West Coast area strategic plan
System Capacity Planning Project
Aurora Energy

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Executive summary

The long term plan for West Coast recommends maintaining the existing 110 kV transmission network and converting the existing 44 kV subtransmission network out of Rosebery substation to 66 kV. This will provide an increase in capacity for the area and remove an unusual voltage from the subtransmission network. All projects recommended for the West Coast area are subject to impending supply to major mining customer loads.

The ten year plan for West Coast recommends an upgrade to Rosebery substation, a 44 kV feeder audit and a staged approach for the replacement of the 44 kV network to 66 kV. A transformer replacement due to predicted age limitations is recommended at Savage River substation.

The five year plan focuses on the distribution works required in the West Coast area and outlines the staging for the 44 kV feeder conversion at Rosebery.

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 West Coast covers an area from Strahan to Arthur River on the west coast, the Savage River National Park, Rosebery and Queenstown.

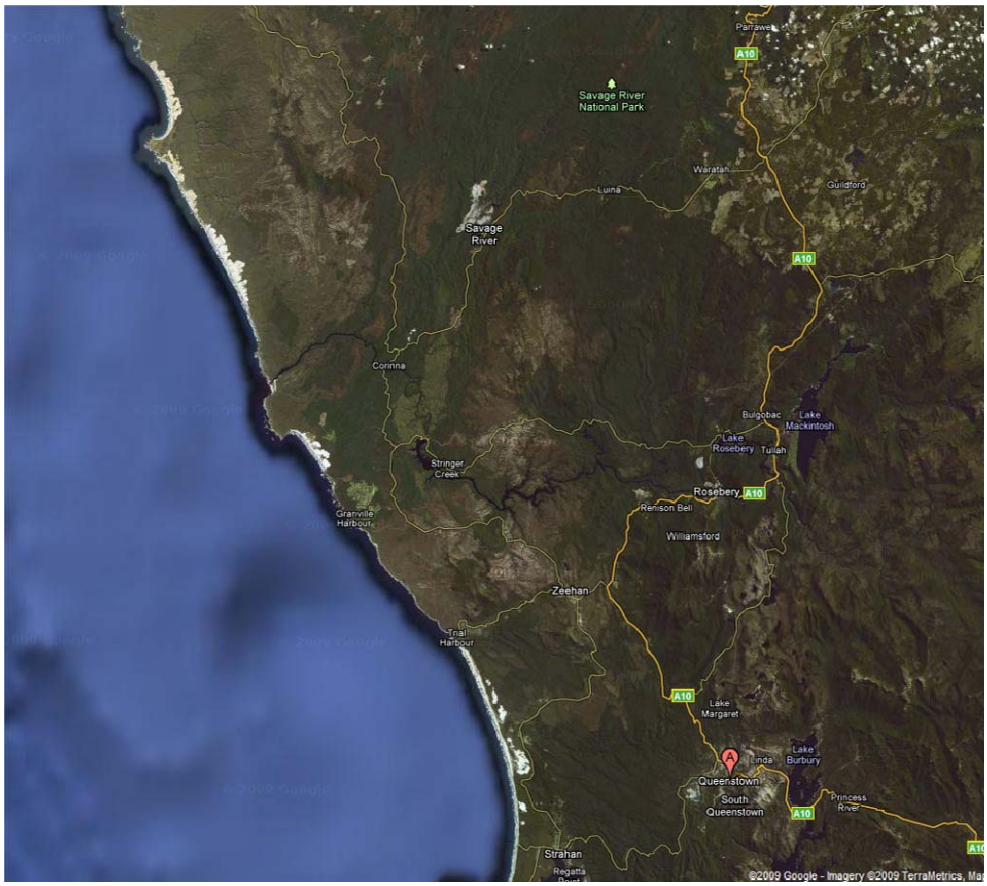

Figure 2-1 West Coast study area

The area has a strong mining industry with a number of terminal substations in the area supplying direct connected mining customers. There is a developing tourism industry particularly in the coastal town of Strahan. The load growth in the area is very dependent upon the mining industry and based upon individual requests by direct connected customers.

The network in this area faces a number of challenges including limited access, wild weather, salt pollution and lightning strikes. The townships of Zeehan and Strahan are highly dependent on power for both the tourism and mining industries and these areas are currently supplied by radial feeders.

2.1 Existing infrastructure

There are three Transend terminal substations and one Aurora zone substation supplying the distribution network in the West Coast area.

Table 2-1 West Coast terminal substations

Terminal substation	Number of transformers	Rating of each transformer	Transformer primary voltage	Secondary voltage	Number of distribution feeders
Queenstown	2	22.5 MVA	110 kV	22 kV	3
Rosebery 44 kV	2	30 MVA	110 kV	44 kV	3
Rosebery 22 kV	2	10 MVA	44 kV	22 kV	3
Savage River	2	22.5 MVA	110 kV	22 kV	1
Trial Harbour Zone	2	20 MVA	44 kV	22 kV	3 (One direct connected customer)

Table 2-2 West Coast distribution feeders

Terminal substation	Feeder name	Distribution voltage	Supply area	Comments
Queenstown	98001	22 kV	Strahan	Feeds an urban area
	98002	22 kV	Queenstown and South Queenstown	No capacity issues
	98003	22 kV	Gormanston and Lake Burbury	No capacity issues
Rosebery 44 kV	97011	44 kV	Rosebery Mine	Direct connected customer (Transend)
	97013	44 kV	Supplies Trial Harbour Zone	Predicted load increase at Trial Harbour Zone
	97014	44 kV	Bluestone Mine	Direct connected customer (Aurora)
Rosebery 22 kV	97021	22 kV	Tullah and areas east of the terminal substation	No capacity issues
	97001	22 kV	Rosebery township	No capacity issues
	97002	22 kV	Rosebery township	No capacity issues
Savage River	95001	22 kV	Savage River township	Iron ore mine – direct connected customer

2.2 Council areas and restrictions

The West Coast Council Planning Scheme was released in 2002 and has a number of recent amendments. Part C of the planning scheme discusses the development in urban, commercial, natural resources and environment protection zones. The intents of the zones are as follows:

- Urban –Values are assigned to each of the major towns in the West Coast area. These include promoting heritage form and historical significance, emphasising local attractions and protecting and enhancing residential amenity.

- Commercial – “provide for commercial use and development within discrete areas and to promote the upgrading and improvement in the environmental quality, attractiveness to visitors and physical amenity of commercial areas”
- Natural resources – allow for sustainable use of resources for tourism, hydroelectricity and forestry without adversely affecting the zone
- Environment Protection – “provide for the protection and management of areas and resources in areas of high environmental value for reasons of environmental protection, nature conservation, recreation, scenic amenity, maintenance of natural processes, protection of fragile landforms, catchment protection and appropriate public access”.

These intents and values will be taken into account in the development of the strategic plan for the West Coast.

2.3 Approved and proposed works

The West Coast area has a number of existing system constraints. The approved projects to be completed by December 2012 are outlined below:

Rosebery terminal substation augmentation

This project has been further reviewed in this study in Sections 6.1.1, 7.1.1 and 8.3.2.

3. Load forecast

Due to the rural nature of the load in the West Coast, significant growth above the medium rate is considered unlikely. As a result, for the purposes of the long term strategic study, medium growth has been applied at the Queenstown, Rosebery and Savage River terminal substations. The load growth in the area is very dependent upon the mining industry and based upon individual requests by direct connected customers.

The resulting 38 year load forecast and firm ratings for the terminal substations of the West Coast planning area are provided in Figure 3-1. Figure 3-2 provides a geographic view of the resulting load distribution in 2012 and 2050.

