



FINAL REPORT

DEVELOPMENT OF

NEW BALGOWLAH ZONE SUBSTATION

1st May 2009

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EXECUTIVE SUMMARY

This final report has been prepared to report on upgrade work that is proposed to develop the electricity supply network in the Balgowlah load area in accordance with Clause 5.6.2 (h) of the National Electricity Rules. The work proposed by this report is classified as a new large distribution asset under the National Electricity Rules.

A Consultation Paper on the projected limitation and possible options was published on 12th May 2008. This Consultation Paper included a preliminary application of the Regulatory Test to options that had been identified to address the projected limitations. No submission was received in response to this paper.

To provide a safe and reliable electricity supply for existing customers and new developments in the Manly Warringah area, EnergyAustralia is faced with a primary need to provide additional supply system capacity to meet forecasted load demands. The provision of additional capacity is required to meet network performance requirements set in accordance with Schedule 5.1 of the Rules and EnergyAustralia's licence conditions.

This report covers the following issues:

Section 1 provides a background of the Manly Warringah load area and the need for augmentation of the distribution network.

Section 2 presents EnergyAustralia's service standards for the area and describes, in detail, various asset condition and forecast capacity issues in the area that resulted in the need for augmentation of supply to the area.

Section 3 describes the proposed augmentation in relation to the National Electricity Rule (the Rules). The proposed Balgowlah zone substation is classified as a distribution network asset by the Rules, and the proposed development is classified as a new large network asset as it involves augmentation expenditure of above \$10M.

Section 4 describes the options that were considered to address the issues affecting the supply network including options for supply system development. Two options are described:

Option 1 – Develop a new 33/11kV Balgowlah zone substation

Option 2 – Develop a new 132/11kV Balgowlah zone substation

Option 3 – Develop a new hybrid 132/33/11kV Balgowlah zone substation

These options have been considered in the context of the long term area strategy for the Manly Warringah load area.

Section 5 presents the results of the regulatory test and ranks the options.

Section 6 concludes that the most cost effective option within the regulatory test is Option 3 – Development of a new hybrid 132/33/11kV Balgowlah zone substation with ultimate conversion to full 132kV operation.

The first stage of Option 3 has an estimated capital cost of \$58.6M which includes commissioning of new hybrid 132/33/11kV Balgowlah zone substation, new 132kV feeders, reconfiguration of 33kV feeders, and sale of the existing site. The first stage is anticipated to complete by 2013. The total estimated cost including ultimate full conversion to 132kV operation is \$68.2M.

1 BACKGROUND

This Final Report has been prepared to meet the requirements of clause 5.6.2(h) of the National Electricity Rules (the Rules) and to advise on the development work that is proposed to develop the electricity supply network in the Balgowlah area. The information provided includes:

- A discussion of emerging supply system limitations identified by EnergyAustralia that have led to identification of options to address projected limitations for the supply network in the Manly Warringah area;
- A discussion of the service standard that has been adopted for planning purposes;
- A description of options for development of the electricity supply in the area required; and
- Details of the outcomes of cost effectiveness analysis for the options considered.

The Manly Warringah load area is bordered on three sides by Middle Harbour and the Tasman Sea. It is separated from the adjoining Pittwater area by Narrabeen Lakes and bushland. The network supplies Manly and most of Warringah Shire. The network in the Manly Warringah:

- Is supplied at 33kV from Warringah subtransmission substation, which is in turn supplied from TransGrid's transmission system at Sydney East by four 132kV circuits on two tower lines using a common route close to Warringah;
- Comprises nine 33/11kV zone substations, most of which have relatively small capacity and are located on small sites;
- Is supplied by a network of 33kV feeders, which consists both of overhead lines, which generally cover inland areas, and underground cables, which generally cover the coastal areas;
- Includes zone substations where ratings are limited by the 33kV lines being loaded to capacity as a result of adjacent zone substations sharing the feeder to the tee-point;
- Serves urban residential and commercial areas, as well as industrial demand at Dee why West and retail demand at Warringah Mall; and
- Serves Sydney Water's sewage treatment plant at North Head, which is a large load at the network's extremity.

The Balgowlah load area is part of the Manly/Warringah area, and is currently supplied by Sydney East Bulk Supply Point (BSP) via Warringah Subtransmission Substation (STS). The load transfers of an initial 10MVA from Balgowlah to Harbord zone substation was completed in May 2007 and this has offered short-term load relief at Balgowlah zone substation. The Balgowlah zone substation is forecast to operate above its licence capacity from winter 2012 following this load transfer.

Further, Warringah STS is forecast to exceed firm capacity in winter 2009. Hence, action is required to reduce the risk of loss of supply in the Balgowlah area at times of peak load. Load growth in Warringah load area is in the order of 2% pa in winter and 2.4% pa in summer.

As per the condition assessment report, Balgowlah is a heritage listed substation constructed in 1920s and is in reasonable condition for its age. However, a substantial proportion of the substation equipment is in a deteriorated state and in need for replacement within the next five years.

Figure 1 indicates the geographic overview of the area and the relative locations of the proposed development.

