WorleyParsons
resources & energy

EcoNomics

LANGEBERG MUNICIPALITY

Langeberg Municipality

MASTERPLANNING INVESTIGATION

285200KE0 – 28520V04/VJ

JUNE 2017

COMPILED FOR:

Langeberg Municipality
Manager: Electrical Engineering Services
Private Bag X2
Ashton
6705

Telephone: +2x (0)23 614 8000
Facsimile: +2x (0)23 614 1841

COMPILED BY:

WorleyParsons RSA (Pty) Ltd
ABN 61 001 279 812
Contact person: J D Pike
31 Allen Drive, Loevenstein 7530
Bellville 7530 PO Box 398, Bellville 7535
South Africa
Telephone: +27 (0)21 912 3000
Facsimile: +27 (0)21 912 3222
email: jamie.pike@worleyparsons.com
www.worleyparsons.com

Disclaimer

This report has been prepared on behalf of and for the exclusive use of Langeberg Municipality, and is subject to and issued in accordance with the agreement between Langeberg Municipality and WorleyParsons RSA (Pty) Ltd. WorleyParsons RSA (Pty) Ltd accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

Copying this report without the permission of Langeberg Municipality and WorleyParsons RSA (Pty) Ltd is not permitted.

PROJECT 285200KE0 - LANGEBERG MUNICIPALITY

REV	DESCRIPTION	ORIG	REVIEW	WORLEY-PARSONS APPROVAL	DATE	CLIENT APPROVAL	DATE
1	Re-issue for Client Approval	J Pike Author	W Kotzé A Reviewer	W Snyman N/A	2016-06-29		
2	Re-issue for Client Approval	J Pike Author	W Kotzé A Reviewer	W Snyman N/A	2016-12-14		
3	Re-issue for Client Approval	J Pike Author	W Kotzé A Reviewer	W Snyman N/A	2017-03-29		
4	Re-issue for Client Approval	J Pike Author	W Kotzé A Reviewer	W Snyman N/A	2017-06-28		

The existing Langeberg Municipality's medium voltage network was modelled in ERACS and subjected to simulated load flow studies to establish the effect the increasing maximum demand will have on the capacity of the Municipality's network. The Municipal substations that were subjected to the ERACS simulations were:

- Ashton;
- Bonnievale;
- Goudmyn;
- Le Chasseur;
- McGregor;
- Montagu;
- Noree; and
- Robertson.

The accuracy of the simulated results is restricted by the accuracy of the information received and available for the simulations. The present day simulations for the above mentioned substations were based on actual metering data (Schematic diagrams and electrical network data) as received from Langeberg Municipality.

The initial findings show that Ashton, Bonnievale, Goudmyn, Le Chasseur, McGregor, Montagu & Noree medium voltage networks are all lightly loaded with the 5, 10 and 15 year growth forecasts easily absorbed by the existing network. These networks all operate within their general thermal limits of the network elements. Some element upgrades are however required to these medium voltage networks so that they continue to function as reliable medium voltage networks, given the estimated growth forecasts for the next 5, 10 and 15 years.

The Robertson medium voltage network is relatively lightly loaded in terms of connected load; however based on the results from the simulations, some element upgrades are required immediately to enable the Robertson network to continue to function as a reliable and stable medium voltage network. The volt-drop on the Robertson medium voltage network is 5%, which is higher than the recommended guidelines of 3% as per NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas.

Additional simulations were performed on all of the medium voltage networks with respect to the normally-open and normally-closed points within each network, and it was established that the present configurations are feasible for a host of critical supply scenarios i.e. hypothetical network fault conditions.

The Plant Risk Analysis as conducted by Eskom is presented in Appendix A.

b/c	:	Bus Coupler: An element that links 2 busbars together. The link can either be open to stop the flow of current or closed to allow the flow of current
n/o	:	Normally open: A switch which is normally configured to stop the flow of current
n/c	:	Normally closed: A switch which is normally configured to allow the flow of current
v/d	:	Volt-drop: The decrease in the line or phase voltage as a result of the product of the current flowing through the element and the resistance of the element
LV	:	Low Voltage: Voltage range from 220V to 1000V
MV	:	Medium Voltage: Voltage range from 1000V to 33000V
kVA	:	kiloVolt Ampere: Apparent Power
kW	:	kiloWatt: Real Power
ss	:	Substation: Point in the network to either step up or step down the voltage, or to provide a point to distribute electricity
ADMD	:	After Diversity Maximum Demand: The maximum loading on a network after all loads have been diversified
PQ Multiplier:		ERACS setting to replicate the network diversity, based on the actual figures as indicated by the Langeberg Municipality
Δ	:	Delta: The difference between 2 parameters
DF	:	Demand Factor: Given as the maximum demand for a given period divided by the total installed capacity of the network. It is indicated by the formula:

$$DF = \frac{Maximum\ load\ in\ given\ time\ period}{Maximum\ possible\ load}$$

LG	:	Load Growth: Given as the increase in energy demand over a certain period of time. It is indicated by the formula:

$$Predicted\ Maximum\ Demand = Current\ Maximum\ Demand\ x\ (1 + \%Growth)^n$$

Where n = number of periods/years

CONTENTS

1. APPOINTMENT

WorleyParsons RSA (Pty) Ltd was appointed to investigate the Medium Voltage (MV) electrical supply networks for Langeberg Municipality. The areas which are covered in the appointment are Ashton, Bonnievale, Goudmyn, Le Chasseur, McGregor, Montagu, Noree and Robertson.

2. SCOPE OF WORKS

The analysis and simulations for the various regions within the Langeberg Municipality are based on the single line schematics for the various Municipal substations, verbal and written communication regarding circuit confirmation of the existing network layouts and statistical measurement data as provided and received from the Langeberg Municipality.

The required output from the analyses is to provide an opinion on the capacity of the existing networks. With expected growths for the various substations as calculated from the previous measured data, this report will provide information and recommendations needed to accommodate the expected growths into the future.

3. METHODOLOGY

Simulations were conducted on the various medium voltage networks within the Langeberg Municipality using ERACS power system analyses software. Previous maximum demand data as received from the Langeberg Municipality, was used to establish an estimated growth percentage for Ashton, Bonnievale, Goudmyn, Le Chasseur, McGregor, Montagu and Noree, and these percentages were then added to the present day maximum demand values and projected for a period of 5, 10 and 15 years. Simulations were then conducted to establish the effects the estimated growth would have on the various medium voltage networks.

For the Robertson medium voltage network known 5, 10 and 15 year loads were added to the present day maximum demand value. Simulations were then conducted to establish the effects the known loads would have on the various medium voltage networks.

4. EXISTING INFORMATION

The existing information was obtained from single-line schematics and physical as well as technical input from the Langeberg Municipality for the following areas:

- Ashton
- Bonnievale
- Goudmyn
- Le Chasseur
- McGregor
- Montagu
- Noree
- Robertson

The information obtained as mentioned above was used as a reference for the ERACS (Era Technology) Electrical Network Load Flow Analysis:

- Network models were compiled for the existing MV Langeberg Networks;
- After Diversity Maximum Demand (ADMD) measurements were provided by the Langeberg Municipality and were used to calibrate the simulations to reflect real network conditions as accurately as possible. The calibrations are done by adjusting the PQ Multiplier in the ERACS Software;
- Normally-open (n/o) and normally-closed (n/c) points were applied to the load-flow simulations as found on the schematics, as well as through communication with Langeberg Municipality. The simulation results therefore apply to the system as simulated; and
- Substation outgoing feeder's maximum demand figures were used in modelling the capacity on the individual feeder circuits in the various Municipal substations.

5. ANALYSIS OF DATA AND SIMULATIONS

Historic maximum demand, future load growth estimation, load flow analyses and various ERACS simulations will be discussed per Municipal substation within the Langeberg Municipality jurisdiction. These regions are as follows:

- Ashton
- Bonnievale
- Goudmyn
- Le Chasseur
- McGregor
- Montagu
- Noree
- Robertson

5.1 ASHTON

5.1.1 ASSET REGISTER

A histogram of the transformers located in Ashton's MV Network is as follows. There are 95 transformers located within the Ashton MV Network:

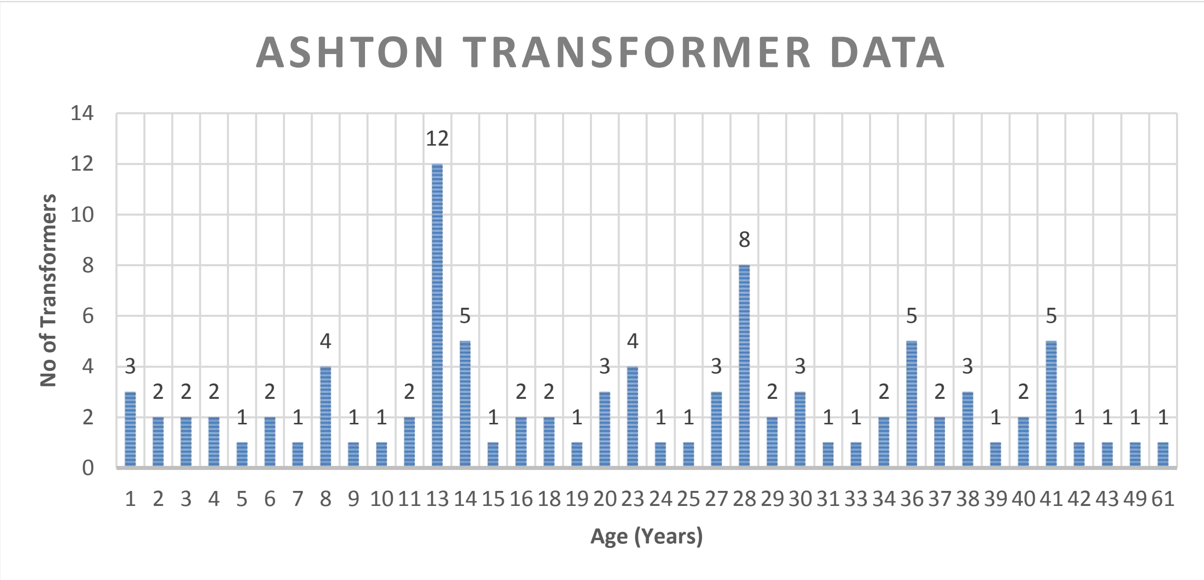

Figure 1: Langeberg Municipality: Ashton Transformer Data

From the above graph there are a number of transformers which are pre 1985 (25 in total). It is recommended that all of these be replaced as part of the network strengthening exercise.

5.1.2 HISTORIC MAXIMUM DEMAND DATA

Historic maximum demand figures for the Ashton MV network are:

- Year 2000 : 7.292MVA
- Year 2005 : 9.143MVA
- Year 2010 : 10.705MVA
- Year 2014 : 10.153MVA

The historic maximum demand figures are based on the statistical metering data obtained from the Eskom Bulk Supply Point, as received from the Langeberg Municipality.

Analysis of this data reveals a future network demand growth of approximately 1.054%. This figure is based upon historical data received from Langeberg Municipality, and projected 15 years to year 2029.

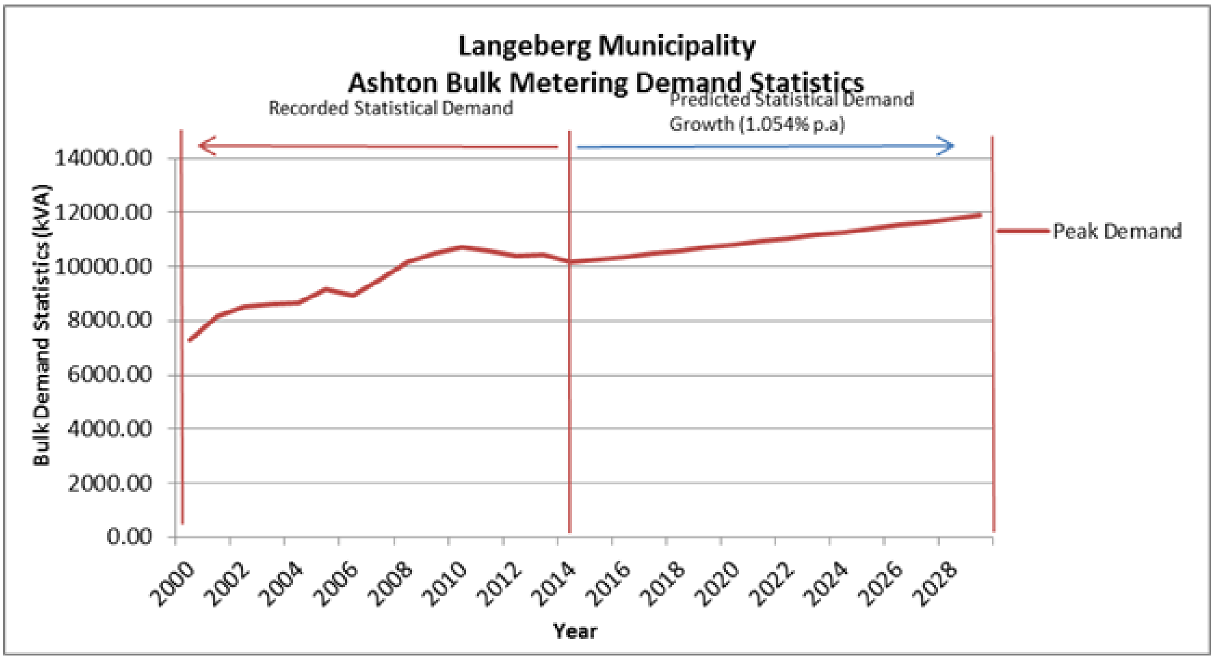

Figure 2: Langeberg Municipality: Ashton Bulk Metering Demand Statistics

The predicted 5, 10 & 15 year bulk peak demand forecast is as follows:

- 5 Year Forecast : 10.699MVA ($= 10.153\text{MVA} \times (1 + 0.01054)^{5\text{ Years}}$)
- 10 Year Forecast : 11.275MVA ($= 10.153\text{MVA} \times (1 + 0.01054)^{10\text{ Years}}$)
- 15 Year Forecast : 11.882MVA ($= 10.153\text{MVA} \times (1 + 0.01054)^{15\text{ Years}}$)

5.1.3 ASHTON MEDIUM VOLTAGE NETWORK LOAD-FLOW ANALYSIS

Five simulations were performed on the Ashton MV Network. The simulations were designed to provide insight into the Ashton MV Network and how it performs under present steady-state and network configuration conditions, as well as future predicted growth forecasts. The simulations mentioned above included:

- Current Peak Demand;
- 5 Year Peak Demand Forecast;
- 10 Year Peak Demand Forecast;
- 15 Year Peak Demand Forecast; and
- Various contingencies.

The simulations were performed on the network to provide an insight into the Ashton MV Network as it currently appears, and how it will perform under the predicted 1.054% annual growth forecast as calculated from the data received from the Langeberg Municipality.

5.1.4 RESULTS OF ASHTON MV NETWORK SIMULATIONS

5.1.4.1 General Comments

Although the Ashton MV Network represents a diversified maximum demand of 10.705MVA (recorded in January 2010), it is clear that 26.019MVA of MV equipment (installed capacity) is connected to the network. This is calculated by adjusting the PQ multiplier in ERACS to 1, and running the simulation

The Ashton MV Network appears relatively diversified and lightly loaded, with a demand factor of approximately 0.411 (0.411 x 26.019 = 10.705MVA).

5.1.4.2 Simulation 1: Current Peak Demand

Drawings **285200KE0/ASH01**, **285200KE0/ASH02** & **285200KE0/E/ASH001** refer.

Simulation 1 was based on the normal network configuration and operating conditions. The n/o and n/c points reflect the actual (present) network status. There are two Eskom transformers which supply the Ashton MV network – a 20MVA 66/11kV transformer and a 5MVA 66/11kVA transformer; however the 5MVA transformer does not contribute to the load and is in the open position.

The ERACS simulation of the Ashton MV Network returns an after-diversity-maximum-demand (ADMD) of 10.716MVA, compared with the real 2010 ADMD of 10.705MVA – a difference of 11kVA, which is an acceptable difference.

A full evaluation of the ERACS simulation reveals the Ashton MV Network is relatively lightly loaded i.e. 95.04% of all conductors supplying the network fall within the thermal utilization range of between 0 and 35%.

The volt-drop across the municipal Ashton MV Network is approximately 1.2%, which complies with the supply authority guidelines. NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas – states that the volt-drop across the MV distributor should be somewhere in the order of 3%. The bus with the lowest voltage, as simulated, is AC.CO (98.8%) – located on the Steeg feeder from the BIB Substation.

The cable that is operating at the highest capacity is the underground copper conductor supplying the Station RMU, which is presently operating above 71% of its thermal capacity.

It must be stated that the Ashton MV network does not offer any form of redundancy as it is supplied by means of only one transformer i.e. the 20MVA Eskom transformer. Should this transformer fail, the Ashton MV network will experience a power failure. It is recommended to introduce a second Eskom transformer of the same size and type to mitigate this risk i.e. offer some form of redundancy. This is further highlighted in the Eskom Plant Risk Analysis (Appendix 4).

5.1.4.3 Simulation 2: 5 Year Peak Demand Forecast

Drawing **285200KE0/E/ASH002** refers.