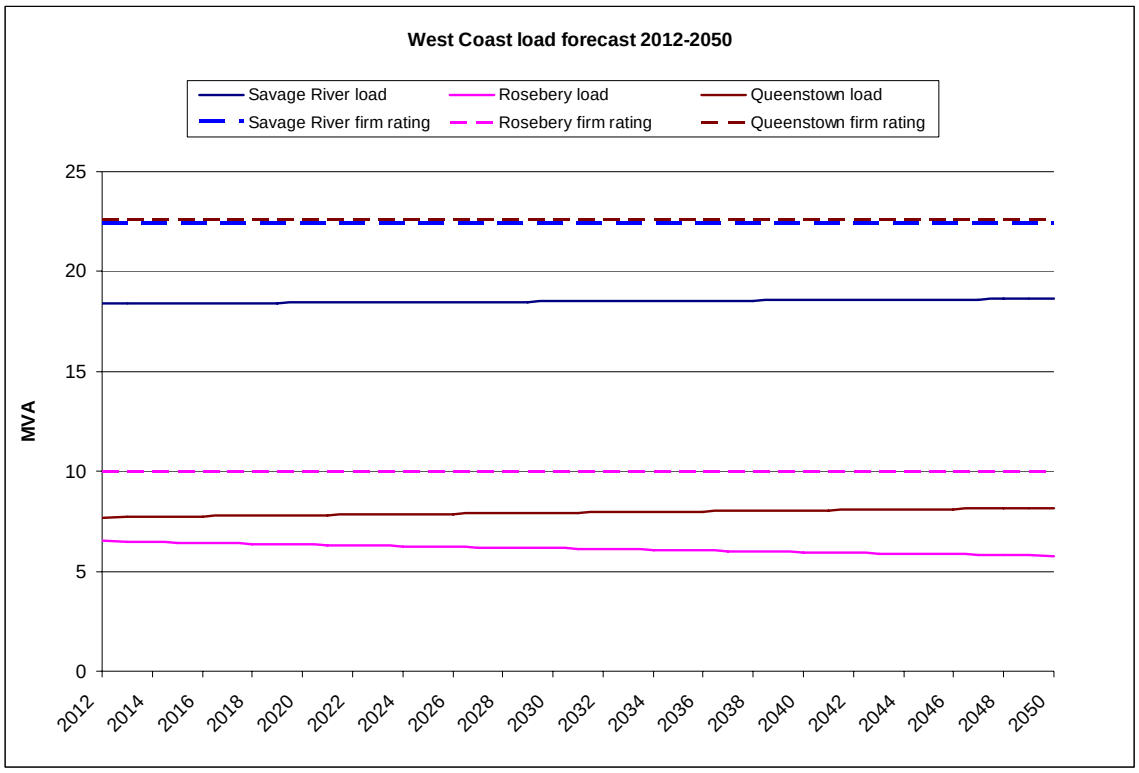

Figure 3-1 West Coast terminal substation load forecast

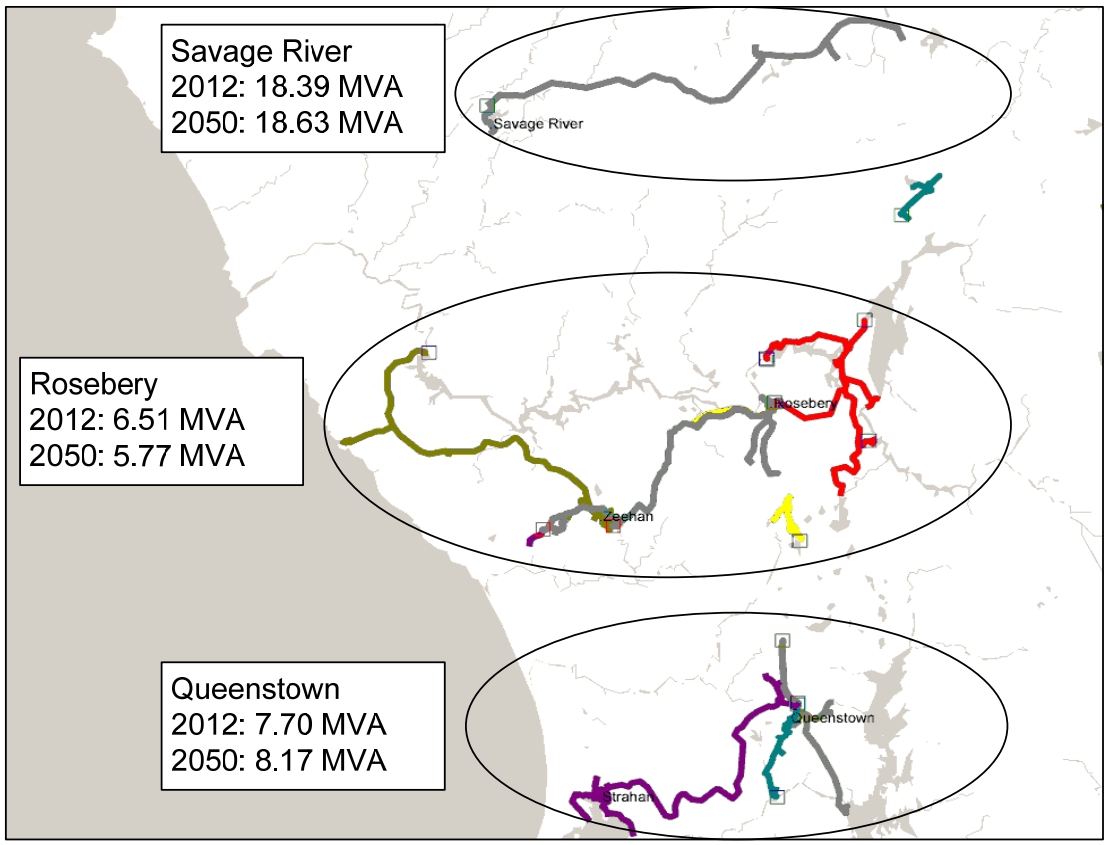

Figure 3-2 West Coast substations area load distribution

4. Limitations

Queenstown

There are three 22 kV distribution feeders from Queenstown terminal substation supplying a load of 7.66 MVA in 2009. Using the medium growth forecast, the terminal substation load grows to 8.17 MVA by 2050. This is well below the firm capacity of the terminal substation. There are no capacity limitations on the Queenstown terminal substation or 22 kV distribution feeders.

The majority of the Queenstown supply area is classified as low density rural for reliability purposes. There are two smaller areas that are classed as urban: Strahan (fed by 98001) and Queenstown (fed by 98002). There is only one radial feeder running to Strahan. This arrangement does not meet the reliability requirements for an area classified as urban.

Natural barriers due to limited access and difficult terrain are major limitations in the West Coast area.

The existing 110/22 kV transformers were installed at Queenstown terminal substation in 1966 and 2003. Assuming an asset life of 50 years, one transformer may reach a predicted age limitation around 2016.

Rosebery

The 44 kV distribution load at Rosebery terminal substation was not modelled with a generic growth forecast due to the presence of large existing point loads.

Table 4-1 Rosebery 44 kV distribution feeder information

Feeder	Customer	Load (2009)	Conductor type	Rating
97011	Rosebery Mine (Transend)	14.8 MVA	Private feeder	685 A / 52 MVA
97013	Supplies Trial Harbour Zone	9.6 MVA	19/3.25 AA	239 A / 18.2 MVA
97014	Bluestone Mine (Aurora)	11.2 MVA	26/.1236-7/.0961	236 A / 18 MVA

Based on the 2009 44 kV peak distribution feeder loads of 35.6 MVA, the firm capacity rating of 30 MVA on the 110/44 kV transformers has been exceeded. Further increases in load will primarily be due to expansions of the existing direct connected customers. The load at Trial Harbour zone substation is predicted to increase by 2-3 MVA with the installation of a secondary crusher at the Allegiance mine. Load increases are also expected at Rosebery and Bluestone mines. This is the only area in the state with 44 kV subtransmission feeders.

The 22 kV distribution load at Rosebery terminal substation in 2009 in the load forecast model is 6.66 MVA. Using the medium growth scenario, the load is predicted to decrease to 5.77 MVA in 2050. There are no capacity limitations on the 22 kV feeders or the 44/22 kV transformers.

The majority of the Rosebery supply area is classified as low density rural for reliability purposes. The Rosebery township is classified as urban. Two 22 kV feeders, 97001 and 97002, supply the township with transfer capacity available between the two feeders in the event of a feeder outage. Zeehan is classified as a high density rural area and is currently supplied from a 22 kV feeder from Trial Harbour zone substation. The old Zeehan substation is due to be decommissioned by 2012.

Natural barriers due to limited access and difficult terrain are major limitations in the West Coast area.

The 110/44/22 kV 30 MVA transformers were installed in 1994. The 44/22 kV 10 MVA transformers were installed in 1983 and 1985. Assuming an asset life of 50 years, the 110/44/22 kV transformers will need to be replaced around 2044 and the 44/22 kV transformers around 2034.

Savage River

The 22 kV distribution load in 2009 in the load forecast model is 1.3 MVA. Using the medium growth forecast, the load is predicted to grow to 1.63 MVA in 2050. There are no capacity limitations on the Savage River 22 kV distribution feeder. The direct connected customer, Goldamere, had an average load of 17 MVA in 2009 and is the major customer on the Savage River terminal substation.

The Savage River area is classified as low density rural and the 110/22 kV 22.5 MVA transformers were installed in 1967. Assuming an asset life of 50 years, the 110/22 kV transformers will need to be replaced around 2017. Transend has advised that the transformers at Savage River were refurbished in the 1990s.

Trial Harbour

The Trial Harbour zone substation principally supplies one customer and is supplied from the Rosebery 44 kV distribution feeder, F97013. Trial Harbour also supplies the Zeehan area at 22 kV. The existing demand is approximately 9 MVA. The load is expected to grow to 14 MVA.

5. Planning philosophy

The West Coast area is characterised by numerous large point loads that are currently supplied at 110 kV and 44 kV. The 22 kV distribution load in the area is fairly small and well supported by the existing 110/22 kV substations. All projects recommended for the West Coast area are subject to impending supply to major mining customer loads.

The 44 kV subtransmission voltage is an unusual voltage and a conversion to 66 kV is planned for the West Coast area. The 66 kV network will provide additional capacity in the subtransmission network and is cheaper to install than new 110 kV network. A staged approach is outlined in the ten year and five year plans for Rosebery in Sections 7.1.1 and 8.3.2.

Network extensions for new large customers (including wind farms) will need to be determined based on the size of the load and the proximity to the 66 kV, 110 kV and 220 kV networks in the West Coast area.

6. Long term strategy

The proposed projects are discussed in more detail 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 Rosebery substation upgrade and 44 kV network conversion

The first stage of the Rosebery substation augmentation includes the installation of a new 110/66/44 kV 60 MVA transformer and relocation of the 22 kV switchroom. This is to be completed in 2014. The conversion of the 44 kV network will be staged to best utilise the existing network throughout the conversion. Further information on the options analysis is provided in the ten year plan in Section 7.1.1 and information on the distribution feeder upgrades is outlined in Section 8.3.2.

6.1.2 Queenstown transformer replacement

The transformer, T1, at Queenstown terminal substation was installed in 1966. Assuming an asset life of 50 years, it is predicted that the transformer will need replacement around 2016. The distribution load is very small and will not influence the timing of the replacement of the transformer. This timing can be refined further by completing regular testing on the transformer as it approaches the 50 year mark.

6.1.3 Savage River transformer replacement

The transformers at Savage River terminal substation were installed in 1967. Assuming an asset life of 50 years, it is predicted that the transformers will need replacement around 2017. The distribution load is very small and will not influence the timing of the replacement of the transformers. The direct connected customer, Goldamere, had an average load of 17 MVA in 2009. An expansion at Goldamere would cause the substation load to approach the firm capacity of the substation. The timing of replacement of the transformers will be dependent on either a request for increased supply from Goldamere or the predicted age replacement year of 2017. This timing can be refined further by completing regular testing on the transformers as they approach the 50 year mark.

6.2 Summary of proposed works

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

Table 6-1 West Coast project summary

Year	Proposed Project	Proposed Outcomes
Ongoing	Rosebery 44 kV network augmentation	Address firm capacity and voltage issues on the Rosebery 44 kV network
2016	Queenstown transformer replacement	Address age limitation on the existing transformer T1
2017	Savage River transformer upgrade	Address age limitation on the existing transformers at Savage River

The resulting load curves and new firm ratings for the West coast substations are shown below.

