



# FINAL REPORT

## ESTABLISH NEW POTTS HILL ZONE SUBSTATION

**28<sup>th</sup> October 2008**

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## EXECUTIVE SUMMARY

This paper has been prepared to report on upgrade work that is proposed to develop the electricity supply network in the Greenacre Park and Sefton 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.

A Consultation Paper on the projected limitation and options for corrective action was published on 2<sup>nd</sup> 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.

There are various capacity issues in the Greenacre Park and Sefton load area. To ensure a safe and reliable electricity supply for existing customers, EnergyAustralia is providing additional capacity to meet forecast load demands.

This report covers the following issues:

**Section 1** provides a background of the Greenacre Park and Sefton load area and the need for augmentation.

**Section 2** describes the various capacity issues in the Greenacre Park and Sefton load area. The concept of service standard, as implemented by EnergyAustralia, is discussed.

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

**Section 4** describes the options that were considered, including Demand Management as well as:

- Option 1 – Establish new zone substation at Potts Hill.
- Option 2 – Rebuild Greenacre Park and Sefton zone substations.

**Section 5** presents the results of economic analysis of the options considered, sensitivity analysis and identification of the least cost option.

**Section 6** concludes that the preferred option is Option 1 – Establish new zone substation at Potts Hill.

EnergyAustralia's recommended action is to provide additional capacity by establishing a new 132/11kV Potts Hill zone substation by summer 2010/11 to relieve surrounding zone substations at an estimated capital cost of \$42.6M with a NPC of \$38.6M.

This recommendation is made on a least cost test (in accordance with regulatory test) to provide increased future capacity and to meet EnergyAustralia's reliability standard.

## 1. BACKGROUND

### 1.1. Introduction

This Final Report has been prepared to advise on the upgrade work that is proposed to be carried out in the Greenacre Park and Sefton load area. This Final Report relates to a Consultation Paper published on 2<sup>nd</sup> May 2008. No submission was received in response to the Consultation Paper. The information provided in this Final Report includes:

- A discussion of emerging supply system limitations identified by EnergyAustralia that have lead to the necessity for construction of a new zone substation in the area;
- A discussion of the service standard that has been adopted for planning purposes;
- Descriptions of options for development of the electricity supply in the area; and
- Details of the outcomes of the cost-effectiveness analysis of the options considered.

The Canterbury/Bankstown supply area extends from Leightonfield in the northwest, south to Revesby and east as far as Dulwich Hill. Within this load area, zone substations are supplied from both the 132kV network and 33kV radial networks emanating from Bankstown STS and Canterbury STS.

Greenacre Park and Sefton are two 132/11kV zone substations that are situated in the northern section of the load area and supply both residential and industrial loads. These substations supply parts of the following suburbs: Auburn, Bankstown, Bass Hill, Berala, Birrong, Chester Hill, Chullora, Enfield, Greenacre, Leightonfield, Lidcombe, Mt Lewis, Punchbowl, Regents Park, Rookwood, Sefton and Yagoona.

Loading at both Greenacre Park and Sefton is summer critical with a summer growth rate of 2.8% at Greenacre Park and 2.1% at Sefton. Presently, both zone substations are heavily loaded in summer and there is a combined capacity shortfall. Installation of a 4<sup>th</sup> transformer at Sefton will provide temporary relief and allow load transfers to address immediate loading constraints, but a new zone substation will be required to maintain supply security in the medium to long term for the area.

### 1.2. Existing Supply Arrangement

#### 1.2.1. Zone Substations

##### 1.2.1.1 Greenacre Park Zone Substation

Greenacre Park 132/11kV zone substation was commissioned in 1970 and is equipped to its maximum design capacity with one 36MVA transformer, two 37.5MVA transformers and one 47.5MVA transformer. Greenacre Park zone substation is supplied via two 132kV feeders from Bankstown STS with tee connections to Sefton zone substation.

##### 1.2.1.2 Sefton Zone Substation

Sefton 132/11kV zone substation was commissioned in 1975 and was designed as a four transformer substation. Sefton is presently equipped with three 37.5MVA 132/11kV transformers. Sefton is supplied at 132kV from Chullora subtransmission switching station (STSS).