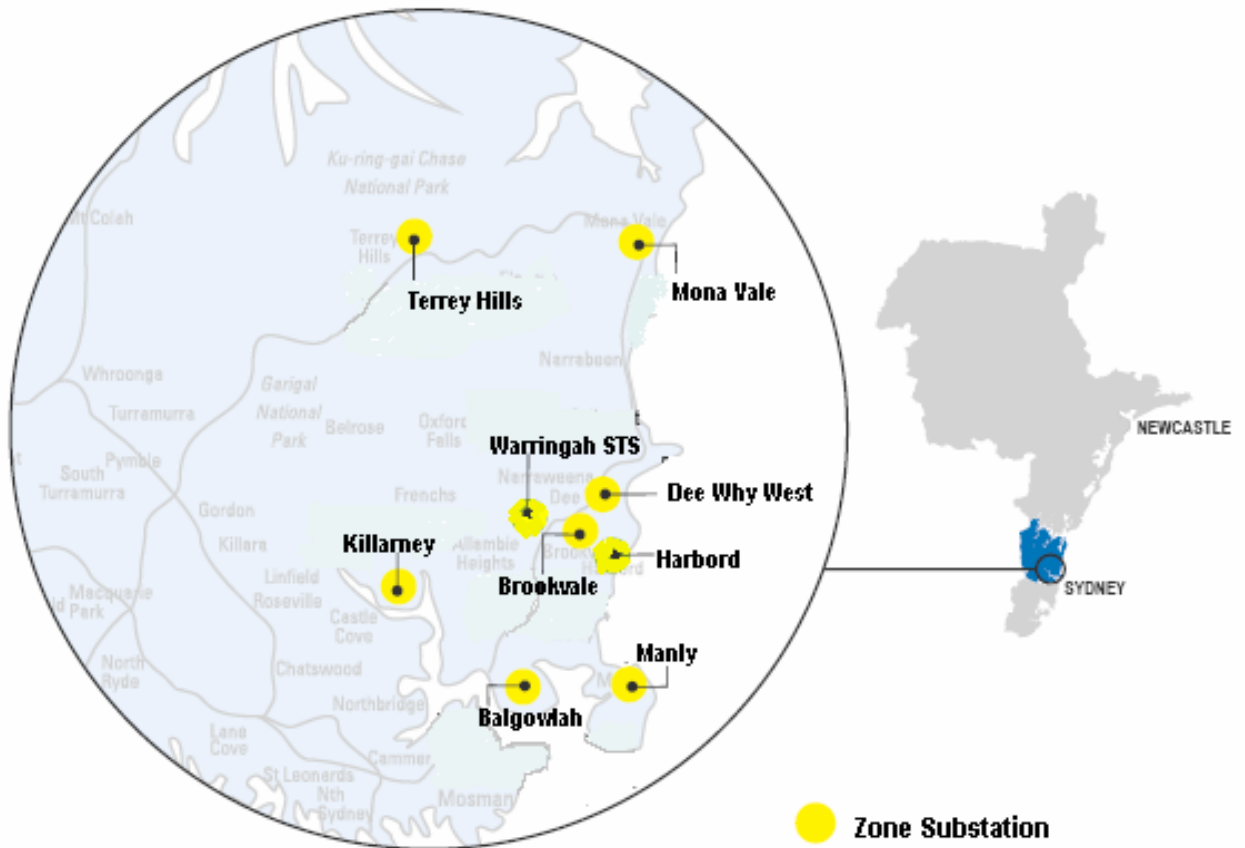


Figure 1: Geographic Overview of Manly Warringah Area

1.1 Supply Arrangement

1.1.1 Zone Substations

Supply to the existing Balgowlah and its surrounding load area is currently provided by the following zone substations:

Balgowlah Zone Substation

Balgowlah zone substation was commissioned in 1955 with the building dating to 1920. The zone is a 33/11kV substation consisting of two 19MVA 33/11kV transformers. The zone has a summer and winter firm capacity of 28.9MVA, limited by the transformers. It is supplied by Warringah sub-transmission substation via two 33kV overhead feeders, S01 and S10. The applicable design planning limit for Balgowlah zone is 30.6MVA in summer limited by the 33kV feeder and 34.6MVA in winter limited by 120% of the firm capacity of the zone.

