Reasonableness Test RT 003/13
Gawler Belt 33/11kV Substation
N-1 Capacity Constraint

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GLOSSARY OF TERMS

Term	Meaning
Contingency Condition (N-1)	The term used to describe the state of the Distribution Network when any one piece of plant (N-1) is out of service, with the rest of the Network remaining intact.
Connection Point	A substation shared with ElectraNet, at which electrical power is injected from the ElectraNet Transmission Network into SA Power Networks' Distribution Network.
Distribution System	Shall have the meaning as defined within Chapter 10 of the National Electricity Rules.
Firm Delivery Capacity (N-1 Rating)	The maximum allowable load of a Substation under single Contingency Conditions, including any short term overload capacity.
POE	Probability of Exceedance. The 50% POE forecast (1 in 2 year event) is compared against the substation's firm delivery capacity.
PV	Photovoltaic (also known as solar cells)
Transfer Capacity	The amount of load that can be transferred to an adjacent substation via the 11kV feeder while still providing adequate customer voltage levels.

GUIDELINE 12 REASONABLENESS TEST

N-1 Capacity Constraint at Gawler Belt Substation

1. CURRENT SUPPLY ARRANGEMENT

Gawler Belt

Gawler Belt Substation is located in the suburb of Gawler Belt on the Thiele Highway (north of Hewett and south of Roseworthy) and is supplied via a single 33kV sub-transmission line from Templers 132/33kV Connection Point.

Gawler Belt Substation contains one 12.5MVA 33/11kV transformer and supplies approximately 2000 customers via two 11kV feeders. The load profile is predominantly residential load with some commercial and light industrial load.

There are 11kV feeder ties to adjacent Wasleys Substation (to the North) and Evanston Substation (to the South) of Gawler Belt Substation. During the 2015/16 summer under 50% PoE conditions approximately 2.4MVA of load can be transferred to these neighbouring substations via the 11kV feeder network. Typically, load transfers via the 11kV feeder network can be performed within 4 hours.

Gawler Belt Substation has a firm delivery capacity of 0MVA. For the summer of 2015/16, the 50% PoE forecast is 8.8MVA. 6.4MVA of customer load is forecast to be unsupplied during a contingency condition event after all available load transfers have been implemented. This load will remain unsupplied until a mobile substation can be deployed and installed (typically up to 24 hours).

The area under consideration is shown on Figure 1 over page.