#### 1.2.2. Main Cable Supplies - 132kV Feeder System

Bankstown STS is supplied via two overhead 132kV feeders 915 and 914 from TransGrid's Sydney South BSP. Two outgoing 132kV feeders 240 and 241 provide 132kV interconnection to Chullora STSS and tee connections to Greenacre Park 132/11kV and Sefton 132/11kV zone substations.



### **2.1.3. 11kV Distribution Network**

For urban feeders (i.e. feeders with an actual maximum demand greater than 0.3MVA/km), the expected demand is to be no more than 80% of feeder thermal capacity (under system normal operating conditions), with switchable interconnection to adjacent feeders to enable restoration following an unplanned failure of a single network element (i.e. N-1 conditions). The 11kV network where in a number of feeders forms an interrelated system, the limits apply to the average loading of the feeders within the one system.

For 11kV networks, voltage drops of up to 5% are regarded as satisfactory. Higher voltage drops are permissible provided that the network connection provided to low voltage customers is within the limits specified in Australian Standard AS2926.

## **2.2. Description of Network Constraints**

### **2.2.1. Four Transformer 132/11kV Zone Substation Design**

Incidents over the past few years at Greenacre Park, Sefton and Mosman zone substations have raised concern over the reliability of the 4 x 37.5MVA 132/11kV transformer zone substation design. This design, adopted in the 1970's as the standard for 132/11kV zone substations, is no longer used and has been replaced with a 3 x 50MVA transformer design of similar firm capacity.

There are two fundamental issues associated with the 4 x 132/11kV zone substation design:

#### **1. 11kV Switchboard Configuration**

The standard design consists of two sections of double bus 11kV switchboards separated by bus section circuit breakers. Therefore, an 11kV busbar failure is likely to require an extended outage of one section of the double bus switchboard which has the potential to place up to half the substation load, 55MVA, at risk.

#### **2. 132kV Busbar and Feeder Configuration**

The design of these substations did not include transformer or feeder circuit breakers and instead rely on remote circuit breakers to clear a transformer, busbar or feeder fault. To add to the risk, many of the 132kV feeders supplying such substations are oil-filled and aging and have ongoing concerns about their reliability.

In general, a 4 x 37.5MVA 132/11kV zone substation is supplied via two 132kV feeders only. A single feeder outage results in an interruption of half (assuming transformer load is shared evenly) of the substation load.

The reason for this total interruption is that 132kV transformer and feeder circuit breakers were not incorporated into the design. An investigation on the feasibility of installing 132kV feeder and transformer circuit breakers was carried out which concluded that the standard design of this type of substation did not allow sufficient space to install these circuit breakers into the existing substation.

As a result of this investigation of the 4 x 37MVA 132/11kV zone substation design, it has been recommended that such substations be derated and have their "planning" firm rating lowered as if the substation were configured with 2 x 37.5MVA transformers normally online with the third 37.5MVA transformer on standby. This decision will therefore advance capacity driven investments and effectively sets a trigger point for investment around 20MVA below that of the original design of four transformers. This is illustrated below in Section 2.2.2 in the load forecasts of Greenacre Park and Sefton zone substations.

### 2.2.2. Load Forecast

EnergyAustralia has previously published details of its load forecasts and the timing of loads exceeding technical limits of the system in its Annual Electricity System Development Review. The load forecast includes committed spot loads and normal levels of load growth. The timing of the constraint for each zone substation is summarised below and is based on the 2008 – 2014 zone forecast.