Simulation 2 is based on a 5 year growth forecast calculated at 1.054% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 5 year estimated bulk demand figure is in the region of 10.699MVA, which is slightly lower than the maximum demand figure recorded in 2010. The decrease in the 5 year maximum demand figure could be as a result of intervening factors such as demand limitations imposed by the Municipality due to Eskom's limited generation capacity during the energy crisis that South Africa experienced between 2008-2012.

Upon a closer study of simulation 2, the overall volt-drop across the municipal Ashton MV Network is 1.2%, which falls within the normal parameters as indicated in NRS 034 for an MV network. The busbar with the lowest voltage is AC.CO (98.8%).

The conductor which is now operating at the highest thermal capacity across the MV Network is the Stasie Weg feeder in the main Ashton Substation. It is operating at 71.221% of its thermal capacity.

The MV network appears stable and in good shape, with 95.03% of all conductors supplying the network falling within the thermal utilization range of between 0 and 35%.

5.1.4.4 Simulation 3: 10 Year Peak Demand Forecast

Drawing **285200KE0/E/ASH003** refers.

Simulation 3 is based on a 10 year growth forecast calculated at 1.054% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 10 year estimated bulk demand figure is in the region of 11.275MVA. The system is still relatively lightly loaded in terms of the installed capacity; however there is a concern with some underground conductors reaching 80% of the upper limits of their thermal capacity:

- Stasie Weg Feeder : 74%
- Station RMU Conductor : 72%

It is recommended that should the growth continue at a rate 1.054% per annum, these conductors be replaced.

The overall volt-drop across the Ashton municipal MV Network is 1.3%, which falls in line with the supply authority guidelines as indicated in NRS 034. The busbar with the lowest voltage is AC.CO (98.7%).

5.1.4.5 Simulation 4: 15 Year Peak Demand Forecast

Drawing **285200KE0/E/ASH004** refers.

Simulation 4 is based on a 15 year growth forecast calculated at 1.054% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 15 year estimated bulk demand figure is in the region of 11.882MVA.

The overall volt-drop on the MV Network is 1.4% which is acceptable in terms of NRS 034.

Although the system is still relatively lightly diversified in terms of the installed capacity (under 50%), there are a few concerns:

- 4% of the conductors are operating above 35% of their thermal utilization capacity;
- 5% of the conductors are operating above 50% of their thermal utilization capacity (Excluding the above conductors);
- 1 Conductor is operating above 78% of its thermal utilization capacity (Excluding the above conductors);

The Stasie Weg feeder in the main Ashton substation is now operating at 78.4% of its thermal utilisation capacity, and the underground conductor feeding the Station RMU is operating at 75.5% of its thermal utilisation capacity.

Whilst the 15 year forecasted MV network can operate without any elements operating outside of their designed parameters, it is clear from Simulation 4 that a strengthening of the MV network will be required should the ADMD maximum demand reach 11.882MVA, in particular upgrading of certain feeders and underground conductors.

5.1.4.6 Simulation 5: Various Contingencies

The purpose of Simulation 5 is to determine the effect various contingencies (switching requirements) will have on the Ashton MV Network, with respect to existing n/o and n/c points, in order to assess network viability in the event of network faults occurring.

The results of the simulation are contained in the table below.

The simulation poses questions, tabulated as “critical supply scenarios”. For each “critical supply scenario” there is an action required to be effected in the Ashton MV Network, and the consequences of the “critical supply scenario” and “action required” are included in the “effect to network”.

The scenarios represent possible network operating conditions for fault conditions within the network. As an example, suppose the following scenario (critical supply scenario 1 below):

- There is a critical fault on the Stasie Weg circuit;
- Stasie Weg is presently configured as a ring-feed, coupled with the BIB Sub circuits;
- By disconnecting the ring-feed through the Stasie Weg circuit breaker, and closing the n/o point presently situated at the Steeg RMU, causes the current to flow through the BIB Sub circuit breakers to increase from 14.4% to 39.3%.

#	Critical Supply Scenarios	Action Required	Effect on Network
1	Fault on Feeder: Stasie Weg	1] Close n/o point Steeg RMU	A] Tiger Feeder remains at 30% thermal capacity
			B] Zolanie Feeder remains at 63% thermal capacity
			C] Extract Feeder remains at 7.4% thermal capacity
			D] BIB Sub Feeders from 14.4% to 39.3% thermal capacity
2	Fault on Feeder: Tiger	1] Close n/o point: Tiger RMU	A] Stasie Weg Feeder remains at 75% thermal capacity
			B] Zolani Feeder remains at 63% thermal capacity
			C] Extract Feeder from 7.4% to 53% thermal capacity
			D] BIB Sub Feeders remain on 14.4% thermal capacity
3	Fault on Feeder: Zolani	1] Close n/o point: Zolani	A] Stasie Weg Feeder from 75% to 94% thermal capacity
			B] Tiger Feeder remains on 30% thermal capacity
		2] Close n/o point: Steeg RMU	C] Extract Feeder remains on 7.4% thermal capacity
			D] BIB Sub Feeders from 14.4% to 29.2% thermal capacity
		1] Close n/o point: Tiger RMU	A] Stasie Weg feeder remains at 75% thermal capacity

#	Critical Supply Scenarios	Action Required	Effect on Network
4	Fault on Feeder: Extract		B] Tiger Feeder from 30% to 26% thermal capacity
		2] Close n/o point: Hoofweg	C] Zolani Feeder remains at 63% thermal capacity
			D] BIB Sub Feeders from 14.4% to 18.6% thermal capacity
5	Fault on Feeder: BIB Sub	1] Close n/o point: Steeg RMU	A] Stasie Weg Feeder from 75% to 884 thermal capacity
			B] Tiger Feeder remains at 30% thermal capacity
		2] Close n/o point: Hoofweg RMU	C] Zolani Feeder remains at 63% thermal capacity
			D] Extract Feeder from 7.4% to 42.9% thermal capacity

Table 1: Critical Supply Scenarios for the Ashton MV Network

The Ashton MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated above.

5.2 BONNIEVALE

5.2.1 ASSET REGISTER

A histogram of the transformers located in Bonnievale's MV Network is as follows. There are 100 transformers located within the Bonnievale MV Network:

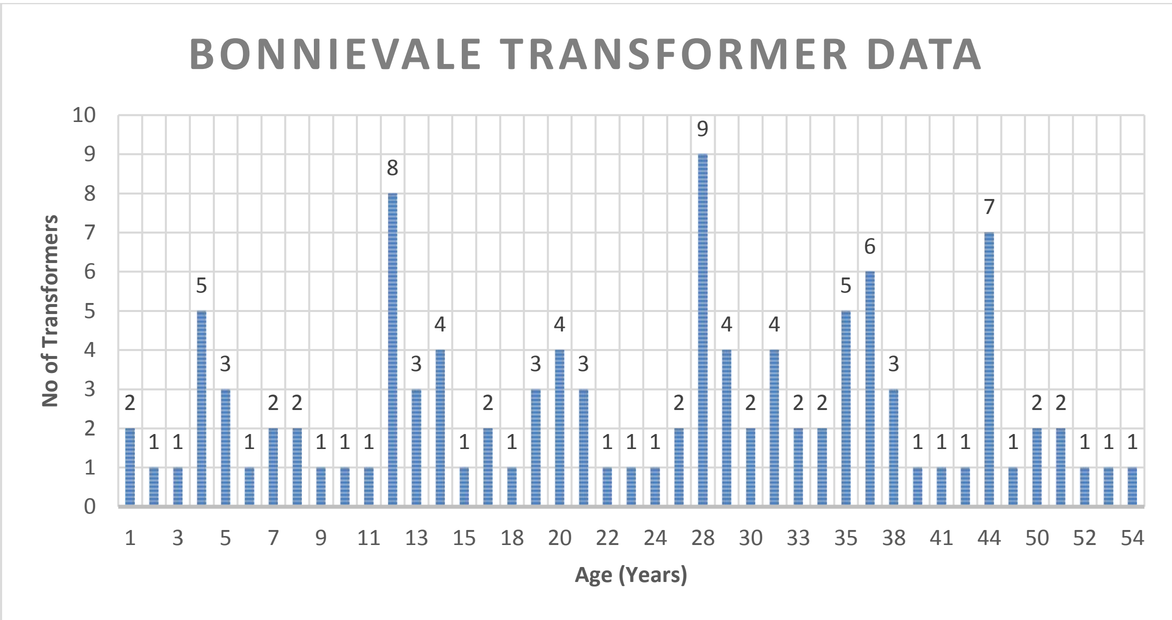

Figure 3: Langeberg Municipality: Bonnievale Transformer Data

From the above graph it is clear that there are a number of transformers dated pre 1985 (36 in total). It is recommended that these 36 transformers be upgraded as part of a network strengthening exercise.

5.2.2 HISTORIC MAXIMUM DEMAND DATA

Historic maximum demand figures for the Bonnievale MV network are:

- Year 2000 : 5.656MVA
- Year 2005 : 6.636MVA

- Year 2010 : 8.427MVA
- Year 2014 : 8.591MVA

The historic maximum demand figures are based on the statistical metering data obtained from the Eskom Bulk Supply Point, as received from the Langeberg Municipality.

Analysis of this data reveals a future network demand growth of approximately 3%. This figure is based upon historical data received from Langeberg Municipality, and projected to year 2029.

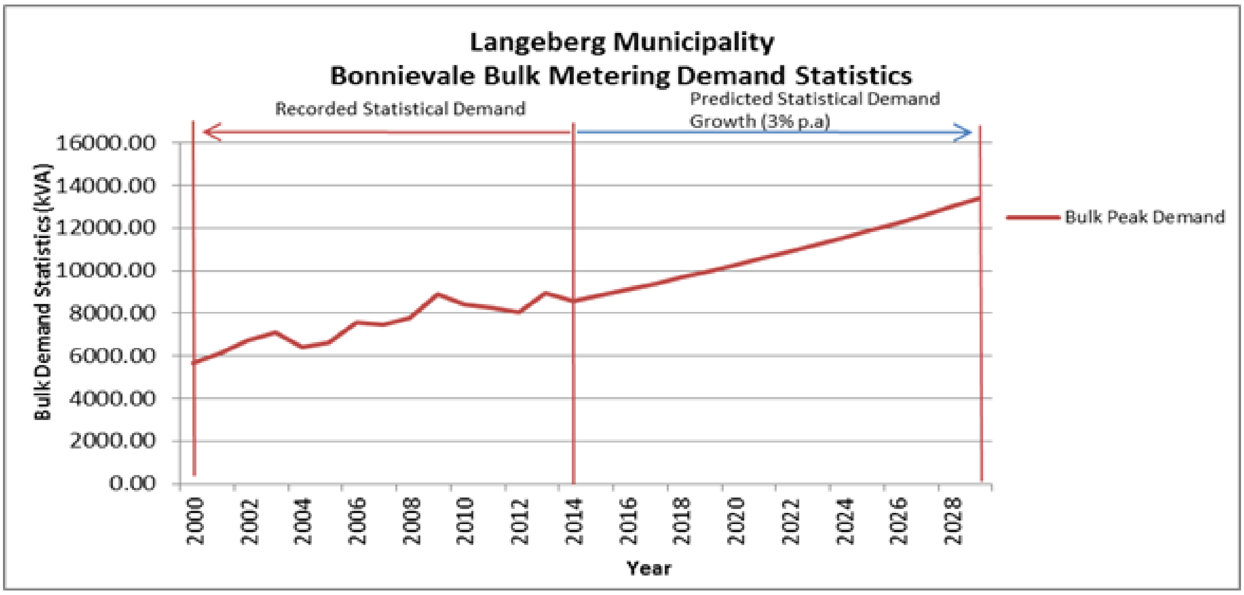

Figure 4: Langeberg Municipality: Bonnievale Bulk Metering Demand Statistics

The predicted 5, 10 & 15 year bulk peak demand forecast is as follows:

- 5 Year Forecast : 9.959MVA ($= 8.591\text{MVA x } (1 + 0.03)^{5\text{ Years}}$)
- 10 Year Forecast : 11.546MVA ($= 8.591\text{MVA x } (1 + 0.03)^{10\text{ Years}}$)
- 15 Year Forecast : 13.385MVA ($= 8.591\text{MVA x } (1 + 0.03)^{15\text{ Years}}$)

5.2.3 BONNIEVALE MEDIUM VOLTAGE NETWORK LOAD-FLOW ANALYSIS

Five simulations were performed on the Bonnievale MV Network. The simulations were designed to provide insight into the Bonnievale MV Network and how it performs under present steady-state and network configuration conditions, as well as future predicted growth forecasts. The simulations mentioned above included:

- Current Peak Demand;
- 5 Year Peak Demand Forecast;
- 10 Year Peak Demand Forecast;
- 15 Year Peak Demand Forecast; and
- Various contingencies.

The simulations were performed on the network to provide insight into the Bonnievale MV Network as it currently appears, and how it will perform under the predicted 3% annual growth forecast as calculated from the data received from the Langeberg Municipality.

5.2.4 RESULTS OF BONNIEVALE MV NETWORK SIMULATIONS

5.2.4.1 General Comments

Although the Bonnievale MV Network represents a diversified maximum demand of 8.930MVA, it is clear that 21.153MVA of MV equipment (installed capacity) is connected to the network. This is calculated by adjusting the PQ multiplier in ERACS to 1, and running the simulation

The Bonnievale MV Network appears relatively diversified and lightly loaded, with an acceptable demand factor of approximately 0.42 (0.422 x 21.153 = 8.930MVA).

5.2.4.2 Simulation 1: Current Peak Demand

Drawings **285200KE0/BON01**, **285200KE0/BON02** & **285200KE0/E/BON001** refer.

Simulation 1 was based on the normal network configuration and operating conditions. The n/o and n/c points reflect the actual (present) network status. There is one 20MVA 66/11kV Eskom transformer which supplies Bonnievale.

The ERACS simulation of the Bonnievale MV Network returns an after-diversity-maximum-demand (ADMD) of 8.824MVA, compared with the actual 2013 ADMD of 8.930MVA – a difference of 106kVA which is an acceptable difference.

A full evaluation of the ERACS simulation reveals the Bonnievale MV Network is relatively lightly loaded i.e. 93% of all lines and cables supplying the network fall within the thermal utilization range of between 0 and 35%.

The volt-drop across the municipal Bonnievale MV Network is approximately 3.3%, which is slightly above the supply authority guidelines. NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas – states that the volt-drop across the MV distributor should be somewhere in the order of 3%. The bus with the lowest voltage, as simulated, is Bus0156 (96.7%) – located on the line towards Beeskrale.

The overall power factor of the Bonnievale MV Network as simulated in ERACS is 0.937, which is acceptable.

It must be stated that the Bonnievale MV network does not offer any form of redundancy as it is supplied by means of only one Eskom transformer i.e. the 20MVA transformer. Should this Eskom transformer fail, the Bonnievale MV network will experience a power failure. It is recommended to introduce a second Eskom transformer of the same size and type to mitigate this risk i.e. offer 100% redundancy. This is further highlighted in the Eskom Plant Risk Analysis (Appendix 4).

5.2.4.3 Simulation 2: 5 Year Peak Demand Forecast

Drawing **285200KE0/E/BON002**

Simulation 2 is based on a 5 year growth forecast calculated at 3% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 5 year estimated bulk peak demand figure is expected to be in the region of 9.959MVA.

The overall volt-drop for the Bonnievale MV Network has increased to 3.7%, which remains above the recommended norms of 3% as indicated in NRS 034.

The MV network appears stable and in good shape, with 92% of all lines and cables supplying the network falling within the thermal utilization range of between 0 and 35%.

The overall power factor of the network is 0.935.

5.2.4.4 Simulation 3: 10 Year Peak Demand Forecast

Drawing **285200KE0/E/BON003** refers.

Simulation 3 is based on a 10 year growth forecast calculated at 3% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 10 year estimated bulk demand figure is in the region of 11.546 MVA. Although the system is still relatively lightly diversified in terms of the installed capacity of 21.153MVA, there is a concern that some conductors are reaching the upper limits of their thermal capacity, and the main feeder conductor feeding the Angora line from the Bonnievale main substation is now operating above 72% of its thermal capacity.

The network is however still relatively stable, with the overall volt-drop across the Bonnievale MV network 4.4%, which is above the Municipal guidelines of 3%. The busbar with the lowest voltage, as simulated, is still Bus0156 (95.6%) – located on the line towards Beeskrale.

5.2.4.5 Simulation 4: 15 Year Peak Demand Forecast

Drawing **285200KE0/E/BON004**

Simulation 4 is based on a 15 year growth forecast calculated at 3% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 15 year estimated bulk demand figure is in the region of 13.385 MVA.

A full evaluation of the ERACS simulation reveals that although the Bonnievale MV Network appears lightly loaded i.e. 91.5% of all the electrical conductors supplying the network fall within the thermal utilization range of between 0 and 35%, there are some electrical conductors that are operating above 80% of their thermal utilization range. Some concerns which are immediately picked up are:

- The overall Bonnievale MV Network volt-drop is 5%, which is above the 3% recommended guideline as indicated by NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas;
- 5% of the conductors are operating above 50% of their thermal utilization capacity;
- 3 Conductors are operating above 80% of their thermal utilization capacity (Excluding the above conductors);

The single largest concern exposed by Simulation 4 is the thermal utilization of the Angora Feeder which is now operating at 83% of its thermal utilisation capacity. This implies that should any of the other main feeder conductors fail, the Angora feeder will not be in a position to safely carry the combined load of the other conductors i.e. there is no form of redundancy available should a fault occur.