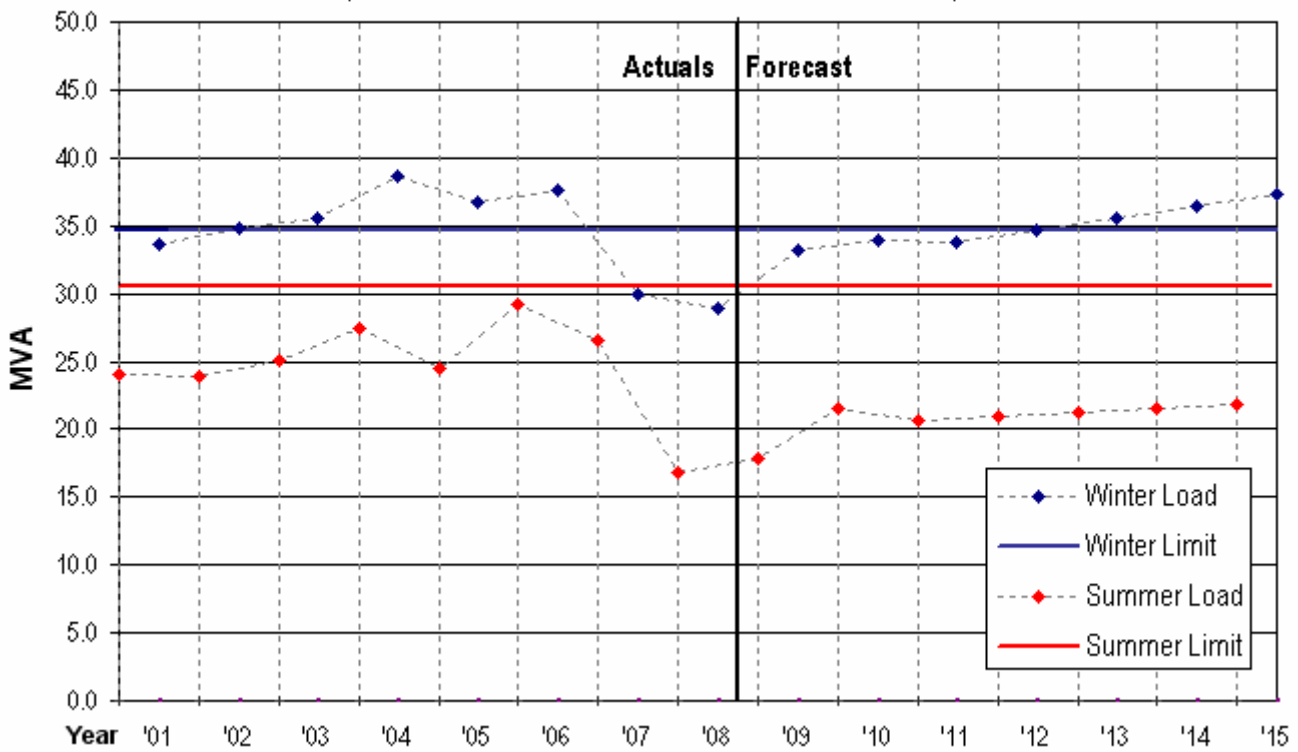
The peak load was 16.8MVA in summer 2007/08 and 29.0MVA in winter 2008. Balgowlah zone is currently operating above its firm capacity in winter, and is forecast to exceed the EnergyAustralia's design planning limit in winter 2012. Sustained load growth is expected to continue.

The zone has 11kV interconnections to Harbord and Manly zones. In order to provide short term load relief, 11kV works was carried out to transfer 10MVA load from Balgowlah to Harbord zone substation. However, this load transfer is considered a temporary measure as it only caters for current load constraints and is not sufficient to cater for future load growth in the Balgowlah load area.

To address 33kV feeder S01 constraint during an outage of feeder S02, a new feeder S14 was constructed in February 2008 to operate in parallel with the S01 feeder section. The new feeder is directly connected to Killarney and the tee from the existing S01 feeder was disconnected. The final configuration allows the supply to Balgowlah and Killarney zones to be independent of each other, improving reliability of supply to both substations.

Balgowlah Zone Substation

(based on actuals from Summer 2007/08 & Winter 2008)

