 South proposed substation group load forecast 2012-2050

7. Ten year plan

The ten year plan for the South planning area recommends the establishment of a new zone substation at Blackmans Bay in order to deload Kingston and Browns Rd substations and address 11 kV feeder capacity issues in the Kingston area.

The plan also recommends the replacement of ageing transformers at Kermandie, with 11 kV reinforcement to transfer load from Knights Rd to Kermandie to defer firm capacity limitations at Knights Rd.

It should be noted that while each proposed project has undergone a thorough high level analysis, these projects will require further detailed analysis to confirm their economic and technical feasibility. A regulatory investment test will also be required for those projects where the augmentation component exceeds $1 million (RIT-D) or $5 million (RIT-T).

7.1 Proposed projects

7.1.1 Upgrade Kermandie terminal substation

Limitations

Kermandie terminal substation is equipped with 2 x 10 MVA 110/11 kV transformers providing a firm capacity of 10 MVA. The transformers at Kermandie were installed in 1962 and Transend have indicated in their APR that these need to be replaced as soon as possible, with an estimated commissioning date of June 2015.

Knights Rd terminal substation is equipped with 2 x 20 MVA 110/11 kV transformers providing a firm capacity of 20 MVA. The transformers at Knights Rd were installed in 1987 which implies a nominal end of life in 2037.

The ten year load forecast for Kermandie and Knights Rd terminal substations are outlined in Figure 7-1.

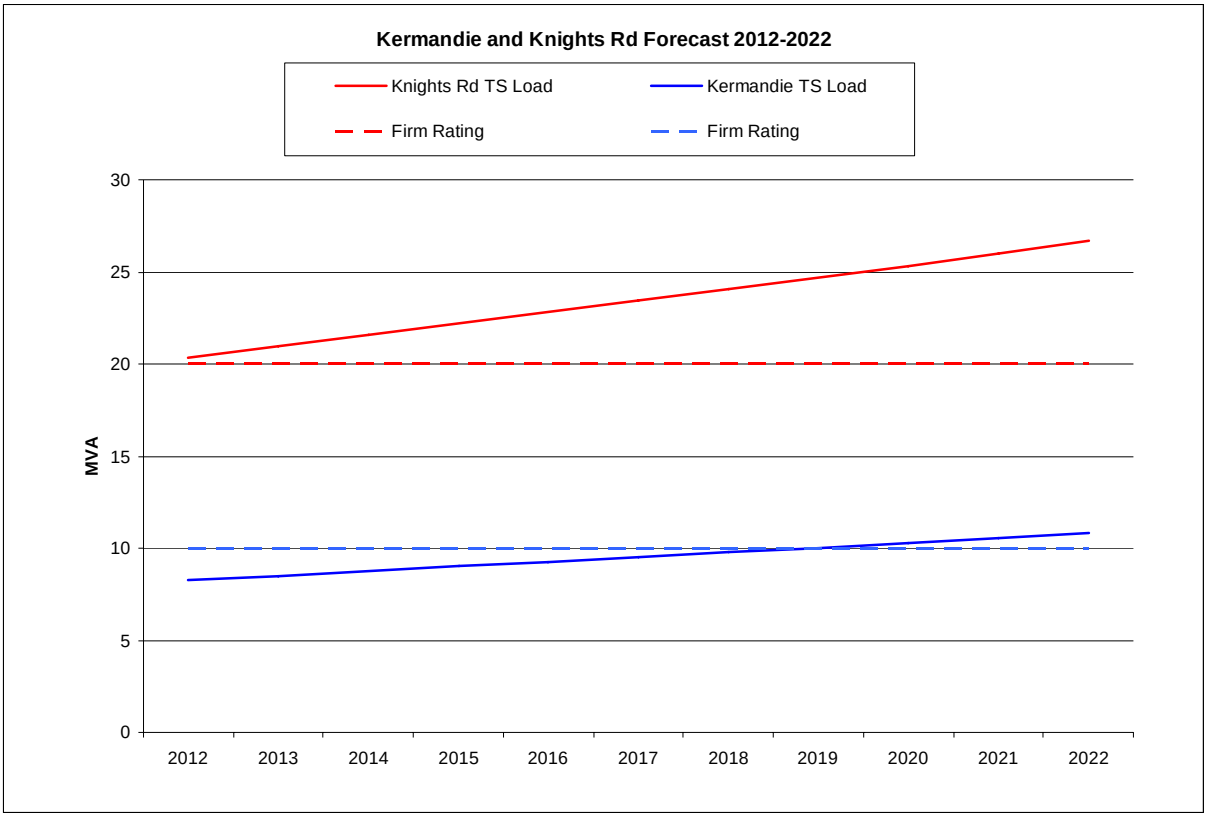

Figure 7-1 Kermandie and Knights Rd existing load forecast 2012-2022

As outlined above, the load at Knights Rd is forecast to exceed firm capacity in 2012 and the load at Kermandie is forecast to exceed firm capacity in 2019.

Option 1 (recommended option) – Upgrade Kermandie terminal substation and transfer load from Knights Rd

This option involves the replacement of the existing 110/11 kV transformers at Kermandie with new 25 MVA units in 2015, with 11 kV load transfers from Knights Rd to Kermandie to deload Knights Rd deferring the firm capacity limitation at Knights Rd until 2024.

Augmentation of the Kermandie 11 kV network, including an additional Huon River crossing, will be required to fully implement these transfers.

The predominant cost of this project is expected to be the transformer replacement component, which is considered a refurbishment cost since it proposes the like-for-like replacement of an ageing asset. The augmentation component of the project does not exceed $5M so a RIT is not required.

Option 2 – Upgrade Kermandie and Knights Rd terminal substations

This option involves the replacement on transformers at both Kermandie and Knights Rd terminal substations with 25 MVA units. This option avoids the 11 kV augmentation required under option 1 to transfer load from Knights Rd to Kermandie.

Option 3 – Establish Franklin terminal substation and upgrade Kermandie terminal substation

This option involves the establishment of a new terminal substation in the vicinity of Franklin (equidistant from Kermandie and Knights Rd substations) to deload Kermandie and Knights Rd substations. The substation would be supplied from the existing 110 kV Knights Rd-Kermandie single circuit.

This option would also require the replacement of the ageing transformers at Kermandie substation in 2015, however they could be replaced with 10 MVA units (i.e. standard transformers without pumps/fans) as opposed to the 25 MVA units required under the other options.

This option would bring forward 110 kV reinforcement to Kermandie, since load would be transferred from Knights Rd to Franklin substation, increasing load on the single circuit from Knights Rd and bringing forward the 25 MW limitation on this feeder.

Technical comparison

Table 7-1 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Upgrade Kermandie terminal substation and transfer load from Knights Rd	• Increases firm capacity at Kermandie by 15 MVA • Optimally utilises existing assets • Better balances the Kermandie and Knights Rd supply areas	• Increases load on the radial 110 kV feeder from Knights Rd to Kermandie
2	Upgrade Kermandie and Knights Rd terminal substations	• Increases firm capacity at Kermandie by 15 MVA and at Knights Rd by 5 MVA	• Fails to fully utilise existing Knights Rd transformers (25 years life remaining)
3	Establish Franklin terminal substation and upgrade Kermandie terminal substation	• Increases firm capacity in the Kermandie and Knights Rd area by 40 MVA. • Results in shortest 11 kV feeders and hence best reliability of all options	• Increases load on the radial 110 kV feeder from Knights Rd to Kermandie, bringing forward 110 kV reinforcement • Substation location not ideal to supply ultimate load • Requires purchase and establishment of a new site

The above technical comparison of options indicates that option 1 provides the best technical solution.

Cost comparison

Table 7-2 Cost comparison of options

Option	Initial Capital Cost	Total Capital Cost	Net Present Value
1	6.2	12.2	6.9
2	11.0	11.0	8.0
3	23.5	29.5	18.1

The above cost comparison of options indicates that option 1 provides the lowest cost solution. Details of the NPV analysis are given in Appendix B.

Recommended option

Based on the technical and cost comparison, option 1 is considered the preferred option to address the forecast limitations.

The Transend scope of works includes:

- Recovery of the existing 2 x 10 MVA 110/11 kV transformers
- Installation of 2 x 25 MVA 110/11 kV transformers
- Connection of new feeder tail to spare 11 kV CB at Kermandie

The Aurora scope of works includes:

- Network switching such that approximately 2 MVA is transferred from 30605 to 31010
- Network switching such that the 31002 supplies the long section of 30607 to Deep Bay and Charlotte's Cover (approximately 2 MVA). This will require the installation of a new voltage regulator on 31002 in the vicinity of Lymington Rd.
- Run a new 11 kV feeder tail from Kermandie to the Huon River along the same route as 31002 (approximately 2 km overhead)
- Install a new sub-marine cable along side the existing 31002 cable (approximately 1 km) and connect to 31002
- Network switching such that the new feeder takes load from 30606 (approximately 2 MVA)

As a result, approximately 6 MVA is transferred from Knights Rd to Kermandie.

It should be noted that the switching operations described above are expected to achieve approximately 4 MVA of load transferred from Knights Rd to Kermandie. Depending on the load growth at Knights Rd, this may be enough to reduce load below firm capacity with out any feeder works (apart from the regulator). The new feeder would then be deferred until justified by the load at Knights Rd. This should be re-evaluated closer to the date.

The resulting load forecast is given in Figure 7-2.

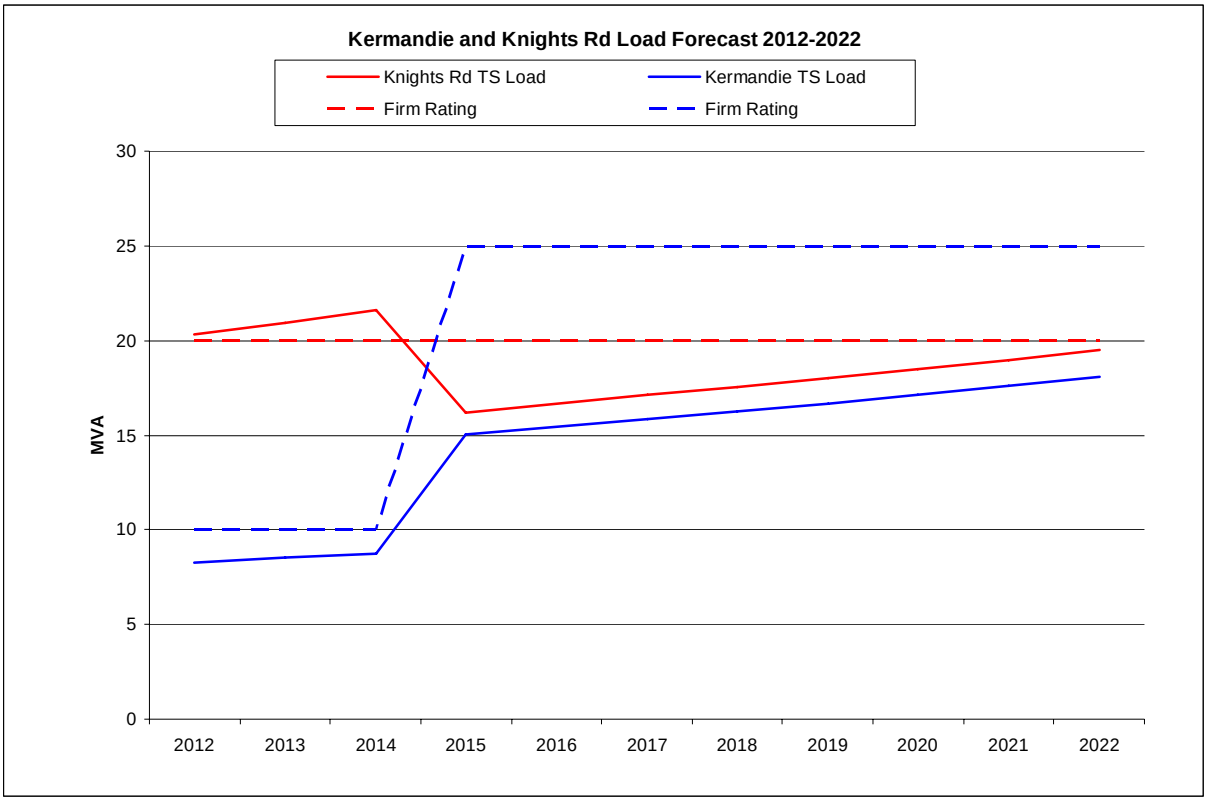

Figure 7-2 Kermandie and Knights Rd proposed load forecast 2012-2022

As outlined above, the load on Knights Rd substation exceeds firm capacity from 2012 until completion of the project in 2015. However, as the load at Knights Rd does not exceed the cyclic rating of the transformers, this is considered to be acceptable. Following the proposed works, Knights Rd substation is below firm capacity for the period of study.

A geographic diagram of the proposed works is shown in Figure 7-3.