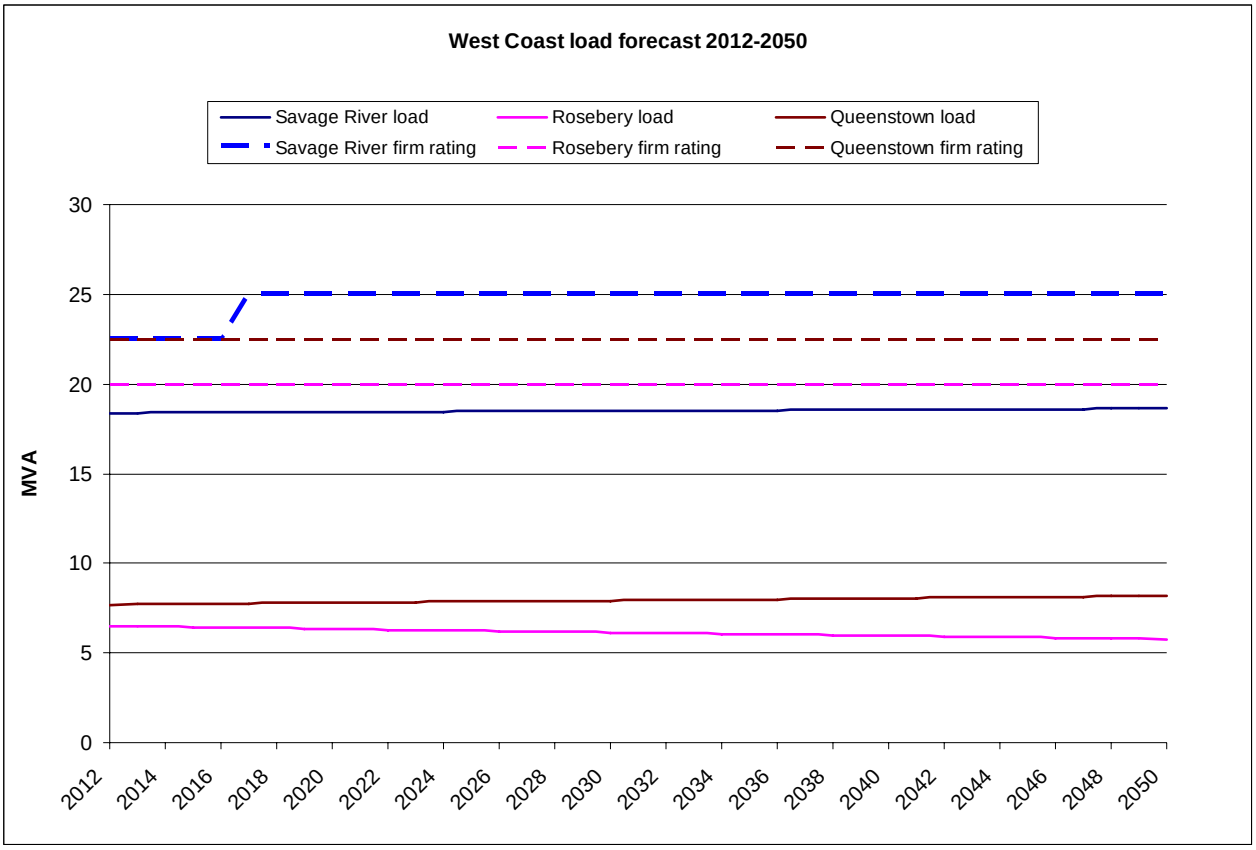

Figure 6-1 West Coast load forecast with updated firm ratings

7. Ten year plan

7.1 Proposed projects

The proposed projects for the ten year plan are outlined below. These projects are subject to impending supply to major mining customer loads.

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).

7.1.1 Rosebery substation upgrade and 44 kV network conversion

Rosebery terminal substation supplies a number of large mines and the Trial Harbour zone at 44 kV and rural areas including Rosebery and Tullah. The Zeehan area is supplied at 22 kV from Trial Harbour.

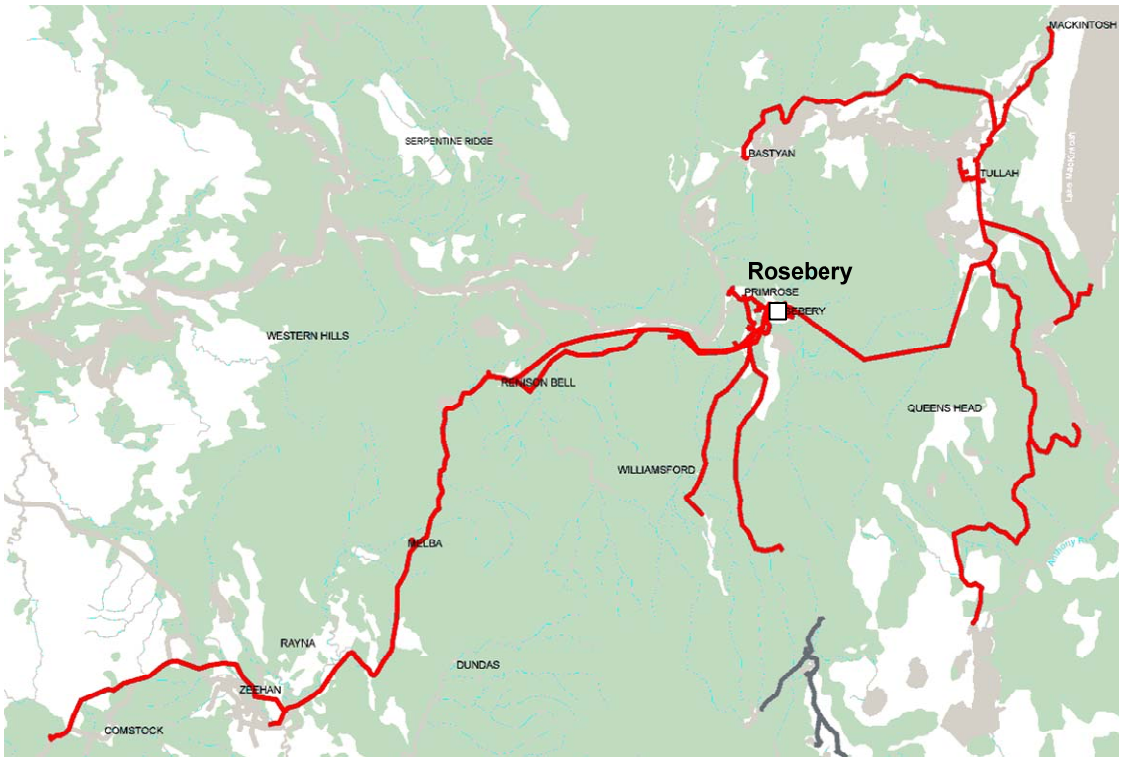

Figure 7-1 Rosebery supply area

Limitations

Rosebery terminal substation has two 30 MVA 110/44 kV transformers and two 44/22 kV transformers. The combined load on the 44 kV feeders and 44/22 kV transformers exceeds the firm capacity of the 110/44 kV transformers during peak times with all mines in operation.

The first 44 kV feeder, 97011, runs to the Rosebery mine and is privately owned and managed by Transend. The second 44 kV feeder, F97013, runs for 33.5 km to Trial Harbour zone substation. The third 44 kV feeder, F97014, runs to Bluestone Mine. The load on the 44 kV feeders to the three mines is forecast to grow significantly as outlined in the following table.

Table 7-1 Rosebery 44 kV distribution feeder information

Feeder	Customer	Load (2009)	Conductor type	Rating	Aurora forecast load
97011	Rosebery Mine (Transend)	14.8 MVA	Private feeder	685 A / 52 MVA	25 MVA
97013	Supplies Trial Harbour Zone	9.6 MVA	19/3.25 AA	239 A / 18.2 MVA	14 MVA
97014	Bluestone Mine (Aurora)	11.2 MVA	26/.1236-7/.0961	236 A / 18 MVA	17.5 MVA

Another main driver for this project is the removal of the 44 kV voltage level from the sub transmission network. This is due to the presence of an unusual voltage and also capacity limitations based on forecast load growth on the existing 44 kV feeders.

Option 1 – Installation of a 110/66 kV terminal substation and a 66/22 kV zone substation

The first option involves the upgrade of the existing transformers to 110/66 kV transformers, new 66 kV switchgear and the installation of a zone substation with two new 66/22 kV transformers. This will be done in stages and the initial configuration will include a 110/66/44 kV transformer and two 66/44/22 kV transformers to allow the continued operation of the 44 kV network.

The three 44 kV feeders will be upgraded to 66 kV in stages and the mining customer transformers will also be replaced.

Option 2 – Installation of a 110/66 kV terminal substation, 110/22 kV transformers and 110/6.6 kV transformers

The second option involves the upgrade of the existing transformers to 110/66 kV transformers, new 66 kV switchgear, two new 110/22 kV transformers and two new 110/6.6 kV transformers. This will be done in stages and the initial configuration will include a 110/66/44 kV transformer and two 110/22 kV transformers to allow the continued operation of the 44 kV network.

The two 44 kV feeders to Bluestone mine and Trial Harbour zone will be upgraded to 66 kV in stages and the mining customer transformers will also be replaced at Bluestone. New 6.6 kV cables will be required to the Rosebery mine when the 110/6.6 kV transformers are installed and the 44 kV feeder will be scrapped.

Option 3 – Installation of a 110/66 kV terminal substation and an 66/22 kV zone substation with 22 kV feeders to supply the Rosebery mine

The third option involves the upgrade of the existing transformers to 110/66 kV transformers, new 66 kV switchgear and the installation of a zone substation with two new 66/22 kV transformers. This will be done in stages and the initial configuration will include a 110/66/44 kV transformer and two 66/44/22 kV transformers to allow the continued operation of the 44 kV network. Larger 66/44/22 kV transformers will be required to support the Rosebery mine load at 22 kV.

The two 44 kV feeders to Bluestone mine and Trial Harbour zone will be upgraded to 66 kV in stages and the mining customer transformers will also be replaced at Bluestone. New 22 kV feeders will be required to the Rosebery mine when the 110/6.6 kV transformers are installed and the 44 kV feeder will be scrapped.

Option 4 – Non-network option

No non-network alternatives have been considered.

Option 5 – Do nothing option

The do nothing option is not considered a feasible option as the firm capacity at Rosebery has been exceeded.