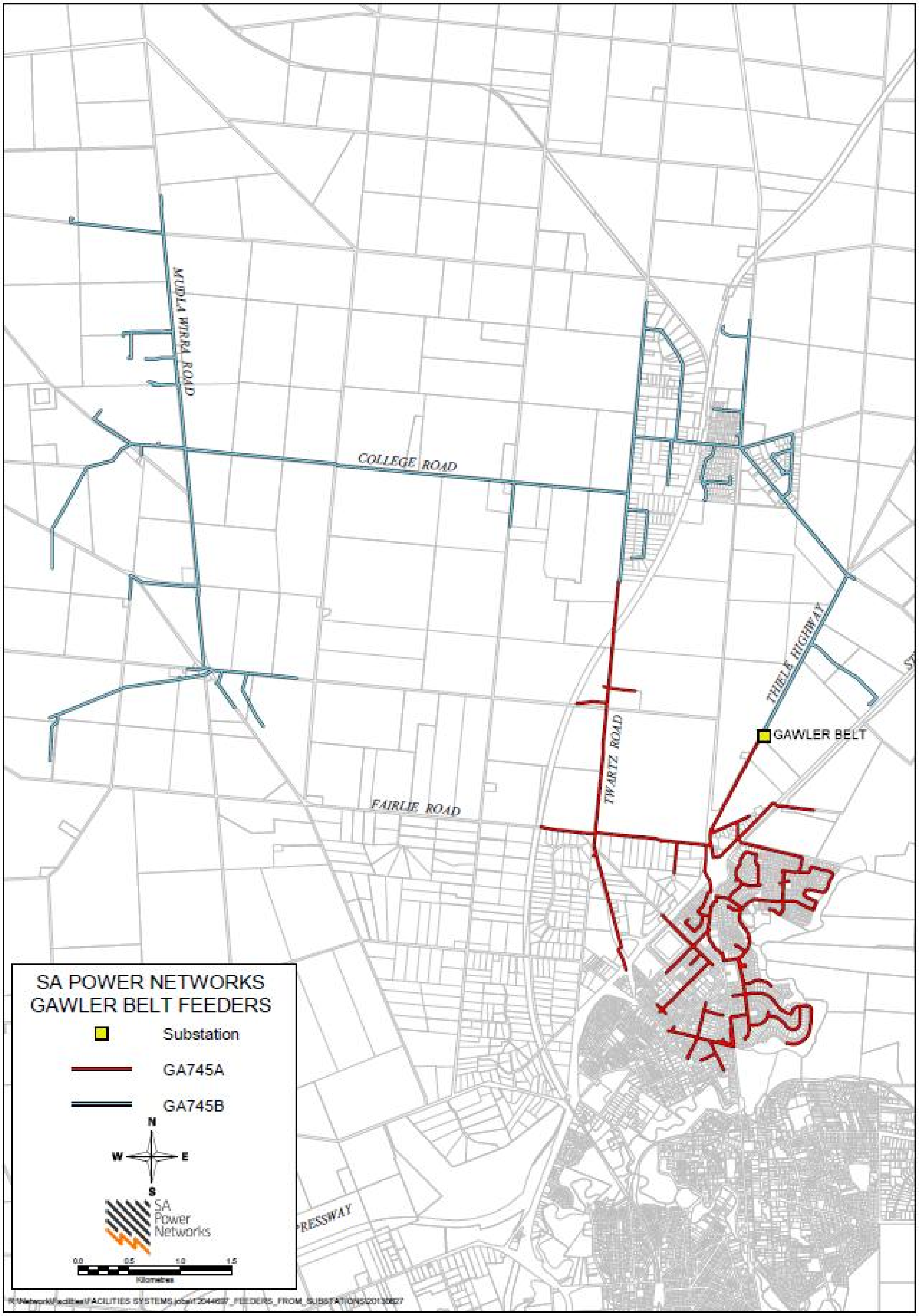

Figure 1: Locality of Gawler Belt Substation

2. FORECAST LOAD AND CAPACITY

2.1 Load Forecast

Total 11kV load at Gawler Belt Substation is forecast to grow at a rate of 4.4% per annum, which sees the 50% PoE load forecast increase from 8.2MVA in 2013/14 to 12.9 MVA in 2023/24, as shown in Table 1. Power factor at peak times is 0.92.

SA Power Networks' load forecasts takes into account all known existing or committed demand management programmes, and also includes an adjustment for the presence of any embedded generation (including PV).

Table 1: 50% PoE load forecast at Gawler Belt Substation

Summer Year	MVA	MW	MVAr
2013/14	8.2	7.6	3.2
2014/15	8.5	7.8	3.3
2015/16	8.8	8.1	3.4
2016/17	9.2	8.5	3.6
2017/18	9.6	8.9	3.7
2018/19	10.0	9.2	3.9
2019/20	10.5	9.7	4.0
2020/21	10.9	10.1	4.2
2021/22	11.4	10.5	4.4
2022/23	11.9	11.0	4.6
2023/24	12.4	11.4	4.8

There is no known significant embedded generation permanently connected to Gawler Belt substation other than PV.

By February 2014, SA Power Networks estimate approximately 2MW of PV will be installed by customers supplied by Gawler Belt Substation, the impact of which is incorporated in the load forecast above.

SA Power Networks has no major committed distribution augmentations in the Gawler Belt area.

2.2 Pattern of Use

Peak electricity demand at Gawler Belt Substation occurs during the summer months, predominantly as a result of air-conditioning load.

The load profile from the 18 February 2013 is typical for a 50% PoE day for substations supplying significant residential load and shows sign of PV penetration from 10:00 through to 18:30.

Substation peak load for the 50% PoE day is recorded at 17:30, with rapid drop off after 19:00.

MW load is above 85% of the recorded 50% PoE day peak between 14:00 and 19:30.