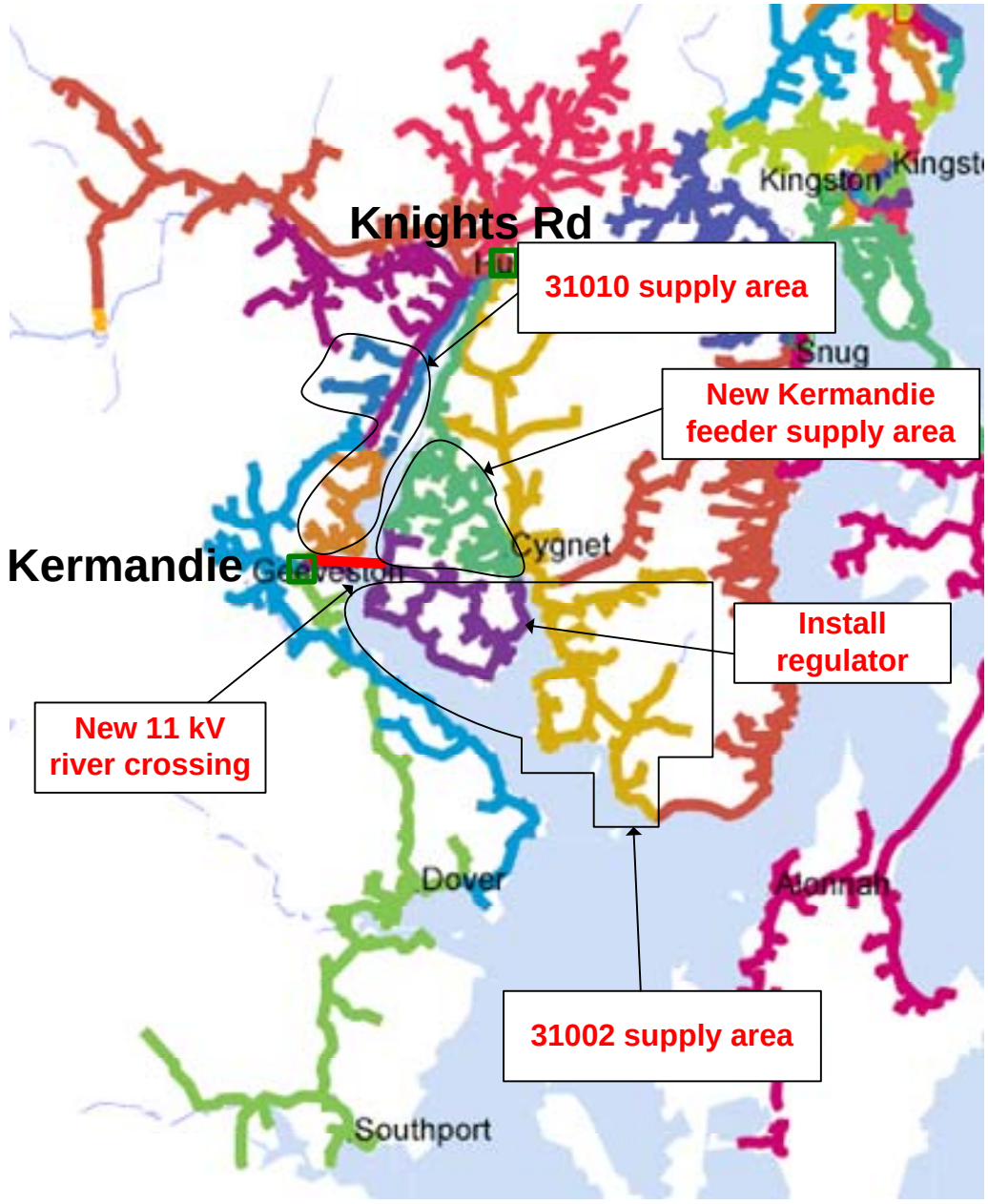

Figure 7-3 Proposed geographic network diagram

7.1.2 Establish Blackmans Bay zone substation

Limitations

Kingston terminal substation is equipped with 2 x 35 MVA 110/11 kV transformers providing a firm capacity of 35 MVA. The transformers at Kingston were installed in 1980 which implies a nominal end of life in 2030.

A geographical network diagram (following the establishment of the 33 kV injection at Kingston and new zone substation at Browns Rd) of the area of study is shown in Figure 7-4.

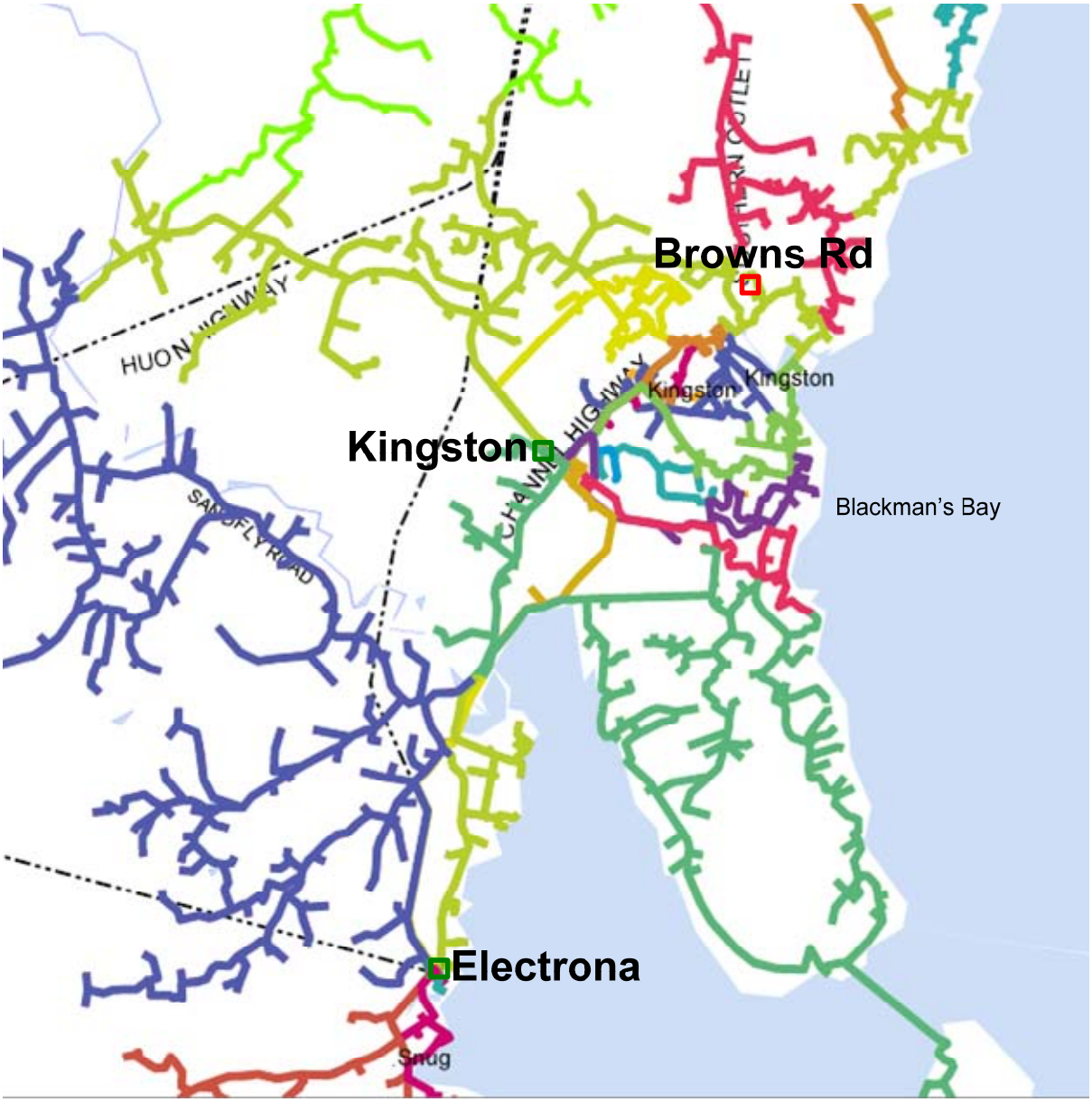

Figure 7-4 Kingston area existing geographic network diagram

As outlined above, the establishment of Browns Rd zone substation in 2012 provides Kingston terminal substation with support from the north, however both of these substations supply into the dense urban load from the outskirts of the town. It is expected that an injection point or significant 11 kV augmentation will ultimately be required to service the load to the south of Kingston in the Blackmans Bay area.

The existing limitations on the Kingston 11 kV feeders which supply to the Blackmans Bay and Bruny Island areas will be addressed by a new feeder from Electrona substation in 2009/10, and by the establishment of Browns Rd in 2012. However load growth in the network is expected to justify additional 11 kV injection in 2017.

The ten year load forecast for Kingston terminal substation and Browns Rd zone substation is outlined in Figure 7-5.

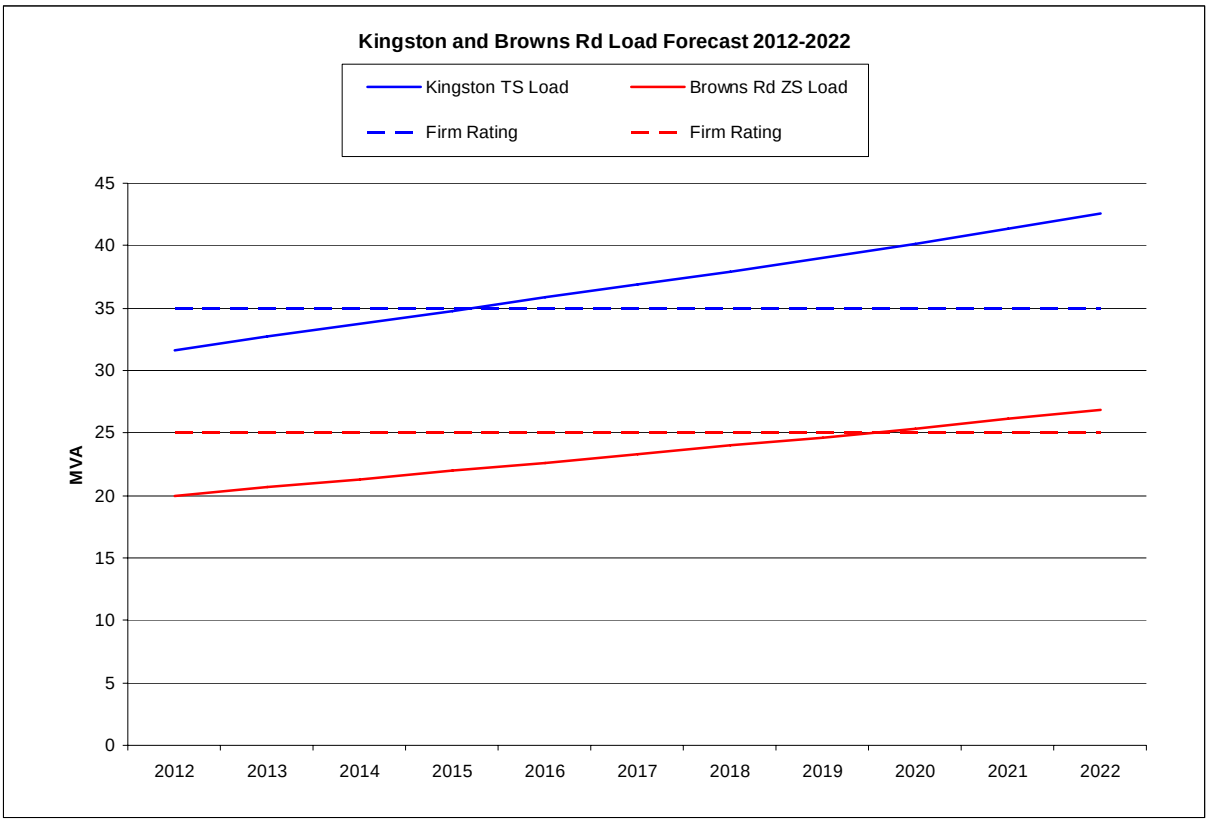

Figure 7-5 Kingston and Browns Rd existing load forecast 2012-2022

As outlined above, the load at Kingston is forecast to exceed firm capacity in 2016. It is possible that this limitation could be deferred by load transfers to adjacent substations. However the combined load of Kingston and Browns Rd substations is forecast to exceed the combined firm capacity in 2017, which implies that additional firm capacity will be required in the area at this time.

As also outlined above, the load at Browns Rd zone substation is forecast to exceed firm capacity in 2020.

Option 1 (recommended option) – Establish Blackmans Bay zone substation

This option involves the establishment of a new zone substation in the Blackmans Bay area supplied by 2 x 33 kV cables from Kingston terminal substation in 2017.

Blackmans Bay zone substation will consist of 2 x 25 MVA 33/11 kV transformers and two sections of 11 kV switchgear. The substation will be supplied transformer-ended from 33 kV cables from Kingston (approximately 4 km).

The 11 kV network would be reconfigured with minimal augmentation so as to deload the existing Kingston and Browns Rd 11 kV feeders. Kingston feeder 34251 would be split by a new cable tail from Blackmans Bay, providing improved reliability to Bruny Island and addressing the capacity limitations on 34251 and 34252.

Option 2 – Upgrade Kingston terminal substation

This option involves the replacement of the existing 2 x 35 MVA transformers at Kingston terminal substation with 60 MVA units in 2017.

This option would also require significant 11 kV reinforcement into the Kingston and Blackmans Bay areas to address the feeder limitations.

Option 3 – Install 3rd transformer at Browns Rd

This option involves the installation of an additional 33/11 kV 25 MVA transformer at Browns Rd zone substation, supplied by a new 33 kV feeder from Kingston substation (approximately 5 km) in 2017.

This option would also require significant 11 kV reinforcement into the Kingston and Blackmans Bay areas to address the feeder limitations.

Technical comparison

Table 7-3 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Establish Blackmans Bay zone substation	Increases group firm capacity by 25 MVA Results in shortest 11 kV feeders and hence best reliability of all options Optimally utilises existing assets	Increases load on Kingston substation and advances firm capacity limitation Requires purchase and establishment of a new site
2	Upgrade Kingston terminal substation	Increases group firm capacity by 25 MVA	Fails to fully utilise existing Kingston transformers (15 years life remaining) Difficulty getting additional 11 kV feeders out of Kingston due to congestion Requires significant 11 kV reinforcement to Kingston/Blackmans Bay Substation location not ideal to supply ultimate load
3	Install 3rd transformer at Browns Rd	Increases group firm capacity by 25 MVA	Difficulty getting additional 11 kV feeders out of Browns Rd due to congestion Requires significant 11 kV reinforcement to Kingston/Blackmans Bay Substation location not ideal to supply ultimate load

The above technical comparison of options indicates that option 1 provides the best technical solution.

Cost comparison

Table 7-4 Cost comparison of options

Option	Initial Capital Cost	Total Capital Cost	Net Present Value
1	12.6	18.1	9.6
2	10.5	28.1	12.4
3	11.3	21.8	11.7

The above cost comparison of options indicates that option 1 provides the lowest cost solution. Details of the NPV analysis are given in Appendix B.

Recommended option

Based on the technical and cost comparison, option 1 is considered the preferred option to address the forecast limitations.

The Transend scope of works includes:

- Termination of new 33 kV feeders to spare 33 kV CBs at Kingston terminal substation

The Aurora scope of works includes:

- Establishment of a zone substation site at Blackmans Bay
- Installation of 2 x 25 MVA 33/11 kV transformers
- Installation of two sections of 11 kV switchgear, with two transformer CBs, twelve feeder CBs and a bus section CB inside a new switchgear building
- Installation of an underground 33 kV double circuit from Kingston to Blackmans Bay (approximately 5 km)
- 11 kV feeder works to split existing Kingston and Browns Rd feeders

The resulting load forecast is given in Figure 7-6.