Technical comparison

Table 7-2 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Installation of a 110/66 kV terminal substation and a 66/22 kV zone substation	• Address firm capacity limitations at Rosebery • Utilises existing 44 kV feeders where upgrade is possible - Additional 22 kV and 6.6 kV feeders not required • Requires only one new 110 kV circuit breaker • Uses 66/44/22 kV transformers that can be used as a spare at Trial Harbour • Can be easily staged to incorporate 44 kV network	• Complex transition of 44 kV network to 66 kV network
2	Installation of a 110/66 kV terminal substation, 110/22 kV transformers and 110/6.6 kV transformers	• Address firm capacity limitations at Rosebery	• Requires four additional 110 kV circuit breakers • Will still ultimately require a third 110/66 kV transformer (assuming load increases at existing mines and the Mt.Lindsey load becoming operational) • 110/22 kV transformers required in the first stage of the project • New 6.6 kV cables required to supply 25 MVA – 6x300mm^2 Cu XLPE spaced 450mm • Existing 44 kV feeder to Rosebery mine will be scrapped
3	Installation of a 110/66 kV terminal substation and a 66/22 kV zone substation with 22 kV feeders to supply the Rosebery mine	• Address firm capacity limitations at Rosebery • Requires only one new 110 kV circuit breaker	• Larger 66/44/22 kV transformers required, different to those installed at Trial Harbour • New high capacity 22 kV cables required to supply 25 MVA at Rosebery mine • Existing 44 kV feeder to Rosebery mine will be scrapped

Cost comparison

Table 7-3 Cost comparison of options

Option	Initial Capital Cost ($M)	Total Capital Cost ($M)	Net Present Value ($M)
1	17.0	37.0	26.3
2	22.0	56.3	40.5
3	18.0	38.1	27.1

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 development

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

The scope of works for Transend includes:

Stage 1

- Installation of a new 110/66/44 kV 60 MVA transformer and 110 kV circuit breaker
- Installation of new 66 kV switchgear with twelve breakers (3 transformers CBs)

Ongoing

- Upgrade of 44 kV F97011 (150 m) to Rosebery mine to 66 kV
- Replacement of customer transformers at Rosebery mine (66/6.6kV)
- Replacement of existing 110/44 kV transformers with 110/66 kV 60 MVA transformers
- Changeover to 66 kV windings at Rosebery

The scope of works for Aurora includes:

Stage 1

- Installation of two new 66/44/22 kV zone substation adjacent to the existing terminal substation (two new transformers, 66 kV connection to Rosebery, 22 kV switchgear and cutovers)

Ongoing

- Upgrade of the 44 kV 35 km section of F97013 from Rosebery to Zeehan to 66 kV
- Construction of a new 66 kV feeder to replace F97014 (10 km) to Bluestone mine
- Conversion of the old 44 kV feeder F97014 and 44/0.415 kV customers to 22 kV
- Replacement of customer transformers at Bluestone mine
- Changeover to 66 kV windings at Trial Harbour

Refer to the five year plan in Section 8.3.2 for information on the staging for the 44 kV conversion to 66 kV. The remaining changeover work including customer transformer replacements and the installation of a new 110/66 kV 60 MVA transformer can be completed just before the changeover is to occur (assuming there are no age limitations on the customer transformers).

This project is very dependent on the location of large future customer loads. Further analysis will be required when more information is available. The location of the load may necessitate the construction of a new substation in a position more suitable to supply the new load.

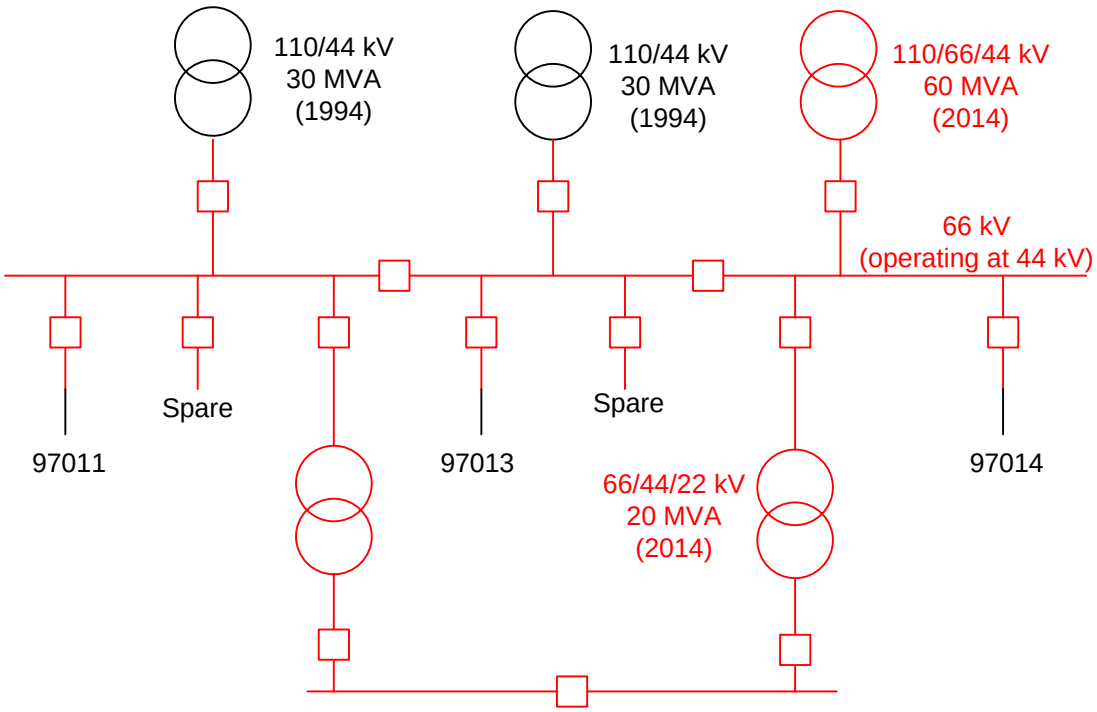

Figure 7-2 Rosebery substation configuration after Stage 1

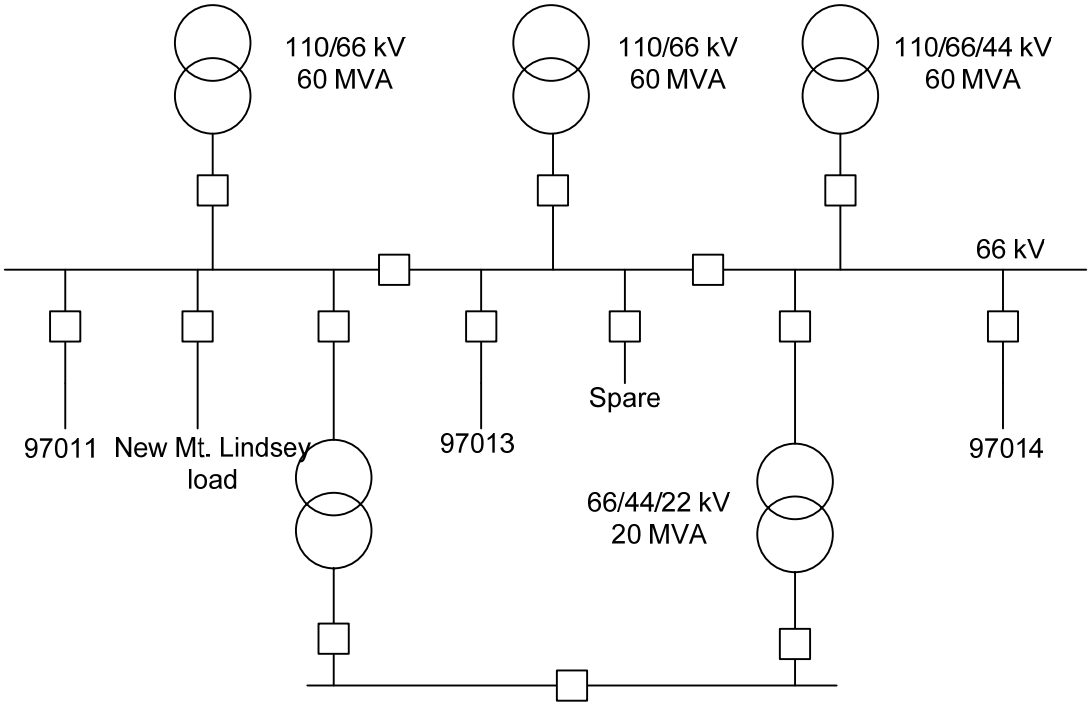

Figure 7-3 Rosebery substation configuration ultimate

7.1.2 Queenstown transformer replacement

Queenstown substation supplies Queenstown and Strahan.

Limitations

The transformer, T1, at Queenstown terminal substation was installed in 1966. Assuming an asset life of 50 years, it is predicted that the transformer will need replacement around 2016. The distribution load is very small and will not influence the replacement of the transformers.

Option 1 – Replace the ageing transformer at Queenstown substation

The first option is to replace the existing 110/22 kV 22.5 MVA transformers with a new 110/22 kV 25 MVA transformer. This will address the predicted age limitation of the existing transformer.

Option 2 – Non-network option

No non-network alternatives have been considered.

Option 3 – Do nothing option

The do nothing option is not considered a feasible option as the Queenstown transformer is predicted to reach its age limitation around 2016.

Recommended development

It is recommended that the existing transformers at Queenstown substation be replaced around 2016. This timing can be refined further by completing regular testing on the transformer as it approaches the 50 year mark.

The estimated cost of this project is $3 million.

7.1.3 Savage River transformer replacement

Savage River substation supplies a direct connected mining customer, Goldamere, and the small township of Savage River.

Limitations

The transformers at Savage River terminal substation were installed in 1967. Assuming an asset life of 50 years, it is predicted that the transformers will need replacement around 2017. The distribution load is very small and will not influence the replacement of the transformers. The direct connected customer, Goldamere, had an average load of 17 MVA in 2009. An expansion at Goldamere would cause the substation load to approach the firm rating of the transformers.

Option 1 – Replace the ageing transformers at Savage River substation

The first option is to replace the two existing 110/22 kV 22.5 MVA transformers with two new 110/22 kV 25 MVA transformers. This will address the predicted age limitation of the existing transformers.

Option 2 – Non-network option

No non-network alternatives have been considered.

Option 3 – Do nothing option

The do nothing option is not considered a feasible option as the Savage River transformers are predicted to reach their age limitation around 2017.

Recommended development

It is recommended that the existing transformers at Savage River substation be replaced around 2017. This timing can be refined further by completing regular testing on the transformer as it approaches the 50 year mark.

The estimated cost of this project is $6 million.

7.2 Summary of proposed works

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

Table 7-4 West Coast project summary

Year	Proposed Project	Proposed Outcomes
Ongoing	Rosebery 44 kV network augmentation	Address firm capacity and voltage issues on the Rosebery 44 kV network
2016	Queenstown transformer replacement	Address age limitation on the existing transformer at Queenstown
2017	Savage River transformer replacement	Address age limitation on the existing transformers at Savage River

8. Five year plan

A five year plan for each of the substations in the West Coast 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 million (RIT-D) or $5 million (RIT-T).