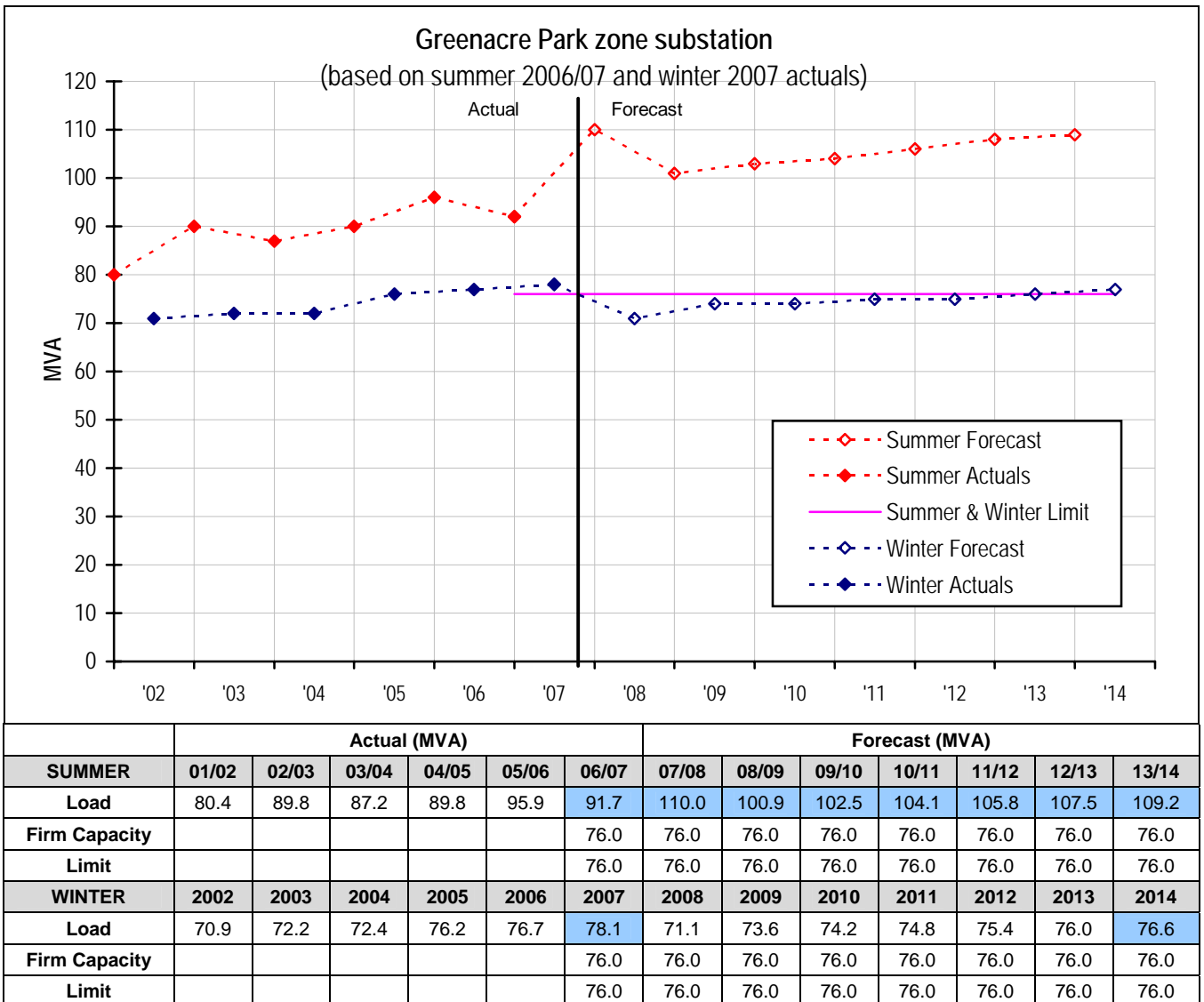
#### 2.2.1.1. Greenacre Park Zone Substation:

Figure 2 shows the peak load forecast and the relevant planning limit, as determined by EnergyAustralia’s service standards, for 132/11kV Greenacre Park zone substation in both summer and winter. The firm capacity under the new derated 4 x 37.5MVA transformer 132/11kV substation policy is the relevant planning limit. The 120% utilisation criteria is not applicable under the new derated zone configuration.

As seen in Figure 2, the peak load presently exceeds EnergyAustralia’s service standards in summer and is expected to exceed EnergyAustralia’s service standards in winter 2014.

Figure 1 includes a planned 11kV load transfer of approximately 14MVA from Greenacre Park zone substation to Sefton zone substation in winter 2008 to relieve immediate capacity issues at Greenacre Park zone substation. The magnitude of this transfer is necessary as approximately 8MVA of new load from various committed customer connections will need to be supplied in 2008.

**Figure 2: Greenacre Park Zone Substation Load Forecast**



Note: The blue highlighted field indicates the load is above EnergyAustralia’s service standards. For simplicity, different capacity limits under previous Licence conditions are not shown.