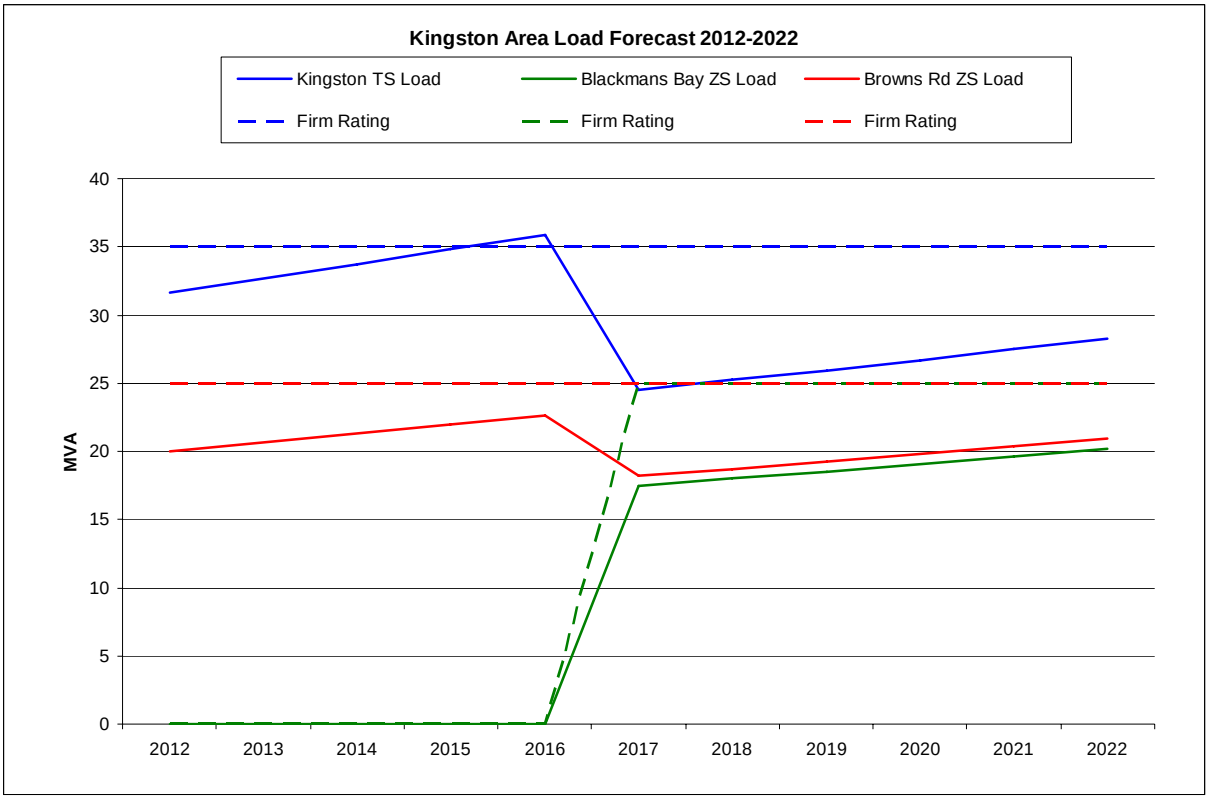

Figure 7-6 Kingston area proposed load forecast 2012-2022

As outlined above, the proposed works deload Kingston and Browns Rd substations to below firm capacity for the period of study.

A geographic diagram of the proposed works is shown in **Error! Reference source not found.**.

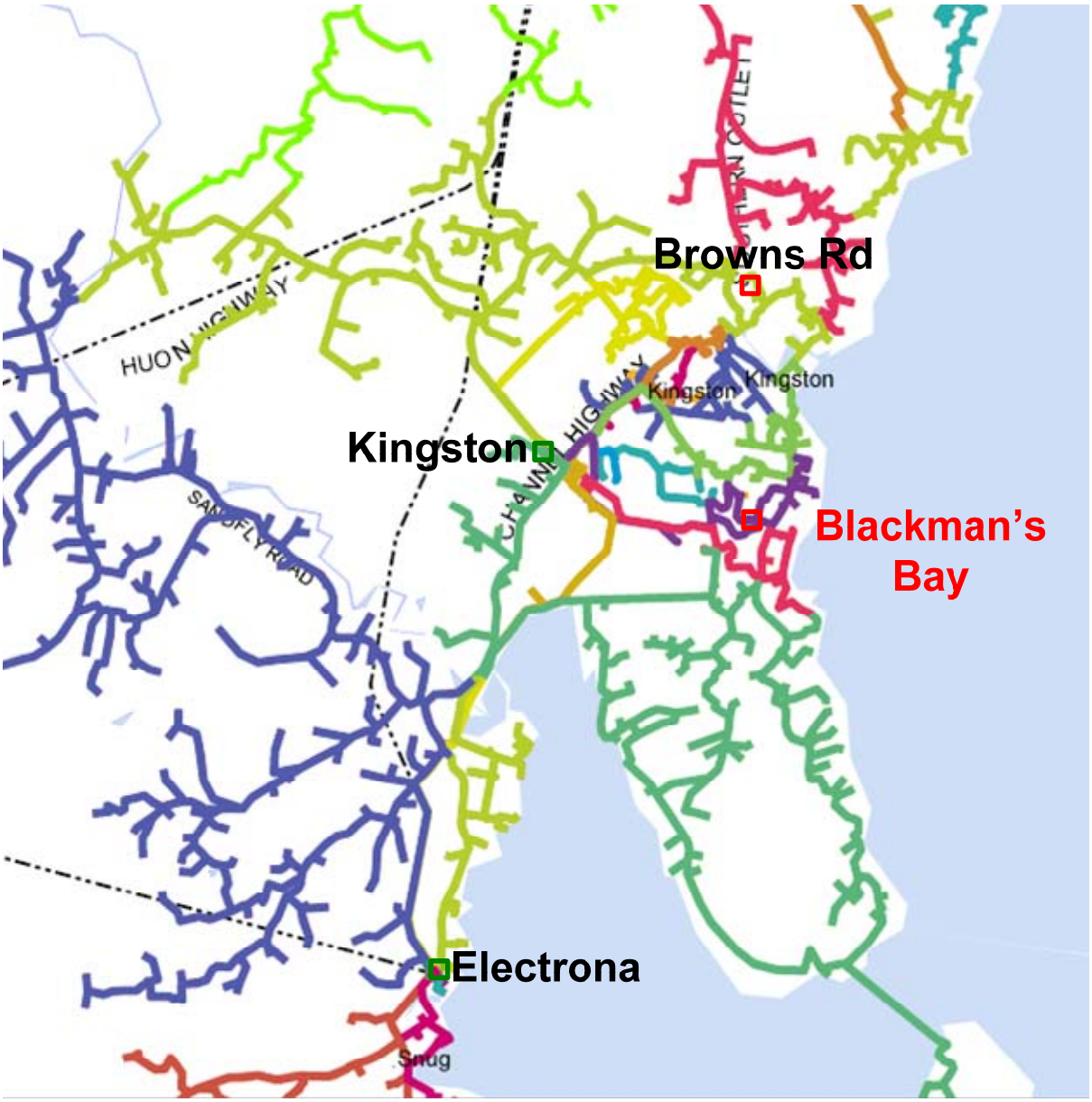

Figure 7-7 Kingston area proposed geographic network diagram

7.2 Summary of proposed works

The proposed works from 2012 to 2022 in the South planning area are listed in Table 6-1.

Table 7-5 South project summary

Year	Proposed Project	Proposed Outcomes
2015	Upgrade Kermandie terminal substation	Replace ageing 110/11 kV transformers and increase firm capacity at Kermandie. Load transfers defer capacity limitation at Knights Rd
2017	Establish Blackmans Bay zone substation	Deload Kingston terminal substation

8. Five year plan

A five year plan for each of the substations (including proposed new substations) in the South area is outlined below.

It should be noted that while each proposed project has undergone a thorough high level analysis, these projects will require further detailed analysis to confirm their economic and technical feasibility. A regulatory investment test will also be required for those projects where the augmentation component exceeds $1 M (RIT-D) or $5 M (RIT-T).

8.1 Kingston substation

Kingston terminal substation currently provides 11 kV supply to the towns of Kingston, Blackmans Bay, and Leslie Vale.

A 33 kV injection point is to be established at the existing Kingston site in 2012, and will supply the new Browns Rd zone substation.

8.1.1 Limitations

Using the medium growth forecast, the Kingston substation 11 kV load is forecast to grow from 31 MVA in 2012 to 36 MVA in 2017 (assuming establishment of Kingston 33 kV injection and Browns Rd zone substation by 2012), in excess of the firm capacity of 35 MVA. The resulting load forecast is given in Figure 8-1.

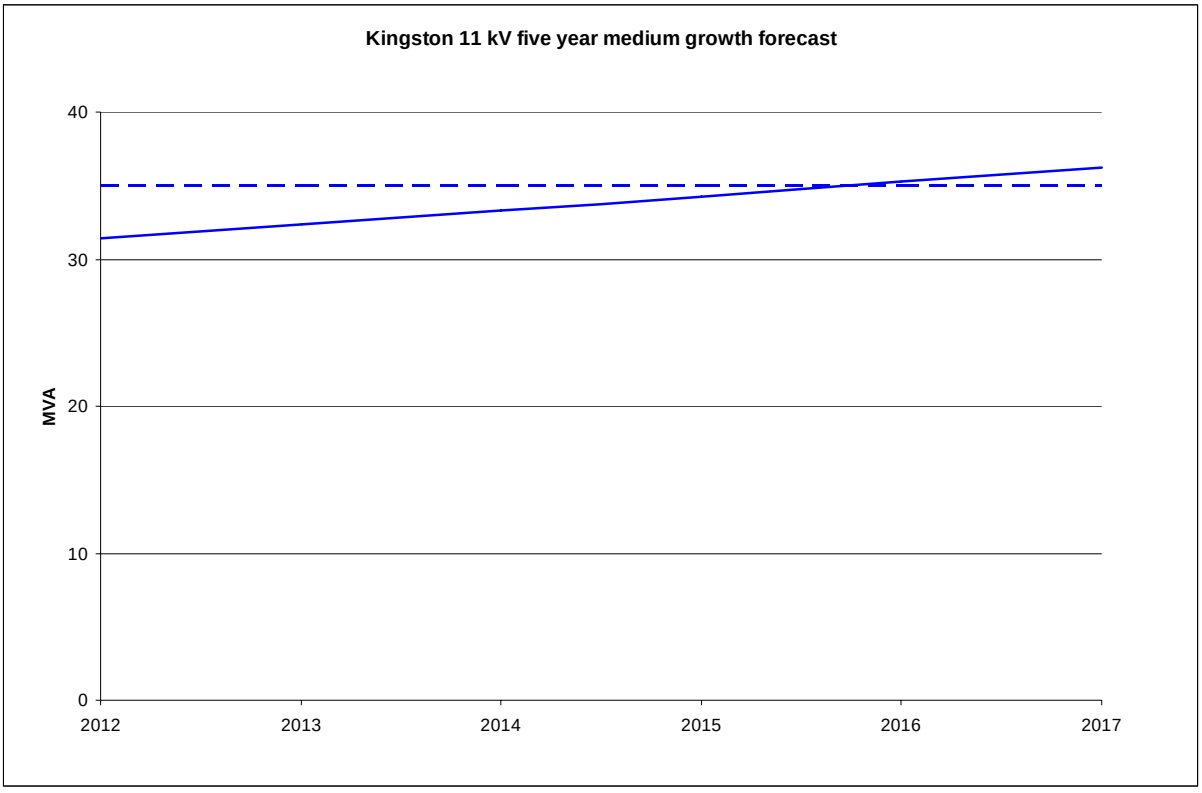

Figure 8-1 Kingston 11 kV five year medium growth forecast

Using the medium growth forecast, the Kingston substation 33 kV load is forecast to grow from 20 MVA in 2012 to 23 MVA in 2017, well below the firm capacity of 60 MVA. The resulting load forecast is given in Figure 8-2.

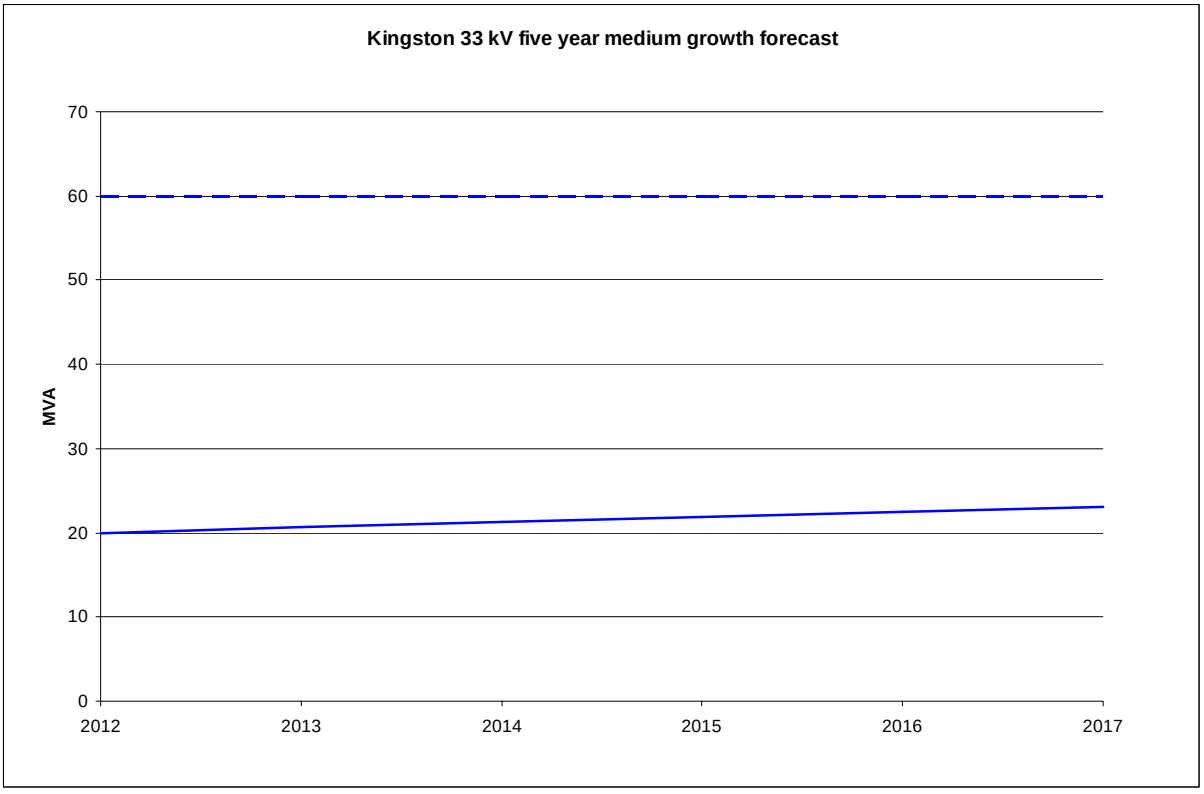

Figure 8-2 Kingston 33 kV five year medium growth forecast

The 11 kV network from Kingston consists of twelve distribution feeders, with no spare circuit breakers available for future feeders. The Kingston supply area and individual feeders are shown in Figure 8-3 and Figure 8-4 below.