It is clear from Simulation 4 that should the ADMD of Bonnievale reach 13.385MVA, a strengthening of the MV network will be required, and in particular an upgrade of the main feeder cables (Angora and Nordale Feeders) within Bonnievale main substation that supply the MV network will be required.

5.2.4.6 Simulation 5: Various Contingencies

The purpose of Simulation 5 is to determine the effect various contingencies (switching requirements) will have on the Bonnievale MV Network, with respect to existing n/o and n/c points, in order to assess network viability in the event of network faults occurring.

The results of the simulation are contained in the table below.

The simulation poses questions, tabulated as "critical supply scenarios". For each "critical supply scenario" there is an action required to be effected in the Bonnievale MV Network, and the consequences of the "critical supply scenario" and "action required" are included in the "effect to network".

The scenarios represent possible network operating conditions, for fault conditions within the network. As an example, suppose the following scenario (critical supply scenario 1 below):

- There is a critical fault on the Hoof Dorp circuit;
- Hoof Dorp is presently configured as a ring-feed, coupled with the Angora and Nordale circuits;

- By disconnecting the ring-feed through the Hoof Dorp circuit breaker, closing the n/o points presently situated at the Busbar 48 and Busbar 49 and creating an open point on the fuse feeding Parmalat, causes the current that flows through the Angora circuit breakers to increase from 58.45% to 73.49%, the current that flows through the Nordale circuit breaker remains at 55.13%, and causes current that flows through Kaas Fabriek circuit breakers to increase from 6.05% to 29%; and

- Power restored to the Hoof Dorp circuit.

#	Critical Supply Scenarios	Action Required	Effect on Network
1	Fault on Feeder: Hoof Dorp	1] Close n/o point: Busbar 48	A] Angora feeder from 58.45% to 73.49% thermal capacity
		2] Close n/o point: Busbar 49	B] Nordale Feeder remains at 55.13% thermal capacity
		3] Open fuse on feeder towards Parmalat 1, 2 & 3	C] Kaas Fabriek Feeder from 6.05% to 29% thermal capacity
2	Fault on Feeder: Angora	No action Required	A] Hoof Dorp Feeder remains at 40.5% thermal capacity
			B] Nordale Feeder remains at 55.13% thermal capacity
			C] Kaas Fabriek Feeder from 6.05% to 59.24% thermal capacity
3	Fault on Feeder: Nordale	1] Close n/o point: RMU towards Waterwerke	A] Hoof Dorp Feeder from 40.54% to 55.56% thermal capacity
		2] Close n/o point: Busbar 48	B] Angora Feeder from 58.45% to 73.47% thermal capacity
		3] Close n/o point: Busbar 49	C] Kaas Fabriek Feeder from 6.05% to 28.98% thermal capacity
		4] Open fuse on feeder towards Parmalat 1, 2 & 3	
4	Fault on Feeder: Kaas Fabriek	No action required	A] Hoof Dorp Feeder remains at 40.54% thermal capacity
			B] Angora Feeder from 58.45% to 65.18% thermal capacity
			C] Nordale Feeder remains at 55.13% thermal capacity

Table 2: Critical Supply Scenarios for the Bonnievale MV Network

The Bonnievale MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated above.

5.3 GOUDMYN

5.3.1 HISTORIC MAXIMUM DEMAND DATA

Langeberg Municipality does not keep records of maximum demand data history for Goudmyn Substation. For these reasons, it is not possible to plot the growth accurately, and therefore an estimated year on year growth of 2% has been selected given the rural nature of the region. The current maximum demand as indicated by Langeberg Municipality is 8.8MVA.

The predicted 5, 10 & 15 year bulk peak demand forecast at a year on year growth percentage of 2% is as follows:

- 5 Year Forecast : 9.716MVA ($= 8.8\text{MVA x } (1 + 0.02)^{5\text{ Years}}$)
- 10 Year Forecast : 10.727MVA ($= 8.8\text{MVA x } (1 + 0.02)^{10\text{ Years}}$)
- 15 Year Forecast : 11.843MVA ($= 8.8\text{MVA x } (1 + 0.02)^{15\text{ Years}}$)

5.3.2 GOUDMYN MEDIUM VOLTAGE NETWORK LOAD-FLOW ANALYSIS

Five simulations were performed on the Goudmyn MV Network. The simulations were designed to provide insight into the Goudmyn MV Network and how it performs under present steady-state and network configuration conditions, as well as future predicted growth forecasts. The simulations mentioned above included:

- Current Peak Demand;
- 5 Year Peak Demand Forecast;
- 10 Year Peak Demand Forecast;
- 15 Year Peak Demand Forecast; and
- Various contingencies.

The simulations were performed on the network to provide insight into Goudmyn’s MV Network as it currently appears, and how it will perform under the estimated 2% annual growth forecast.

5.3.3 RESULTS OF GOUDMYN MV NETWORK SIMULATIONS

5.3.3.1 General Comments

Although the Goudmyn MV Network represents a diversified maximum demand of 8.8MVA (Figures obtained from Langeberg Municipality), it is clear that 18.382MVA of MV equipment (installed capacity) is connected to the network. This is calculated by adjusting the PQ multiplier in ERACS to 1, and running the simulation.

The Goudmyn MV Network appears moderately diversified, with a demand factor of approximately 0.478 (0.478 x 18.382 = 8.8MVA).

5.3.3.2 Simulation 1: Current Peak Demand

Drawing **285200KE0/E/GOU001** refers.

Simulation 1 was based on the normal network configuration and operating conditions. The n/o and n/c points reflect the actual (present) network status. There are two 10MVA 66/11kV transformers which supply the Goudmyn network.

The ERACS simulation of the Goudmyn MV Network returns an after-diversity-maximum-demand (ADMD) of 8.813MVA, compared with the actual ADMD of 8.8MVA – a difference of 13kVA which is an acceptable difference.

A full evaluation of the ERACS simulation reveals the Goudmyn MV Network is relatively lightly loaded i.e. 73.3% of all lines and cables supplying the network fall within the thermal utilization range of between 0 and 35%. This implies that 26.7% of the lines and cables are operating above the 35% thermal utilization range.

The volt-drop across the municipal Goudmyn MV Network is approximately 15.3%, which is more than double the recommended norm as indicated by the supply authority guidelines. NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas – states that the volt-drop across the MV distributor should be somewhere in the order of 3%. The bus with the lowest voltage, as simulated, is Bus0083 (85.4%). A possible reason for this high volt drop is due to the rural nature of the network, and the vast lengths of overhead conductors.

The overall power factor of the Goudmyn MV Network as simulated in ERACS is 0.929, which is acceptable.

5.3.3.3 Simulation 2: 5 Year Peak Demand Forecast

Drawing **285200KE0/E/GOU002** refers.

Simulation 2 is based on a 5 year growth forecast calculated at 2% per annum. This is an estimated figure.

The 5 year estimated bulk peak demand figure is in the region of 9.716MVA.

The overall volt-drop for the Goudmyn MV Network has increased to 17.2%, which remains above the recommended norms of 3% as indicated in NRS 034.

Apart from the high volt drop, the MV network appears stable, with 66.5% of all lines and cables supplying the network falling within the thermal utilization range of between 0 and 35%.

The overall power factor of the network is 0.926.

5.3.3.4 Simulation 3: 10 Year Peak Demand Forecast

Drawing **285200KE0/E/GOU003** refers.

Simulation 3 is based on a 10 year growth forecast calculated at 2% per annum. This is an estimated figure.

The 10 year estimated bulk demand figure is in the region of 10.272 MVA. The system is still relatively lightly diversified in terms of the installed capacity of 18.382MVA.

The overall volt-drop for the Goudmyn MV 10 year network has increased to 18.1%, which remains a concern.

Apart from the high volt drop, the MV network appears stable, with 65% of all lines and cables supplying the network falling within the thermal utilization range of between 0 and 35%.

The overall power factor of the 10 year network is 0.924.

5.3.3.5 Simulation 4: 15 Year Peak Demand Forecast

Drawing **285200KE0/E/GOU004** refers.

Simulation 4 is based on a 15 year growth forecast calculated at 2% per annum. This is an estimated figure.

The 15 year estimated bulk demand figure is in the region of 11.843 MVA.

A full evaluation of the ERACS simulation reveals that although the Goudmyn MV Network appears relatively lightly loaded i.e. 62% of all the electrical conductors supplying the network fall within the thermal utilization range of between 0 and 35%, there are a few concerns that a few of the conductors are nearing there thermal capacity of 100%. Some concerns which are immediately picked up are:

- The overall Goudmyn MV Network volt-drop is 21.2%, which is above the 3% recommended guideline as indicated by NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas;
- 23 Conductors are operating above 50% of their thermal utilization capacity;
- 7 Conductor are operating above 80% of their thermal utilization capacity (Excluding the above conductors);

The two single largest concerns exposed by Simulation 4 is the large volt drop of 21.2%.

It is clear from Simulation 4 that should the maximum demand of Goudmyn reach 11.843MVA, the network will still cope with the increased demand; however an exercise which looks into the excessive volt drop and ways to overcome this are recommended.

5.3.3.6 Simulation 5: Various Contingencies

The purpose of Simulation 5 is to determine the effect various contingencies (switching requirements) will have on the Goudmyn MV Network, with respect to existing n/o and n/c points, in order to assess network viability in the event of network faults occurring.

The results of the simulation are contained in the table below.

The simulation poses questions, tabulated as “critical supply scenarios”. For each “critical supply scenario” there is an action required to be effected in the Goudmyn MV Network, and the consequences of the “critical supply scenario” and “action required” are included in the “effect to network”.

The scenarios represent possible network operating conditions, for fault conditions within the network. As an example, suppose the following scenario (critical supply scenario 1 below):

- There is a critical fault on the Hennie Retief feeder circuit;
- Hennie Retief feeder is presently configured as a ring-feed, coupled with the Viljoensdrift and Dr. Gilomee circuits;
- By disconnecting the Hennie Retief circuit breaker simulating the fault, closing the n/o point presently situated at Busbar-0004, causes the current that flows through the Viljoensdrift circuit breaker feeder to increase from 18.742% to 58.341%; and
- Power restored to the Hennie Retief.

#	Critical Supply Scenarios	Action Required	Effect on Network
1	Fault on Feeder: Hennie Retief	1] Close N/O Point situated at BUS-0004	A] Viljoensdrift feeder from 18.742% to 58.341% thermal capacity
			B] Opgrond Gemonteer feeder remains at 24.488% thermal capacity
			C] Dr. Gilomee feeder decreases from 41.924% to 40.352% thermal capacity
			D] DJ Zeeman feeder decreases from 46.394% to 46.391% thermal capacity
2	Fault on Feeder: Viljoensdrift	1] Close N/O Point situated at BUS-0004	A] Hennie Retief feeder increases from 47.178% to 68.925% thermal capacity.
			B] Opgrond Gemontee feeder remains at 24.488% thermal capacity

#	Critical Supply Scenarios	Action Required	Effect on Network
			C] Dr. Gilomee feeder increases from 41.924% to 43.689% thermal capacity
			D] DJ Zeeman feeder increases from 46.394% to 46.404% thermal capacity
3	Fault on Feeder: Dr. Gilomee	1] Close N/O Point situated at BUS-0018	A] Hennie Retief feeder decreases from 47.178% to 21.781% thermal capacity
		2] Close N/O Point situated at BUS-0004	B] Viljoensdrift feeder increases from 18.742% to 48.595% thermal capacity
			C] Opgrond Gemontee feeder remains at 24.488% thermal capacity
			D] DJ Zeeman feeder increases from 46.394% to 88.621% thermal capacity
4	Fault on Feeder: DJ Zeeman	1] Close N/O Point situated at BUS-0018	A] Hennie Retief feeder increases from 47.178% to 50.474% thermal capacity
			B] Viljoensdrift feeder remains at 18.742% thermal capacity
			C] Opgrond Gemontee feeder remains at 24.488% thermal capacity
			D] Dr. Gilomee feeder increases from 41.924% to 74.567% thermal capacity

Table 3: Critical Supply Scenarios for the Goudmyn MV Network

The Goudmyn MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated above.

5.4 LE CHASSEUR

5.4.1 HISTORIC MAXIMUM DEMAND DATA

Langeberg Municipality does not keep records of maximum demand data history for Le Chasseur Substation. For these reasons, we have estimated a year on year growth of 2% given the rural nature of the region. The current maximum demand as indicated by Langeberg Municipality is 3.8MVA.

The predicted 5, 10 & 15 year bulk peak demand forecast at a year on year growth percentage of 2% is as follows:

- 5 Year Forecast : 4.195MVA $(= 3.8\text{MVA x } (1 + 0.02)^{5\text{ Years}})$
- 10 Year Forecast : 4.632MVA $(= 3.8\text{MVA x } (1 + 0.02)^{10\text{ Years}})$
- 15 Year Forecast : 5.115MVA $(= 3.8\text{MVA x } (1 + 0.02)^{15\text{ Years}})$

5.4.2 LE CHASSEUR MEDIUM VOLTAGE NETWORK LOAD-FLOW ANALYSIS

Four simulations were performed on the Le Chasseur MV Network. The simulations were designed to provide insight into the Le Chasseur MV Network and how it performs under present steady-state and network configuration conditions, as well as future predicted growth forecasts. The simulations mentioned above included:

- Current Peak Demand;
- 5 Year Peak Demand Forecast;
- 10 Year Peak Demand Forecast;
- 15 Year Peak Demand Forecast; and

The simulations were performed on the network to provide insight into the Le Chasseur Municipal MV Network as it currently appears, and how it will perform under the predicted 2% annual growth forecast as estimated.

5.4.3 RESULTS OF LE CHASSEUR MV NETWORK SIMULATIONS

5.4.3.1 General Comments

Although the Le Chasseur MV Network represents a diversified maximum demand of 3.8MVA, it is clear that 9.226MVA of MV equipment (installed capacity) is connected to the network. This is calculated by adjusting the PQ multiplier in ERACS to 1, and running the simulation

The Le Chasseur MV Network appears relatively diversified and lightly loaded, with a demand factor of approximately 0.411 (0.411 x 9.226 = 3.8MVA).

5.4.3.2 Simulation 1: Current Peak Demand

Drawing **285200KE0/E/LEC001** refers.

Simulation 1 was based on the normal network configuration and operating conditions. The n/o and n/c points reflect the actual (present) network status. There are two 5MVA transformers which supply the Le Chasseur MV network.

The ERACS simulation of the Le Chasseur MV Network returns an after-diversity-maximum-demand (ADMD) of 3.897MVA, compared with the real ADMD of 3.8MVA – a difference of 97kVA, which is an acceptable difference. This is due to the sensitivity of the PQ multipliers within the ERACS Software.

A full evaluation of the ERACS simulation reveals the Le Chasseur MV Network is relatively lightly loaded i.e. 96.8% of all conductors supplying the network fall within the thermal utilization range of between 0 and 35%.

The volt-drop across the municipal Ashton MV Network is approximately 5.3%, which does not comply with the supply authority guidelines. NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas – states that the volt-drop across the MV distributor should be somewhere in the order of 3%. The bus with the lowest voltage, as simulated, is the pole transformer at De Hoek House 2 (94.7%) – located at the end of the Agterkliphoogte feeder.

The overhead conductor that is operating at the highest thermal capacity is the Le Chasseur feeder conductor, which is presently operating at 45.8% of its thermal capacity, and is carrying a load of approximately 2.3MVA.

5.4.3.3 Simulation 2: 5 Year Peak Demand Forecast

Drawing **285200KE0/E/LEC002** refers.

Simulation 2 is based on a 5 year growth forecast estimated at 2% per annum. This is an estimated figure.

The simulation returns an ADMD of 4.182MVA, compared to an estimated figure of 4.195MVA. A difference of 13kVA. This is an acceptable difference and is due to the sensitivity of the PQ multipliers in the ERACS Software.

The volt-drop across the Municipal Le Chasseur MV Network is approximately 5.6%, which does not comply with the supply authority guidelines as stated in NRS034. The bus with the lowest voltage, as simulated, is BUS-0131 which is operating at 94.4%. This voltage can be increased by introducing a capacitor bank into the network.

The Le Chasseur MV network still appears lightly loaded, with 95.2% of all conductors supplying the network falling within the thermal utilization range of between 0 and 35%.

The overall power factor of the 5 year network is 0.947.

5.4.3.4 Simulation 3: 10 Year Peak Demand Forecast

Drawing **285200KE0/E/LEC003** refers.

Simulation 3 is based on a 10 year growth forecast estimated at 2% per annum. This is an estimated figure.

The 10 year estimated bulk demand figure is approximately 4.632MVA. The MV network is still relatively lightly diversified in terms of its installed capacity (under 50%).

The simulation returns an ADMD of 4.617MVA, compared to the calculated figure of 4.632MVA. A difference of 15kVA.

The overall volt-drop across the Le Chasseur Municipal MV Network is 5.6%, which does not comply with the supply authority guidelines as indicated in NRS 034. The busbar with the lowest voltage is BUS-0131 (94.4%).

The remainder of the MV network appears stable, with 93.7% of all overhead lines and underground conductors operating below the 35% of their rated thermal capacity.

The overall power factor of the 10 year network is 0.944.

5.4.3.5 Simulation 4: 15 Year Peak Demand Forecast

Drawing **285200KE0/E/LEC004** refers.

Simulation 4 is based on a 15 year growth forecast estimated at 2% per annum.