### 2.2.2. Sefton Zone Substation

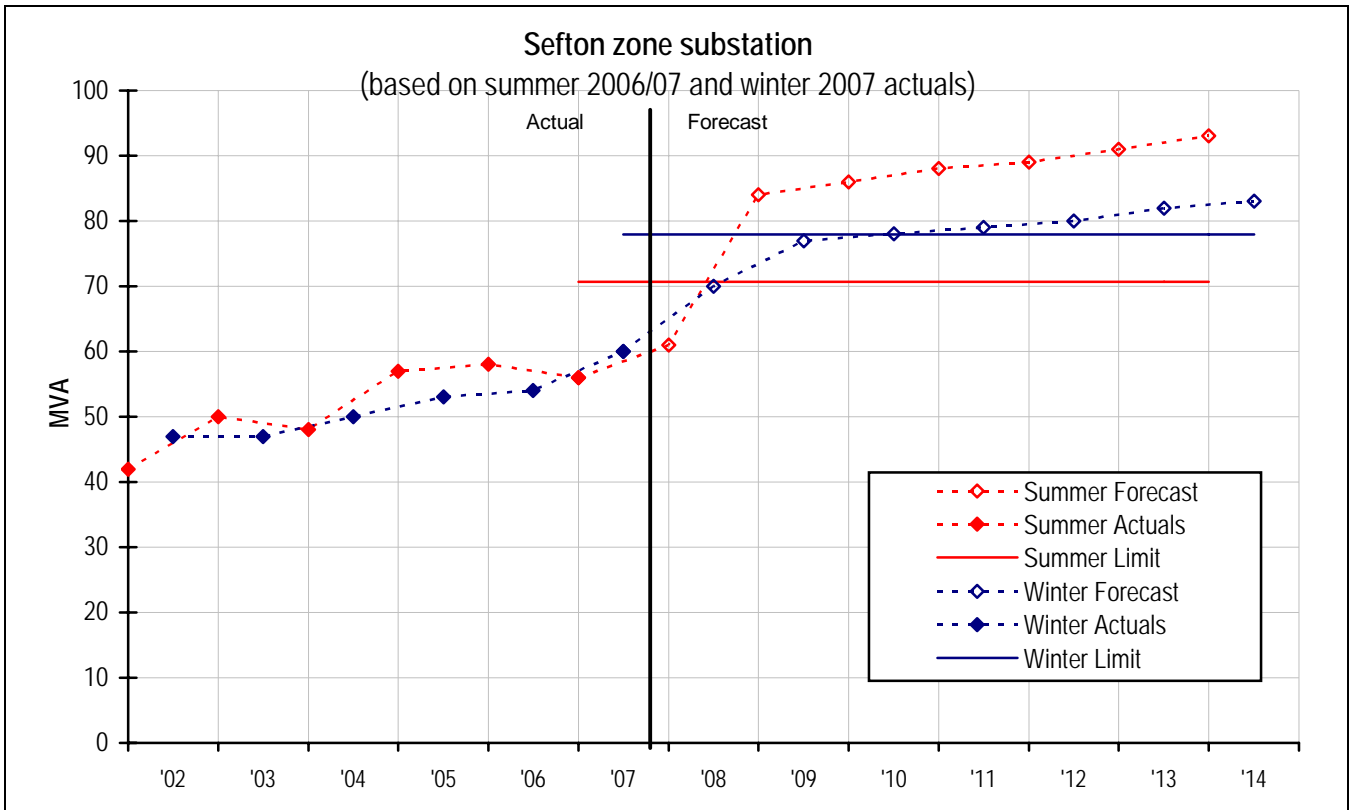
Figure 3 shows the peak load forecast and the relevant planning limit, as determined by EnergyAustralia’s service standards, for 132/11kV Sefton zone substation in both summer and winter. The firm capacity under the new derated 4 x 37.5MVA transformer 132/11kV substation policy is the relevant planning limit. The 120% utilisation criteria is not applicable under the new derated zone configuration.

As seen in Figure 3, the peak load is expected to exceed EnergyAustralia’s service standards in summer 2009/10 and winter 2011.

The forecast includes expected loads arising from the Regents Park Industrial Site development, which is estimated to be 4.8MVA by mid 2008 increasing to 7.6MVA by summer 2011/12.