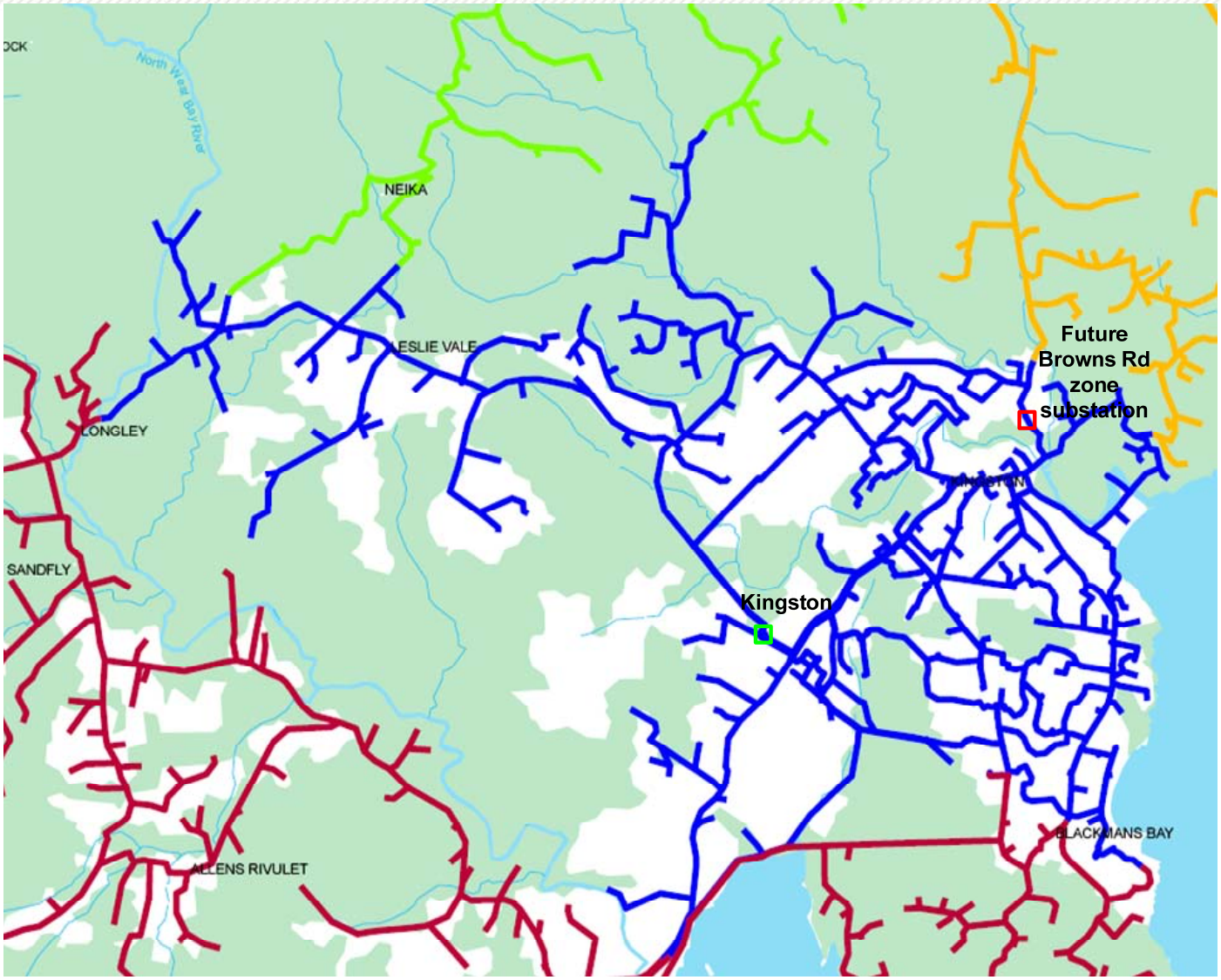

Figure 8-3 Kingston 11 kV supply area

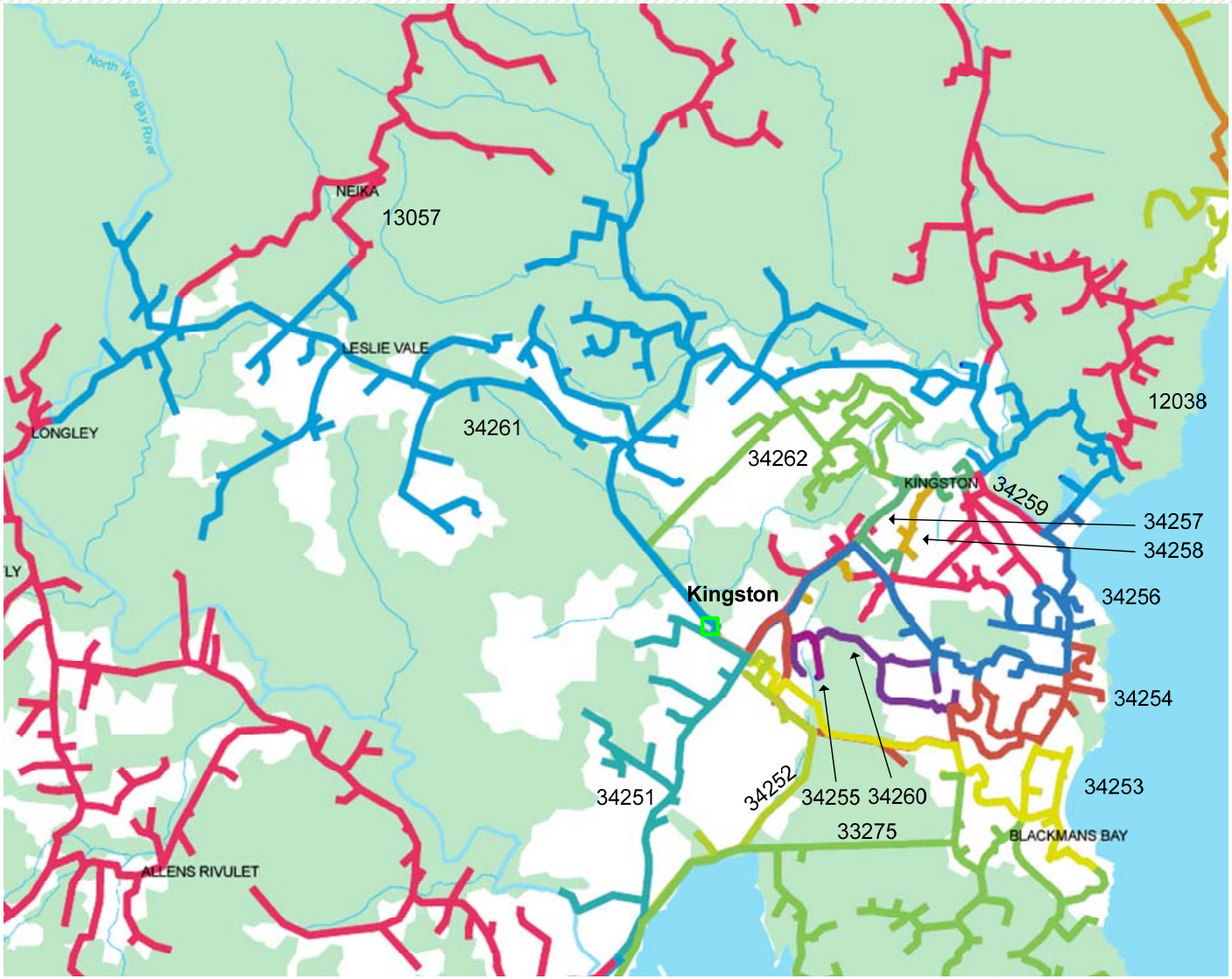

Figure 8-4 Kingston 11 kV feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the feeder peak loads. The feeder forecast is outlined in Table 8-1. It should be noted that these loads do not take into account the establishment of Browns Rd zone substation since feeder configuration has not been finalised at the time of writing.

Table 8-1 Kingston substation feeder forecast

Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
34251	1.0	1.0	1.1	1.1	1.1	1.1
34252	0.8	0.8	0.8	0.9	0.9	0.9
34253	4.1	4.2	4.3	4.5	4.6	4.7
34254	3.0	3.1	3.2	3.3	3.4	3.5
34255	0.1	0.1	0.1	0.1	0.1	0.1
34256	5.1	5.3	5.4	5.6	5.7	5.9
34257	5.8	6.0	6.2	6.4	6.5	6.7
34258	3.6	3.7	3.8	3.9	4.0	4.1
34259	5.8	6.0	6.2	6.4	6.6	6.7
34260	2.3	2.4	2.5	2.5	2.6	2.7
34261	5.3	5.4	5.6	5.7	5.9	6.1
34262	5.2	5.4	5.6	5.7	5.9	6.0

As outlined above, feeders 34256, 35257, 35259, 34261 and 34262 are forecast to exceed the 5 MVA planning rating by 2017. All of these feeders, apart from 34251, are expected to be deloaded by the establishment of Browns Rd zone substation in 2012.

Feeder 34251 was deloaded by approximately 3 MVA in 2009 by the establishment of a new feeder 33275 from Electrona.

The remainder of Kingston 11 kV feeders are within their planning ratings for the scope of the study.

The available transfer capacity from Kingston substation to the Electrona substation is outlined in Table 8-2.

Table 8-2 Kingston substation transfer capability

Substation	Feeder	2012 transfer (MVA)	2013 transfer (MVA)	2014 transfer (MVA)	2015 transfer (MVA)	2016 transfer (MVA)	2017 transfer (MVA)
Electrona	33272	2.6	2.5	2.4	2.3	2.2	2.1
	33274	2.9	2.8	2.7	2.6	2.6	2.5
Total transfers	-	5.5	5.3	5.1	4.9	4.8	4.6

As outlined above, there is sufficient transfer capacity to Electrona to reduce the 11 kV load at Kingston below firm capacity for the period of study.

The 33 kV network from Kingston will consist of two 33 kV feeders and there will be four spare feeder circuit breakers available.

Table 8-3 below shows the ratings of the 33 kV feeders from Kingston, as well as the ratings of the zone substation transformer supplied by that feeder. The table also shows an approximate load on the feeder for the loss of an adjacent feeder in 2017.

Table 8-3 Kingston 33 kV feeder loads and ratings

Substation	Feeder no.	Transformer rating	SD rating (MVA)	WD rating (MVA)	SD N-1 load 2017 (MVA)	WD N-1 load 2017 (MVA)
Browns Rd	-	25	-	27.1*	15	23
	-	25	-	27.1*	15	23

* Rating given is Aurora standard rating – actual rating is not yet known

As outlined above, all of the 33 kV feeders are forecast to be loaded within their ratings beyond 2017 for an N-1 condition.

8.1.2 Proposed projects

Blackmans Bay zone substation

Blackmans Bay zone substation is proposed to be installed in 2017 and will address the firm capacity limitations at Kingston and Browns Rd substations, as well as deloading the 11 kV network south and east of Kingston and Browns Rd. For information on the options analysis for this project please refer to the ten year plan in Section 7.1.2. For information on the distribution network details please refer to the five year plan in Section 8.3.

The resulting Kingston 11 kV and 33 kV five year load forecasts are shown in Figure 8-5 and Figure 8-6.