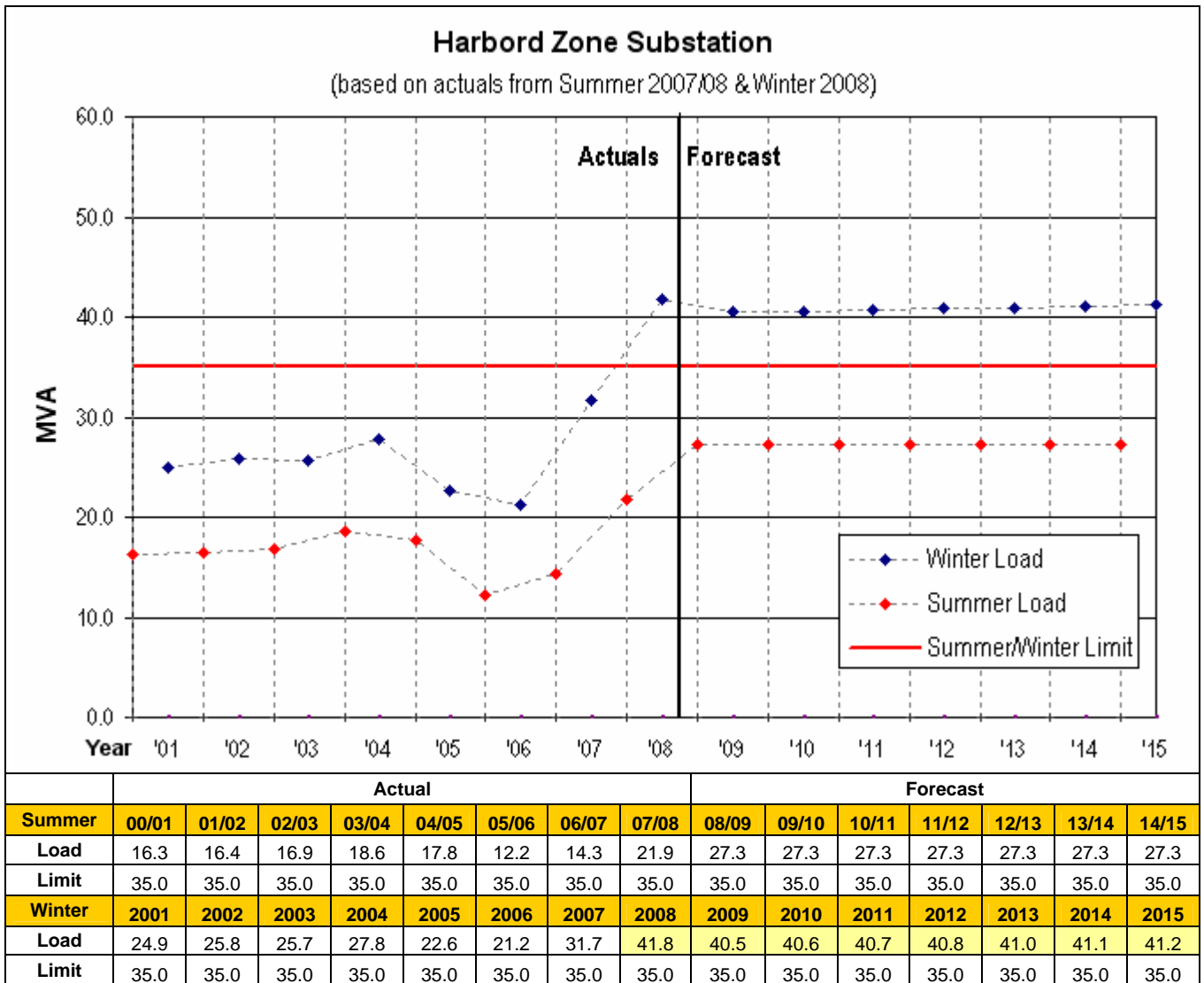


	Actual								Forecast						
	00/01	01/02	02/03	03/04	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15
Summer															
Load	24.0	23.9	25.1	27.4	24.5	29.2	26.5	16.8	17.9	21.5	20.6	20.9	21.2	21.5	21.9
Limit	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Winter	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Load	33.6	34.8	35.6	38.6	36.7	37.6	29.9	29.0	33.2	34.0	33.8	34.6	35.5	36.4	37.3
Limit	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6	34.6

Harbord Zone Substation

Harbord zone substation is a 33/11kV zone substation that was commissioned in 1971. It is supplied by Warringah STS, via three 33kV feeders, S07, S08 and S18. The substation is equipped with two 25MVA transformers and the firm capacity of the substation is limited by the 33kV switchgear rating.

The planned augmentation work of replacing the 11kV switchgear and also changing the operating arrangements such that both transformers will be normally energised are completed. The firm capacity of the zone after the augmentation is 29.2MVA both in summer and winter. The peak load was 31.7MVA in winter 2007 and 14.3MVA in summer 2006/07. The applicable design planning limit for Harbord zone is 120% of the firm capacity, or 35.0MVA. The zone has already reached its firm capacity in winter mainly due to temporary 11kV load transfer of 10MVA from Balgowlah zone substation. The zone is forecast to exceed the EnergyAustralia's design planning limit in winter 2009. Load growth is expected to be sustained in the medium term.



1.1.2 Subtransmission Substations

Supply to Manly Warringah area is normally provided from Warringah STS.

Warringah Subtransmission Substation (STS)

Warringah STS is supplied from TransGrid's Sydney East BSP via four 132kV feeders 9M1, 9M2, 9M3 and 9M4 and is equipped with two 120MVA and two 60MVA, 132/33kV transformers. The firm capacity of Warringah STS is 250MVA in summer and 260MVA in winter. The peak load for summer 2007/08 and winter 2008 was 169.3MVA and 247.2MVA and is forecasted to be constraint by winter 2009.