8.1 Queenstown substation

Queenstown terminal substation supplies the urban areas of Queenstown and Strahan and the surrounding rural area.

8.1.1 Limitations

Using the medium growth forecast, the Queenstown terminal substation load in 2012 is forecast to be 7.70 MVA and it is forecast to grow to 7.77 MVA in 2017.

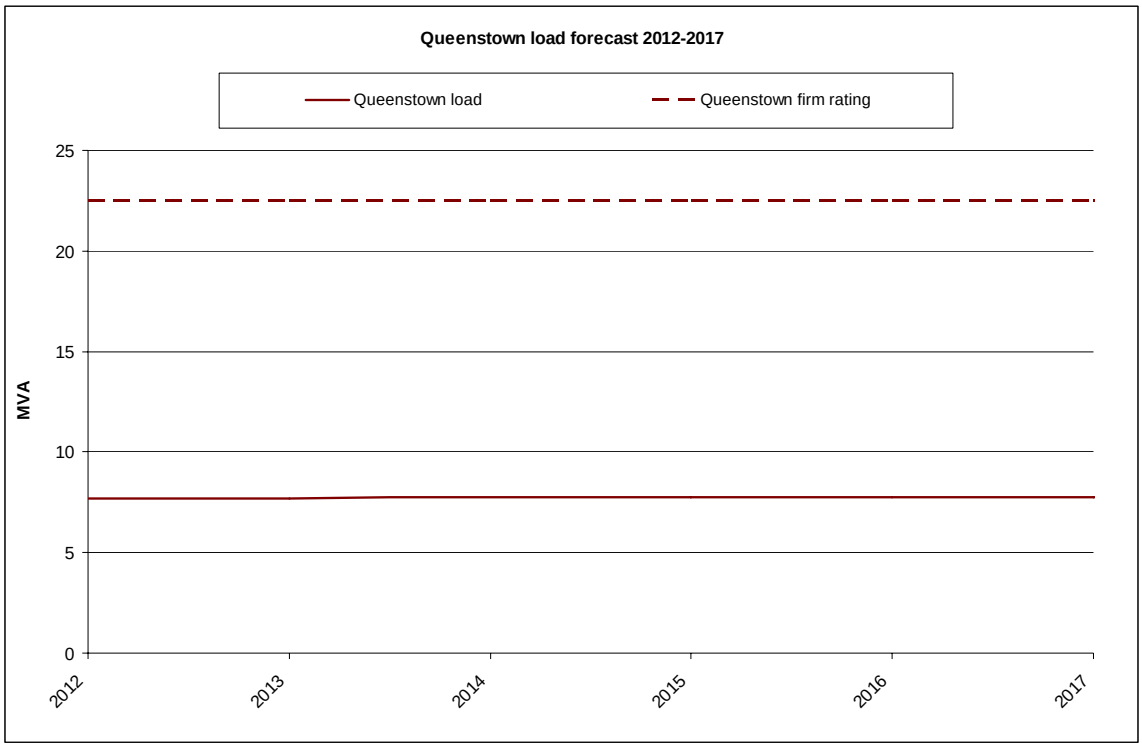

Figure 8-1 Substation five year medium growth forecast

The existing 22 kV network consists of three 22 kV feeders and there is one spare 22 kV circuit breaker. The Queenstown 22 kV supply area and individual 22 kV feeders are shown in the following figures.

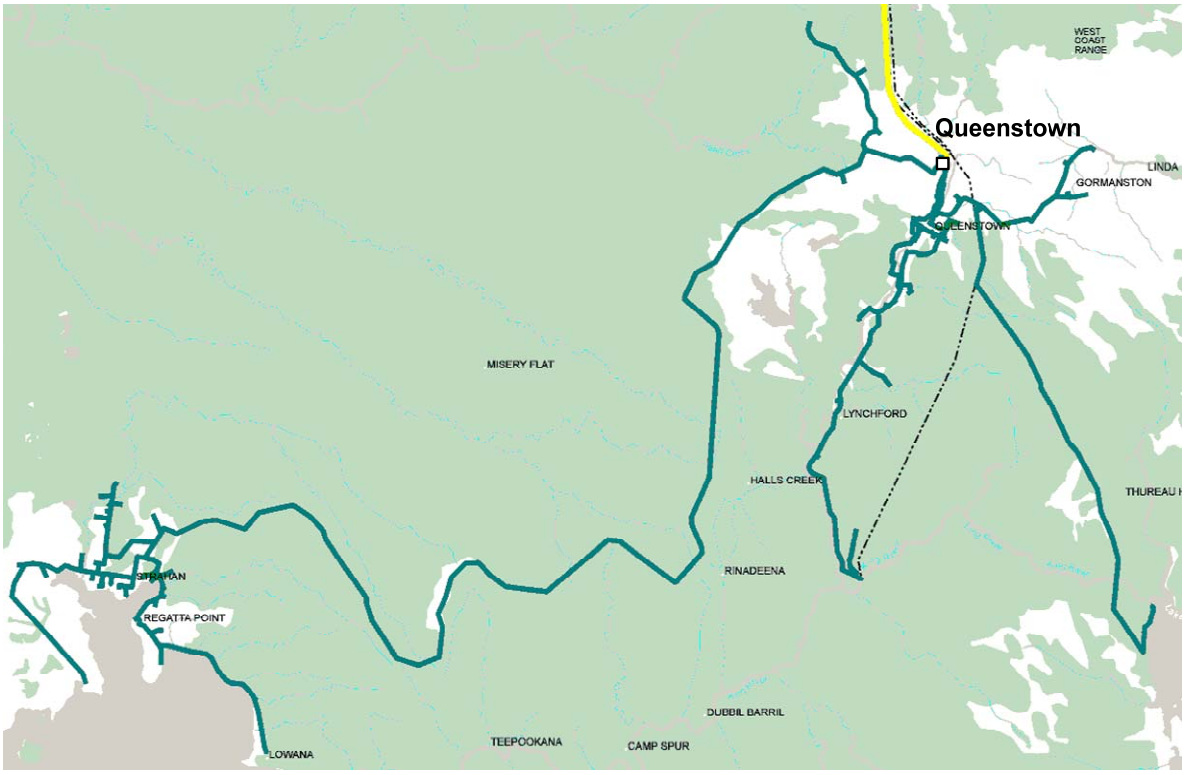

Figure 8-2 Queenstown 22 kV supply area

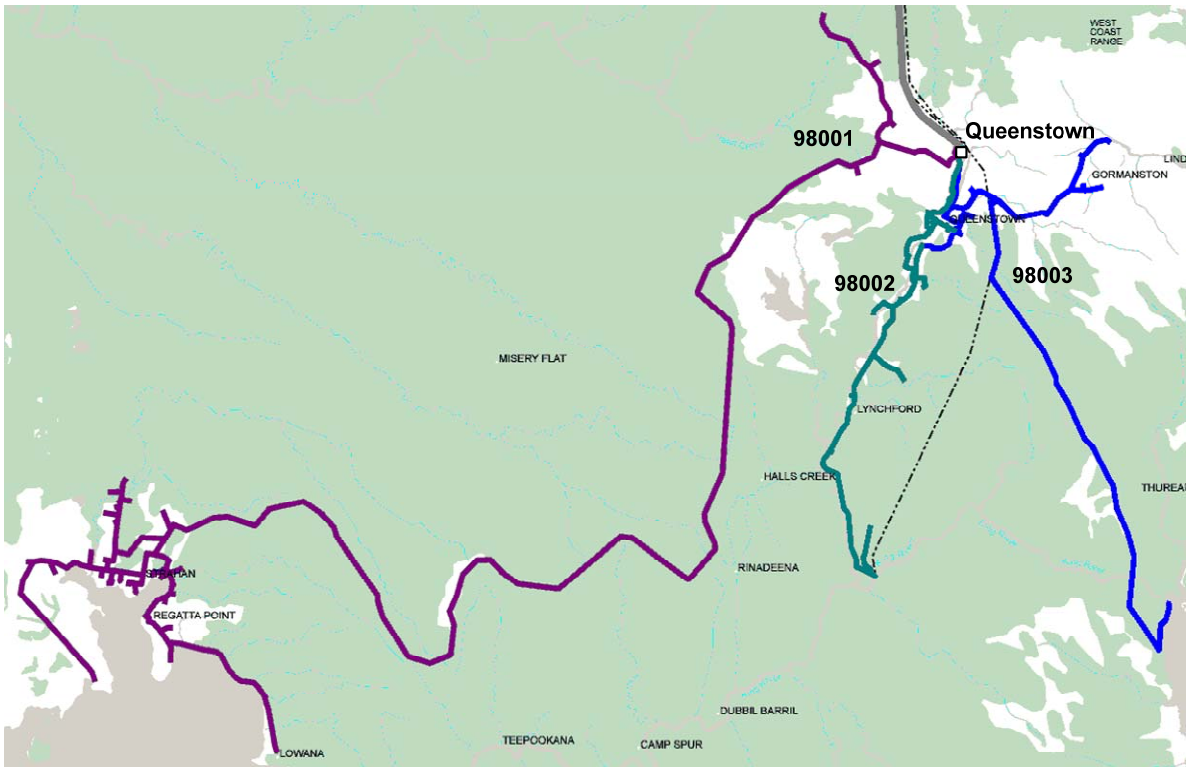

Figure 8-3 Queenstown 22 kV individual feeders

A five year feeder forecast has been developed using the actual peak feeder loads from 2009 and the forecast medium substation growth. The forecast for each feeder is outlined in the following table.

Table 8-1 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Queenstown	98001	2.52	2.53	2.53	2.54	2.54	2.55
	98002	3.20	3.20	3.21	3.21	3.22	3.23
	98003	1.89	1.89	1.89	1.90	1.90	1.90

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that there are no limitations present on the Queenstown 22 kV feeders.

Queenstown substation does not have any transfer capability with other terminal substation in the network.

8.1.2 Proposed projects

There are no proposed substation or feeder projects in the Queenstown supply area.

8.1.3 Ultimate configuration

Substation

Queenstown is expected to remain a two transformer 110/22 kV substation up to 2050. The transformer T1 will be replaced around 2016 due to a predicted age limitation.