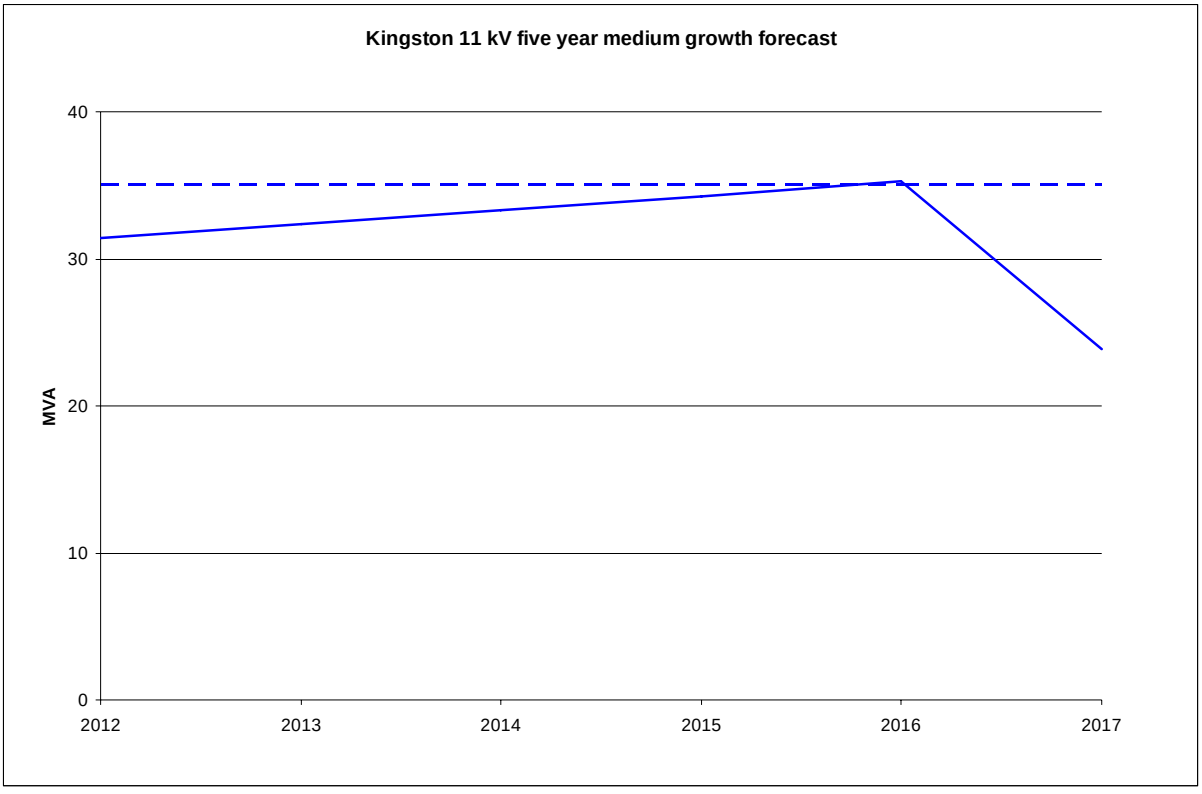

Figure 8-5 Kingston 11 kV proposed five year medium growth forecast

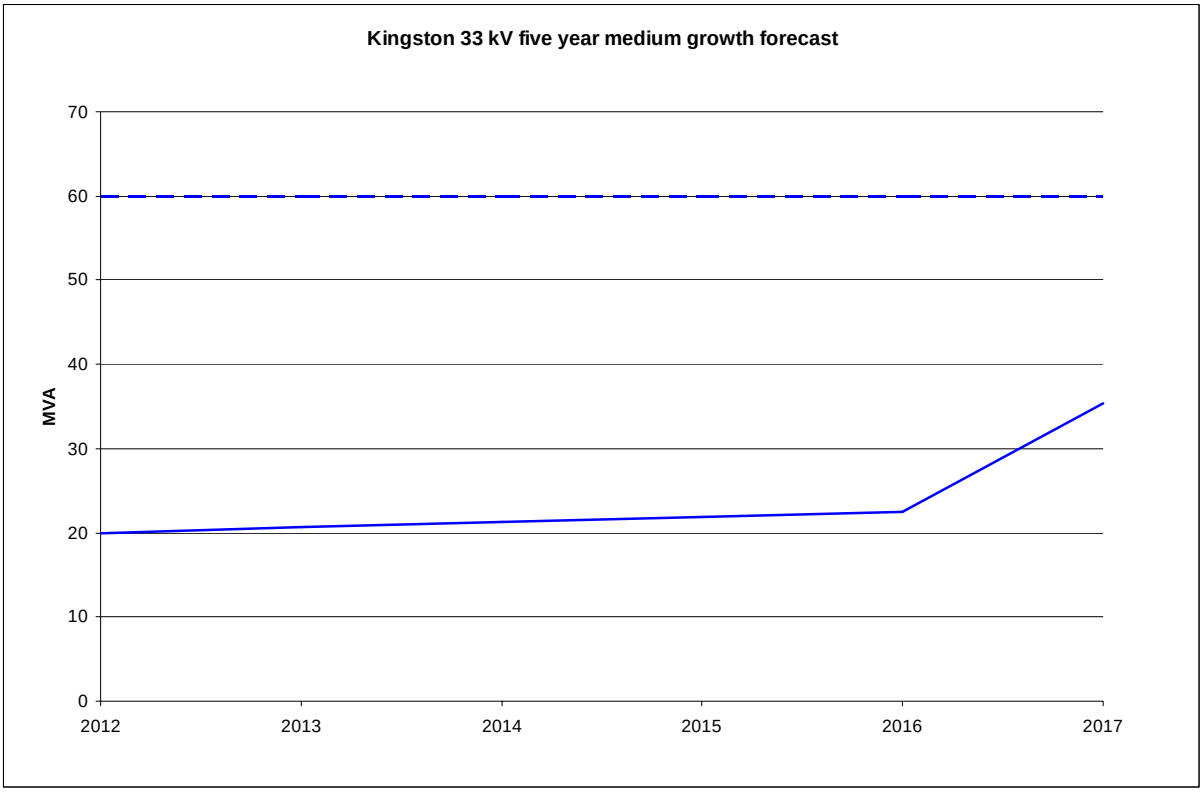

Figure 8-6 Kingston 33 kV proposed five year medium growth forecast

As outlined above, Kingston 11 kV load is reduced below firm capacity in 2017. Kingston 33 kV load remains well below capacity following the establishment of Blackmans Bay zone substation.

New feeder projects

Based on the medium growth forecast all feeder overloads are addressed by existing projects within the period of study.

8.1.3 Ultimate configuration

Substation

Kingston is expected to remain a two (110/11 kV) transformer substation up to 2050, though the existing 110/11 KV 35 MVA transformers were installed in 1980 so are predicted to be end of life around 2030. It is expected that existing site will be extended and the transformers will be replaced with 60 MVA units at this time. The 11 kV switchboard may also need to be replaced or extended at this time to enable additional 11 kV feeders to be established.

While it could be contended that the load in the vicinity of the Kingston site does not justify a 60 MVA substation, it should be noted that the substation is currently loaded above 40 MVA, so the existing distribution network from Kingston already has significant capacity. With the expected development on the land to the west of Blackmans Bay, it is considered likely that Kingston 11 kV network will be able to be loaded sufficiently to justify the 60 MVA firm capacity. It should also be noted that the next smaller Transend standard transformer size is 25 MVA, which is considered too small.

It is expected that the two 110/33 kV transformers to be installed at Kingston will be sufficient to supply the Browns Rd and Blackmans Bay zone substations up to 2034. The proposed establishment of Margate zone substation at this time would drive the installation of a third 110/33 kV transformer at Kingston.

Feeders

Following the establishment of zone substations at Browns Rd and Blackmans Bay, the Kingston 11 kV feeder network will be quite lightly loaded and new feeders are not expected to be required from the substation prior to the transformer replacement in 2030. As noted above, there are no spare circuit breakers at Kingston substation, so additional feeders would not be possible without replacing or extending the switchgear, which may be undertaken with the transformer age replacement in 2030.

There are significant areas of vacant land in the vicinity of Kingston substation, so ultimately new 11 kV feeders could be required in any direction dependent on where development occurs. Feeders to the north and east to support the urban areas of Kingston are considered most likely, with load growth to the west of Kingston substation considered unlikely due to the hilly terrain in the area and the establishment on Margate zone substation in 2034 expected to support Kingston from the south.

New 33 kV feeders are expected to be required from Kingston to Margate in 2034. If 11 kV feeder reinforcement is required in the Margate direction prior to this, the installation of 33 kV circuits energised at 11 kV should be considered. A similar approach should be considered if it is decided that a new zone substation is ultimately required between Browns Rd and Blackmans Bay.

8.2 Browns Rd substation

Browns Rd zone substation is to be established by Aurora in 2012. Browns Rd will deload the existing Kingston and Sandy Bay substations, supplying the commercial hub of Kingston, Kingston Beach and northern Blackmans Bay, as well as north to Taronga and Taroona.

8.2.1 Limitations

Using the medium growth forecast, Browns Rd substation load is forecast to grow from 20 MVA in 2012 to 23 MVA in 2017, below the substation firm capacity of 25 MVA. The five year load forecast for Browns Rd substation is given in Figure 8-7.

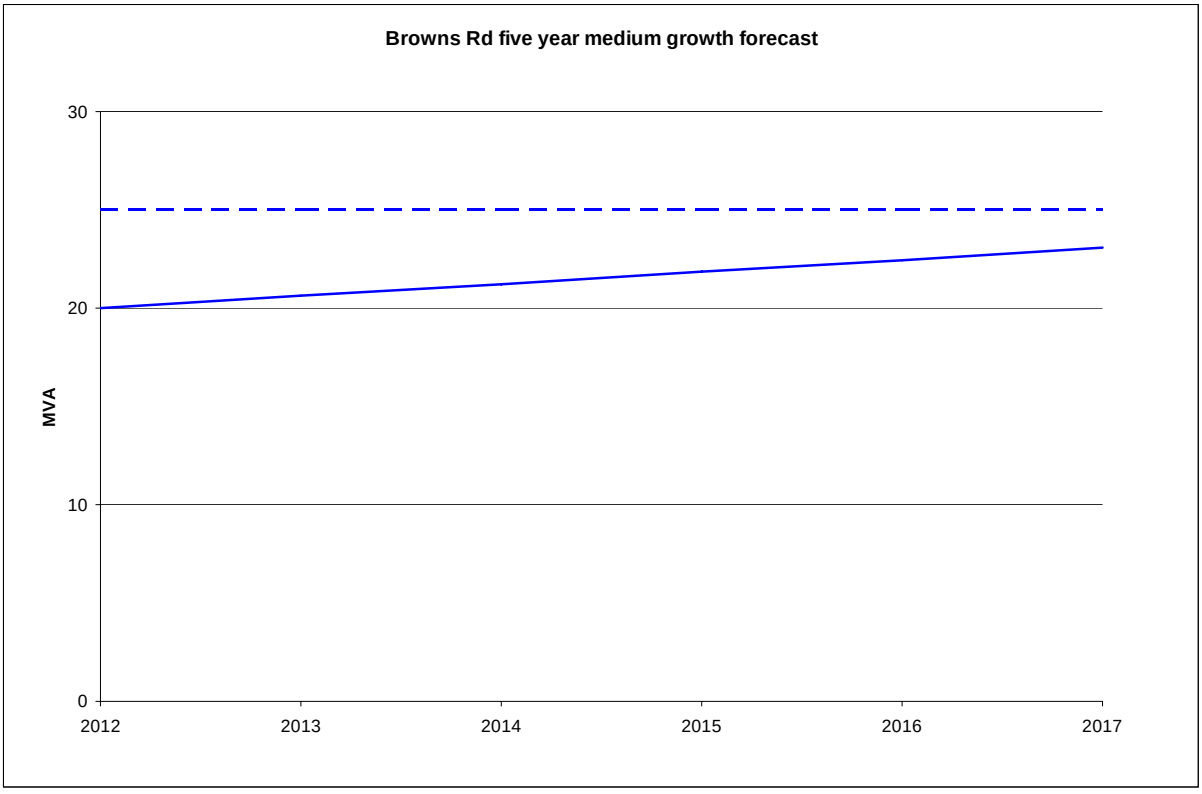

Figure 8-7 Browns Rd five year medium growth forecast

The 11 kV network from Browns Rd is expected to consist of six distribution feeders, with four spare circuit breakers available for future feeders.

The expected Browns Rd supply area is shown in Figure 8-8.

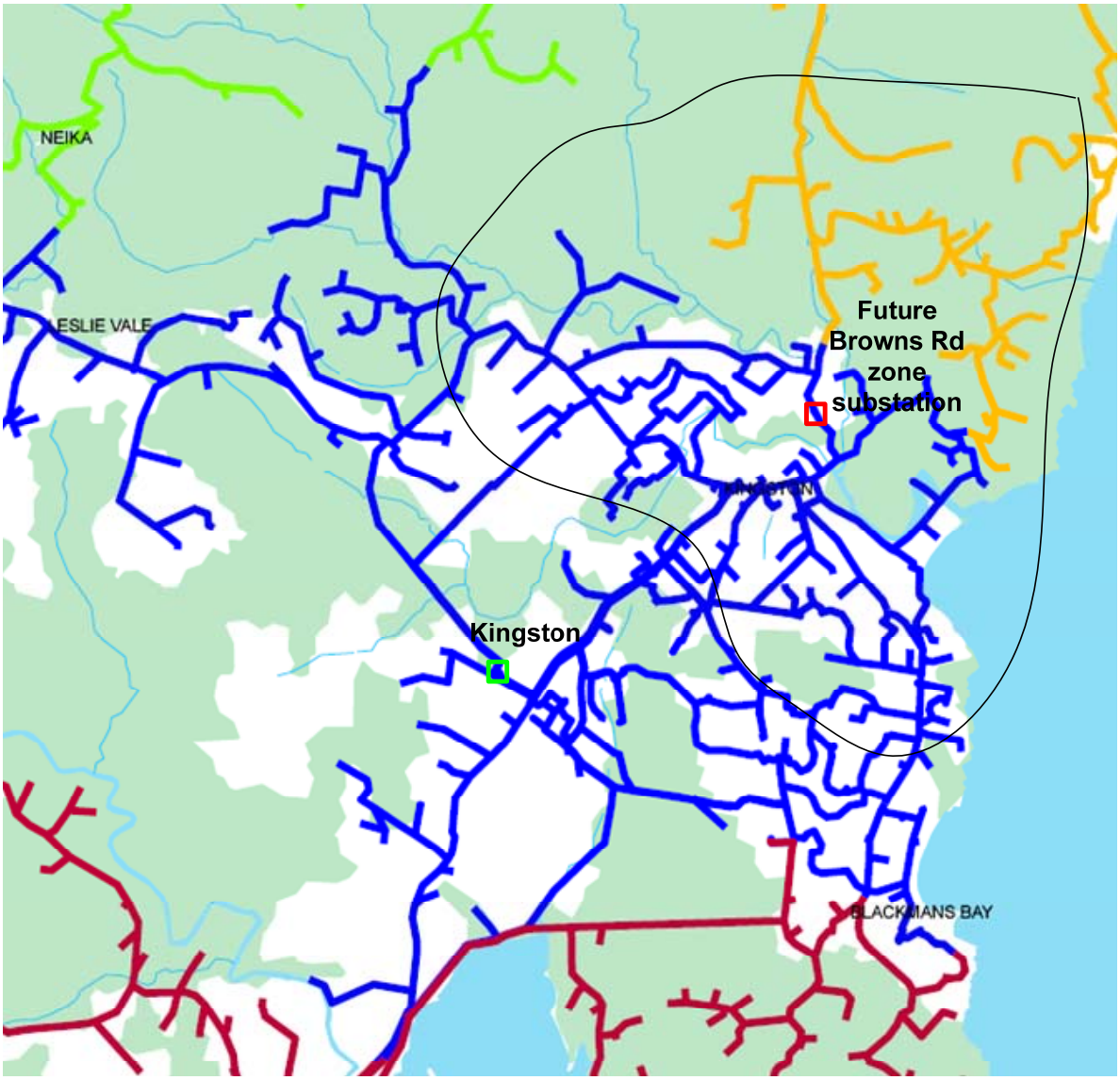

Figure 8-8 Browns Rd 11 kV supply area

It should be noted that the above is indicative only, and the exact supply area has not been finalised at the time of writing.

Aurora have advised that the Browns Rd will have six feeders initially, with loading expected to be approximately 3.5 MVA per feeder.

Applying the Kingston growth rate, the feeders will reach approximately 4 MVA in 2017, below the planning rating of 5 MVA.

8.2.2 Proposed projects

Blackmans Bay zone substation

Blackmans Bay zone substation is proposed to be installed in 2017 and will address the firm capacity limitations at Kingston and Browns Rd substations, as well as deloading the 11 kV network south and east of Kingston and Browns Rd. For information on the options analysis for this project please refer to the ten year plan in Section 7.1.2. For information on the distribution network details please refer to the five year plan in Section 8.3.

The resulting Browns Rd five year load forecast is shown in Figure 8-9.