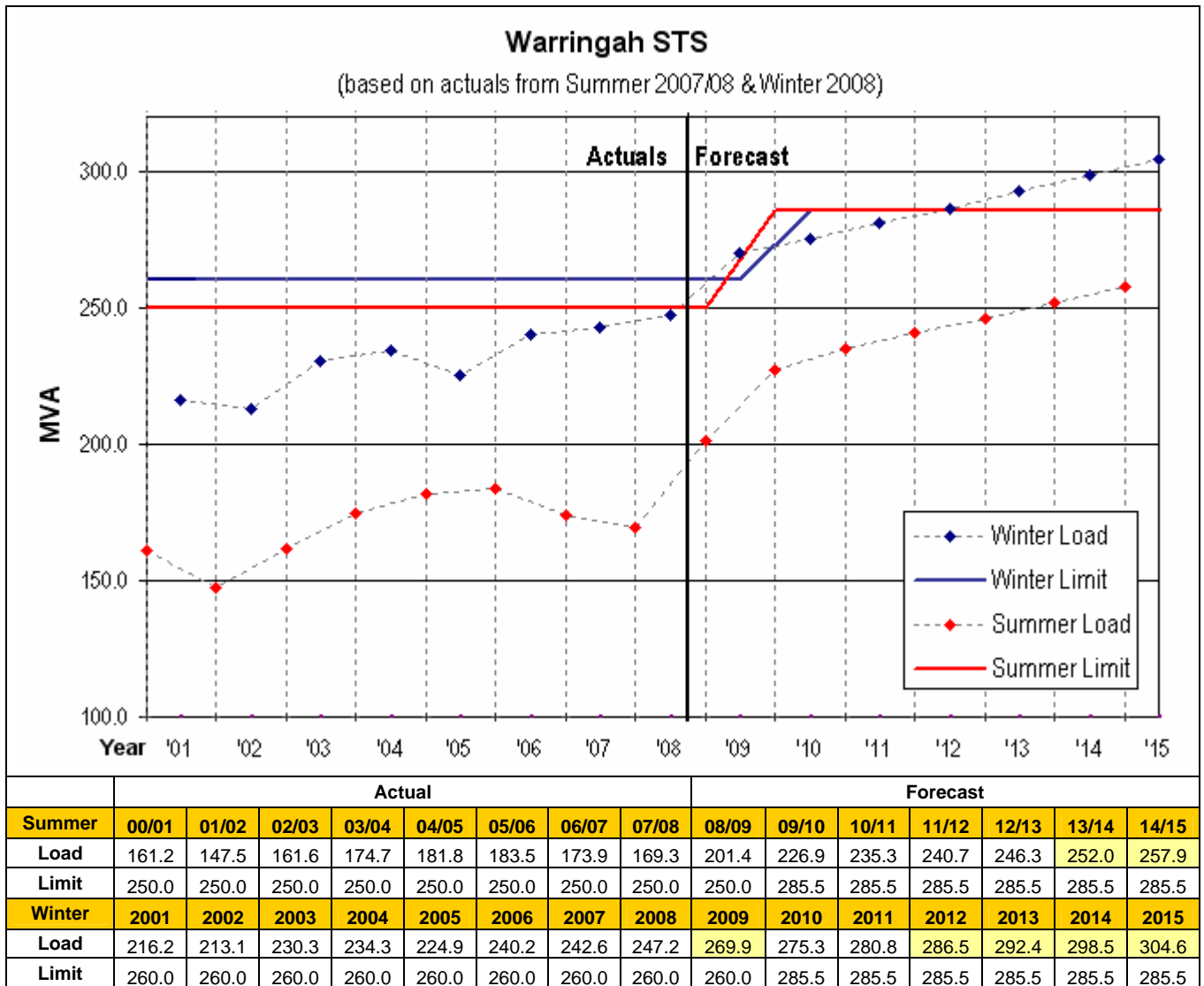
The supply capacity to the area is limited by the capacity of individual zone substations and the 33kV network supplying these substations. The 33kV feeder network is comprised of a number of teed feeders and configured such that two zone substations may be impacted by an outage of any given feeder.

Warringah STS 132kV circuit breakers are currently being replaced. In addition to this, the 132/33kV transformers Tx1 and Tx3 are scheduled for replacement with commissioning expected in October 2009. Following this project, the firm capacity at Warringah STS will be increased from 250MVA to 285.5MVA in summer and winter.

Figure 2 below shows the Warringah STS supply network area.



Figure 2 : Warringah STS Supply Network Area



2 ISSUES

2.1 Applied Service Standard

EnergyAustralia is required to comply with service standards that are specified in the 'Design, Reliability and Performance Licence Conditions' (Licence Conditions), which were imposed on NSW distributors by the Minister for Energy on 1 October 2007. The design planning criteria are specified in Schedule 1 of the Licence Conditions and reliability standards are specified in Schedules 2 and 3. For existing network, a distributor must be as compliant as practicable with these requirements by 1 July 2014 and fully compliant by 1 July 2019. All new network elements must comply with these requirements.

The service standards that are applicable to a consideration of supply constraints affecting the Manly Warringah area are summarised below. For further details refer to the Licence Conditions or to EnergyAustralia's Network Management Plan.

Subtransmission substations (urban/non-urban)

With all elements in service, the thermal capacity is required to meet at least 115% of forecast demand.

For a failure of a single critical element (i.e. N-1 conditions) within a subtransmission substation, the forecast demand is not to exceed the thermal capacity. Recovery of load should be within one minute.

Zone substations and subtransmission network (urban/non-urban)

With all elements in service, the thermal capacity is required to meet at least 115% of forecast demand.

Following a failure of a single critical element (i.e. N-1 conditions), the network must be designed to recover supply within one minute for systems supplying >10MVA, and otherwise, within best practice repair times. For systems that supply >10MVA, the forecast demand of a zone substation or overhead feeder network may exceed the N-1 capacity for up to 1% of the year i.e. a total aggregate time of 88 hours per annum, up to a maximum of 20% above the N-1 capacity; and the forecast demand of an underground feeder network may not exceed the N-1 capacity.

2.2 Description of Network Issues

2.2.1 Capacity limitation

If all elements of the network supplying this area are in service, the network has adequate capacity. However, the network is expected to be constrained during the first contingency outages in the near future. These constraints are described in the following sections and involve:

- Operational issues in Manly/Warringah area.
- Capacity constraint at Balgowlah zone substation (refer section 1.1.1 for details)
- Age and condition of network assets at Warringah STS and Balgowlah zone substation.

2.2.2 Operational Issues

A range of operational issues apply to the Manly Warringah network area.