Feeders

The growth in the Queenstown area is forecast to be very low and capacity of the existing 22 kV feeders is currently sufficient. There are spare circuit breakers available on the 22 kV board and new feeders may be required throughout the long term plan to address reliability issues on the long 22 kV feeders.

8.2 Savage River substation

Savage River terminal substation supplies the small town of Savage River, nearby rural communities and the Savage River mine.

8.2.1 Limitations

Using the medium growth forecast, the Savage River terminal substation load in 2012 is forecast to be 18.39 MVA and it is forecast to grow to 18.41 MVA in 2017.

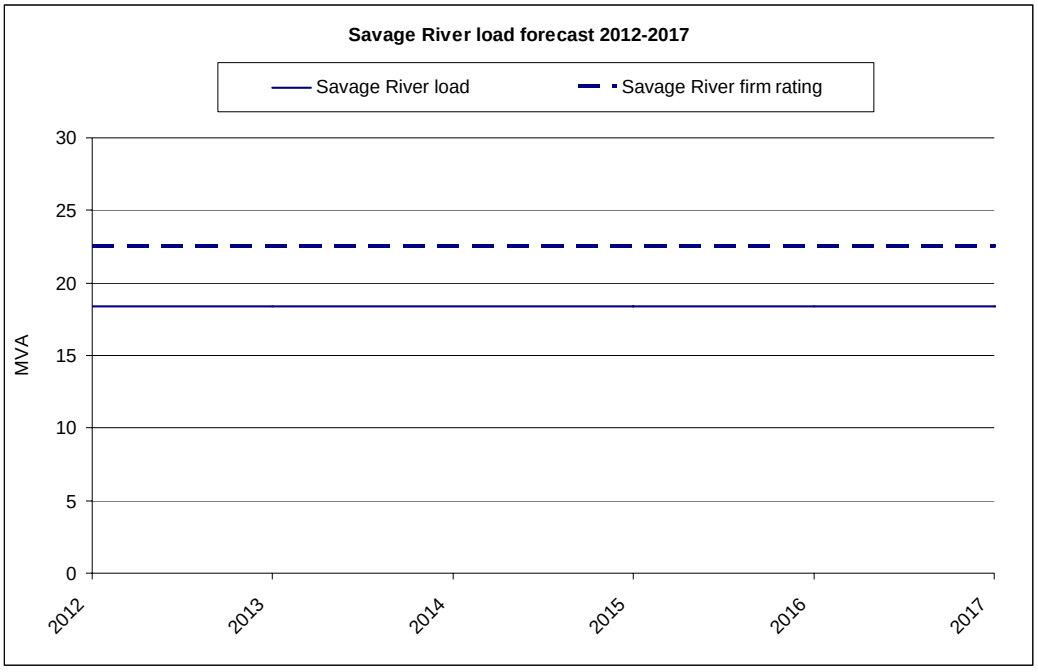

Figure 8-4 Substation five year medium growth forecast

The existing Aurora 22 kV network consists of one 22 kV feeder to the township and rural areas and there are no spare 22 kV circuit breakers. The Savage River 22 kV supply area is shown in the following figure.

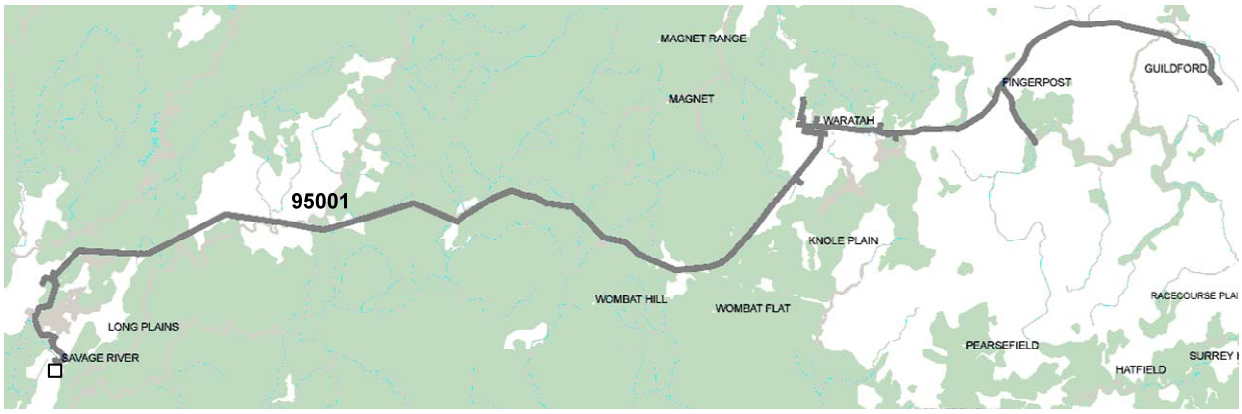

Figure 8-5 Savage River 22 kV supply area

A five year feeder forecast has been developed using the actual peak feeder loads from 2009 and the forecast medium substation growth. The forecast for the 22 kV feeder is outlined in the following table.

Table 8-2 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Savage River	95001	1.20	1.20	1.20	1.20	1.20	1.20

The forecast feeder load has been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that there is no limitation present on the Savage River 22 kV feeder.

Savage River substation does not have transfer capability with any other terminal substations in the network.

8.2.2 Proposed projects

Savage River transformer replacement

It is recommended that the existing transformers at Savage River substation be replaced around 2017. This timing can be refined further by completing regular testing on the transformer as it approaches the 50 year mark. Information on the options analysis for this project is available for reference in Section 7.1.2.

8.2.3 Ultimate configuration

Substation

Savage River substation supplies a small distribution load and a large mining load. The future of the substation is dependent upon the mine. Savage River is expected to remain a two transformer 110/22 kV substation up to 2050. The transformers have been recommended to be replaced around 2017 due to age limitations and slightly larger transformers will be installed to allow for a load increase at Savage River mine.

Feeders

The growth in the Savage River area is forecast to be very low and the capacity of the existing 22 kV feeders is currently sufficient.

8.3 Rosebery substation

Rosebery terminal substation supplies a number of areas including Rosebery, Tullah and Trial Harbour at both 22 kV and 44 kV. The Zeehan area is supplied at 22 kV from Trial Harbour.

8.3.1 Limitations

Using the medium growth forecast, the Rosebery 22 kV terminal substation load in 2012 is forecast to be 6.51 MVA and it is forecast to decline to 6.40 MVA in 2017.

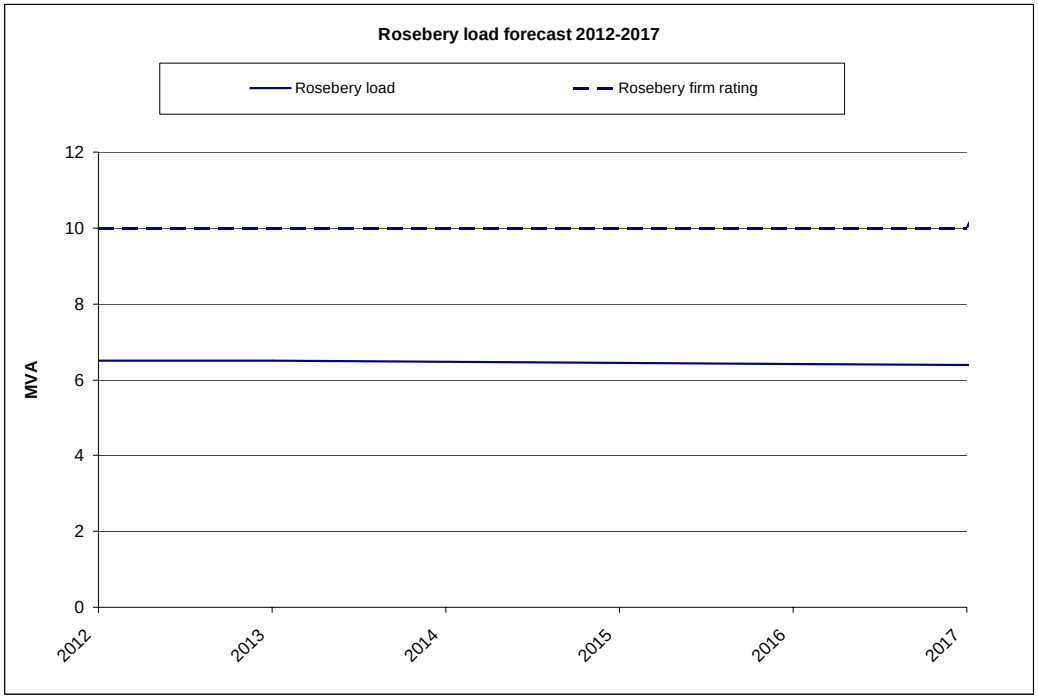

Figure 8-6 Substation five year medium growth forecast

The 44 kV feeder forecast is outlined below.

Table 8-3 Rosebery 44 kV distribution feeder information

Feeder	Customer	Load (2009)	Conductor type	Rating	Aurora forecast load
97011	Rosebery Mine (Transend)	14.8 MVA	Private feeder	685 A / 52 MVA	25 MVA
97013	Supplies Trial Harbour Zone	9.6 MVA	19/3.25 AA	239 A / 18.2 MVA	14 MVA
97014	Bluestone Mine (Aurora)	11.2 MVA	26/.1236-7/.0961	236 A / 18 MVA	17.5 MVA

The existing network consists of three 22 kV feeders and three 44 kV feeders. There are currently no spare circuit breakers but this will be addressed in the Rosebery substation upgrade to be completed before 2012. The Rosebery 22 kV and 44 kV supply area and individual 22 kV and 44 kV feeders are shown in the following figures.