The 15 year estimated bulk demand figure is estimated at approximately of 5.115MVA. The network is now operating at 60% of its installed capacity.

The overall volt-drop on the MV Network is 7% which does not comply with NRS 034. The busbar with the lowest voltage is BUS-0131 (93%).

Although the system is still relatively lightly diversified in terms of the installed capacity, there is one concern:

- The two 5MVA transformers are operating above 50% of their rated capacity, meaning that should one transformer fail the second transformer will be operating above 100% of its rated capacity. Whilst this is possible, it is not recommended for an extended period of time.

5.4.3.6 Simulation 5: Various Contingencies

The purpose of Simulation 5 is to determine the effect various contingencies (switching requirements) will have on the Le Chasseur MV Network, with respect to existing n/o and n/c points, in order to assess network viability in the event of network faults occurring.

The results of the simulation are contained in the table below.

The simulation poses questions, tabulated as “critical supply scenarios”. For each “critical supply scenario” there is an action required to be effected in the Le Chasseur MV Network, and in this case the Noree MV Network as these two networks are on a ring feed network, and the consequences of the “critical supply scenario” and “action required” are included in the “effect to network” on both of the networks.

#	Critical Supply Scenarios	Action Required	Effect on Network (Le Chasseur & Noree MV Networks)
1	Fault on Feeder: Le Chasseur Feeder	1] Close N/O Point situated at River Bend Pump 1	A] Noree Feeder 3 increases from 17.425% to 85.187%.
			B] Noree's 10MVA Transformer increases from 5.2MVA to 8.6MVA.
			C] Overall Volt-drop on Noree's feeder 3 line increases to 36%.
			D] Le Chasseur Feeder remains operational despite the high volt drop
2	Fault on Feeder: Agterkliphoogte	1] No Ring Feed	A] Agterkliphoogte Feeder remains down as there is no ring feed from another MV Network

Table 4: Critical Supply Scenarios for the Le Chasseur MV Network

The Le Chasseur and Noree MV Network have sufficient capacity to accommodate the critical supply scenarios as simulated above, although the Agterkliphoogte spur feed on the Le Chasseur network remains an issue. A possible ring feed to McGregor Substation must be investigated.

5.5 McGREGOR

5.5.1 HISTORIC MAXIMUM DEMAND DATA

Historic maximum demand figures for the McGregor MV network are:

- Year 2000: 1.405MVA
- Year 2005: 2.829MVA
- Year 2010: 2.415MVA
- Year 2015: 2.414MVA

The historic maximum demand figures are based on the statistical metering data obtained from the Eskom Bulk Supply Point.

Analysis of this data reveals a future network demand growth of approximately 3.65%. This figure is based upon historical data received from Langeberg Municipality, and projected to year 2030.

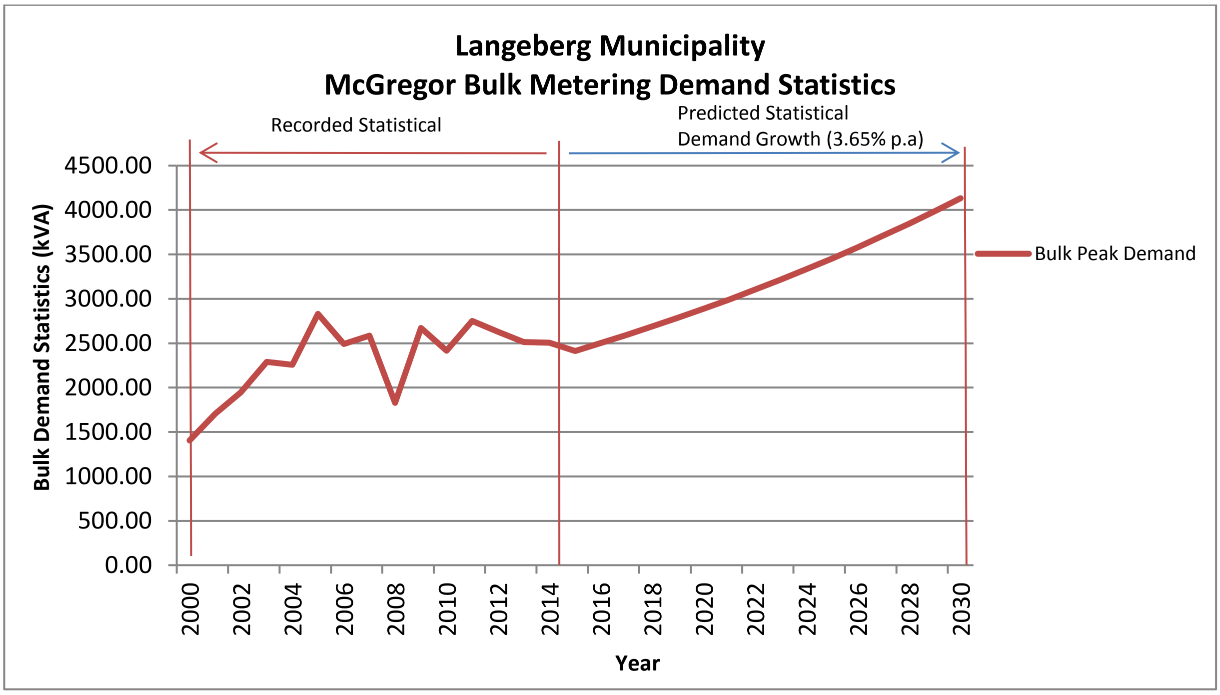

Figure 5: Langeberg Municipality: McGregor Bulk Metering Demand Statistics

The predicted 5, 10 & 15 year bulk peak demand forecast is as follows:

- 5 Year Forecast : 2.887MVA $(= 2.414\text{MVA x } (1 + 0.0365)^{5\text{ Years}})$
- 10 Year Forecast : 3.454MVA $(= 2.414\text{MVA x } (1 + 0.0365)^{10\text{ Years}})$
- 15 Year Forecast : 4.133MVA $(= 2.414\text{MVA x } (1 + 0.0365)^{15\text{ Years}})$

5.5.2 McGREGOR MEDIUM VOLTAGE NETWORK LOAD-FLOW ANALYSIS

Five (5) simulations were performed on the McGregor MV Network. The simulations were designed to provide insight into the McGregor MV Network and how it performs under present steady-state and network configuration conditions, as well as future predicted growth forecasts. The simulations mentioned above included:

- Current Peak Demand;
- 5 Year Peak Demand Forecast;
- 10 Year Peak Demand Forecast;
- 15 Year Peak Demand Forecast; and
- Various contingencies.

The simulations were performed on the network to provide an insight into the McGregor MV Network as it currently appears, and how it will perform under the predicted 3.65% annual growth forecast as calculated from the data received from the Langeberg Municipality.

5.5.3 RESULTS OF McGREGOR MV NETWORK SIMULATIONS

5.5.3.1 General Comments

Although the McGregor MV Network represents a diversified maximum demand of 2.502MVA (Estimated as the 2016 maximum demand), it is clear that 7.4MVA of MV equipment (installed capacity) is connected to the network. This is calculated by adjusting the PQ multiplier in ERACS to 1, and running the simulation

The McGregor MV Network appears diversified and lightly loaded, with a demand factor of approximately 0.338 (0.338 x 7.4 = 2.502MVA).

5.5.3.2 Simulation 1: Current Peak Demand

Drawing **285200KE0/E/MCG001** refers.

Simulation 1 was based on the normal network configuration and operating conditions. The n/o and n/c points reflect the actual (present) network status. There is one 10MVA 66/11kV transformer which supplies the McGregor MV network.

The ERACS simulation of the McGregor MV Network returns an after-diversity-maximum-demand (ADMD) of 2.494MVA, compared with the estimated 2016 ADMD of 2.502MVA – a difference of 8kVA, which is an acceptable difference due to the sensitivity of the PQ multiplier setting on the ERACS Software.

A full evaluation of the ERACS simulation reveals the McGregor MV Network is lightly loaded i.e. 100% of all conductors supplying the network fall within the thermal utilization range of between 0 and 35%.

The volt-drop across the municipal McGregor MV Network is approximately 4.4%, which does not comply with the supply authority guidelines. NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas – states that the volt-drop across the MV distributor should be below 3%. The bus with the lowest voltage, as simulated, is BUS-0119 (96.1%).

The overall power factor of the current network is 0.947 which is acceptable.

It must be stated that the McGregor MV network does not offer any form of redundancy as it is supplied by means of a single 66/11kV 10MVA transformer. Should this single transformer fail, the McGregor MV network will be required to undergo localised load shedding. It is recommended to introduce a second 10MVA transformer i.e. offer 100% redundancy should one transformer fail.

5.5.3.3 Simulation 2: 5 Year Peak Demand Forecast

Drawing **285200KE0/E/MCG002** refers.

Simulation 2 is based on a 5 year growth forecast calculated at 3.65% per annum. This figure was calculated from year on year historical data dating back 15 years as received from the Langeberg Municipality.

The 5 year estimated bulk demand figure is in the region of 2.887MVA.

The simulation returns an ADMD of 2.918MVA, compared to a calculated figure of 2.887MVA. A difference of 31kVA.

The volt-drop across the municipal McGregor MV Network is approximately 5.1%, which does not comply with the supply authority guidelines as stated in NRS034. The bus with the lowest voltage, as simulated, is BUS-0119 (95.1%).

The McGregor MV network still appears lightly loaded, with 100% of all lines and cables supplying the network falling within the thermal utilization range of between 0 and 35%.

The overall power factor for the network is 0.943 which is acceptable.

5.5.3.4 Simulation 3: 10 Year Peak Demand Forecast

Drawing **285200KE0/E/MCG003** refers.

Simulation 3 is based on a 10 year growth forecast calculated at 3.65% per annum. This figure was calculated from year on year historical data dating back 15 years as received from the Langeberg Municipality.

The 10 year estimated bulk demand figure is approximately 3.454MVA. The MV network is still relatively lightly diversified in terms of its installed capacity (51%).

The simulation returns an ADMD of 3.484MVA, compared to the calculated figure of 3.454MVA. A difference of 30kVA.

The overall volt-drop across the McGregor municipal MV Network is 5.9%, which does not comply with the supply authority guidelines as indicated in NRS 034. The busbar with the lowest voltage is BUS-0119 (94.1%).

The remainder of the MV network appears stable, with 100% of all overhead lines and underground conductors operating below 35% of their rated thermal capacity.

5.5.3.5 Simulation 4: 15 Year Peak Demand Forecast

Drawing **285200KE0/E/MCG004** refers.

Simulation 4 is based on a 15 year growth forecast calculated at 3.65% per annum. This figure was calculated from year on year historical data dating back 15 years as received from the Langeberg Municipality.

The 15 year estimated bulk demand figure is in the region of 4.133MVA. The network is still relatively lightly diversified in terms of its installed capacity (55% of its installed capacity).

The overall volt-drop on the MV Network is 7.1% which does not comply with NRS 034. The busbar with the lowest voltage is BUS-0119 (92.9%).

The remainder of the MV network appears stable, with 99% of all overhead lines and underground conductors operating between 0% and 35% of their rated thermal capacity.

The McGregor MV network however does not offer 100% redundancy as it is supplied by means of a single 10MVA transformer. Depending on the nature of the connected load, a second transformer can be introduced to provide 100% redundancy.

5.5.3.6 Simulation 5: Various Contingencies

The purpose of Simulation 5 is to determine the effect various contingencies (switching requirements) will have on the McGregor MV Network, with respect to existing n/o and n/c points, in order to assess network viability in the event of network faults occurring.

The results of the simulation are contained in the table below.

The simulation poses questions, tabulated as “critical supply scenarios”. For each “critical supply scenario” there is an action required to be effected in the McGregor MV Network, and the consequences of the “critical supply scenario” and “action required” are included in the “effect to network”.

#	Critical Supply Scenarios	Action Required	Effect on Network
1	Fault on outgoing feeder 1	1] Close N/O point at BUS-0091	A] Feeder 2 increases from 22.83% to 48.89% thermal capacity
2	Fault on outgoing feeder 2	1] Close N/O point at BUS-0091	A] Feeder 1 increases from 25.39% to 48.63% thermal capacity

Table 5: Critical Supply Scenarios for the McGregor MV Network

The McGregor MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated above.

5.6 MONTAGU

5.6.1 ASSET REGISTER

A histogram of the transformers located in Montagu's MV Network is as follows. There are 156 transformers located within the Montag MV Network:

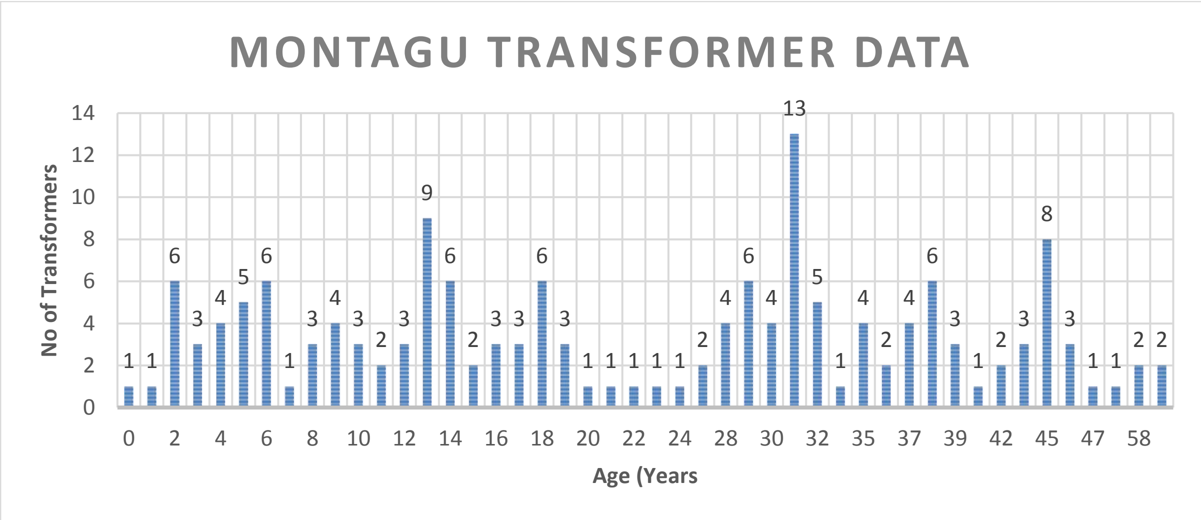

Figure 6: Langeberg Municipality: Montague Transformer Data

From the above graph there are a number of transformers which are pre 1985 (47 in total). It is recommended that all of these be replaced as part of the network strengthening exercise.

5.6.2 HISTORIC MAXIMUM DEMAND DATA

Historic maximum demand figures for the Montagu MV network are:

- Year 2000 : 5.213MVA
- Year 2005 : 6.188MVA
- Year 2010 : 7.644MVA
- Year 2014 : 8.265MVA

The historic maximum demand figures are based on the statistical metering data obtained from the Eskom Bulk Supply Point.

Analysis of this data reveals a future network demand growth of approximately 2.94%. This figure is based upon historical data received from Langeberg Municipality, and projected to year 2029.

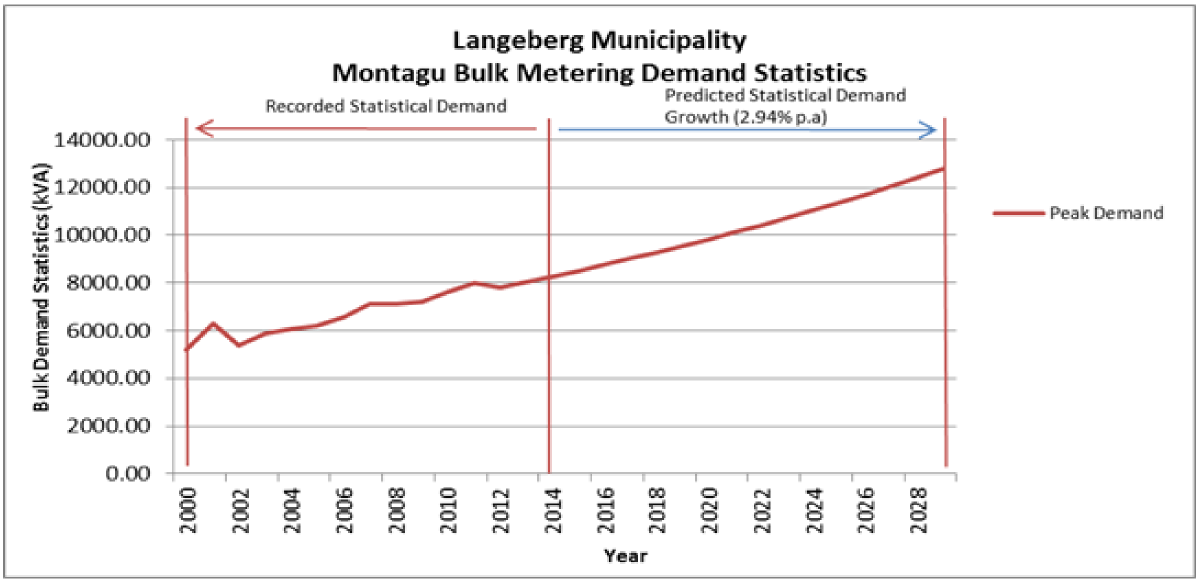

Figure 7: Langeberg Municipality: Montagu Bulk Metering Demand Statistics

The predicted 5, 10 & 15 year bulk peak demand forecast is as follows:

- 5 Year Forecast : 9.553MVA ($= 8.265\text{MVA x } (1 + 0.0294)^{5\text{ Years}}$)
- 10 Year Forecast : 11.042MVA ($= 8.265\text{MVA x } (1 + 0.0294)^{10\text{ Years}}$)
- 15 Year Forecast : 12.764MVA ($= 8.265\text{MVA x } (1 + 0.0294)^{15\text{ Years}}$)

5.6.3 MONTAGU MEDIUM VOLTAGE NETWORK LOAD-FLOW ANALYSIS

Six simulations were performed on the Montagu MV Network. The simulations were designed to provide insight into the Ashton MV Network and how it performs under present steady-state and network configuration conditions, as well as future predicted growth forecasts. The simulations mentioned above included:

- Current Peak Demand;

- 5 Year Peak Demand Forecast;
- 10 Year Peak Demand Forecast;
- 15 Year Peak Demand Forecast;
- Various contingencies; and
- Current Peak Demand with Proposed Golf Development added.