- The Manly Warringah 33kV system is complex in operational terms. Supply to eight of the nine zone substations is provided by two meshed 33kV networks. Most 33kV feeders are tee-connected to at least three zone substations. A large portion of the network must be radially split in the event of an outage. This requires extensive and complex switching.
- A large proportion of zone substations in the area have limited numbers of 11kV feeder panels, and accordingly, double banking (ie. two feeders on a single circuit breaker) is adapted to provide 11kV connections when the loading of the circuit breaker is adequate. This has the disadvantage that an outage of one feeder results in the outage of the other. The result of this is that there is then:
 - Greater load (per circuit breaker) to transfer on to other 11kV feeders than would otherwise be the case with a single feeder circuit breaker; or
 - The risk of an interruption to a greater number of customers than would otherwise be the case for non-double banked panels.
- There are operational issues at Balgowlah zone substation including:
 - Some 11kV switchgear is operating close to its fault level ratings and this requires the 33kV network to be operated radially, reducing security of supply;
 - Each transformer is connected via two 11kV transformer circuit breakers of unequal rating, and loads must be carefully distributed between busbar sections and
 - Work at Balgowlah is limited by the width of transformer roadways.
- Some 33kV overhead feeders cross bush reserve areas and have difficult access. This increases restoration times following outages caused by fauna and vegetation. These feeders are also subject to damage from bushfires.

2.2.3 Age and Condition of Network Asset

Warringah STS

- The existing two 60MVA 132/33kV transformers are in the process of being replaced with a single 120MVA transformer and is scheduled for completion in October 2009.

Balgowlah zone substation

- The existing Balgowlah zone substation building dates from the 1920s and is heritage-listed and hence redevelopment of the existing site would be difficult and costly due to space limitations.. The transformer entrance to the substation is too small to accommodate current transformer designs.
- The 33kV indoor bulk oil circuit breakers need to be replaced within the next five years.
- The 11kV switchgear has been prioritised for replacement in the period 2009-11. The J & P circuit breakers have a history of overheating and failure.
- The underground cable sections of 33kV feeders S01 have been prioritised for replacement in the period 2017-27.

Whilst the building is in reasonable condition for its age, it was built to 1920's standards and there are significant issues associated with on site refurbishment. In particular, the building does not comply with current fire management standards, there is no segregation between 33kV and 11kV oil circuit breakers.

The majority of equipment at Balgowlah zone substation indicates a history of poor performance.. The poor condition of 11kV switchgear is evident by a recent circuit breaker failure which resulted in a minor fire. Transformers 1 and 2 at Balgowlah zone substation also require replacement within 5 years and 5-10 years respectively.

Harbord zone substation

The 33kV circuit breakers at Harbord zone substation require replacement within the next 5 years.

3 TYPE OF AUGMENTATION

Balgowlah zone substation is classified as distribution system assets by the National Electricity Rules (the Rules). The Rules require that, where analysis indicates that any relevant technical limits of a distribution system will be exceeded, that the Distribution Network Service Provider must notify any affected Registered Participants of these limitations and the expected time for corrective action and consult with affected Registered Participants and interested parties on the possible options to address the projected limitations of the relevant distribution system. A Network Service Provider does not need to consult on a network option that would be a small network asset, or for options that do not augment the system.

The proposed development strategy at the Balgowlah zone substation involves capital expenditure in excess of \$10 million and is regarded by the Rules as a new large network asset. Accordingly, a Consultation Paper on the projected limitation and options for corrective action was published on 12th May 2008. This Consultation Paper included a preliminary application of the Regulatory test to options that had been identified to address the projected limitations. No submission was received in response to the Consultation Paper.

The new capacity provided by the proposed augmentation has been necessitated by both the need to address aged asset issues and to provide increased system capacity to meet EnergyAustralia's licence conditions described in Section 2.1 and would thus be regarded as a reliability driven augmentation for the purposes of the Regulatory Test. Consequently, EnergyAustralia has used a least cost test to examine the options identified to address projected system limitations.

4 OPTIONS CONSIDERED

Three feasible options were considered for providing additional capacity to support the extra demand from Balgowlah:

- Option 1 – Development of a new 33/11kV Balgowlah zone substation
- Option 2 – Development of a new 132/11kV Balgowlah zone substation
- Option 3 – Development of a new hybrid 132/33/11kV Balgowlah zone substation

These options are discussed in detail in the following sections. The options have been considered in the context of the long term area strategy.

4.1 Demand Management

An assessment of demand management opportunities has identified the opportunity of reducing demand in winter 2009 to defer the supply side option until 2011. Demand Management has engaged a program for the reduction of demand through diesel generator sets, and power factor correction until 2011. The program is currently at development phase.

The proposed investment is driven by Warringah STS capacity and zone substation capacity issues. The age and condition of some of the equipment at Balgowlah zone substation means that it will need to be replaced at the end of 2010 in any case. Because of this, it is very unlikely that the project could be deferred beyond 2010.

4.2 Option 1: Develop a New 33/11kV Balgowlah Zone Substation

Option 1 is to develop a new 33/11kV zone substation and associated 33kV feeders to allow retirement of existing Balgowlah zone substation and meet the increased load requirement in the Balgowlah load area. After the commissioning of the zone, the existing Balgowlah zone will be decommissioned.