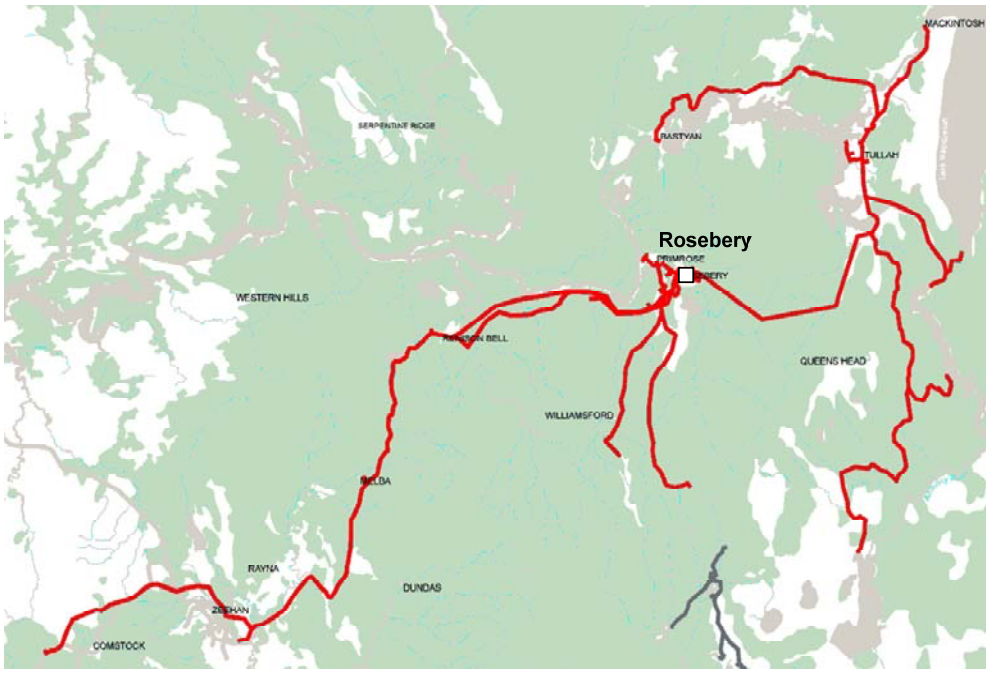

Figure 8-7 Rosebery 22 kV and 44 kV supply area

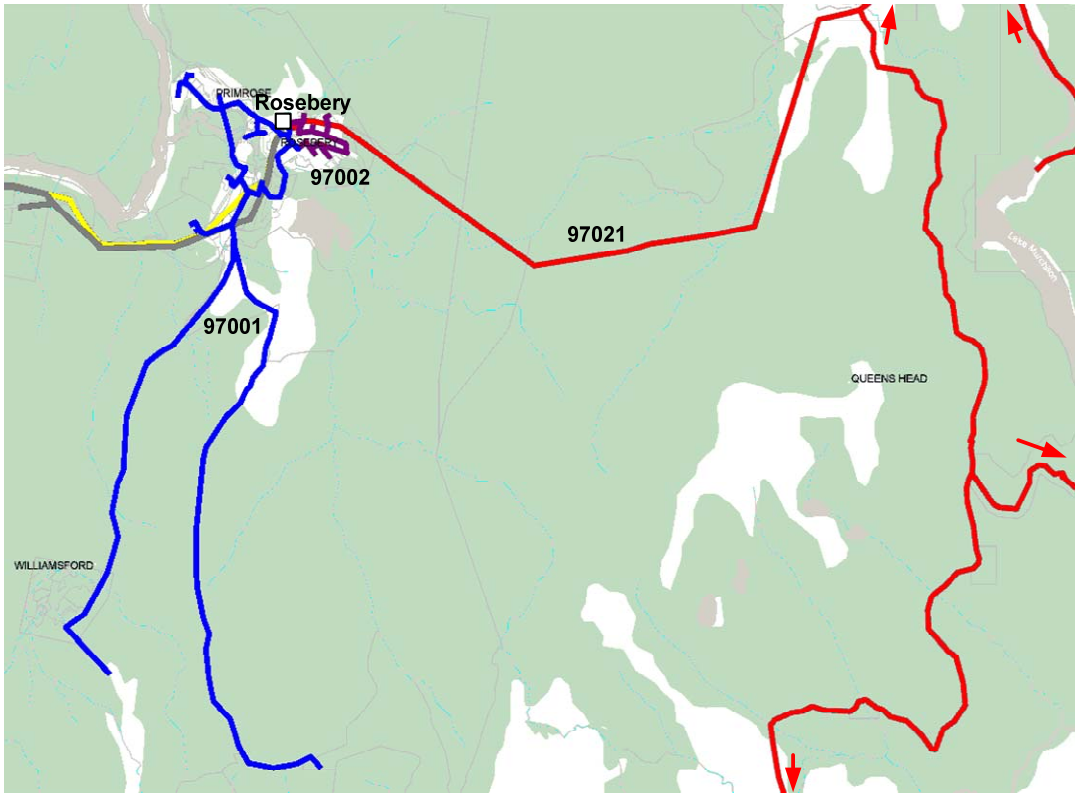

Figure 8-8 Rosebery 22 kV individual feeders

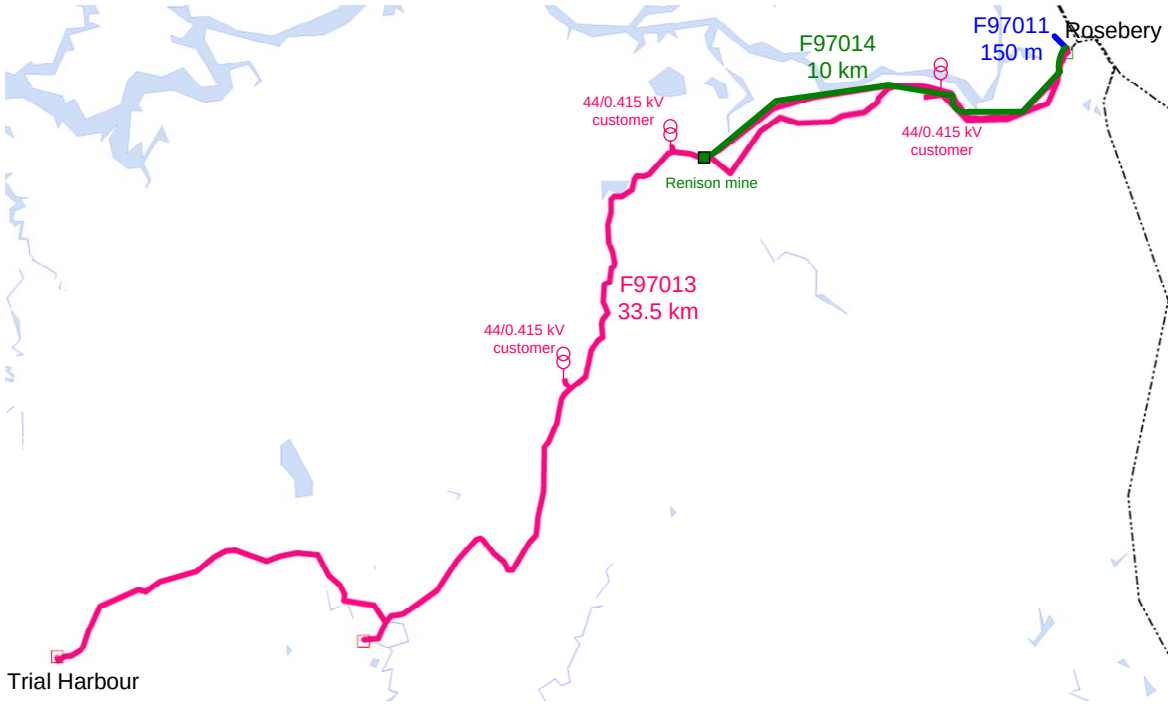

Figure 8-9 Rosebery 44 kV individual feeders

A five year feeder forecast for the 22 kV feeders has been developed using the actual peak feeder loads from 2009 and the forecast medium substation growth. The forecast for each feeder is outlined in the following table.

Table 8-4 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Rosebery	97001	1.35	1.35	1.34	1.34	1.33	1.33
	97002	1.02	1.01	1.01	1.01	1.00	1.00
	97021	0.61	0.61	0.61	0.61	0.60	0.60

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that there are no limitations present on the Rosebery 22 kV feeders.

Rosebery substation does not have any transfer capability with other terminal substation in the network.

8.3.2 Proposed projects

Rosebery substation upgrade and 44 kV network conversion

The first stage of the Rosebery substation augmentation includes the installation of a new 110/66/44 kV 60 MVA transformer and relocation of the 22 kV switchroom. This is to be completed in 2014. The conversion of the 44 kV network will then be staged to best utilise the existing network throughout the conversion. Further information on the options analysis is provided in the ten year plan in Section 7.1. The staging for the 44 kV network conversion is outlined below.

The initial stage will be to build a single circuit 66 kV feeder from Rosebery substation to the Renison mine. This feeder will initially be cut in to F97013 near the Rension mine. It will be used to supply the load on F97013 while the first 10 km of this feeder is upgraded to operate at 66 kV. This will assist in avoiding outages and live line work on the first section of F97013. F97011 will be upgraded to 66 kV by Transend after discussion with Rosebery mine.

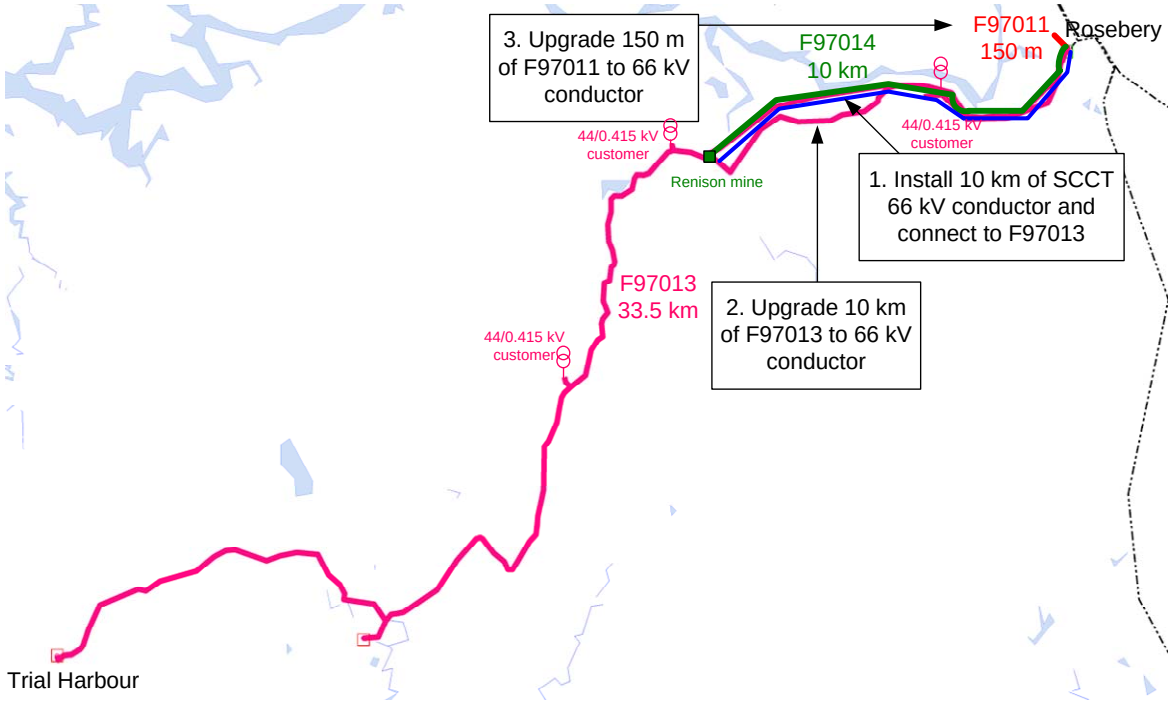

Figure 8-10 Rosebery 44 kV network upgrade Stage 1

When the replacement of the first section of F97013 is complete, the new section of 66 kV feeder will then be connected to the Renison mine in place of F97014. The remaining 25 km section of 44 kV feeder F97013 from Zeehan to the Renison mine will then need to be upgraded to operate at 66 kV.