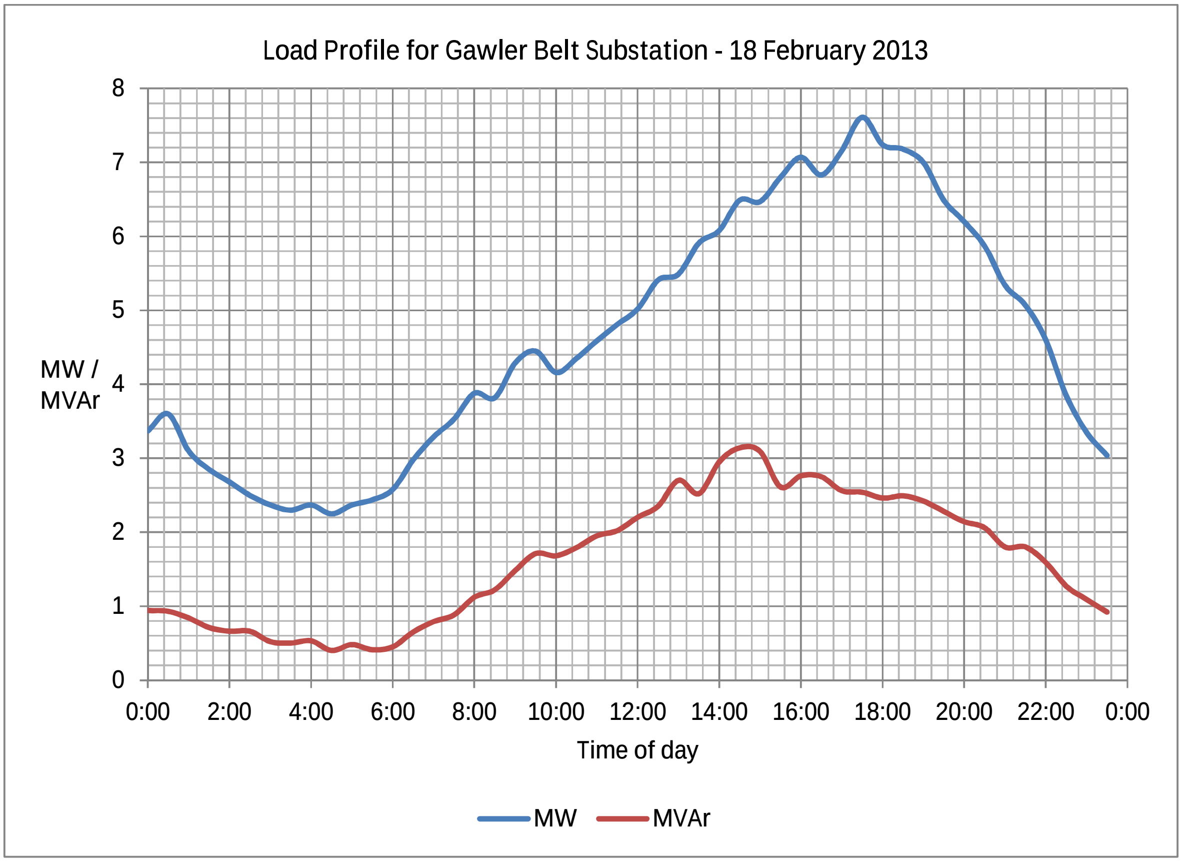

Figure 2: Load Profile for 50% PoE day at Gawler Belt Substation

In terms of the annual spread, Gawler Belt Substation load duration curve is typical of a substation supplying predominately residential load with some commercial and light industrial load.

- A sharp peak occurring on a few hot days a year and a quite low average for the rest of the time.
- Loads are in excess of 95% of peak for approximately 10 hours a year.
- Loads are in excess of 85% of peak for approximately 40 hours a year.
- Average load is approximately 35% of the recorded peak.