The forecast assumes the installation of a 4<sup>th</sup> transformer at Sefton zone substation by summer 2008/09. Although Sefton zone substation will be derated under the new policy, the installation of the 4<sup>th</sup> transformer is necessary to mitigate loading constraints until load transfers are possible to the proposed new Potts Hill zone substation.

**Figure 3: Sefton Zone Substation Load Forecast**



	Actual (MVA)						Forecast (MVA)							
	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	
<b>SUMMER</b>														
Load	41.9	49.9	47.9	56.6	57.7	55.8	61.3	83.7	85.7	87.5	89.2	91.0	92.8	
Firm Capacity						70.7	70.7	70.7	70.7	70.7	70.7	70.7	70.7	
Limit						70.7	70.7	70.7	70.7	70.7	70.7	70.7	70.7	
<b>WINTER</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>	<b>2012</b>	<b>2013</b>	<b>2014</b>	
Load	46.5	47.3	49.9	53.3	54.2	59.8	69.6	76.5	77.9	79.2	80.4	81.7	83.0	
Firm Capacity						77.9	77.9	77.9	77.9	77.9	77.9	77.9	77.9	
Limit						77.9	77.9	77.9	77.9	77.9	77.9	77.9	77.9	

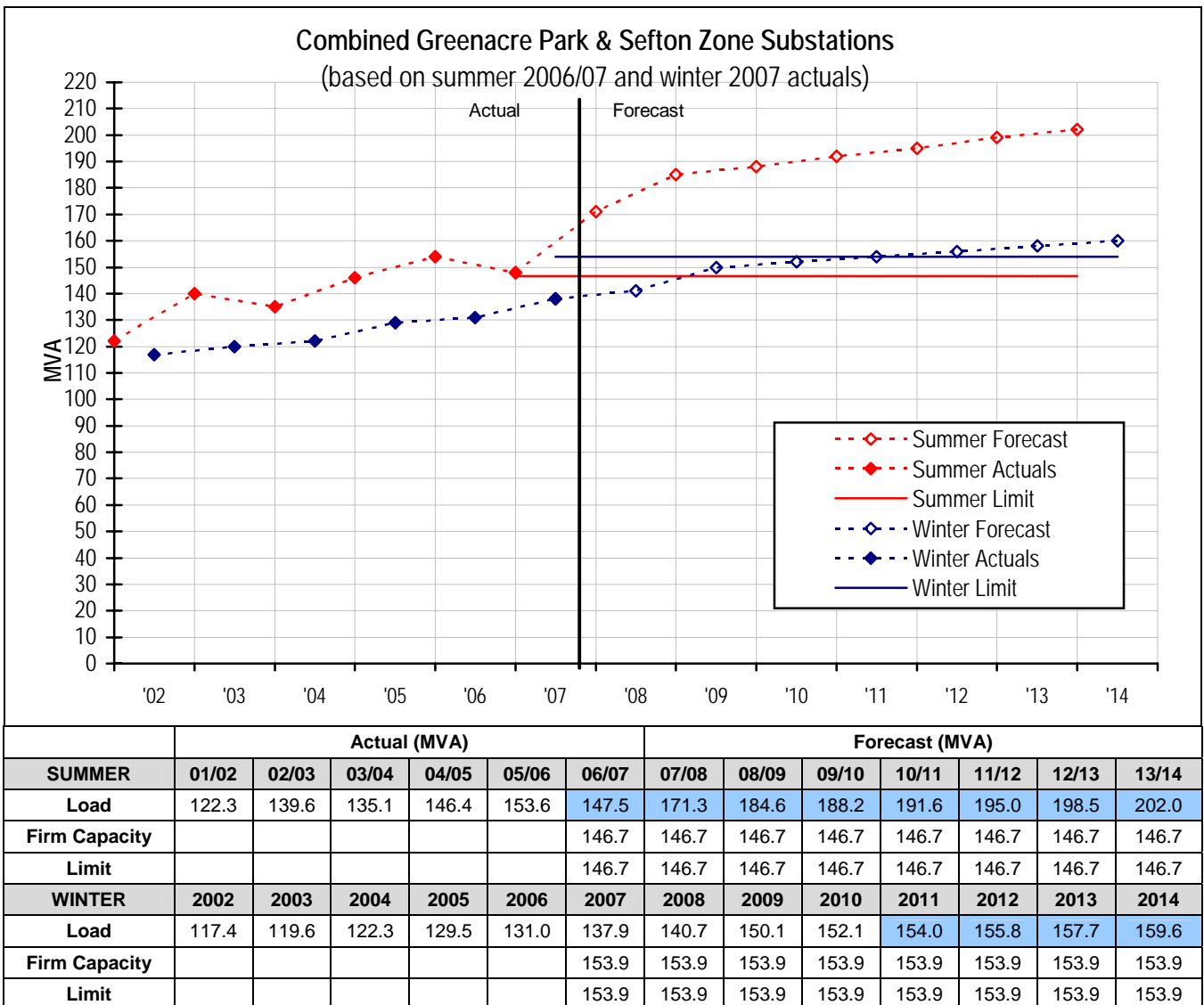
Note: The blue highlighted field indicates the load is above EnergyAustralia’s service standards. For simplicity, different capacity limits under previous Licence conditions are not shown.