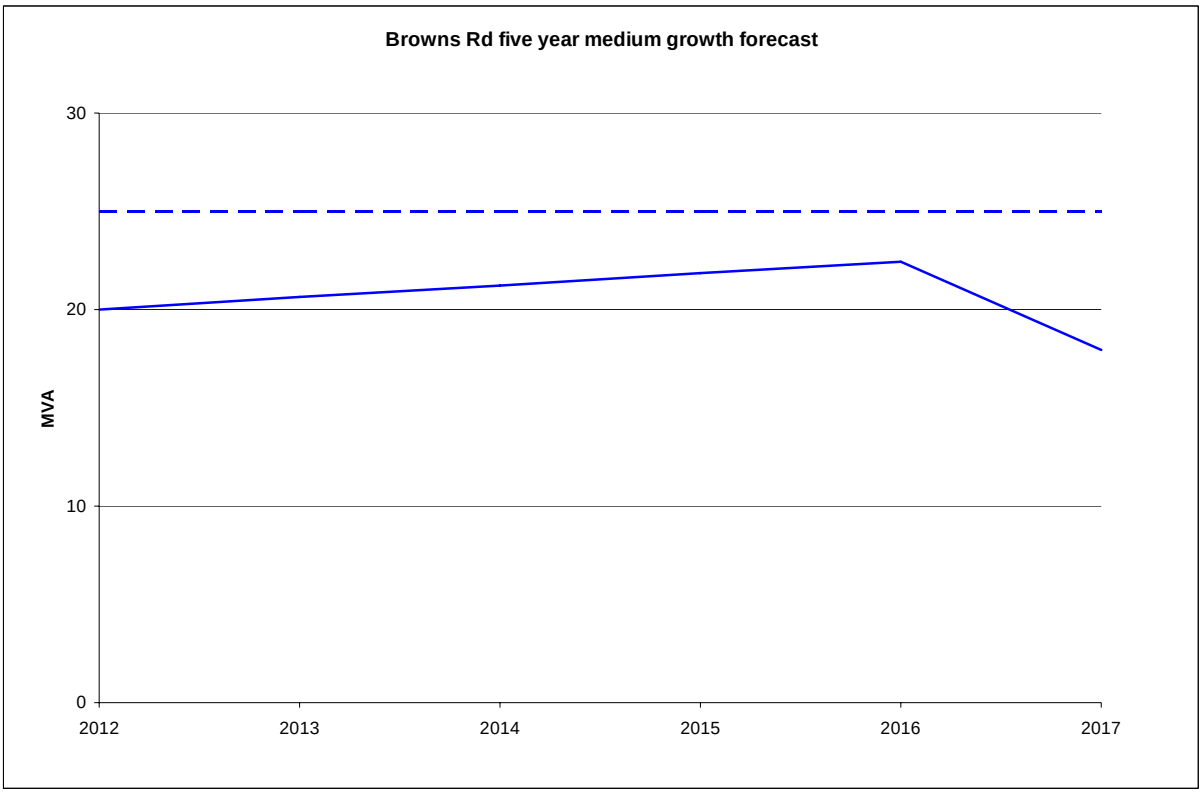

Figure 8-9 Browns Rd proposed five year medium growth forecast

As outlined above, Browns Rd load is deloaded by approximately 5 MVA in 2017.

8.2.3 Ultimate configuration

Substation

The long term plan discusses the possibility of a third transformer at both Browns Rd and Blackmans Bay zone substations to relieve firm capacity limitations in the Kingston area substations from 2040.

The installation of 33 kV switchgear has not been proposed for Browns Rd in the long term plan, with the assumption being that third transformers will be supplied from dedicated feeders from Kingston substation.

However there is the possibility that a future zone substation will be required in Kingston between Browns Rd and Blackmans Bay zone substations, in place of a third transformer at an existing zone substation. Depending on the location of the substation, it may be cost effective to supply from 33 kV switchboards at the existing zone substations, rather than from Kingston terminal substation.

Feeders

Based on the proposed loading of 3.5 MVA in 2012 and the reinforcement provided by Blackmans Bay in 2017, no new feeders are expected to be required from Browns Rd in the short term.

8.3 Blackmans Bay substation

Blackmans Bay zone substation is proposed to be installed in 2017 to address the firm capacity limitations at Kingston and Browns Rd substations and to address 11 kV feeder limitations to the south of Kingston. For information on the options analysis and justification for this project please refer to the

ten year plan in section 7.1.2. This section of the report will focus on the scope of work for Aurora and the impact on the distribution network.

An approximate site location has been assumed and the proposed Blackmans Bay feeder configuration is shown in Figure 8-10.

Feeder loads have been determined using DINIS and a five year feeder forecast has been developed by applying the substation medium growth rate to the feeder peak loads. The feeder forecast is outlined in Table 8-4.

Table 8-4 Blackmans Bay substation feeder forecast

Feeder/s	2017 load (MVA)	2018 load (MVA)	2019 load (MVA)	2020 load (MVA)	2021 load (MVA)	2022 load (MVA)
1	1.6	1.7	1.7	1.7	1.8	1.8
2	2.1	2.1	2.2	2.2	2.3	2.4
3	1.6	1.7	1.7	1.7	1.8	1.8
4	3.9	4.0	4.1	4.2	4.4	4.5
5	3.6	3.7	3.8	3.9	4.0	4.1
6	2.7	2.7	2.8	2.9	2.9	3.0

As outlined above there are no forecast feeder limitations in the five years following the establishment of Blackmans Bay substation, based on the feeder planning rating of 5 MVA.

Figure 8-10 Blackmans Bay proposed feeder configuration

8.3.1 Proposed projects

No projects are proposed in the five year plan for the Blackmans Bay supply area.

8.3.2 Ultimate configuration

Substation

The long term plan discusses the possibility of a third transformer at both Browns Rd and Blackmans Bay zone substations to relieve firm capacity limitations in the Kingston area substations from 2040.

The installation of 33 kV switchgear has not been proposed for Blackmans Bay in the long term plan, with the assumption being that third transformers will be supplied from dedicated feeders from Kingston substation.

However there is the possibility that a future zone substation will be required in Kingston between Browns Rd and Blackmans Bay zone substations, in place of a third transformer at an existing zone substation. Depending on the location of the substation, it may be cost effective to supply from 33 kV switchboards at the existing zone substations, rather than from Kingston terminal substation.

Feeders

Additional feeders are not expected to be required from Blackmans Bay in the short term.

The establishment of a Margate zone substation, proposed for 2034 in the long term plan, will provide support to Blackmans Bay from the south and west. With Kingston substation already supplying into the Blackmans Bay from the west, it is expected that any future feeders from Blackmans Bay are likely to be most effective directed to the north.

8.4 Electrona substation

Electrona terminal substation supplies a large footprint to the south of Kingston, including the coastal townships from Margate in the north to Verona Sands in the south, as well as to Bruny Island and inland to the township of Longley.

8.4.1 Limitations

Using the medium growth forecast, Electrona substation load is forecast to grow from 15 MVA in 2012 to 17 MVA in 2017, well below the substation firm capacity of 25 MVA. The five year load forecast for Electrona substation is given in Figure 8-11.

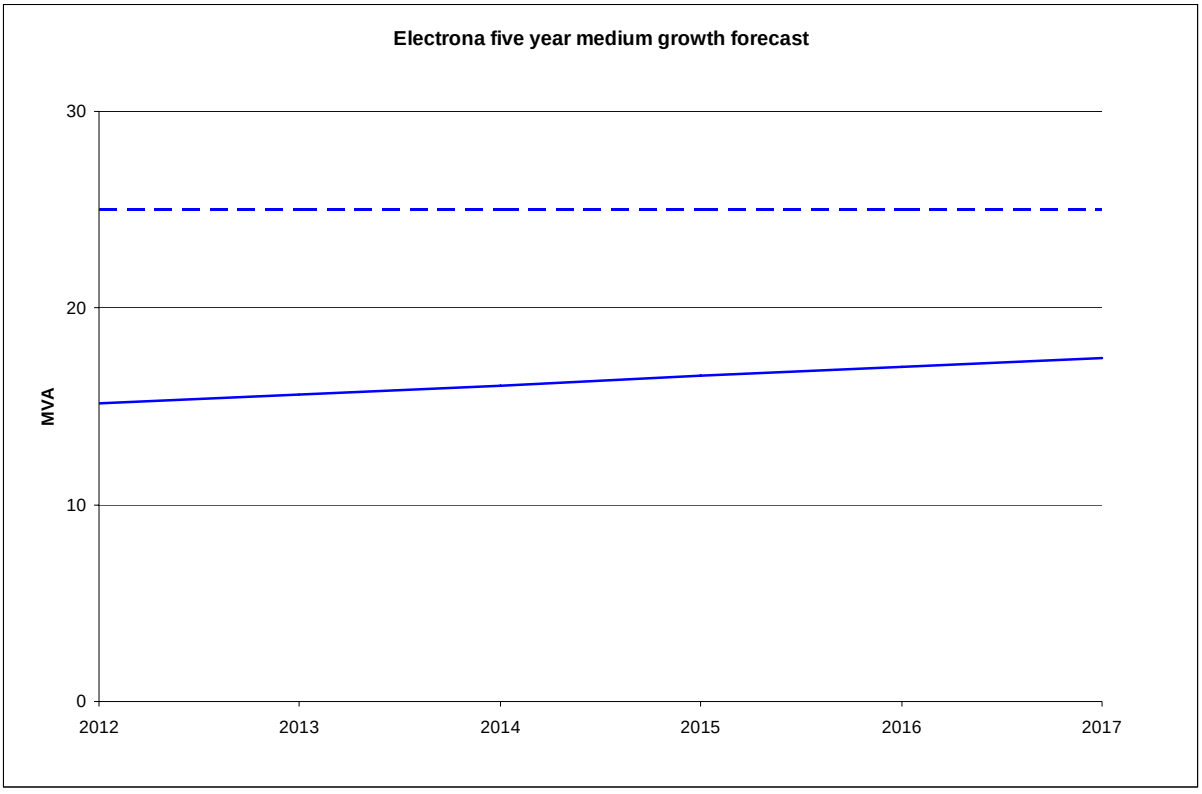

Figure 8-11 Electrona five year medium growth forecast

The 11 kV network from Electrona consists of seven distribution feeders and there is a single spare feeder circuit breaker available.

The Electrona supply area and individual feeders are shown in Figure 8-12 and Figure 8-13 below.

Figure 8-12 Electrona 11 kV supply area

Figure 8-13 Electrona 11 kV feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the feeder peak loads. The feeder forecast is outlined in Table 8-5.

Table 8-5 Electrona substation feeder forecast

Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
33271	3.0	3.1	3.2	3.3	3.4	3.5
33272	4.8	5.0	5.1	5.3	5.4	5.6
33273	0.2	0.2	0.2	0.2	0.2	0.2
33274	3.3	3.4	3.5	3.6	3.7	3.8
33275	3.5	3.6	3.7	3.9	4.0	4.1
33276	3.9	4.0	4.1	4.2	4.4	4.5
33277	0.3	0.3	0.3	0.3	0.3	0.3

As outlined above, feeder 33272 exceeds the feeder planning rating of 5 MVA within the period of study.

Feeder 33275 has undergone a load transfer to deload Kingston substation prior to the commissioning of Browns Rd zone substation. It is expected that much of this load will be transferred back to Kingston feeder 34252 (forecast load of 0.8 MVA in 2012) to deload 33275 at this time.

Feeder 33276 is a long feeder which supplies the coastal towns from Electrona all the way south to Verona Sands (approximately 35 km).

Feeder 33273 is a short feeder which formerly supplied industrial loads adjacent to the substation. The industrial loads no longer exist and this feeder is available for use as required.

Feeder 33277 is a dedicated feeder to Hazel Bros which is not available for extension or reuse.

The available transfer capacity from Electrona substation to Kingston substation is outlined in Table 8-6.

Table 8-6 Electrona substation transfer capability

Substation	Feeder	2012 transfer (MVA)	2013 transfer (MVA)	2014 transfer (MVA)	2015 transfer (MVA)	2016 transfer (MVA)	2017 transfer (MVA)
Kingston	34252	1.2	1.1	1.0	0.0	0.0	0.0
Total transfers	-	1.2	1.1	1.0	0.0	0.0	0.0

As outlined above, there is no transfer capacity away from Electrona from 2015 onwards.

8.4.2 Proposed projects

Deload feeder 33272

As discussed above, feeder 33272 is forecast to exceed the 5 MVA planning rating in 2013. Following the establishment of Browns Rd substation in 2012 it is expected that the load on feeder 33275 can be transferred back to Kingston feeder 34241.

The long spurs down Nieninna and Van Morey roads could then be transferred from 33272 to 33275 or 33274 to deload 33272 by approximately 2 MVA.

8.4.3 Ultimate configuration

Substation

Electrona is expected to remain a two transformer substation up to 2050. The transformers at Electrona were installed in 2008, which implies that they will not require replacement due to age limitations prior to 2050.

The spare circuit breaker and two lightly loaded feeders are expected to provide sufficient capacity for new feeders for the foreseeable future.

Feeders

As discussed above, it is expected that feeder limitations at Electrona up to 2017 can be addressed by the proposed project to deload 33272.

Feeders 33272, 33274 and 33275 would be significantly deloaded by the proposed establishment of Margate zone susbstation in 2034. In the meantime, it is expected that Blackmans Bay zone substation will provide sufficient support to the area in 2017 that additional feeders north from Electrona will not be required prior to Margate.

Feeder 33276, the long feeder which supplies south to Verona Sands, is of concern in the near term. This feeder is forecast to exceed the planning rating of 5 MVA in around 2021, with no transfer capacity to adjacent feeders. The proposed project to establish a new cable from Kermandie and extend its supply area to Cygnet south to Charlotte Cove may mitigate this limitation somewhat, since this would significantly deload Knights Rd feeder 30607 and potentially allow it to support 33276 via the tie along Nicholls Rivulet Rd.

The establishment of Blackmans Bay zone substation would allow the feeder from the north (currently 33275) to deload 33271 by taking the entire Bruny Island load. This would then allow 33271 to also support 33276. However the majority of Bruny Island load is on South Bruny, so ultimately feeder support will be required there also. Therefore it is considered likely that a new sub-marine cable from South Bruny to the mainland around Gordon will ultimately be required.

8.5 Knights Rd substation

Knights Rd terminal substation supplies a large footprint to the west of Kingston, including the townships of Huonville, Franklin, Cygnet, as well as the rural area north to Crabtree and the coastal area south to Verona Sands.

8.5.1 Limitations

Using the medium growth forecast, Knights Rd substation load is forecast to grow from 20 MVA in 2012 to 23 MVA in 2017, in excess of the substation firm capacity of 20 MVA. The five year load forecast for Knights Rd substation is given in Figure 8-11.