The simulations were performed on the network to provide an insight into the Montagu MV Network as it currently appears, and how it will perform under the predicted 2.94% annual growth forecast as calculated from the data received from the Langeberg Municipality.

5.6.4 RESULTS OF MONTAGU MV NETWORK SIMULATIONS

5.6.4.1 General Comments

Although the Montagu MV Network represents a diversified maximum demand of 8.265MVA (recorded in March 2014), it is clear that 33.256MVA of MV equipment (installed capacity) is connected to the network. This is calculated by adjusting the PQ multiplier in ERACS to 1, and running the simulation

The Montagu MV Network appears highly diversified and lightly loaded, with a demand factor of approximately 0.248 (0.248 x 33.256 = 8.265MVA).

5.6.4.2 Simulation 1: Current Peak Demand

Drawings **285200KE0/MON01**, **285200KE0/MON02** & **285200KE0/E/MON001** refer.

Simulation 1 was based on the normal network configuration and operating conditions. The n/o and n/c points reflect the actual (present) network status. There are two 5MVA 66/11kV transformers which supply the Montagu MV network.

The ERACS simulation of the Montagu MV Network returns an after-diversity-maximum-demand (ADMD) of 8.124MVA, compared with the recorded 2014 ADMD of 8.265MVA – a difference of 141kVA, which is an acceptable difference due to the sensitivity of the PQ multiplier setting on ERACS.

A full evaluation of the ERACS simulation reveals the Montagu MV Network is relatively lightly loaded i.e. 96.55% of all conductors supplying the network fall within the thermal utilization range of between 0 and 35%.

The volt-drop across the municipal Montagu MV Network is approximately 2.4%, which complies with the supply authority guidelines. NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas – states that the volt-drop across the MV distributor should be below 3%. The bus with the lowest voltage, as simulated, is QUI SISANA (97.6%) – located on the Badenlyn feeder from the Industrial RMU.

It must be stated that the Montagu MV network does not offer any form of redundancy as it is supplied by means of two 66/11kV 5MVA Eskom transformers, where each transformer is currently operating at 82.6% of its rated capacity. Should either of the Eskom transformers fail, the Montagu MV network will be required to undergo localised load shedding. It is recommended to upgrade both transformers so that the combined load of both can be supplied by only one transformer i.e. offer some form of redundancy. This is further highlighted in the Eskom Plant Risk Analysis (Appendix 4).

5.6.4.3 Simulation 2: 5 Year Peak Demand Forecast

Drawing **285200KE0/E/MON002** refers.

Simulation 2 is based on a 5 year growth forecast calculated at 2.94% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 5 year estimated bulk demand figure is in the region of 9.553MVA.

The volt-drop across the municipal Montagu MV Network is approximately 2.8%, which complies with the supply authority guidelines as stated in NRS034. The bus with the lowest voltage, as simulated, is QUI SISANA (97.2%) – located on the Badenlyn feeder from the Industrial RMU.

The Montagu MV network still appears relatively lightly loaded, with 91% of all lines and cables supplying the network falling within the thermal utilization range of between 0 and 35%.

5.6.4.4 Simulation 3: 10 Year Peak Demand Forecast

Drawing **285200KE0/E/MON003** refers.

Simulation 3 is based on a 10 year growth forecast calculated at 2.94% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 10 year estimated bulk demand figure is approximately 11.042MVA. The MV network is still relatively lightly diversified in terms of its installed capacity (under 50%),

The overall volt-drop across the Montagu municipal MV Network is 3.4V, which does not comply with the supply authority guidelines as indicated in NRS 034. The busbar with the lowest voltage is QUI SISANA (96.6%).

From this simulation it is now clear that the two 5MVA transformers are operating at 110% of their rated capacity. Whilst it is possible for these transformers to operate above their designed parameters, this is only for a limited period. Should the Montagu MV network experience a year on year growth of 2.94%, the two transformers will be required to be upgraded as part of a strengthening exercise for the network within the next 10 years.

The remainder of the MV network appears stable, with 89% of all overhead lines and underground conductors operating below 35% of their rated thermal capacity.

5.6.4.5 Simulation 4: 15 Year Peak Demand Forecast

Drawing **285200KE0/E/MON004** refers.

Simulation 4 is based on a 15 year growth forecast calculated at 2.94% per annum. This figure was calculated from year on year historical data dating back 10 years as received from the Langeberg Municipality.

The 15 year estimated bulk demand figure is in the region of 12.764MVA. The network is still relatively lightly diversified in terms of its installed capacity (under 50%).

The overall volt-drop on the MV Network is 3.8% which does not comply with NRS 034. The busbar with the lowest voltage is QUI SISANA (96.2%).

Although the system is still relatively lightly diversified in terms of the installed capacity, there are a few concerns:

- The two 5MVA transformers are operating at 126% of their rated capacity;

- 2 Conductors are operating above 75% of their thermal utilization capacity (Excluding the above conductors);

It is evident that should the Montagu MV network continue to experience a 2.94% per annum growth, the above elements will be required to be upgraded to avoid unnecessary outages.

5.6.4.6 Simulation 5: Various Contingencies

The purpose of Simulation 5 is to determine the effect various contingencies (switching requirements) will have on the Montagu MV Network, with respect to existing n/o and n/c points, in order to assess network viability in the event of network faults occurring.

The results of the simulation are contained in the table below.

The simulation poses questions, tabulated as “critical supply scenarios”. For each “critical supply scenario” there is an action required to be effected in the Montagu MV Network, and the consequences of the “critical supply scenario” and “action required” are included in the “effect to network”.

The scenarios represent possible network operating conditions for fault conditions within the network. As an example, suppose the following scenario (critical supply scenario 1 below):

- There is a critical fault on the Montagu South circuit;
- Montagu South is presently configured as a ring-feed, coupled with the Brink and Moni’s circuits;
- By disconnecting the ring-feed through the Montagu South circuit breaker, and closing the n/o point presently situated at Spar and Park Street RMU, causes the current to flow through the Brink circuit breakers to increase from 22.5% to 53.3%.

#	Critical Supply Scenarios	Action Required	Effect on Network
1	Fault on Feeder: Montagu South	1] Close n/o point Spar	A] Brink Feeder increases from 22.5% to 53.3% thermal capacity
			B] Moni’s feeder remains at 28.9% thermal capacity

#	Critical Supply Scenarios	Action Required	Effect on Network
		2] Close n/o point Park Street RMU	C] Landelik Feeder remains at 18.9% thermal capacity
2	Fault on Feeder: Brink	1] Close n/o point: Spar	A] Montagu South Feeder increases from 25.5% to 44.6% thermal capacity
		2] Close n/o point: Park Street RMU	B] Moni's Feeder remains at 28.9% thermal capacity
			C] Landelik Feeder remains at 18.9% thermal capacity
3	Fault on Feeder: Moni's	1] Close n/o point: Bus 21	A] Montagu South Feeder remains at 25.5% thermal capacity
			B] Brink Feeder increases from 22.5% to 56.9% thermal capacity
			C] Landelik Feeder remains at 18.9% thermal capacity
4	Fault on Feeder: Landelik	1] Close n/o point: La Dom Pak	A] Montagu South Feeder remains at 25.5% thermal capacity
			B] Brink Feeder remains at 22.5% thermal capacity
			C] Moni's Feeder increases from 28.9% to 45.3% thermal capacity

Table 6: Critical Supply Scenarios for the Montagu MV Network

The Montagu MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated above.

5.6.4.7 Simulation 6: Current Peak Demand With Golf Development Added

Drawing **285200KE0/E/MON005** refers.

Simulation 6 is based on the current peak demand figures as simulated in simulation 1; however a new 1.445MVA notified maximum demand future planned golf development has been added to the MV network to establish the effects the golf development will have on the existing MV network.

An extract of the main Montagu Substation from the ERACS simulation 6 with the golf development added appears as follows:

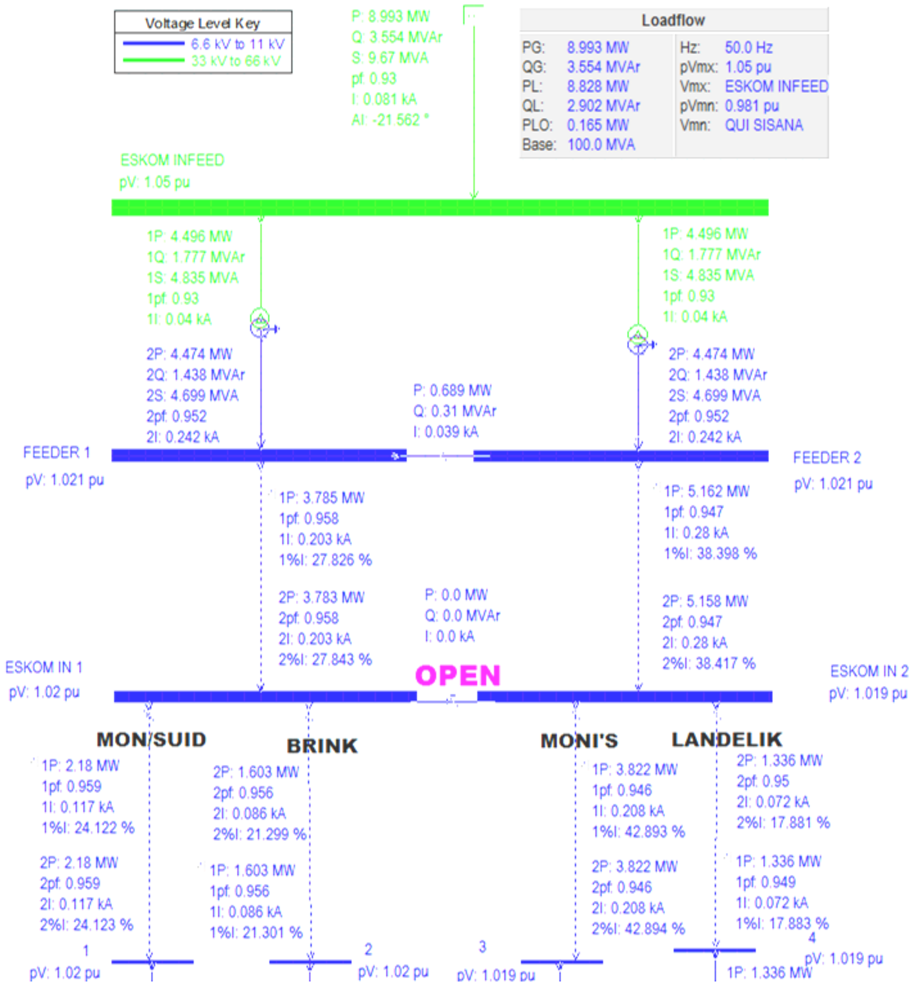

Figure 8: Montagu main Substation with Golf Development Added

A closer evaluation of simulation 6 reveals the following:

- The maximum peak demand for the MV network is now at 9.67MVA, compared to the current maximum peak demand of 8.2MVA from simulation 1;
- The overall volt-drop on the MV network is 4%, compared with 2.5% from simulation 1;
- The Badenlyn feeder from the Industrial RMU which is the proposed main feeder that supplies the new golf development has increased from 25.421% to 72.9% of its thermal capacity;
- The two 5MVA transformers have increased from 82% to 96% of their rated capacity on the primary side with the addition of the golf development load. Should the golf development go ahead, the 2x5MVA transformers may need to be upgraded as there would be no redundancy available to the balance of the network.
- The balance of the network (lines and underground conductors) appear stable and within normal operating limits.

5.7 NOREE

5.7.1 HISTORIC MAXIMUM DEMAND DATA

Historic maximum demand figures for the Noree MV network are:

- Year 2000: 3.486MVA
- Year 2005: 3.735MVA
- Year 2010: 4.824MVA
- Year 2015: 5.278MVA

The historic maximum demand figures are based on the statistical metering data obtained from the Eskom Bulk Supply Point, as received from the Langeberg Municipality.

Analysis of this data reveals a future network demand growth of approximately 2.65% average year on year. This figure is based upon historical data received from Langeberg Municipality, and projected to year 2031.

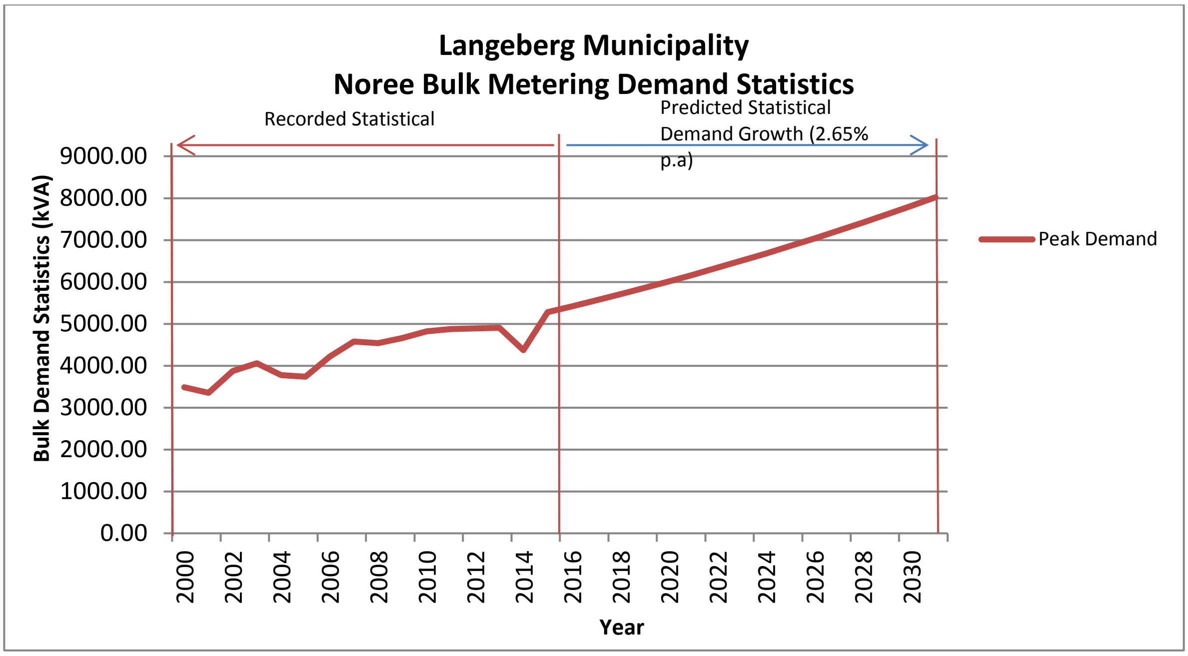

Figure 9: Langeberg Municipality: Noree Bulk Metering Demand Statistics

The predicted 5, 10 & 15 year bulk peak demand forecast is as follows:

- 5 Year Forecast : 6.015MVA ($= 5.278\text{MVA x } (1 + 0.0265)^{5\text{ Years}}$)
- 10 Year Forecast : 6.855MVA ($= 5.278\text{MVA x } (1 + 0.0265)^{10\text{ Years}}$)
- 15 Year Forecast : 7.813MVA ($= 5.278\text{MVA x } (1 + 0.0265)^{15\text{ Years}}$)

5.7.2 NOREE MEDIUM VOLTAGE NETWORK LOAD-FLOW ANALYSIS

Five (5) simulations were performed on the Noree MV Network. The simulations were designed to provide insight into the Noree MV Network and how it performs under present steady-state and network configuration conditions, as well as future predicted growth forecasts. The simulations mentioned above included:

- Current Peak Demand;
- 5 Year Peak Demand Forecast;
- 10 Year Peak Demand Forecast;

- 15 Year Peak Demand Forecast; and
- Various contingencies.

The simulations were performed on the network to provide an insight into the Noree MV Network as it currently appears, and how it will perform under the predicted 2.65% annual growth forecast as calculated from the data received from the Langeberg Municipality.

5.7.3 RESULTS OF NOREE MV NETWORK SIMULATIONS

5.7.3.1 General Comments

Although the Noree MV Network represents a diversified maximum demand of 5.278MVA (recorded in February 2015), it is clear that 11.081MVA of MV equipment (installed capacity) is connected to the network. This is calculated by adjusting the PQ multiplier in ERACS to 1, and running the simulation

The Noree MV Network appears diversified with a demand factor of approximately 0.476 (0.476 x 11.081 = 5.278MVA).

5.7.3.2 Simulation 1: Current Peak Demand

Drawing **285200KE0/E/NOR001** refers.