### 2.2.3. Combined Greenacre Park and Sefton Zone Substation Capacity

Three 11kV feeders were established between Greenacre Park and Sefton zone substations to provide approximately 20MVA of transfer capacity between the two zone substations. Loads of less than 20MVA can be transferred between the two zone substations relatively inexpensively to maintain each zone substation's load within EnergyAustralia's service standard. Therefore, it is relevant to consider the combined load and firm capacity of Greenacre Park and Sefton zone substations.

Figure 4 below shows the combined load and firm capacity of Greenacre Park and Sefton zone substations, using an arithmetic summation for load and capacity. The 120% utilisation criteria is not applicable to the combined forecast under the new derated zone configurations at Greenacre Park and Sefton zone substations.

**Figure 4: Combined Greenacre Park and Sefton Zone Substation Load Forecast**



Note: The blue highlighted field indicates the load is above EnergyAustralia's service standards. For simplicity, different capacity limits under previous Licence conditions are not shown.

### 3. TYPE OF AUGMENTATION

Most of the EnergyAustralia network within the Greenacre Park and Sefton load area, including the aforementioned zone substations are classified as distribution system assets by the National Electricity Rules (the Rules).

The rules (clauses 5.6.2 (e) and (f)) requires 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 for the Greenacre Park and Sefton load area involves 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 2nd May 2008. This Consultation Paper included a preliminary application of the Regulatory test to options which had been identified to address the projected limitations. No submission was received in response to the Consultation Paper. In addition, EnergyAustralia has provided notification of these limits in its Annual Electricity System Development Review (AESDR).

The new capacity provided by the proposed augmentation has been necessitated by the need to meet the service standards described in Section 2 and has therefore been treated 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

The development strategy for the Greenacre Park and Sefton load area is driven by an immediate need to provide:

- Sufficient capacity to relieve Greenacre Park and Sefton zone substations;
- A reduction in energy at risk at Greenacre Park and Sefton zones due to their 132/11kV four transformer designs; and
- Capacity to meet forecast load growth in the area for the medium term.

To meet these immediate objectives EnergyAustralia has investigated a number of options. Possible options are impacted by:

- The availability of land for substation sites in existing established areas.
- The need to establish new zone substations in close proximity to existing 132kV feeders to minimise connection costs.
- The need for the new zone substations to be located near existing zone substations to minimise 11kV connection costs.
- The need to replace aging 33kV infrastructure.
- The need to be in close proximity to load centres.

The following section describes Demand Management and two area supply strategy options for the Greenacre Park and Sefton load area:

- Option 1: Establish new zone substation at Potts Hill.
- Option 2: Rebuild Greenacre Park and Sefton zone substations.

#### 4.1. Consideration of Demand Management

Demand Management was investigated as an alternative to the proposed network investment. The DM screening test was completed in October 2007.

The value of avoided cost due to one year deferral would be \$2.7M, or approximately \$65/kVA, which is low.

It is thus not considered reasonable to expect that it would be cost-effective to postpone the development of Potts Hill 132/11kV zone substation by implementing demand management strategies.