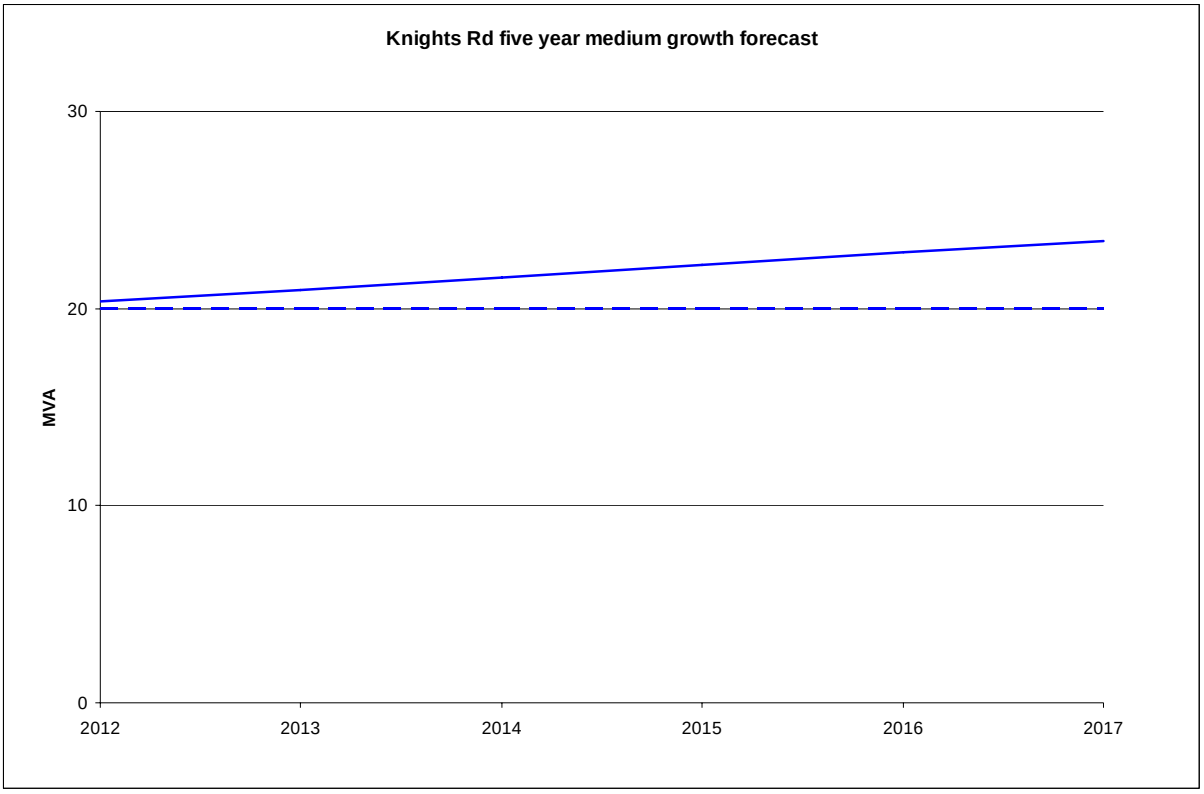

Figure 8-14 Knights Rd five year medium growth forecast

The 11 kV network from Knights Rd consists of six distribution feeders and there is a single spare feeder circuit breaker available. Aurora are proposing to establish a new feeder from this circuit breaker in 2009/10.

The Knights Rd supply area and individual feeders are shown in Figure 8-12 and Figure 8-13 below.

Figure 8-15 Knights Rd 11 kV supply area

Figure 8-16 Knights Rd 11 kV feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the feeder peak loads. The feeder forecast is outlined in Table 8-5.

Table 8-7 Knights Rd substation feeder forecast

Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
30603	2.9	3.0	3.1	3.1	3.2	3.3
30604	3.5	3.6	3.7	3.8	3.9	4.0
30605	2.5	2.6	2.6	2.7	2.8	2.9
30606	2.9	3.0	3.1	3.2	3.3	3.4
30607	2.6	2.7	2.7	2.8	2.9	3.0
30608	4.1	4.2	4.3	4.4	4.6	4.7

As outlined above, there are no feeders that exceed the feeder planning rating of 5 MVA within the period of study.

There is no available transfer capacity from Knights Rd substation to adjacent substations.

8.5.2 Proposed projects

Load transfer from 30608 to 30603

As discussed above, feeder 30608 is forecast to approach the 5 MVA planning rating in 2017. The establishment of feeder 30602 in 2009/10 is expected to deload 30603 and 30604, allowing load to be transferred from 30608 to 30603. Feeder 30608 may also be able to be partially deloaded by Kingston feeder 34261 after this feeder is deloaded by the establishment of Browns Rd zone substation.

Upgrade Kermandie substation

As discussed in the long term and ten year plans, the existing transformers at Kermandie are proposed to be replaced in 2015. At this time, it is also proposed to transfer approximately 6 MVA from Knights Rd to Kermandie. The impact on the distribution network is discussed in the Kermandie section of the five year plan (Section 8.6). The resulting five year load forecast for Knights Rd substation is given in Figure 8-17.

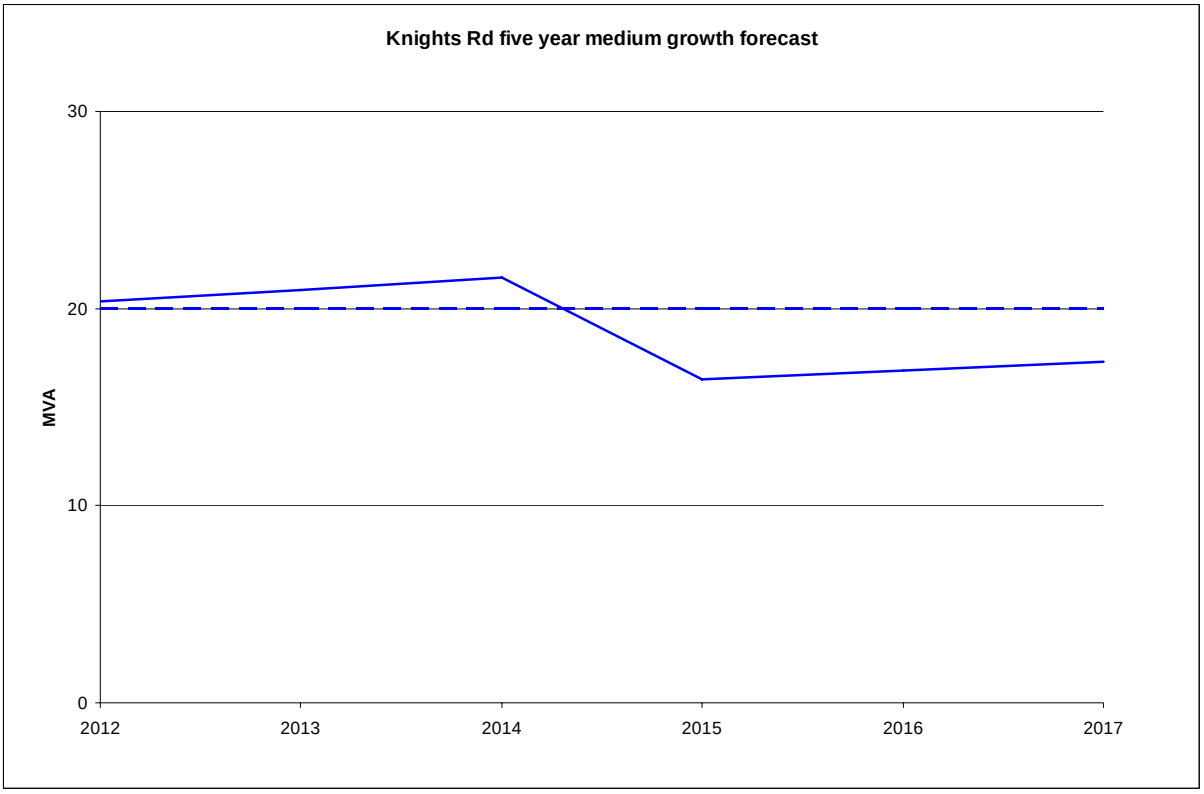

Figure 8-17 Knights Rd proposed five year medium growth forecast

As outlined above, load at Knights Rd is reduced below firm capacity for the period of study.

The resulting Knights Rd feeder loads are shown in Table 8-10

Table 8-8 Knights Rd substation proposed feeder forecast

Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
30605	2.5	2.6	2.6	0.8	0.8	0.8
30606	2.9	3.0	3.1	0.9	0.9	1.0
30607	2.6	2.7	2.7	1.0	1.0	1.1

As outlined above, feeders 30605, 30606 and 30607 are deloaded in 2015 by the proposed load transfers.

8.5.3 Ultimate configuration

Substation

Knights Rd is expected to remain a two transformer substation up to 2050. The transformers at Knights Rd were installed in 1987, which implies that they will require replacement due to age limitations in 2037. However it is likely that replacement will be required prior to this date to increase the firm capacity at the substation (proposed for 2024 in the long term plan). The 11 kV switchboard may also be replaced at this time to enable additional 11 kV feeders to be established.

Feeders

As discussed above, it is expected that feeder limitations at Knights Rd up to 2017 will be addressed by existing Aurora projects. The proposed project to transfer load from Knights Rd to Kermandie would push back the supply area of Knights Rd, however it is expected that this will be partially reversed after the Knights Rd transformer upgrade (proposed for 2024).

Loading on feeder 30608 is expected to be an ongoing concern. Feeder 30608 is a long rural feeder with ties to other long and heavily loaded feeders from Kingston (34241) and Electrona (33272). The capacity limitation may be deferred by the load transfers to the new Knights Rd feeder, however this is not expected to provide a long term solution. Further limitations in this area may be addressed by taking some load onto feeder 30607 after it is deloaded by the proposed Kermandie feeder project in 2015, however it is expected that a new feeder will ultimately be required to the north from Kermandie.

8.6 Kermandie substation

Kermandie terminal substation supplies the township of Geeveston and the coastal towns south to Dover and Southport, as well as across the Huon river towards the township of Cygnet.

8.6.1 Limitations

Using the medium growth forecast, Kermandie substation load is forecast to grow from 8.3 MVA in 2012 to 9.5 MVA in 2017, below the substation firm capacity of 10 MVA. The five year load forecast for Kermandie substation is given in Figure 8-18.

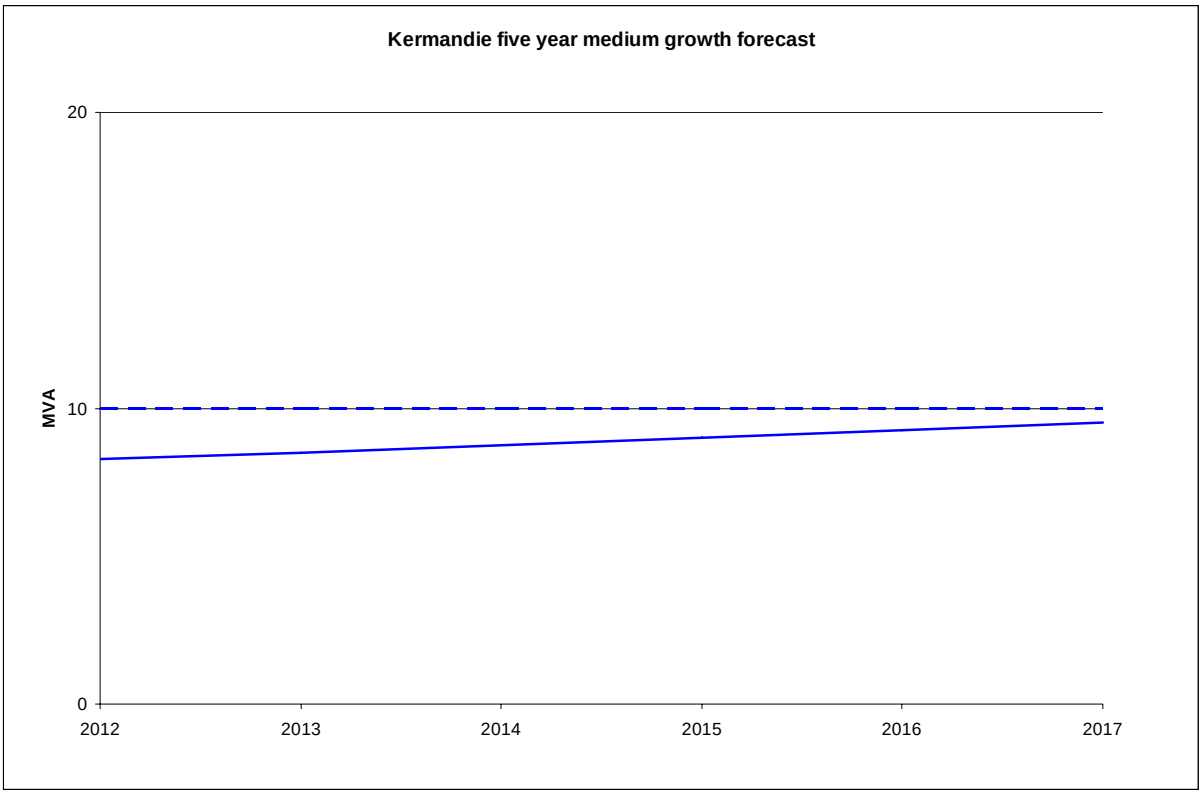

Figure 8-18 Kermandie five year medium growth forecast

The 11 kV network from Kermandie consists of four distribution feeders and there is a single spare feeder circuit breaker available.

The Kermandie supply area and individual feeders are shown in Figure 8-19 and Figure 8-20 below.

Figure 8-19 Kermandie 11 kV supply area

Figure 8-20 Kermandie 11 kV feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the feeder peak loads. The feeder forecast is outlined in Table 8-9.

Table 8-9 Kermandie substation feeder forecast

Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
31002	0.9	1.0	1.0	1.0	1.1	1.1
31007	2.5	2.6	2.6	2.7	2.8	2.9
31008	2.9	2.9	3.0	3.1	3.2	3.3
31010	1.7	1.7	1.8	1.8	1.9	1.9

As outlined above, there are no feeders that exceed the feeder planning rating of 5 MVA within the period of study.

There is no available transfer capacity from Kermandie substation to adjacent substations.

8.6.2 Proposed projects

Upgrade Kermandie substation

As discussed in the long term and ten year plans, the existing transformers at Kermandie are proposed to be replaced with 25 MVA units in 2015. At this time, it is also proposed to transfer approximately 6 MVA from Knights Rd to Kermandie. The resulting five year load forecast for Kermandie substation is given in Figure 8-17.