Simulation 1 was based on the normal network configuration and operating conditions. The n/o and n/c points reflect the actual (present) network status. There is one 10MVA 66/11kV transformer which supplies the Noree Municipal MV network.

The ERACS simulation of the Noree MV Network returns an after-diversity-maximum-demand (ADMD) of 5.317MVA, compared with the recorded 2015 ADMD of 5.278MVA – a difference of 39kVA, which is an acceptable difference due to the sensitivity of the P & Q multiplier settings in the ERACS software.

A full evaluation of the ERACS simulation reveals the Noree MV Network is relatively lightly loaded in general i.e. 91.8% of all conductors supplying the network fall within the thermal utilization range of between 0 and 35%.

The volt-drop across the municipal Noree MV Network is approximately 5.7%, which higher than supply authority guidelines. NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical

Distribution Networks in Residential Areas – states that, as a general rule, the volt-drop across the MV distributor should be of the order of 3%. The bus with the lowest voltage, in the simulated network, is BUS 0031 (94.4%).

It must be stated that the Noree MV network does not offer any form of redundancy as it is supplied by means of a single 66/11kV 10MVA transformer, which is operating at 50% of its rated capacity. Should this transformer fail, localised load shedding will need to occur. Normally open points however can be closed to redirect power flow from Le Chasseur Main Substation, depending on the current network capacity and status of the Le Chasseur MV network. It is recommended to upgrade the Noree Substation by adding a further 10MVA transformer to offer 100% redundancy.

5.7.3.3 Simulation 2: 5 Year Peak Demand Forecast

Drawing **285200KE0/E/NOR002** refers.

Simulation 2 is based on a 5 year growth forecast calculated at 2.65% per annum. This figure was calculated from year on year historical data dating back 15 years as received from the Langeberg Municipality.

The 5 year (2020) estimated bulk demand figure is in the region of 6.015MVA.

The volt-drop across the municipal Montagu MV Network is approximately 6.4%, which is higher than the supply authority guidelines as stated in NRS034. The bus with the lowest voltage, in the simulated network, is BUS-0031 (94.4%).

The Noree MV network still appears relatively lightly loaded, with 91% of all conductors supplying the network operating within their thermal utilization range of between 0 and 35%.

The main Noree 66/11kV 10MVA transformer is operating at 60% of its rated capacity.

The overall power factor of the network is 0.943.

5.7.3.4 Simulation 3: 10 Year Peak Demand Forecast

Drawing **285200KE0/E/NOR003** refers.

Simulation 3 is based on a 10 year growth forecast calculated at 2.65% per annum. This figure was calculated from year on year historical data dating back 15 years as received from the Langeberg Municipality.

The 10 year estimated bulk demand figure is approximately 6.855MVA.

The overall volt-drop across the Montagu municipal MV Network is 7.3V, which does not comply with the supply authority guidelines as indicated in NRS 034. The busbar with the lowest voltage is BUS0031 (93.2%). The high volt drop stems from the new 12.5km line which is connected from the Noree Main Substation to Elandia.

The main Noree 66/11kV transformer is operating at 68% of its rated capacity.

The remainder of the MV network appears stable, with 91% of all conductors operating below 35% of their rated thermal capacity.

The overall power factor of the network is 0.939.

5.7.3.5 Simulation 4: 15 Year Peak Demand Forecast

Drawing **285200KE0/E/NOR004**

Simulation 4 is based on a 15 year growth forecast calculated at 2.65% per annum. This figure was calculated from year on year historical data dating back 15 years as received from the Langeberg Municipality.

The 15 year estimated bulk demand figure is in the region of 7.813 MVA.

A full evaluation of the ERACS simulation reveals that although the Noree MV Network appears lightly loaded i.e. 91.7% of all the electrical conductors supplying the network fall within the thermal utilization range of between 0 and 35%:

- The overall Noree MV Network volt-drop is 7.8%, which is above the 3% recommended guideline as indicated by NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas;
- 8.1% of the conductors are operating above 50% of their thermal utilization capacity;

The overall power factor of the network is 0.936 which is acceptable.

The main Noree 66/11kV 10MVA transformer is operating at 77% of its rated capacity.

5.7.3.6 Simulation 5: Various Contingencies

The purpose of Simulation 5 is to determine the effect various contingencies (switching requirements) will have on the Noree MV Network, with respect to existing n/o and n/c points, in order to assess network viability in the event of network faults occurring.

The results of the simulation are contained in the table below.

The simulation poses questions, tabulated as “critical supply scenarios”. For each “critical supply scenario” there is an action required to be effected in the Noree MV Network, and the consequences of the “critical supply scenario” and “action required” are included in the “effect to network”.

The scenarios represent possible network operating conditions for fault conditions within the network. As an example, suppose the following scenario (critical supply scenario 1 below):

- There is a critical fault on the Feeder 1 Circuit;
- Feeder 1 is presently configured as a ring-feed, coupled with Feeder 2 circuits;
- By disconnecting the ring-feed through Feeder 1, and closing the n/o point presently situated at RMU 5 and the Auto-recloser, causes the current that flows through the Feeder 2 circuit breaker to increase from 50% to 104%.

#	Critical Supply Scenarios	Action Required	Effect on Network
1	Fault on Feeder: Feeder 1	1] Close n/o point RMU 5	A] Feeder 2 increases from 50% to 104% thermal capacity
		2] Close n/o point Auto-recloser	B] Overall volt drop on the network increases from 5.7% 20.7%

#	Critical Supply Scenarios	Action Required	Effect on Network
2	Fault on Feeder: Feeder 2	1] Close n/o point RMU 5	A] Feeder 1 increases from 39% to 91.5% thermal capacity
		2] Close n/o point Auto-recloser	B] Overall volt drop on the network increases from 5.7% 17.2%

Table 7: Critical Supply Scenarios for the Noree MV Network

The Noree MV Network is capable of accommodating the critical supply scenarios as simulated above in terms of rated capacity of the conductors; however it is not capable in terms of overall volt drop. As can be seen from the simulation, the volt drop increases to 20% and 17.2% respectively during the 2 critical supply scenarios. These scenarios are based on the current network status, and should the growth continue as per the estimated figure, the MV network will not be in a position to cater for the above scenarios. Should Le Chasseur feeder fail and the N/O switch at River Bend Pump 1 closed, the volt drop on the Noree network will increase to 36%, which is not advisable.

5.8 ROBERTSON

5.8.1 ASSET REGISTER

A histogram of the transformers located in Robertson's MV Network is as follows. There are 1059 transformers located within the Robertson MV Network:

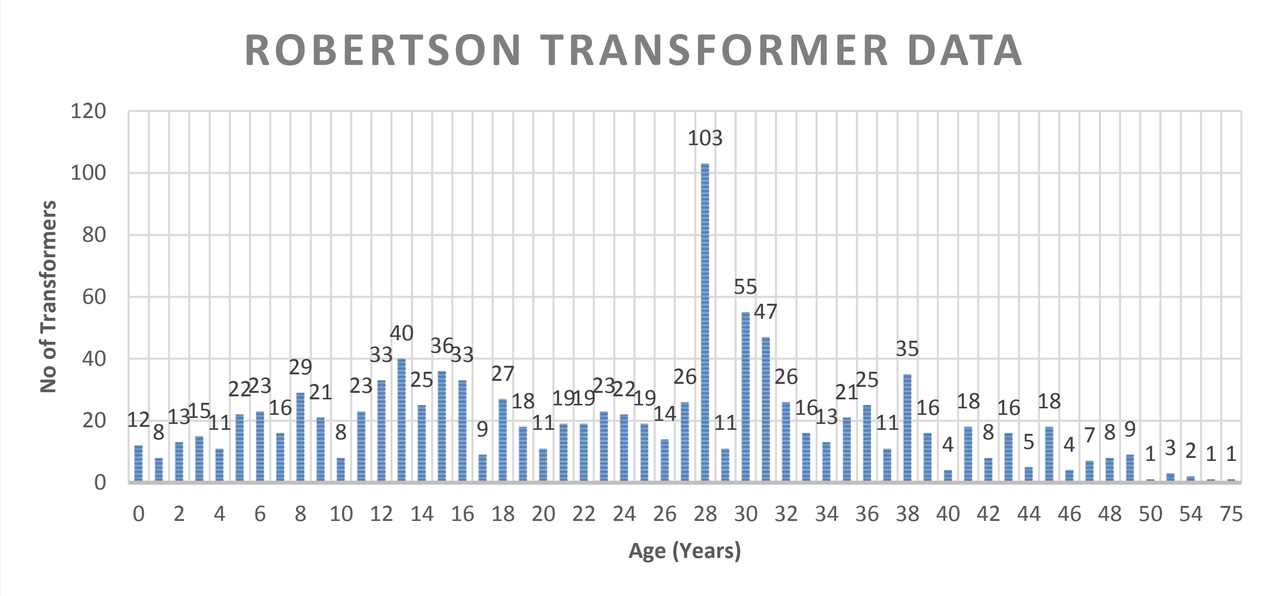

Figure 10: Langeberg Municipality: Robertson Transformer Data

From the above graph there are a number of transformers which are pre 1985 (268 in total). It is recommended that all of these be replaced as part of the network strengthening exercise.

5.8.2 HISTORIC MAXIMUM DEMAND DATA

Historic maximum demand figures for the Robertson MV network, which include Le Chasseur and Goudmyn on the 66kV bus are:

- Year 2000 : 24.572MVA
- Year 2005 : 24.946MVA
- Year 2010 : 30.479MVA
- Year 2014 : 31.304MVA

The historic maximum demand figures are based on the statistical metering data obtained from the Eskom Bulk Supply Point, as received from Langeberg Municipality.

Analysis of this data reveals a predicted future network demand growth of approximately 1.8% per annum. Known loads were added to the Robertson MV Network over a 5, 10 and 15 year period to establish the effects these loads would have on the network. These are illustrated in simulations 2, 3 and 4 which will be discussed below.

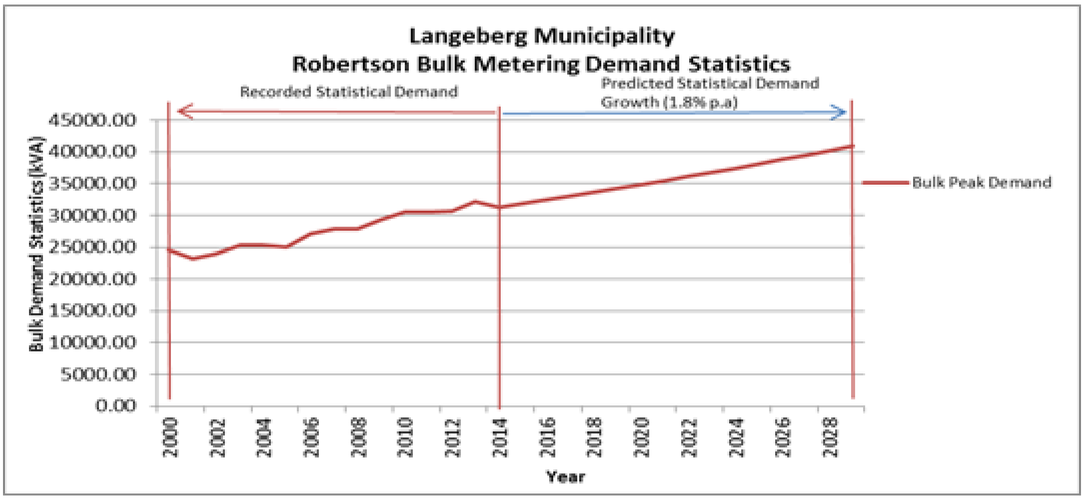

Figure 10: Langeberg Municipality: Robertson Bulk Metering Demand Statistics

The known 5, 10 & 15 year loads which will be simulated as such will extend the maximum demand figures for Robertson by:

- 5 Year Forecast : An additional 7.120MVA
- 10 Year Forecast : An additional 8.940MVA
- 15 Year Forecast : An additional 4.250MVA

The above additional known loads will be diversified to reflect actual present day Robertson diversity of 0.50.

5.8.3 ROBERTSON MEDIUM VOLTAGE NETWORK LOAD-FLOW ANALYSIS

Five simulations were performed on the Robertson MV Network. The simulations were designed to provide insight into the Robertson MV Network and how it performs under present steady-state and network configuration conditions, as well as future predicted growth forecasts. The simulations mentioned above included:

- Current Peak Demand;
- 5 Year Forecast;
- 10 Year Forecast;
- 15 Year Forecast; and
- Various contingencies.

The simulations were performed on the network to provide insight into the Robertson MV Network as it currently appears, and how it will perform with the addition of the known 5, 10 and 15 year loads as well as the 2% per annum increase for Le Chasseur and Goudmyn.

5.8.4 RESULTS OF ROBERTSON MV NETWORK SIMULATIONS

5.8.4.1 General Comments

The Robertson MV Network includes Le Chasseur and Goudmyn at 66kV, represents a diversified maximum demand of 32.1MVA (measured in February 2013). This implies that the Robertson MV network (Excluding Le Chasseur at 3.3MVA and Goudmyn at 8.8MVA) has a diversified maximum demand of 20MVA (32.1MVA – 12.1MVA).

The Robertson MV Network (excluding Le Chasseur and Goudmyn) has a total installed capacity of 42.2MVA. Therefore the Robertson network appears relatively lightly loaded, with a demand factor of approximately 0.47 (0.47 x 42.2MVA = 20MVA).

5.8.4.2 Simulation 1: Current Peak Demand

Drawings **285200KE0/ROB01**, **285200KE0/ROB02** and **285200KE0/E/ROB001** refer.

Simulation 1 was based on the normal network configuration and operating conditions. The n/o and n/c points reflect the actual (present) network status. The Robertson MV network is supplied by means of three 15MVA 66/11kV transformers.

The ERACS simulation of the Robertson MV Network returns an after-diversity-maximum-demand (ADMD) of 32.296MVA, compared with the actual 2013 ADMD of 32.124MVA, an acceptable difference of 172kVA.

A full evaluation of the ERACS simulation reveals the Robertson MV Network is relatively lightly loaded. Justification for this statement can be indicated as follows:

- 10.23% of the conductors are operating above 35% of their thermal utilization capacity;
- 11% of the conductors are operating above 50% of their thermal utilization capacity (Excluding the above conductors);
- 0 conductors are operating above 80% of their thermal utilization capacity (Excluding the above conductors);
- 1 conductor is operating above 100% of its thermal utilization capacity (Excluding the above conductors). At the current network configuration with the n/o and n/c points, this conductor is operating at 111% of its thermal utilisation capacity. By changing the n/o switch at Victoria RMU to closed, the above cable's thermal utilisation capacity decreases from 111% to 79.4%, which is recommended.

The volt-drop across the municipal Robertson MV Network is approximately 4.5%, which is above the supply authority guidelines. NRS 034 – Electricity Distribution Guidelines for the Provision of Electrical Distribution Networks in Residential Areas – states that the volt-drop across the MV distributor should be somewhere in the order of 3%. The bus with the lowest voltage, as simulated, is P Kruger (95.5%) – located on the Coetzee line from the Waterwerke Substation.

The overall power factor of the Robertson MV Network as simulated in ERACS is 0.946.

5.8.4.3 Simulation 2: 5 Year Forecast

Drawing **285200KE0/E/ROB002** refers.

Simulation 2 is based on a 5 year growth forecast where actual known loads have been added to simulation 1 to produce an MV network which reflects future growth. The Le Chasseur and Goudmyn loads have also been increased by 2% per annum for 5 years, and are included in this simulation. The known loads were added to the existing network at a diversity of 0.5 to establish the effects on the various elements (Overhead and underground conductors) within the network. The known future loads that were indicated by Langeberg Municipality to come online within 5 years are as follows:

Future 5 Year Loads	kVA
Nkqubela Transfer Area	200 * 0.5 (Diversity) = 100Kva 100kVA
Erf136	200 * 0.5 = 100kVA
August Street	150 * 0.5 = 75kVA
Erf2	200 * 0.5 = 100kVA
Erf4900	300 * 0.5 = 150kVA
Masakhane Street	200 * 0.5 = 100kVA
Church Street	1000 * 0.5 = 1000kVA
Callie de Wet Sports Centre	400 * 0.5 = 200kVA
Nestle	200 * 0.5 = 100kVA
Constitution Street	300 * 0.5 = 150kVA
Erf4620	500 * 0.5 = 250kVA
Hope Street	600 * 0.5 = 300kVA
Van Reenen Street	200 * 0.5 = 100kVA
Hospital	200 * 0.5 = 100kVA
Johan de Jong Drive	500 * 0.5 = 250kVA
Erf656	100 * 0.5 = 50kVA
Erf1237	200 * 0.5 = 100kVA
Erf5857	100 * 0.5 = 50kVA
Erf5822	120 * 0.5 = 60kVA
Erf1099	200 * 0.5 = 100kVA
White Street	150 * 0.5 = 75kVA
Erf3	150 * 0.5 = 75kVA
Erf4024	150 * 0.5 = 75kVA
Paddy Street	200 * 0.5 = 100kVA
Rose Street	200 * 0.5 = 100kVA
Droeheuwel	100 * 0.5 = 50kVA
Robertson Golf Development	300 * 0.5 = 150kVA
Total (5 Year Forecast)	**7120 * 0.5 = 3560kVA**

Table 8: Langeberg Municipality: Robertson Future 5 Year Loads

The above loads have been added into the MV network to establish the effects these loads would have on the network. A closer evaluation of simulation 2 reveals the following:

- The total maximum demand for Robertson, as simulated (Including Le Chasseur and Goudmyn) is 37.456MVA.
- The total maximum demand for Robertson, as simulated (Excluding Le Chasseur and Goudmyn): 24.119MVA. The Robertson MV network still offers redundancy in the fact that the combined load of the MV network can be supplied by two of the three 15MVA 66/11kV transformers should one of the transformers fail;
- Total maximum demand for Le Chasseur and Goudmyn (Represented by a 2% increase carried through for 5 years): 3.643MVA & 9.71MVA respectively;
- Overall volt-drop on the Robertson MV Network: 5% (Bus with the lowest voltage is Paul Kruger which is currently measured at 95%);
- 16.6% of all conductors are operating above 35% of their thermal utilisation capacity;
- 11.1% of all conductors are operating above 50% of their thermal utilisation capacity (Excluding the above conductors);
- 1 Conductors is operating above 80% of its thermal utilisation capacity (Excluding the above conductors);
- 1 Conductor is operating above 100% of its thermal utilisation capacity (Excluding the above conductors).