The 22 kV works can be completed in conjunction with the 44 kV upgrades. The old 44 kV feeder F97014 will be converted to operate at 22 kV. This can be as a new dedicated 22 kV feeder from Rosebery or a section of the old 44 kV feeder can be connected to the existing 22 kV feeder 97001 approximately 2 km from the Rosebery substation. The 44/0.415 kV customers will be converted to 22/0.415 kV. A new section of 22 kV feeder will be required from the Renison mine to the customer transformers at the old Renison Village and Melba Siding. This will be a 7 km section and will be under built on the existing highway route when the remaining section of F97013 is upgraded to 66 kV.

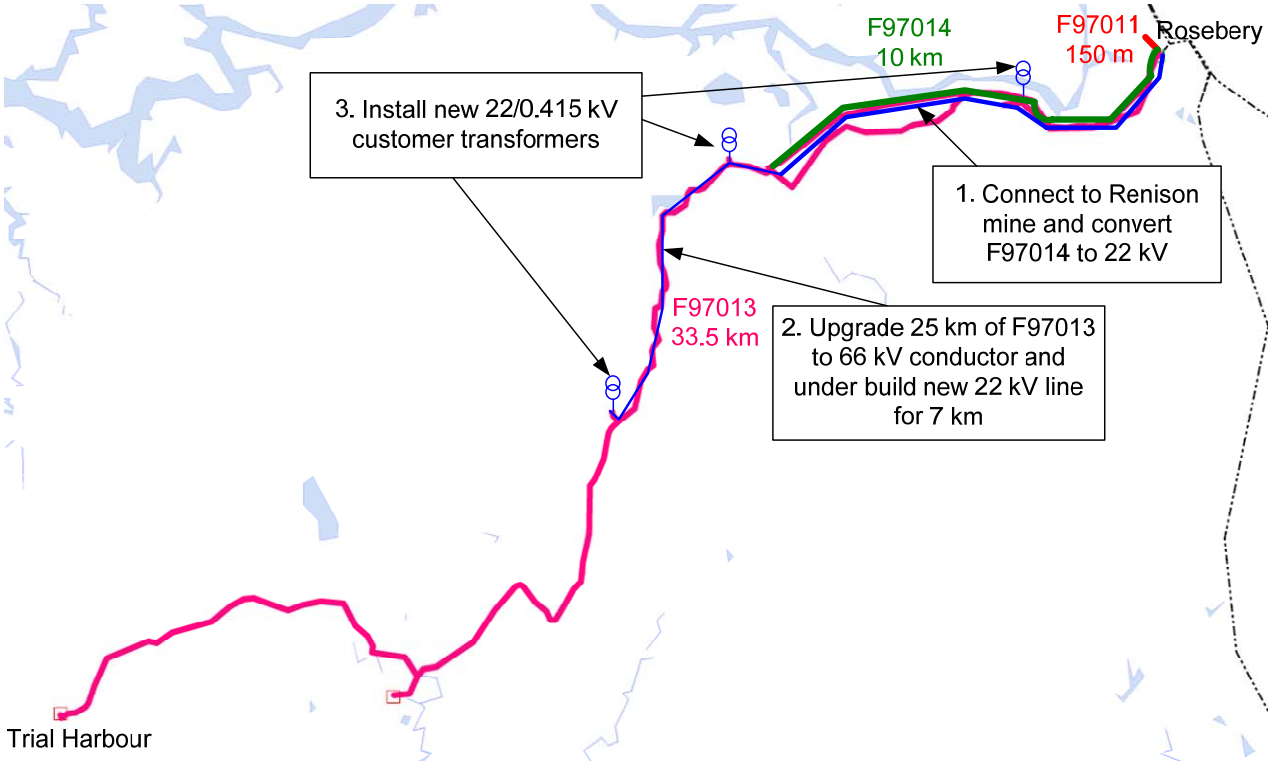

Figure 8-11 Rosebery 44 kV network upgrade Stage 2

8.3.3 Ultimate configuration

Substation

Rosebery substation will ultimately become a three transformer substation with three 110/66 kV 60 MVA transformers. The 66/22 kV zone substation may be adjacent to the site or nearby depending on land availability. The zone substation will remain a two transformer substation until 2050.

Feeders

The general growth in the Rosebery area is forecast to be very low and capacity of the existing 22 kV feeders is currently sufficient. There will be spare circuit breakers available on the new 22 kV board and new feeders may be required throughout the long term plan to address reliability issues on the long 22 kV feeders. Conduit routes out of the substation will be established during the upgrade and should include additional conduits for future feeders.

The growth on the new 66 kV network will be based on new customer applications for large point loads. These applications will need to be assessed on a case by case basis. Spare circuit breakers will be available on the new 66 kV switchboard.

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	Rosebery substation upgrade and 44 kV network conversion	7.1.1

Rosebery substation upgrade and 44 kV network conversion

Base Year

2010

OPTION 1

Installation of a 110/66 kV terminal substation and an 66/22 kV zone substation

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2014	2013	2015	Rosebery 110/44 kV transformer capacity exceeded	- Install 110/66/44 kV transformer, 110 kV CB and 66 kV switchgear - Install 66/44/22 kV zone substation	$17,000	$13.65	$13.15	$12.66	$14.42	$14.02	$13.63	$12.92	$12.33	$11.76
2015	2014	2016	44 kV feeder capacity exceeded	- Convert 44 kV feeders to 66 kV	$6,000	$4.56	$4.35	$4.15	$4.82	$4.64	$4.47	$4.32	$4.08	$3.86
2015	2014	2016	44 kV feeder capacity exceeded	- Replace 110/44 kV tranformers with new 110/66 kV 60 MVA transformer	$7,000	$5.32	$5.08	$4.84	$5.62	$5.41	$5.21	$5.04	$4.76	$4.50
2020	2019	2021	Rosebery 110/66 kV transformer capacity exceeded	- Install third 110/66 kV transformer	$7,000	$4.04	$3.68	$3.35	$4.27	$3.92	$3.61	$3.83	$3.45	$3.11
					Total	**$27.58**	**$26.25**	**$25.01**	**$29.13**	**$28.00**	**$26.92**	**$26.10**	**$24.62**	**$23.24**

OPTION 2

Installation of a 110/66 kV terminal substation, 110/22 kV transformers and 110/6.6 kV transformers

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2014	2013	2015	Rosebery 110/44 kV transformer capacity exceeded	- Install 110/66/44 kV transformer, 110 kV CB and 66 kV switchgear - Install 110/22 kV zone substation with two new 110 kV CBs	$22,000	$17.66	$17.01	$16.39	$18.66	$18.14	$17.64	$16.72	$15.95	$15.22
2015	2014	2016	44 kV feeder capacity exceeded	- Install 110/6.6 kV zone substation and 6.6 kV cables	$14,325	$10.89	$10.39	$9.91	$11.50	$11.08	$10.67	$10.31	$9.74	$9.21
2015	2014	2016	44 kV feeder capacity exceeded	- Convert 44 kV feeders to 66 kV	$6,000	$4.56	$4.35	$4.15	$4.82	$4.64	$4.47	$4.32	$4.08	$3.86
2015	2014	2016	44 kV feeder capacity exceeded	- Replace 110/44 kV tranformers with new 110/66 kV 60 MVA transformer	$7,000	$5.32	$5.08	$4.84	$5.62	$5.41	$5.21	$5.04	$4.76	$4.50
2020	2019	2021	Rosebery 110/66 kV transformer capacity exceeded	- Install third 110/66 kV transformer	$7,000	$4.04	$3.68	$3.35	$4.27	$3.92	$3.61	$3.83	$3.45	$3.11
					Total	**$42.48**	**$40.51**	**$38.65**	**$44.87**	**$43.19**	**$41.60**	**$40.21**	**$37.98**	**$35.91**

OPTION 3

Installation of a 110/66 kV terminal substation and an 66/22 kV zone substation with 22 kV feeders to supply the Rosebery mine

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2014	2013	2015	Rosebery 110/44 kV transformer capacity exceeded	- Install 110/66/44 kV transformer, 110 kV CB and 66 kV switchgear - Install 66/44/22 kV zone substation with large transformers	$18,000	$14.45	$13.92	$13.41	$15.27	$14.84	$14.43	$13.68	$13.05	$12.46
2015	2014	2016	44 kV feeder capacity exceeded	- Install 22 kV cables to Rosebery mine	$100	$0.08	$0.07	$0.07	$0.08	$0.08	$0.07	$0.07	$0.07	$0.06
2015	2014	2016	44 kV feeder capacity exceeded	- Convert 44 kV feeders to 66 kV	$6,000	$4.56	$4.35	$4.15	$4.82	$4.64	$4.47	$4.32	$4.08	$3.86
2015	2014	2016	44 kV feeder capacity exceeded	- Replace 110/44 kV tranformers with new 110/66 kV 60 MVA transformer	$7,000	$5.32	$5.08	$4.84	$5.62	$5.41	$5.21	$5.04	$4.76	$4.50
2020	2019	2021	Rosebery 110/66 kV transformer capacity exceeded	- Install third 110/66 kV transformer	$7,000	$4.04	$3.68	$3.35	$4.27	$3.92	$3.61	$3.83	$3.45	$3.11
					Total	**$28.45**	**$27.10**	**$25.83**	**$30.06**	**$28.90**	**$27.80**	**$26.93**	**$25.41**	**$23.99**

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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