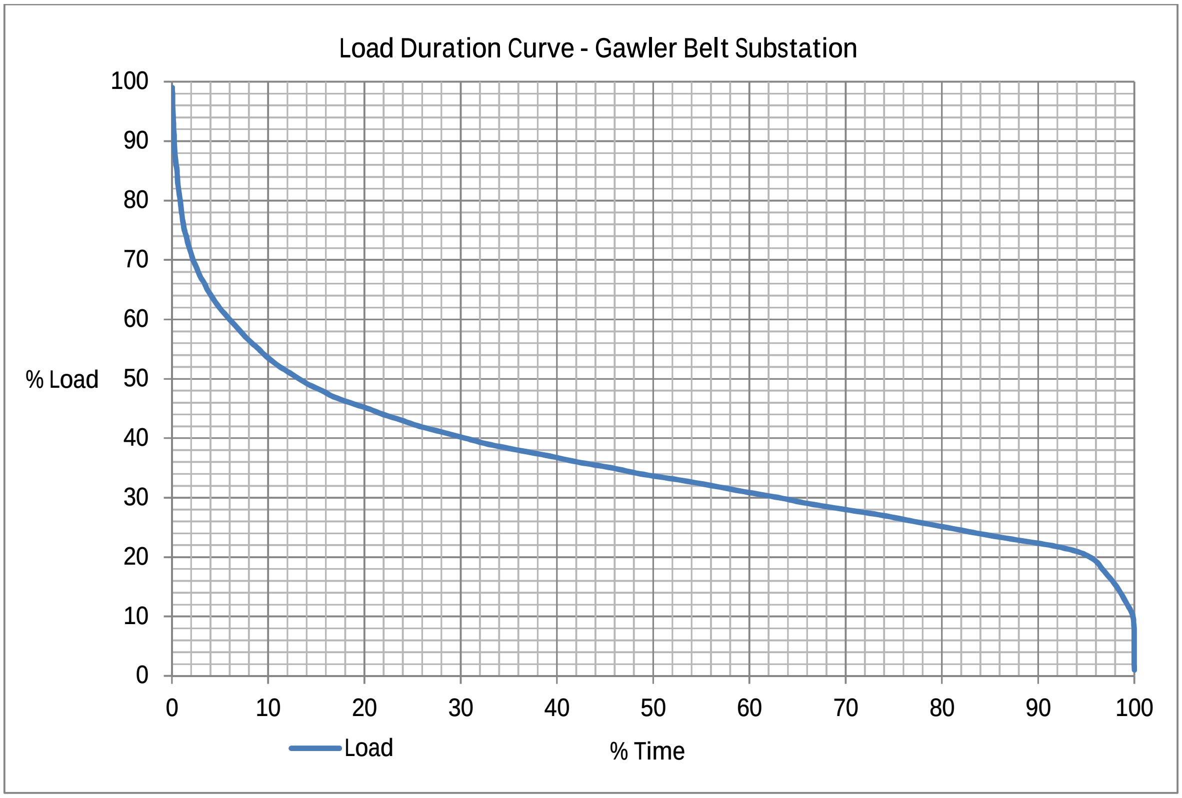

Figure 3: Load Duration Curve – Gawler Belt Substation

2.3 System Limitations

Following the loss of the single 33/11kV transformer, not all load at Gawler Belt Substation on a 50% PoE day can be transferred to other substations via the 11kV feeder network within 4 hours.

In summer 2015-16 on a 50% PoE day, 6.4MVA of customer load is forecast to be unsupplied during a contingency condition event after all available load transfers have been implemented. Following transfers to adjacent substations the load at risk will remain unsupplied until a mobile substation is installed (typically up to 24 hours).

3. NETWORK UPGRADE

The preferred network option to address the identified N-1 capacity constraint is:

- Install a second 12.5MVA 33/11kV transformer at Gawler Belt Substation (in case of failure of the existing 33/11kV substation transformer) along with two new 11kV feeders connecting to the existing 11kV feeder network.

It is expected that the preferred network option will cost in the order of $4.5 Million.

Alternative upgrade options considered include:

- Establish a new greenfield 12.5MVA 33/11kV Modular 1 substation at Hewitt (approximately 2.5km South of Gawler Belt Substation), upgrade 11kV feeder backbone conductor and cut in to the existing 11kV network (increase transfer capacity by approximately 7MVA).
- Upgrade Wasleys 33/11kV Substation and construct an new 8km 11kV feeder with voltage regulators and transfer load from Gawler Belt Substation (increase transfer capacity by approximately 4MVA).

The alternative options considered are either much more expensive or offer insufficient deferral benefits to be cost effective when compared to the preferred option.

4. DEMAND MANAGEMENT ANALYSIS

4.1 Required Demand Management Characteristics

For a demand management option to be credible it must be capable of:

- Increase transfer capacity by decreasing load upon Gawler West 11kV feeder, ex Evanston Substation.
- Increase transfer capacity by decreasing load upon Wasleys East 11kV feeder, ex Wasleys Substation.
- Reduce load upon Hewett and Kingsford 11kV feeders, ex Gawler Belt substation.

Given the substantial hours at risk this load reduction must be available all year and include both day and evening hours. It may operate post fault in conjunction with manual 11kV line switching operations.