#### 4.2. Option 1: Establish New Zone Substation at Potts Hill

This strategy involves the establishment of a 132/11kV zone substation at Potts Hill by summer 2010/11. The new substation would be initially equipped with two 50MVA 132/11kV transformers with provision for a third. Potts Hill zone substation will provide sufficient capacity to relieve both Greenacre Park and Sefton zone substations.

The capital cost for construction of a new two transformer 132/11kV zone substation at Potts Hill is expected to be \$42.6M, which includes 35MVA of load transfers from Greenacre Park zone substation and 25MVA from Sefton zone substation via the 11kV network to provide load relief for these two zone substations.

Following the installation of a 3<sup>rd</sup> transformer at Potts Hill zone substation in 2016/17, loading on the combined Greenacre Park, Sefton and Potts Hill networks is not forecast to exceed combined capacity before 2023.

Aside from the construction of Potts Hill zone substation, the other major projects in this supply strategy include:

- Greenacre Park 11kV switchgear replacement and 10MVA load transfer to Potts Hill (2014/15),
- Potts Hill additional transformer (2014/15),
- Sefton derate and 15MVA load transfer to Potts Hill (2014/15),
- Sefton replace oil circuit breakers with vacuum circuit breakers (2017/18),
- 5MVA load transfer from Sefton to Potts Hill (2021/22).

The costs of these investments have been included in the economic analysis.

The total Capital Cost of this area strategy is **\$72.7M**. The Net Present Cost (NPC) is **\$56.6M**.

#### 4.3. Option 2: Rebuild Greenacre Park and Sefton Zone Substations

This strategy involves the rebuilding of both Greenacre Park and Sefton zone substations to 3 x 50MVA transformers on a new site. This represents a firm capacity increase of approximately 54MVA at Greenacre Park zone substation and 59MVA at Sefton zone substation. It is assumed that land is readily available adjacent to both sites to minimize 11kV costs.

This strategy also requires 132kV reconfiguration works to supply the new substations.

The total Capital Cost of this area strategy is **\$85.3M**. The Net Present Cost (NPC) is **\$73.5M**.

## 5. APPLICATION OF THE REGULATORY TEST

A preliminary economic analysis has been carried out. It involves the comparison of options on an economic basis by carrying out Net Present Cost (NPC) analysis for each of the two options.

The economic analysis incorporates:

- Capital costs.
- Operation and Maintenance (O&M) costs.
- Sensitivities to changing:
  - Substation construction costs.
  - Transmission mains costs.
  - Distribution mains costs.
  - Discount Factor.
  - Growth rates.

The unserved energy benefits do not vary materially between options and have thus been excluded from analysis.

### 5.1. Base Case Analysis

The results of the base case economic analysis using a discount factor of 8.5% p.a. are summarised in Table 1 below.

**Table 1 - Comparison of Options – Base Case**

Option	Description	Capital Cost* (\$M)	Net Present Cost* (\$M)
Option 1	Establish new zone substation at Potts Hill	72.7	56.6
Option 2	Rebuild Greenacre Park and Sefton zone substations	85.3	73.5

The analysis above indicates that the NPC of Option 1 is the least cost solution under the base case scenario.

### 5.2. Sensitivity Analysis

The base case and the range over which sensitivity checks were conducted are shown in Table 2.

**Table 2 - Base Case Values and Range of Values Used in Sensitivity Checks**

Parameter	Base Case Value	Sensitivity Checks at
Substation Costs	100%	75% and 125%
Transmission Mains Costs	100%	75% and 125%
Distribution Mains Costs	100%	75% and 125%
Discount Factor	8.5%	7.0% and 10.0%
Growth Rate	100%	75% and 125%

\* Including future works covering the long term strategy for the area.

The results of sensitivity analysis are displayed in Table 3 below.

**Table 3 - Sensitivity Analysis: Comparison of Options**

Scenario	Net Present Cost (\$M)	
	Option 1	Option 2
25% reduction in substation costs	46.6	60.4
25% increase in substation costs	66.6	86.6
25% reduction in transmission mains costs	55.7	72.6
25% increase in transmission mains costs	57.5	74.3
25% reduction in distribution mains costs	51.6	72.6
25% increase in distribution mains costs	61.7	74.4
7% discount factor	59.9	75.3
10% discount factor	53.6	71.7
25% reduction in load growth	56.6	73.5
25% increase in load growth	57.6	73.5

The results from the sensitivity analysis indicate that Option 1 remains the least cost option under all sensitivity checks.