This option provides for a three 33MVA 33/11kV transformer substation arrangement with three incoming 33kV feeders from Warringah STS. The firm capacity of the 33/11kV Balgowlah zone substation would be 68MVA. The two existing feeders to the current Balgowlah zone substation would be extended and an additional 33kV feeder from the new Balgowlah zone to Warringah STS would be constructed.

However, with this option Warringah STS will still be loaded above its firm capacity and is forecast to be constrained in winter 2012. Hence, there is a requirement to install a fourth 120MVA transformer at Warringah STS before winter 2012 as part of this option.

This option consists of following stages:

Stage 1 - Construction of new 33/11kV Balgowlah zone substation in 2010.

Stage 2 – Installation of fourth transformer at Warringah STS in 2012.

The estimated capital cost for Stage 1 – Development of 33/11kV Balgowlah zone substation is \$54.5M which includes 33kV and 11kV feeder works and also decommissioning of the existing Balgowlah zone. The total estimated capital cost including Stage 1 and 2 is \$57.8M.

4.3 Option 2: Develop a New 132/11kV Balgowlah Zone Substation

Option 2 provides for a 132kV development option with two 50MVA 132/11kV transformers. The firm capacity of the 132/11kV Balgowlah zone substation will be 68MVA limited by the emergency rating of the transformers. The supply to the zone substation will require two 132kV feeders from Warringah STS to Balgowlah zone substation. This option will also facilitate the decommissioning of the existing Balgowlah zone and provide load relief for Warringah STS.

With this option, Warringah STS will no longer be constrained till 2020+.

The estimated total capital cost for Option 2 – Development of 132/11kV Balgowlah zone substation is \$60.5M which includes 132kV and 11kV feeder works and also decommissioning of the existing Balgowlah zone.

4.4 Option 3: Develop a New Hybrid 132/33/11kV Balgowlah Zone Substation

Option 3 presents a hybrid 132/33/11kV Balgowlah zone substation with main supply at 132kV and standby supply at 33kV. The firm capacity of the hybrid Balgowlah zone would be 49.5MVA limited by the emergency rating of the 33kV feeder. The hybrid zone is to be constructed such that eventual conversion to full 132/11kV operation is possible. This option will address the following constraints;

- The issue of aging 11kV and 33kV switchgear at Balgowlah zone substation.
- Capacity constraints on Balgowlah and surrounding zones.
- Capacity constraint on Warringah STS in winter 2009.
- Security of supply and reliability issues.
- The need to offload Manly zone in the medium term to facilitate replacement of 11kV and 33kV switchgear.

Under this option Balgowlah zone substation would initially be equipped with two 33MVA 33/11kV and one 50MVA 132/11kV transformers. The hybrid zone is anticipated to be commissioned in early 2011.

As per the current forecast, the full 132/11kV operation of the zone is only anticipated in 2027.

This option consists of following stages:

Stage 1 - Construction of new hybrid 132/33/11kV Balgowlah zone substation in 2011.

Stage 2 - Conversion of hybrid Balgowlah zone to full 132/11kV operation in 2027.

The estimated capital cost for Stage 1 – Development of a new hybrid 132/33/11kV Balgowlah zone substation is \$57.0M which includes 132kV, 33kV and 11kV feeder works and also decommissioning of the existing Balgowlah zone. The total estimated capital cost including Stage 1 and 2 is \$66.6M.

5 ANALYSIS OF OPTIONS

Economic analysis has been carried out for the period 2007/08 to 2028/29. This analysis involves the comparison of options on an economic basis by carrying out NPC analysis for each of the three options.

EnergyAustralia has included a range of parameters in comparison of options such as change in discount rates and variations in zone, transmission and feeder costs. In summary, the three options as presented are technically and economically comparable, given due consideration to all capital costs and operating costs that are able to be defined and quantified.

5.1 Base Case Analysis

The options considered are ranked by cost considering 8.5% discount rate as the base case in the following table. The options are considered in the context of the broader area strategy.

Description	NPC* (\$M)	Cost (\$M)	Rank
Option 3: Develop a new hybrid 132/33/11kV Balgowlah zone substation	53.2	66.6	1
Option 2: Develop a new 132/11kV Balgowlah zone substation	53.5	60.5	2
Option 1: Develop a new 33/11kV Balgowlah zone substation	54.7	57.8	3

*NPC includes operational and maintenance cost

The analysis above indicates that under base case conditions, the NPC of Option 3 is the least cost solution.

Refer to APPENDIX A – ECONOMIC ANALYSIS OF BASE CASE for the detailed analysis.

5.2 Sensitivity Analysis

Sensitivity Analysis was carried out to consider the impact of different discount factors and price variations. The base case and the range over which sensitivity checks were conducted are shown in Table 2.

Parameter	Base Case Value	Cases Considered
<i>Discount Rate</i>		
Real Discount Rate	8.5%	7% and 10%
<i>Cost Variations</i>		
Zone Costs	100%	75% and 125%
Transmission Costs	100%	75% and 125%
132kV or 33kV Feeder Costs	100%	75% and 125%

5.2.1 Results of Sensitivity Analysis

The results of the sensitivity analysis are provided in Table 3.