Table 2: Load reduction required (MVA)

Summer Year	50% PoE (MVA)	Transfer Capacity (MVA)	Load Reduction Required (MVA)
2013/14	8.2	2.5	5.7
2014/15	8.5	2.5	6.0
2015/16	8.8	2.4	6.4
2016/17	9.2	2.2	7.0
2017/18	9.6	2.1	7.5
2018/19	10.0	2.0	8.0
2019/20	10.5	1.8	8.7
2020/21	10.9	1.7	9.2
2021/22	11.4	1.6	9.8
2022/23	11.9	1.4	10.5
2023/24	12.4	1.3	11.1

4.2 Demand Management Value

The following table indicates how much can be spent in year 1 to achieve a 1, 2 or 3 year deferral expressed both as an overall cost and as $ per kVA. The minimum and maximum amounts are derived by using different assumptions on the cost of capital from a minimum of 8.98% to 12.5%. The stated benefits also include an allowance of $50k per annum to cover our administrative costs. Note that these figures are indicative only.

Table 3 $ per kVA available for Demand Management

Deferral benefits	Total Available Benefit $,000's (min)	Total Available benefit $,000's (max)	$ available per kVA (Min)	$ available per kVA (Max)
1 year Deferral	$337	$466	$53	$73
2 year Deferral	$692	$924	$99	$132
3 year Deferral	$1,018	$1,331	$136	$177

4.3 Demand Management Options Considered

Various Demand Management (DM) technologies were considered to determine their viability to assist in reducing the demand in the constrained area. These DM options were evaluated for both technical feasibility as well as cost effectiveness.

4.3.a Standby diesel generators

Establish contracts with customers who have standby diesel generators on their premises and utilise the generators at peak load times or install peak lopping generators to reduce load at peak times. This option is not viable as there are not enough large customers with standby generators within the region to make this option feasible.

4.3.b Install new diesel generation

It is unlikely that planning permission would be given to install a medium sized (6-15 MW) power plant in the middle of a medium density residential suburb. In addition, recent experience indicates that the $ per kVA value available is too small to support a peaking plant, even if one could be built.

4.3.c Install power factor correction

This option is not technically feasible as there are not enough large customers supplied from Gawler Belt Substation to make individual power factor correction viable and substation based correction would not address the identified need.

4.3.d Retrofit commercial lighting with efficient lighting.

This option relies upon the ability to upgrade existing commercial fluorescent lighting to T5 lighting. Based on the upgrade of an existing 400W fluorescent bank with a 2x 80W efficient bank to provide the equivalent lumen output, the demand saving per bank is 240W.

The estimated cost for this option is $2,500/kVA. Significant disruption to the customer while the retrofit is carried out can be expected, which may influence the number of willing participants. It is highly unlikely that sufficient volume could be achieved to make a significant difference due to the amount of commercial load in the area.

4.3.e Peak load control – direct load control

Direct load control technology may be available where tripping multiple small air conditioning units supplied from a single distribution transformer can be performed. Recent experiences have shown the costs of such solutions to range from $300 to $800/kVA. Given the size of the constraint it is highly unlikely that sufficient volume would be available to make a significant difference in the size of constraint.

4.3.f Peak load control – curtailable load

This involves establishing a contract with one or more large customer's requiring them to reduce their load by either turning off the power supply to part of their business or shifting load to "off peak" times. Practically, there are no suitable customers with a load large enough to individually have a material impact on the network load for this option to be viable.

4.3.g Residential compact fluorescent lamp (CFL) program

This option was deemed not relevant due to peak load conditions occurring in daylight hours. Load contribution from residential housing lighting during daylight hours is believed to be minimal.

4.3.h Thermal storage systems

Installation of this form of storage system at a suitable site in a previous trial revealed a saving in load in the order of 150kVA. Smaller scale installations have also been trialled and are still very much in the development stage. However, the expected cost of this size of installation ranges from $1,000-1,600/kVA, which is much more expensive than the $ per kVA available.

4.3.i Energy Storage

Use of energy storage technology such as flow batteries is typically in the order of $6000 per kVA, which is significantly more than the available amount.

5. CONCLUSION

Based on the Demand Management options considered when compared to the preferred network solution, it is not possible that sufficient Demand Management measures could be implemented to achieve the demand reduction required to make project deferral technically and economically viable.

The constraint on the Gawler Belt substation has therefore failed the Reasonableness Test and a Request for Proposal (RFP) will not be issued.