## 6. CONCLUSION

Option 1 is the least cost option under all sensitivity scenarios and is thus the recommended course of action to be taken by EnergyAustralia.

The first stage of the Option 1 strategy involves the establishment of a new 132/11kV zone substation in the Potts Hill area and associated 11kV works to relieve surrounding zone substations. This Final Report covers the first stage of this area strategy. The estimated capital cost for the first stage is \$42.6M with a NPC of \$38.6M.

For the entire Option 1 strategy, the estimated capital cost is \$72.7M with a NPC of \$56.6M.

The first stage of Option 1 is forecast to be completed by summer 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. Any enquiries regarding this report should be directed to the contact listed below:

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## 8. APPENDIX A – ECONOMIC ANALYSIS OF BASE CASE

WACC = 8.5% p.a.

### Option 1 – Establish new zone substation at Potts Hill (Preferred Option)

Actions	NPC* (\$M)	CAPEX # (\$M)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
<b>STAGE 1 - 132/11kV Potts Hill Zone</b>																	
Establish Potts Hill Zone Substation	24.94	28.98	0.40	7.57	16.74	4.28											
132kV Connection Works	3.73	4.68	0.00	0.00	0.96	3.73											
11kV Distribution Works including 35MVA load transfer from Greenacre Park and 25MVA from Sefton to Potts Hill	7.03	8.88	0.01	0.11	0.89	7.87											
Operation & Maintenance for Stage 1	2.92		0.00	0.00	0.00	0.00	0.45	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
<b>Total Capital Cost (Stage 1)</b>		<b>42.55</b>															
<b>STAGE 2 - Additional Works</b>																	
Greenacre Park Zone 11kV Switchgear Replacement and 10MVA load transfer to Potts Hill Zone	11.12	19.56	0.00	0.00	0.00	0.00	0.00	0.00	1.48	18.08							
Potts Hill Zone additional transformer	3.62	6.36	0.00	0.00	0.00	0.00	0.00	0.00	0.48	5.88							
Sefton Zone derate and 15MVA load transfer to Potts Hill Zone	2.04	3.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.60							
Sefton Zone Oil Circuit Breaker Replacement	0.31	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.65					
Operation & Maintenance for Stage 2	0.90		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.26	0.34	0.35	0.35	0.35	0.35
<b>TOTAL (STAGE 1 + STAGE 2)</b>	<b>56.60</b>	<b>72.72</b>	0.40	7.69	18.58	15.88	0.45	0.55	2.51	28.11	0.79	1.46	0.88	0.90	0.90	0.90	0.90

Notes:

- 1) 2007 refers to the 2007/08 financial year and so forth.
- 2) All amounts are quoted in 2006/07 dollars.

\* Including future works covering the long term strategy for the area.

# Capital cost of work proposed by this Consultation Paper.

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**Option 2 – Rebuild Greenacre Park and Sefton zone substations**

Actions	NPC* (\$M)	CAPEX #(\$M)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Rebuild Greenacre Park Zone at 3x50MVA	31.50	37.56	0.34	6.67	16.41	14.13											
Rebuild Sefton Zone at 3x50MVA	26.00	31.00	0.28	5.51	13.55	11.67											
132kV feeder reconfiguration works	7.87	9.29	0.00	0.00	8.96	0.33											
Greenacre Park Zone land purchase	4.70	4.70	4.70	0.00	0.00	0.00											
Sefton Zone land purchase	4.70	4.70	4.70	0.00	0.00	0.00											
Sale of old Greenacre Park and Sefton zone sites after remediation	-3.22	-4.85	0.00	0.00	0.00	0.00	0.00	-4.85									
<b>Operation &amp; Maintenance</b>	1.92		0.00	0.00	0.00	0.00	0.87	1.00	1.02								
<b>TOTAL</b>	<b>73.47</b>	<b>85.30</b>	10.03	12.18	38.91	26.14	0.87	-3.85	1.02								

Notes:

- 1) 2007 refers to the 2007/08 financial year and so forth.
- 2) All amounts are quoted in 2006/07 dollars.

\* Including future works covering the long term strategy for the area.

# Capital cost of work proposed by this Consultation Paper.