The conductor that is operating above 100% its thermal utilisation capacity is as follows:

- Bergsig Substation conductor (121%) found in White Street 1 Substation which feeds the Bergsig RMU. By closing the normally open switch at Victoria substation, the thermal utilisation of this conductor decreases to 90%. It is either recommended to replace this conductor with the next available appropriate size (Currently it is a 35mm² Cu 3C), or change the configuration of the N/O & N/C points mentioned above.

5.8.4.4 Simulation 3: 10 Year Forecast

Drawing **285200KE0/E/ROB003** refers.

Simulation 3 is based on a 10 year growth forecast where actual known loads have been added to simulation 2 to produce an MV network which reflects 10 years of future growth. The Le Chasseur and Goudmyn loads have also been increased by 2% per annum for 10 years, and are included in this simulation. These loads were added to the existing network at a diversity of 0.5 to establish the effects on the various elements (Overhead and underground conductors) within the network. The known loads that were indicated by Langeberg Municipality to come online within 10 years are as follows:

Future 10 Year Loads	kVA
Nkqubela Transfer Area	300 * 0.5 (Diversity) = 150kVA
Erf136	200 * 0.5 = 100kVA
August Street	165 * 0.5 = 82.5kVA
Erf2	115 * 0.5 = 57.5kVA
Erf4900	300 * 0.5 = 150kVA
Airfield	300 * 0.5 = 150kVA
Church Street	250 * 0.5 = 125kVA
Callie de Wet Sports Centre	400 * 0.5 = 200kVA
Church Street	400 * 0.5 = 200kVA
Nestle	300 * 0.5 = 150kVA
Constitution Street	200 * 0.5 = 100kVA
Erf4620	1000 * 0.5 = 500kVA
Robertson Winery	1000 * 0.5 = 500kVA
Van Reenen Street	100 * 0.5 = 50kVA
Erf1174	500 * 0.5 = 250kVA
Hospital	300 * 0.5 = 150kVA
Johan de Jong Drive	400 * 0.5 = 200kVA
Wesley Street (3943)	200 * 0.5 = 100kVA
Erf1237	115 * 0.5 = 57.5kVA
Wolfkloof	500 * 0.5 = 250kVA
Erf1099	300 * 0.5 = 150kVA

Future 10 Year Loads	kVA
White Street	165 * 0.5 = 82.5kVA
Erf3	165 * 0.5 = 82.5kVA
Erf4024	150 * 0.5 = 75kVA
Paddy Street	115 * 0.5 = 57.5kVA
Rose Street	300 * 0.5 = 150kVA
Droeheuwel	200 * 0.5 = 100kVA
Robertson Golf Development	500 * 0.5 = 250kVA
Total (10 Year Forecast)	**8940 * 0.5 = 4470kVA**

Table 9: Langeberg Municipality: Robertson Future 10 Year Loads

The above loads have been added into the MV network to establish the effects these loads would have on the network. A closer evaluation of simulation 3 reveals the following:

- The total maximum demand for Robertson, as simulated (Including Le Chasseur and Goudmyn) is 43.625MVA.

- The total maximum demand for Robertson, as simulated (Excluding Le Chasseur and Goudmyn): 28.839MVA. The three 15MVA 66/11kV transformers still offer 100% redundancy as the combined load for Robertson can be carried by two of the three transformers should one transformer fail;

- Total maximum demand for Le Chasseur and Goudmyn (Represented by a 2% increase per year carried through for 10 years): 4.022MVA & 10.727MVA respectively;

- Overall volt-drop on the Robertson MV Network remains is at 5.1% (Bus with the lowest voltage is Paul Kruger which is currently measured at 94.9%);

- 15.9% of all conductors are operating above 35% of their thermal utilisation capacity;

- 9.7% of all conductors are operating above 50% of their thermal utilisation capacity (Excluding the above conductors);

- 6 Conductors are operating above 80% of their thermal utilisation capacity (Excluding the above conductors);

- 1 Conductors is operating above 100% of its thermal utilisation capacity (Excluding the above conductors).

The conductor that is operating above 100% its thermal utilisation capacity is as follows:

- Bergsig Substation conductor (125.1%) found in White Street 1 Substation which feeds the Bergsig RMU. By closing the normally open switch at Victoria substation, the thermal utilisation of this conductor decreases to 93%. It is either recommended to replace this conductor with the next available appropriate size (Currently it is a 35mm² Cu 3C), or change the configuration of the N/O & N/C points mentioned above.

The overall power factor of the network is 0.94.

5.8.4.5 Simulation 4: 15 Year Forecast

Drawing **285200KE0/E/ROB004** refers.

Simulation 4 is based on a 15 year growth forecast where actual known loads have been added to simulation 3 to produce an MV network which reflects future growth. The Le Chasseur and Goudmyn loads have also been increased by 2% per annum for 15 years, and are included in this simulation. These loads were added to the existing network to establish the effects on the various elements (Overhead and underground conductors) within the network. The known loads that were indicated by Langeberg Municipality to come online within 15 years are as follows:

Future 15 Year Loads	kVA
Nkqubela Transfer Area	300 * 0.5 (Diversity) = 150kVA
Erf4900	400 * 0.5 = 200kVA
Airfield	300 * 0.5 = 150kVA
Church Street	400 * 0.5 = 200kVA
Robertson Winery	1000 * 0.5 = 500kVA
Johan de Jong Drive	350 * 0.5 = 175kVA
Wolfkloof	1000 * 0.5 = 500kVA
Robertson Golf Development	500 * 0.5 = 250kVA
Total (15 Year Forecast)	**4250 * 0.5 = 2125kVA**

Table 10: Langeberg Municipality: Robertson Future 15 Year Loads

The above loads have been added into the MV network at a diversity of 0.5 to establish the effects these loads would have on the network. A closer evaluation of simulation 4 reveals the following:

- The total maximum demand for Robertson, as simulated (Including Le Chasseur and Goudmyn) is 47.281MVA.
- The total maximum demand for Robertson, as simulated (Excluding Le Chasseur and Goudmyn): 31.052MVA. The three 15MVA 66/11kV transformers no longer offer any form of redundancy as the combined load for Robertson cannot be carried by two of the three transformers should one transformer fail;
- Total maximum demand for Le Chasseur and Goudmyn (Represented by a 2% increase per year carried through for 15 years): 4.441MVA & 11.843MVA respectively;
- Overall volt-drop on the Robertson MV Network remains at 5.1% (Bus with the lowest voltage is Paul Kruger which is currently measured at 94.9%);
- 15.3% of all conductors are operating above 35% of their thermal utilisation capacity;
- 11% of all conductors are operating above 50% of their thermal utilisation capacity (Excluding the above conductors);
- 7 Conductors are operating above 80% of their thermal utilisation capacity (Excluding the above conductors);
- 1 Conductors is operating above 100% of its thermal utilisation capacity (Excluding the above conductors).

The conductor that is operating above 100% its thermal utilisation capacity is as follows:

- Bergsig Substation conductor (125.1%) found in White Street 1 Substation which feeds the Bergsig RMU. By closing the normally open switch at Victoria substation, the thermal utilisation of this conductor decreases to 93.7%. It is either recommended to replace this conductor with the next available appropriate size (Currently it is a 35mm² Cu 3C), or change the configuration of the N/O & N/C points mentioned above.

The overall power factor of the network is 0.94.

5.8.4.6 Simulation 5: Various Contingencies

The purpose of Simulation 5 is to determine the effect various contingencies (switching requirements) will have on the Robertson MV Network, with respect to existing n/o and n/c points, in order to assess network viability in the event of network faults occurring.

The results of the simulation are contained in the table below.

The simulation poses questions, tabulated as "critical supply scenarios". For each "critical supply scenario" there is an action required to be effected in the Robertson MV Network, and the consequences of the "critical supply scenario" and "action required" are included in the "effect to network".

The scenarios represent possible network operating conditions, for fault conditions within the network. As an example, suppose the following scenario (critical supply scenario 1 below):

- There is a critical fault on the Robertson Kelder circuit;
- Robertson Kelder is presently configured as a ring-feed, coupled with the Nestle circuit;
- By disconnecting the ring-feed through the Robertson Kelder circuit breaker, and closing the n/o point presently situated at the Kelder RMU which is coupled as a ring feed with the Nestle circuit breaker, causes the current to flow through the Nestle circuit breaker to increase from 5.3% to 34.7%. All other feeders in the Muiskraalskop Substation remain unchanged; and
- Power restored to the Robertson Kelder circuit.

#	Critical Supply Scenarios	Action Required	Effect on Network
	Fault on Feeder: Robertson Kelder	1] Close n/o point: Kelder RMU fed from Nestle feed in Muiskraalskop Substation	A] Goedehoop Laan Feeder remains at 0% (n/o point)
			B] Nestle Feeder from 5.3% to 34.7%
			C] Goedhooop Laan Feeder remains at 73.6%

#	Critical Supply Scenarios	Action Required	Effect on Network
			D] White Street 1 Feeder remains at 75.6%
			E] Load Control Feeder remains at 68.2%
			F] White Street 2 feeder remains at 63.6%
			G] KWV Feeder remains at 56.8%
2	Fault on Feeder: Nestle	1] Close n/o point: Kelder RMU fed from Nestle feed in Muiskraalskop Substation	A] Goedehoop Laan Feeder remains at 0% (n/o point)
			B] Robertson Kelder Feeder from 29.3% to 34.7%
			C] Goedhooop Laan Feeder remains at 73.6%
			D] White Street 1 Feeder remains at 75.6%
			E] Load Control Feeder remains at 68.2%
			F] White Street 2 feeder remains at 63.6%
			G] KWV Feeder remains at 56.8%
3	Fault on Feeder: Goedehoop Laan in Muiskraalskop Substation	1] Close n/o point: Goedehoop Laan Substation situated in Muiskraalskop Substation	A] Goedehoop Laan Feeder increases from 0% to 75.1%
			B] Robertson Kelder Feeder remains at 29.3%
			C] Nestle Feeder remains at 5.3%
			D] White Street 1 Feeder remains at 75.6%
		2] Close n/o point: Muiskraalskop 1 at Goedehoop Laan Substation	E] Load Control Feeder remains at 68.2%
			F] White Street 2 feeder remains at 63.6%
			G] KWV Feeder remains at 56.8%

#	Critical Supply Scenarios	Action Required	Effect on Network
4	Fault on Feeder: White Street 1 in Muiskraalskop Substation	1] Close bus coupler between White 1 and White 2 Substation	A] Goedehoop Laan Feeder increases from 0% to 48.8%%
			B] Robertson Kelder Feeder remains at 29.3%
		2] Close n/o points: Goedehoop Laan at Muiskraalskop Substation and Muiskraalskop at Goedehoop Laan Substations	C] Nestle Feeder remains at 5.3%
			D] Goedehoop Laan Feeder from 73.6% to 41.3%
		3] Close n/o point: Waterwerke at White 1 Substation	E] Load Control Feeder remains at 68.2%
			F] White Street 2 feeder from 63.6% to 86.6%
		4] Close n/o point: Victoria RMU	G] KWV Feeder from 56.8% to 82.4%
5	Fault on Feeder: Load Control	1] Close n/o point: Drom RMU	A] Goedehoop Laan Feeder from 0% to 62.9%
			B] Robertson Kelder Feeder remains 29.3%
			C] Nestle Feeder remains at 5.3%
			D] Goedehoop Laan Feeder from 73.64% to 53.3%
		2] Close n/o points: Goedehoop Laan at Muiskraalskop Substation and Muiskraalskop at Goedehoop Laan Substations	E] White Street 1 Feeder increases from 75.6 to 78.8%
			F] White Street 2 Feeder remains at 63.6%
			G] KWV Feeder remains at 56.8%
		1] Close bus coupler between White 1 and White 2 Substation	A] Goedehoop Laan Feeder from 0% to 48.8%

#	Critical Supply Scenarios	Action Required	Effect on Network
6	Fault on Feeder: White Street 2	2] Close n/o point: Waterwerke at White Street 1 Substation	B] Robertson Kelder Feeder remains 29.3%
			C] Nestle Feeder remains at 5.3%
		3] Close n/o points: Goedehoop Laan at Muiskraalskop Substation and Muiskraalskop at Goedehoop Laan Substations	D] Goedehoop Laan Feeder from 73.6% to 41.3%
			E] White Street 1 Feeder from 75.6% to 86.6%
		4] Close n/o point: Victoria RMU	F] Load Control Feeder remains at 68.2%
			G] KWV Feeder from 56.8% to 82.4%
7	Fault on Feeder: KWV	1] Close n/o point: Kelder RMU from Roodezant RMU	A] Goedehoop Laan Feeder remains at 0% (n/o point)
			B] Robertson Kelder Feeder from 29.3% to 81.8%
			C] Nestle Feeder remains at 5.3%
			D] Goedehoop Laan Feeder decrease from 73.6% to 71.1%
			E] White Street 1 Feeder increases from 75.6% to 78.8
			F] Load Control Feeder remains at 68.2%
			G] White Street 2 Feeder remains at 63.6%

Table 11: Critical Supply Scenarios for the Robertson MV Network

The Robertson MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated above.

6. CONCLUSIONS

The following conclusions can be drawn from the Langeberg MV Network load-flow simulations:

6.1 ASHTON

- The present ADMD of the Ashton MV Network, recorded during January 2010, is 10.7MVA. Load growth is estimated at 1.054% per annum;
- The Ashton MV Network has an installed capacity of 26.019MVA;
- The Ashton MV Network is both lightly loaded and a diversified electrical load;
- The volt-drop across the Ashton MV Network is 1.2%, which falls in line with NRS034 as indicated;
- The Ashton MV Network is not a “safe” network as only one 66/11kV transformer supplies the entire MV network;
- Network strengthening in the form of conductor upgrades will be required should Ashton continue to grow at a rate of 1.054% per annum.
- The Ashton MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated in Table 1;
- The present Ashton MV Network configuration – the location of normally-open and normally-closed points – appear to be a feasible and effective configuration.

6.2 BONNIEVALE

- The present ADMD of the Bonnievale MV Network, recorded during February 2013, is 8.9MVA. Load growth is estimated at 3% per annum;
- The Bonnievale MV Network has an installed capacity of 21.153MVA;

- The Bonnievale MV Network is both lightly loaded and a diversified electrical load;
- The volt-drop across the Bonnievale MV Network is 3.3% which falls outside the recommended volt drop as indicated in NRS034. This can be overcome by boosting the infeed voltage at the main Bonnievale substation;
- The Bonnievale MV Network is not a “safe” network as only one 66/11kV transformer supplies the entire load;
- Network strengthening in the form of conductor upgrades will be required should Bonnievale continue to grow at a rate of 3% per annum;
- The Bonnievale MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated in Table 2;
- The present Bonnievale MV Network configuration – the location of normally-open and normally-closed points – appear to be a feasible and effective configuration.

6.3 GOUDMYN

- The present ADMD of the Goudmyn MV Network is 8.8MVA. Load growth is estimated at 2% per annum;
- The Goudmyn MV Network has an installed capacity of 18.382MVA;
- The Goudmyn MV Network is both lightly loaded and a diversified electrical load;
- The volt-drop across the Goudmyn MV Network is 15.3% which falls outside the recommended volt drop as indicated in NRS034. This could be as a result of the rural nature of the network;
- The Goudmyn MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated in Table 3;
- The present Goudmyn MV Network configuration – the location of normally-open and normally-closed points – appear to be a feasible and effective configuration.

6.4 LE CHASSEUR

- The present ADMD of the Le Chasseur MV Network is 3.8MVA. Load growth is estimated at 2% per annum;
- The Le Chasseur MV Network has an installed capacity of 9.226MVA;
- The Le Chasseur MV Network is both lightly loaded and a diversified electrical load;
- The volt-drop across the Le Chasseur MV Network is 5.3% which falls outside the recommended volt drop as indicated in NRS034;
- The overall power factor on the network is 0.948 which is acceptable;
- The 5MVA transformers are operating at 38% of their rated capacity, which implies if one transformer failed the network would still be classified as a safe network; and
- The Agterkliphhoogte feeder is a spur feed, and should a fault occur on this feeder the entire line would be without power.