Parameter	Option 1		Option 2		Option 3	
	NPC (\$M)	Cost (\$M)	NPC (\$M)	Cost (\$M)	NPC (\$M)	Cost (\$M)
Real Discount Rate 7%	56.41	57.81	55.73	60.50	55.86	66.61
Real Discount Rate 10%	53.16	57.81	51.50	60.50	50.82	66.61
Zone Costs Decrease 25%	48.79	52.00	47.79	54.15	47.39	60.19
Zone Costs Increase 25%	60.63	63.61	59.27	66.85	58.98	73.02
Transmission Costs Decrease 25%	54.06	56.98	53.53	60.50	53.07	66.12
Transmission Costs Increase 25%	55.37	58.63	53.53	60.50	53.30	67.10
132kV / 33kV feeder Costs Decrease 25%	47.94	50.15	46.29	51.98	46.58	58.93
132kV / 33kV feeder Costs Increase 25%	61.49	65.47	60.77	69.03	59.80	74.29

The results of the sensitivity analysis indicates that Option 3 – Development of a new hybrid 132/33/11kV Balgowlah zone substation is the least cost option under majority of the sensitivity scenarios.

6 CONCLUSION AND RECOMMENDED ACTION

Option 3 is the least cost option for majority of the analysed scenarios, and is thus the recommended course of action to be taken by EnergyAustralia.

EnergyAustralia intends to develop a new hybrid 132/33/11kV Balgowlah zone substation, install associated 132kV and 33kV feeders and decommission the existing 33kV Balgowlah zone substation as the first stage

of the strategy, with provision to ultimately convert the Balgowlah zone substation to full 132/11kV operation in the future.

The estimated capital cost of the first stage of this option is \$57.0M which includes commissioning of new 132/33/11kV Balgowlah zone substation, associated 132kV feeders cost, 33kV feeders cost, decommissioning of existing Balgowlah zone substation and associated 11kV feeder works. The first stage of project is scheduled for completion in 2010/11.

This service availability date may change if the project is affected by circumstances beyond EnergyAustralia's control, such as changes in the timing of customer load increases or other issues such as: delays in the approval process, equipment supply difficulties, unforeseen technical constraints, acts of God and industrial action.

7 CONTACT DETAILS FOR ENQUIRIES

This report recommends the construction of a new large distribution network asset. Registered Participants may dispute the recommendations of the report under Clause 5.6.2(i) of the Rules. Registered Participants who intend to dispute the recommendations of this report must do so within 40 business days of the report being published and made available on EnergyAustralia's website.

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8 APPENDIX A – ECONOMIC ANALYSIS OF BASE CASE

Discount Rate = 8.5%

All figures are in 2007/08 real dollars.

Option 1 – Develop a new 33/11kV Balgowlah zone substation

Description	NPC (\$m)	Capex (\$m)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Construct Balgowlah zone at 33/11kV	21.35	23.21	4.04	14.21	4.96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Decommissioning of existing Balgowlah	-1.18	-2.14	-	0.21	1.35	-0.48	-	-3.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Three 33kV Feeder Works & Connections	26.04	30.65	-	1.63	27.38	1.63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11kV works	2.29	2.80	-	-	1.40	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total (Stage 1)	48.50	54.52	4.04	16.06	35.09	2.55	-	-3.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Installation of fourth Transformer at Warringah STS	2.37	3.29	-	-	-	-	3.29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O&M Costs	3.84		-	-	-	0.29	0.32	0.53	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
TOTAL	54.71	57.81	4.04	16.06	38.37	2.84	0.32	-2.68	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55

Option 2 – Develop a new 132/11kV Balgowlah zone substation

Description	NPC (\$m)	Capex (\$m)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Construct Balgowlah zone at 132/11kV	20.92	25.41	0.33	2.26	10.07	12.27	0.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Decommissioning of existing Balgowlah	-0.89	-1.81	-	0.54	1.09	-0.23	-	-3.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Two 132kV Feeder Works & Connections	27.79	34.10	-	-	16.37	17.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11kV works	2.29	2.80	-	-	1.40	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total (Stage 1)	50.10	60.50	0.33	2.80	28.93	31.17	0.48	-3.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O&M Costs	3.43		-	-	-	-	0.02	0.54	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
TOTAL	53.53	60.50	0.33	2.80	28.93	31.17	0.50	-2.68	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55

Option 3 – Develop a new hybrid 132/33/11kV Balgowlah zone substation

Description	NPC (\$m)	Capex (\$m)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
Construct Balgowlah zone at 132/33/11kV	21.11	25.66	0.33	2.26	10.07	12.55	0.44	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Decommission existing Balgowlah zone	-1.18	-2.14	-	0.21	1.35	-0.48	-	-3.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
33kV and 132kV Feeder Works & Connections	25.38	30.72	-	0.94	18.03	11.74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
11kV works	2.29	2.80	-	-	1.40	1.40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Total (Stage 1)	47.60	57.03	0.33	3.41	30.85	25.21	-	-3.21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Conversion of Balgowlah to full 132/11kV zone - 2nd feeder	1.79	7.61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.81	1.90	1.90	-	-	
Replace 33kV Transformer with 132kV Transformer	0.45	1.96	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.96	-	-	-	
O&M Costs	3.34		-	-	-	-	0.02	0.52	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.56	0.57	0.61
TOTAL	53.19	66.61	0.33	3.41	30.85	25.21	0.46	-2.69	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	4.35	4.40	2.47	0.57	0.61	