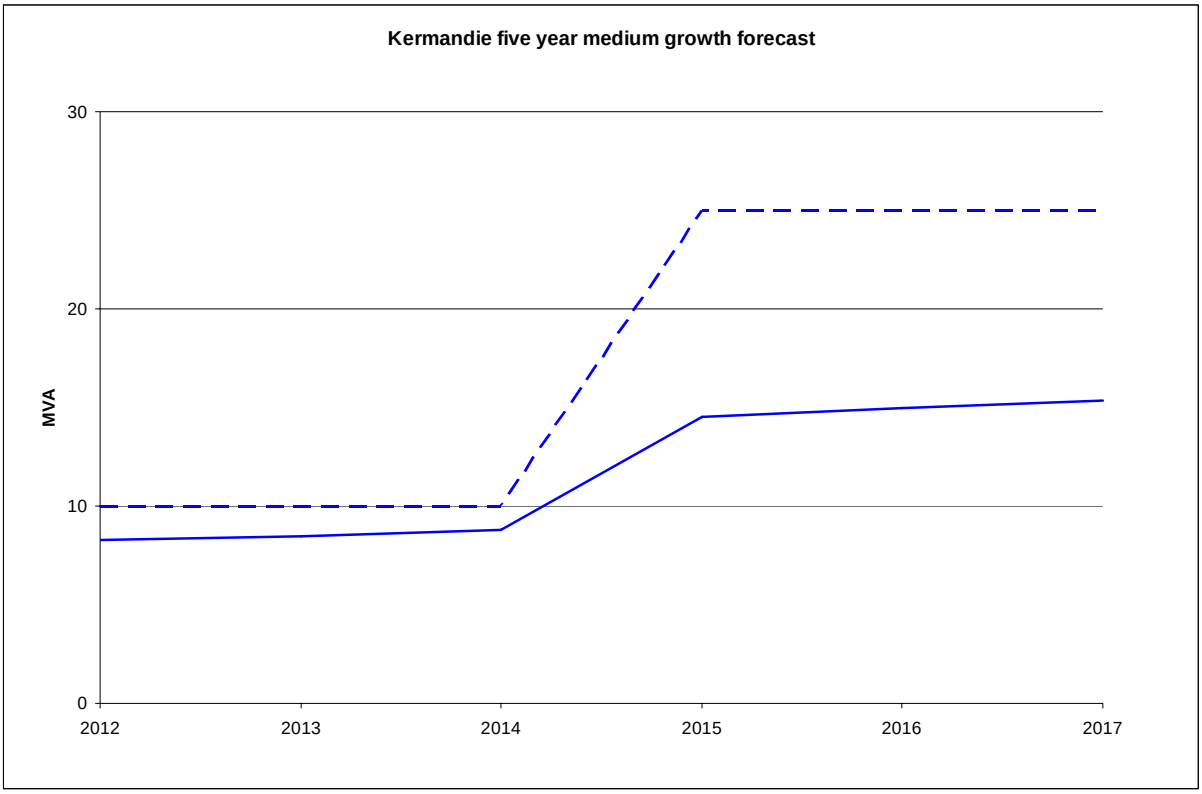

Figure 8-21 Kermandie proposed five year medium growth forecast

As outlined above, Kermandie load is below firm capacity for the period of study.

The resulting Kermandie feeder loads are shown in Table 8-10.

Table 8-10 Kermandie substation proposed feeder forecast

Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
31002	0.9	1.0	1.0	2.9	3.0	3.1
31010	1.7	1.7	1.8	3.8	3.9	4.0
New	-	-	-	2.0	2.1	2.1

As outlined above, feeders 31002, 31010 and the new Kermandie feeder are within the 5 MVA planning capacity for the period of study.

8.6.3 Ultimate configuration

Substation

Kermandie is expected to remain a two transformer substation up to 2050. The transformers at Kermandie are not expected to require replacement on condition grounds prior to 2050, following the proposed replacement of the existing transformers with 25 MVA units in 2015.

The last spare circuit breaker is proposed to be used in 2015 to establish a new feeder across the Huon River and it is expected that future 11 kV feeders will be required from Kermandie substation. Therefore it is likely that the switchboard will ultimately need to be replaced or extended.

Feeders

As discussed above, there are no feeder limitations at Kermandie up to 2017.

The proposal to transfer load from Knights Rd to Kermandie will increase loading on the existing Kermandie network, and push the supply area of Kermandie substation to the north and east. However this arrangement is expected to be adequate up to the proposed upgrade of the Knights Rd transformers in 2029, at which time load can be partially transferred back to Knights Rd to deload the Kermandie network.

The two long feeders 31007 and 31008 south to Dover and Hastings are not expected to experience capacity limitations in the near term. Running a new feeder to take the Geeveston load from feeder 31007 would defer this limitation further, as more than half of the load on this feeder is in the Geeveston area.

Appendix A
Estimating data

Appendix A

The following tables list the standard feeder and substation costs used for this report.

Voltage	Feeder Type	Cost ($k/km)			Source
		Rural	Urban	High density Urban	
110 kV	Overhead single circuit	450	-	-	Transend (advised $400-500k)
110 kV	Over head single circuit (double circuit construction)	500	-	-	Transend (advised $400-500)
110 kV	Overhead double circuit	550	-	-	Transend (advised $500-600k)
66 kV	Overhead single circuit	250	-	-	Aurora
66 kV	Overhead double circuit	330	-	-	Aurecon assumption
66 kV	Overbuild of existing 22 kV	180	290	360	Aurecon assumption
33 kV	Underground single circuit	250	300	500	Aurora
33 kV	Underground double circuit	420	500	750	Aurora
33 kV	Overhead single circuit	150	200	300	Aurora
22 kV	Overhead single circuit	100	150	200	Aurora
22 kV	Underground single circuit	220	270	470	Aurora
22 kV	Underground double circuit	360	440	690	Aurora
11 kV	Overhead single circuit	100	150	200	Aurora
11 kV	Underground single circuit	220	270	470	Aurora
11 kV	Underground double circuit	360	440	690	Aurora

Component	Cost ($k)	Source
110/22/11 kV terminal substation	17,500	Transend (advised $15-20M)
110/22/11 kV terminal substation (single 25 MVA transformer)	9,000	Transend (advised $8-10M)
Install 3rd 110/22/11 kV transformer at existing site	7,000	Transend (advised $6-8M)
Install 3rd 33/11 kV transformer at existing site	3,000	Aurecon assumption
Replace 2 x 110/22/11 kV 60 MVA transformers	6,000	Aurecon assumption based Transend projects in APR
Replace 2 x 110/22/11 kV 25 MVA transformers	5,000	Aurecon assumption based Transend projects in APR
Establish 110/33 kV substation at existing site	13,500	Transend (advised $12-15M)
Establish 110/66 kV substation at existing site	14,000	Aurecon assumption
66/22 kV zone substation	9,000	Aurora
33/11 kV zone substation	7,000	Aurora
33 kV switchboard (5 CBs in existing building)	500	Aurecon assumption
11 kV switchboard (8 CBs in existing building)	300	Aurecon assumption

Appendix B
NPV analysis

Appendix B

The following table lists the NPV analyses attached in this section of the report.

NPV	Project	Section reference
1	Upgrade Kermandie terminal substation	7.1.1
2	Establish Blackmans Bay substation	7.1.2

Upgrade Kermandie terminal substation NPV analysis (South area)

Base Year
2010

OPTION 1
Upgrade Kermandie substation and transfer load from Knights Rd

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2015	2014	2016	Kermandie transformer end of life Knights Rd exceeds firm capacity	Upgrade Kermandie substation and transfer load from Knights Rd: - Replace 110/11 kV transformers - Install new 11 kV switchboard - 11 kV feeder tail to split 31007 1km OH 1km UG - 11 kV river crossing at Snake Island DCCT 1km	$7,070	$5.37	$5.13	$4.89	$5.68	$5.47	$5.27	$5.09	$4.81	$4.55
2037	2036	2038	Knights Rd transformers end of life	Replace Knights Rd transformers with 2 x 25 MVA	$5,000	$1.14	$0.88	$0.68	$1.20	$0.94	$0.74	$1.08	$0.83	$0.64
					Total	**$6.51**	**$6.01**	**$5.58**	**$6.88**	**$6.41**	**$6.00**	**$6.16**	**$5.63**	**$5.18**

OPTION 2
Upgrade Kermandie and Knights Rd substations

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2015	2014	2016	Kermandie transformer end of life Knights Rd exceeds firm capacity	Replace Knights Rd transformers with 2 x 25 MVA	$5,000	$3.80	$3.63	$3.46	$4.01	$3.87	$3.72	$3.60	$3.40	$3.21
2015	2014	2016	Kermandie transformer end of life Knights Rd exceeds firm capacity	Replace Knights Rd transformers with 2 x 25 MVA	$5,000	$3.80	$3.63	$3.46	$4.01	$3.87	$3.72	$3.60	$3.40	$3.21
					Total	**$7.60**	**$7.25**	**$6.92**	**$8.03**	**$7.73**	**$7.45**	**$7.19**	**$6.80**	**$6.43**

OPTION 3
Establish Franklin terminal substation and upgrade Kermandie substation

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2015	2014	2016	Kermandie transformer end of life Knights Rd exceeds firm capacity	Replace Knights Rd transformers with 2 x 25 MVA	$5,000	$3.80	$3.63	$3.46	$4.01	$3.87	$3.72	$3.60	$3.40	$3.21
2015	2014	2016	Kermandie transformer end of life Knights Rd exceeds firm capacity	Establish Franklin terminal substation: - 2 x 25 MVA 110/11 kV transformers - 11 kV river crossing at Snake Island DCCT 1 km	$18,500	$14.06	$13.41	$12.80	$14.85	$14.31	$13.78	$13.31	$12.58	$11.89
2037	2036	2038	Knights Rd transformers end of life	Replace Knights Rd transformers with 2 x 25 MVA	$5,000	$1.14	$0.88	$0.68	$1.20	$0.94	$0.74	$1.08	$0.83	$0.64
					Total	**$19.00**	**$17.92**	**$16.95**	**$20.07**	**$19.11**	**$18.24**	**$17.98**	**$16.81**	**$15.75**

Establish Blackman's Bay zone substation NPV analysis (South area)

Base Year
2010

OPTION 1
Establish Blackman's Bay zone substation

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2017	2016	2018	Kingston/Browns Rd exceed firm capacity Kingston 11 kV feeders exceed planning capacity	Establish Blackman's Bay zone substation: - 33/11 kV zone substation - 33 kV DCCT UG 3.6 km - 6 x 11 kV feeder tails	$12,600	$8.58	$8.03	$7.53	$9.07	$8.57	$8.10	$8.12	$7.53	$6.99
2030	2029	2031	Kingston 110/11 kV transformers end of life	Upgrade Kingston substation - Replace transformers with 2 x 60 MVA - Install new 11 kV switchboard	$5,500	$1.84	$1.52	$1.26	$1.94	$1.62	$1.36	$1.74	$1.43	$1.17
					Total	**$10.42**	**$9.55**	**$8.79**	**$11.00**	**$10.19**	**$9.46**	**$9.86**	**$8.96**	**$8.16**

OPTION 2
Upgrade Kingston terminal substation

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2017	2016	2018	Kingston/Browns Rd exceed firm capacity Kingston 11 kV feeders exceed planning capacity	Upgrade Kingston substation: - Replace transformers with 2 x 60 MVA - Install new 11 kV switchboard - 2 x 11 kV superfeeders to Blackman's Bay	$10,500	$7.15	$6.69	$6.27	$7.55	$7.14	$6.75	$6.77	$6.28	$5.83
2018	2017	2019	Kingston 11 kV feeders exceed planning capacity	Establish 2 x 11 kV superfeeders to Margate	$5,000	$3.22	$2.99	$2.77	$3.41	$3.19	$2.99	$3.05	$2.80	$2.58
2034	2033	2035	Kingston exceeds firm capacity	Establish Blackman's Bay zone substation: - 33/11 kV zone substation - 33 kV DCCT UG 3.6 km - 6 x 11 kV feeder tails	$12,600	$3.38	$2.69	$2.15	$3.57	$2.87	$2.32	$3.20	$2.53	$2.00
					Total	**$13.75**	**$12.38**	**$11.20**	**$14.53**	**$13.20**	**$12.05**	**$13.02**	**$11.61**	**$10.40**

OPTION 3
Install 3rd transformer at Browns Rd

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2017	2016	2018	Kingston/Browns Rd exceed firm capacity Kingston 11 kV feeders exceed planning capacity	Upgrade Browns Rd zone substation: - Install 1 x 25 MVA 33/11 kV transformer - 33 kV DCCT UG 3.6 km - Install 1 x 11 kV switchboard - 2 x 11 kV superfeeders to Blackman's Bay	$11,300	$7.70	$7.21	$6.75	$8.13	$7.68	$7.27	$7.29	$6.76	$6.27
2018	2017	2019	Kingston 11 kV feeders exceed planning capacity	Establish 2 x 11 kV superfeeders from Kingston to Margate	$5,000	$3.22	$2.99	$2.77	$3.41	$3.19	$2.99	$3.05	$2.80	$2.58
2030	2029	2031	Kingston 110/11 kV transformers end of life	Upgrade Kingston substation - Replace transformers with 2 x 60 MVA - Install new 11 kV switchboard	$5,500	$1.84	$1.52	$1.26	$1.94	$1.62	$1.36	$1.74	$1.43	$1.17
					Total	**$12.76**	**$11.72**	**$10.79**	**$13.47**	**$12.49**	**$11.61**	**$12.07**	**$10.99**	**$10.02**

Appendix C
Glossary

Appendix C – Glossary of terms

AAC – All Aluminium Conductor

AAAC – All Aluminium Alloy Conductor

ACO – Auto Change-Over

APR – Annual Planning Report

AVR – Automatic Voltage Regulation

CB – Circuit Breaker

CBD – Central Business District

DCCT – Double Circuit

DINIS – Power systems software package used by Aurora for load flow studies.

ESI regulations – Electricity Supply Industry regulations, transmission network performance standards specified by the Tasmanian Department of Energy

ECC – Emergency Cyclic Capacity

FLRS – Feeder Load Reporting System, Aurora database of historical distribution feeder loading.

HV – High Voltage

NCC – Normal Cyclic Capacity

NPV – Net Present Value

PMR – Pole-Mounted Recloser

RIT – Regulatory Investment Test

RMU – Ring Main Unit

SCCT – Single Circuit

TRIP – Targeted Reliability Improvement Project

WACC – Weighted Average Cost of Capital

Webmap – Software package used by Aurora to maintain geographical information about installed assets.

XLPE – Cross Linked Poly Ethylene

Adelaide 61 8 8237 9777
Auckland 64 9 520 6019
Bangkok 66 2 260 4560
Blenheim 64 3 520 6060
Brisbane 61 7 3173 8000
Cairns 61 7 4051 6266
Canberra 61 2 6112 0100
Christchurch 64 3 366 0821
Darwin 61 8 8919 9777
Geraldton 61 8 9964 2764
Gladstone 61 7 4962 0600
Gold Coast 61 7 5591 7775
Hamilton 64 7 834 1565
Hanoi 84 4976 1282
Ho Chi Minh City 84 8 3910 0288
Hong Kong 852 3664 6888
Jakarta 62 21 5140 2470
Karratha 61 8 9185 6344
Kuala Lumpur 60 3 2164 7301
Lithgow 61 2 6351 3750
Mackay 61 7 4951 3500
Maroochydore 61 7 5443 4055
Melbourne 61 3 8683 1333
Mildura 61 3 5022 2766
Morwell 61 3 5116 7205
Nelson 64 3 539 0190
Newcastle 61 2 4941 5415
Paraparaumu 64 4 296 1240
Parramatta 61 2 9890 4100
Perth 61 8 9223 1500
Phnom Penh 855 12 923 248
Port Augusta 61 8 8642 3197
Queenstown 64 3 441 0346
Rangiora 64 3 313 8776
Shanghai 86 21 3313 4750
Singapore 65 6256 6188
Sydney 61 2 9465 5599
Tauranga 64 7 578 6183
Toowoomba 61 7 4632 6249
Townsville 61 7 4772 2858
Traralgon 61 3 5176 0113
Wellington 64 4 472 9589
Whyalla 61 8 8645 5755
Wollongong 61 2 4224 7274

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