6.5 MCGREGOR

- The present ADMD of the McGregor MV Network is 2.502MVA. Load growth is estimated at 3.65% per annum;
- The McGregor MV Network has an installed capacity of 7.4MVA;
- The McGregor MV Network is both lightly loaded and a diversified electrical load;
- The volt-drop across the McGregor MV Network is 4.4% which falls outside the recommended volt drop as indicated in NRS034;
- The McGregor MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated in Table 4;
- The present McGregor MV Network configuration – the location of normally-open and normally-closed points – appear to be a feasible and effective configuration.
- There is only a single 10MVA transformer supplying the MV network. This implies that should this transformer fail, the entire MV network will be without power.

6.6 MONTAGU

- The present ADMD of the Montagu MV Network, recorded during March 2014, is 8.2MVA. Load growth estimated at 2.94% per annum;
- The Montagu MV Network has an installed capacity of 33.256MVA;
- The Montagu MV Network is both lightly loaded and a diversified electrical load;
- The volt-drop across the Montagu MV Network is 2.4% which complies with NRS034;
- The Montagu MV network is not a “safe” network as it is supplied by means of two 66/11kV 5MVA transformers, where each transformer is currently operating at 82.6% of its rated capacity. Should either of the transformers fail, the Montagu MV network will be required to undergo localised load shedding;
- Network strengthening in the form of conductor and transformer upgrades will be required should Montagu continue to grow at a rate of 2.94% per annum;
- The Montagu MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated in Table 5;
- The Montagu MV Network has sufficient capacity to accommodate the future planned 1.5MVA Montagu Golf Estate;
- The present Montagu MV Network configuration – the location of normally-open and normally-closed points – appear to be a feasible and effective configuration.

6.7 NOREE

- The present ADMD of the Noree MV Network is 5.278MVA. Load growth is estimated at 2.65% per annum;
- The Noree MV Network has an installed capacity of 11.081MVA;
- The Noree MV Network is both lightly loaded and a diversified electrical load;

- The volt-drop across the Noree MV Network is 5.7% which falls outside the recommended volt drop as indicated in NRS034;
- The Noree MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated in Table 4;
- The present Noree MV Network configuration – the location of normally-open and normally-closed points – appear to be a feasible and effective configuration;
- There is only a single 10MVA transformer supplying the MV network. This implies that should this transformer fail, the entire MV network will be without power; and
- The Noree MV network can absorb the Le Chasseur feeder's load should it fail. This is achieved by closing the open point located at River Bend Pump 1. This would however increase the volt drop on Noree's feeder number 3 to 36% which is not advisable.

6.8 ROBERTSON

- The present ADMD of the Robertson MV Network, recorded during February 2013 and which includes Le Chasseur and Goudmyn, is 32.1MVA;
- The installed capacity of Robertson is 42.2MVA;
- The Robertson MV Network is relatively lightly loaded, with a demand factor of 0.50;
- The volt-drop across the Robertson MV Network is 4.9%. This is higher than supply authority guidelines as NRS034 recommends a maximum volt-drop for the MV distributor of 3%;
- Network strengthening in the form of conductor upgrades are required immediately as results from the present day simulation indicates that one conductor is operating at above 100% of its thermal capacity limits;
- The Robertson MV Network has sufficient capacity to accommodate the critical supply scenarios as simulated in Table 7;
- The present Robertson MV Network configuration – the location of normally-open and normally-closed points – appear to be a feasible and effective configuration.

7. RECOMMENDATIONS

The following recommendations can be made, based upon the data contained through the load-flow simulations discussed within this report. The costs associated with the recommendations exclude VAT and Professional Fees.

7.1 ASHTON

- Upgrade the existing 66/11kV 5MVA transformer currently not in use to a 66/11kV 20MVA transformer to add redundancy to the Ashton MV Network. **ESTIMATED COST: R4,500,000.00**
- Replacement of the following transformers which are pre 1985:

Ashton Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
1	Distribution Transformer	Ground Mounted	11kV/400V	100kVA	Industreel GMT	36	R64 000.00
2	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	Robot TRF	61	R30 000.00
3	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF FT ZEEMAN	41	R30 000.00
4	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF ACCO SPAAR	41	R30 000.00
5	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF LAVENDER CREEK	41	R30 000.00
6	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF STOCKWELL BEVISS CHALLENOR 1	40	R30 000.00
7	Distribution Transformer	Ground Mounted	11kV/400V	150kVA	Park Substation	36	R150 000.00
8	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	Steeg Str Substation	36	R160 000.00
9	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	Middel Str Substation	42	R160 000.00
10	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	Roodewal Substation	37	R160 000.00
11	Mini Substation	Without RMU	11kV/400V	200kVA	MS ASHTON BOOSTER	39	R250 000.00
12	Mini Substation	With RMU	11kV/400V	200kVA	WildePerde MSB	36	R300 000.00
13	Distribution Transformer	Pole Mounted	11kV/400V	200kVA	Zolani Booster Pump	34	R160 000.00
14	Distribution Transformer	Pole Mounted	11kV/400V	20kVA	Gorree MelkStaal	34	R40 000.00
15	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	Vee Pos/80A	41	R40 000.00
16	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF ACCO 2	38	R40 000.00

17	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF KUILVOER	38	R40 000.00
18	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF STOCKWELL BEVISS CHELLENOR 2	36	R40 000.00
19	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF SNYMAN HUIS	33	R40 000.00
20	Distribution Transformer	Pole Mounted	11kV/400V	30kVA	PTRF M BARNARD	49	R50 000.00
21	Distribution Transformer	Pole Mounted	11kV/400V	30kVA	Abbatoir TRF	40	R50 000.00
22	Distribution Transformer	Ground Mounted	11kV/400V	400kVA	Bruwer Str Substation	37	R200 000.00
23	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF HERFURTH	43	R46 000.00
24	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF SPORTGROND	41	R46 000.00
25	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF ACCO POMP 2	38	R46 000.00
						Total (Excl VAT)	R2 232 000.00

Table 12: Ashton Transformer Replacement Schedule

7.2 BONNIEVALE

- Introduce a second 66/11kV 20MVA transformer to add redundancy to the Bonnievale MV Network. **ESTIMATED COST: R4,500,000.00**

- Replacement of the following transformers which are pre 1985:

Bonnievale Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
1	Distribution Transformer	Ground Mounted	11kV/400V	100kVA	Bonnevale Main Substation	44	R64 000.00
2	Distribution Transformer	Ground Mounted	11kV/400V	100kVA	Louisiana Substation	36	R64 000.00
3	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF SONSKYN	51	R64 000.00
4	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF BOTTELSTOOR	44	R64 000.00
5	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF PLAKKERSKAMP	35	R64 000.00
6	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF NYERS VAN DE MERWE 2	41	R30 000.00
7	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF ANDRIES JONHEER 1	39	R30 000.00

Bonnievale Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
8	Distribution Transformer	Pole Mounted	11kV/400V	150kVA	PTRF MOOIUITSIG POMP	44	R130 000.00
9	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF VAN GRAAN	36	R35 000.00
10	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF MOOIUITSIG HUISE 2	36	R35 000.00
11	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF ROOI KAMP	35	R35 000.00
12	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF VAALKAMP 2	34	R35 000.00
13	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF ANDRIES JONHEER 5	33	R35 000.00
14	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	Jongkeer Botteelstoor Substation	43	R160 000.00
15	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF JAN HOPPIES	52	R40 000.00
16	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF SKERPIOENKOP 1	44	R40 000.00
17	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF VAALKAMP 1	38	R40 000.00
18	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF LUKAS WENSEL 2	38	R40 000.00
19	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF NYERS VAN DE MERWE 1	36	R40 000.00
20	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF THYS WESEL 2	35	R40 000.00
21	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	Happy Valley Substation	54	R170 000.00
22	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	Golf Substation	38	R170 000.00
23	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	Kop Substation	44	R170 000.00
24	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	Police Substation	53	R170 000.00
25	Distribution Transformer	Ground Mounted	11kV/400V	315kVA	Mollenaar Substation	33	R180 000.00
26	Distribution Transformer	Ground Mounted	11kV/400V	500kVA	Uitsig Substation	34	R250 000.00
27	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF SCHALK WENSEL 3	51	R46 000.00
28	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF J.J BOTHES UITSIG	50	R46 000.00
29	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF SWELLENSHARON	50	R46 000.00
30	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF OOSTHYSEN	49	R46 000.00
31	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF SCHALK WENSEL 1	44	R46 000.00
32	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF PIET DE WET 2	44	R46 000.00

Bonnievale Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
33	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF RESEVIOR	36	R46 000.00
34	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF SKERPIOENKOP 3	36	R46 000.00
35	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF KIEWIET ROSSOUW	35	R46 000.00
36	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF PIET DE WET 1	35	R46 000.00
						Total (Excl VAT)	R2 664 000.00

Table 13: Bonnievale Transformer Replacement Schedule

7.3 GOUDMYN

- Investigation exercise into the excessive volt drop.

7.4 LE CHASSEUR

- Investigation exercise into an additional feeder to McGregor substation to create a ring network between McGregor substation and the Agterkliphoogte feeder in Le Chasseur's MV network.

7.5 MCGREGOR

- Introduce a second 66/11kV 10MVA transformer to add redundancy to the McGregor MV Network. **ESTIMATED COST: R2,500,000.00**

7.6 MONTAGU

- Upgrade the two 5MVA transformers to 15MVA transformers to offer 100% redundancy for the next 15 years. **ESTIMATED COST: R8,500,000.00**

- Replacement of the following transformers which are pre 1985:

Montagu Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
1	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF I.M JACOBSON 1	62	R30 000.00
2	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF BADEN POMP	45	R30 000.00
3	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF KRIEL	44	R30 000.00
4	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF S.W BURGER LOCKARNO 3	41	R30 000.00
5	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF A.F KRIEL PRIMARY SCHOOL	32	R30 000.00
6	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF BADEN SKOOL	32	R30 000.00
7	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF DEON BRUWER HUIS	48	R35 000.00
8	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF H.W MEYER	47	R35 000.00
9	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF JACQUE KRIEL	38	R35 000.00
10	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF J.J.C BELEGING	35	R35 000.00
11	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	Brink no 2 Substation	35	R160 000.00
12	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	Long str Substation	62	R160 000.00
13	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	Sentrale Substation	45	R160 000.00
14	Distribution Transformer	Pole Mounted	11kV/400V	20kVA	PTRF CW JOUBERT & VOORMAN HUIS	58	R40 000.00
15	Distribution Transformer	Pole Mounted	11kV/400V	20kVA	PTRF J. A BRUWER WITSAND(OLD)	42	R40 000.00
16	Distribution Transformer	Pole Mounted	11kV/400V	20kVA	PTRF H.J JOUBERT HOPEVILLE	42	R40 000.00
17	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF WOLMAGANG 1(Raws)	45	R40 000.00
18	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF BON ACCORD KRUIS(SKOOLHUIS)	39	R40 000.00
19	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF HAASBROEK TALANA PAD	38	R40 000.00
20	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF PRINCE	38	R40 000.00
21	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF BOERE RUS 2	36	R40 000.00
22	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF J.P MARAIS HUIS	36	R40 000.00
23	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF J.R STRYDOM DIE PLEIN	34	R40 000.00
24	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF KLOORKAMER	32	R40 000.00
25	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	Bergsib Substation	44	R170 000.00

Montagu Replacement Transformer Data							
No	Type	Type	Voltage	Size	Name	Age	Replacement Cost
26	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	Brink no 1 Substation	35	R170 000.00
27	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	KWV Substation	58	R170 000.00
28	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	Laerskool Substation	39	R170 000.00
29	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	TRF STEENOONDE	45	R170 000.00
30	Distribution Transformer	Pole Mounted	11kV/400V	30kVA	PTRF M.W BUSSEL KNIPES HOPE	45	R50 000.00
31	Distribution Transformer	Pole Mounted	11kV/400V	30kVA	PTRF P..FOUCHE DAM(PAKKERS)	44	R50 000.00
32	Distribution Transformer	Pole Mounted	11kV/400V	30kVA	PTRF BOERE RUS 1	38	R50 000.00
33	Distribution Transformer	Ground Mounted	11kV/400V	500kVA	Avalon Springs Substation	32	R250 000.00
34	Distribution Transformer	Ground Mounted	11kV/400V	500kVA	Badskop singel Substation	46	R250 000.00
35	Distribution Transformer	Ground Mounted	11kV/400V	500kVA	TRF MONTAGU SPRINGS	32	R250 000.00
36	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF P.HUGO RIETVLEI TRUST 2	46	R46 000.00
37	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF QUI-SI-SANA HUIS	46	R46 000.00
38	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF P.J FOUCHE POORTJIES KLOOF 2(FLIP)	45	R46 000.00
39	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF H.T KRIEL	39	R50 000.00
40	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF JAY SMITH	38	R46 000.00
41	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF D. NEL	38	R46 000.00
42	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF QUI-SI-SANA RESTAURANT	35	R46 000.00
43	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF KOSIE FOUCHE KLIPKUIL POMP(PAKKERS)	45	R70 000.00
44	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF W.M BUSSEL BARDEN ARBEIDERSHUISE	45	R70 000.00
						Total (Excl VAT)	R3 452 000.00

Table 14: Montagu Transformer Replacement Schedule

7.7 NOREE

- Introduce a second 66/11kV 10MVA transformer to add redundancy to the Noree MV Network. **ESTIMATED COST: R2,500,000.00**

7.8 ROBERTSON

- Upgrade the 11kV 35mm² Bergsig Substation conductor located between White 1 Substation and Bergsig Substation. Upgrade to a 70mm² conductor. **ESTIMATED COST: R1,000,000.00**
- Replacement of the following transformers which are pre 1985:

Robertson Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
1	Distribution Transformer	Ground Mounted	11kV/400V	100kVA	Police Station Substation	37	R64 000.00
2	Distribution Transformer	Ground Mounted	11kV/400V	100kVA	Bon Cap Substation	33	R64 000.00
3	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF UITSIG FARM PUMP 01	54	R67 000.00
4	Distribution Transformer	Ground Mounted	11kV/400V	100kVA	TRF LUCERNE	49	R64 000.00
5	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF KEURKLOOF 2	47	R64 000.00
6	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF LE CHASSEUR JOHAN & RIANA ROUX PUMP 4	47	R64 000.00
7	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF PROSPECT DE WET FAMILY STORE 2	45	R64 000.00
8	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF 2 LANGVERWACHT	43	R64 000.00
9	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF PREVOYANCE PUMP 5	43	R64 000.00
10	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF EXCELSIOR WORKER HOUSES	36	R64 000.00
11	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF PROSPECT WORKER HORSES	36	R64 000.00
12	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF WOLFKLOOF HOUSE 2	35	R64 000.00
13	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF BO FARM PUMP 2	35	R64 000.00
14	Distribution Transformer	Pole Mounted	11kV/400V	100kVA	PTRF LANDSFONTEIN	35	R64 000.00
15	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF BOERBOK VOETSLAANPAT OFFICE	51	R30 000.00

Robertson Replacement Transformer Data							
No	Type	Type	Voltage	Size	Name	Age	Replacement Cost
16	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF OUTNOOD SKOOL	51	R30 000.00
17	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF SEWEFONTEIN WORKERS HOUSES	49	R30 000.00
18	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF OILIFANT PUMP 3	49	R30 000.00
19	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF OILIFANT OFFICE	49	R30 000.00
20	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF CROXLEY FARM PUMP 01	49	R30 000.00
21	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF SKOOL	48	R30 000.00
22	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF WEL VAN PAS WOUTER DE WET WORKERS HOUSES 3	47	R30 000.00
23	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF MOUNTAIN VIEW 1	46	R30 000.00
24	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF 2 ZANDBERG	45	R30 000.00
25	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF WEL VAN PAS WOUTER DE WET KERK	45	R30 000.00
26	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF STEVEN	44	R30 000.00
27	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF OILFANT 3	43	R30 000.00
28	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF HOUSEE 4	42	R30 000.00
29	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF NERINA GUEST FARM HOUSE 1	42	R30 000.00
30	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF MITTEL FARM	41	R30 000.00
31	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF VLIEGTUIG VLIEGVELD	41	R30 000.00
32	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF GOREERS HOOGTE PUMP	41	R30 000.00
33	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF MIDDELFARM	41	R30 000.00
34	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF 2 DANTJIE ZEEMAN	41	R30 000.00
35	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF AGTRERKLIP HOOGTE FARMHOUSE 1	41	R30 000.00
36	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF OPPIE FARM IZAK & JULIANA VERSTER	41	R30 000.00
37	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF SOEKERSHOF 2	41	R30 000.00
38	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF OLYFENBOSCH COTTAGES	41	R30 000.00
39	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF BOESMAN HOUSEE	41	R30 000.00

Robertson Replacement Transformer Data

No	Type	Type	Voltage	Size	Name	Age	Replacement Cost
40	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF MAIN CHANCE WORKERS HOUSES	41	R30 000.00
41	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF STR LIGHT	41	R30 000.00
42	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF BUITEHOF	39	R30 000.00
43	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF HELP MEKAAR	39	R30 000.00
44	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF KLAASVOOGDS PUMP 2	39	R30 000.00
45	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF LANGWERWACHT WINKEL	39	R30 000.00
46	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF McGREGOR BOOSTER	38	R30 000.00
47	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF ASHTON LINE 30	38	R30 000.00
48	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF UITNOOD KERK	38	R30 000.00
49	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF RETREAT JDE WET HOUSE	38	R30 000.00
50	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF VREDELUS HOUSE	38	R30 000.00
51	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF ORANGE GROVE FARM ARAUJO WERKERSHOUSE	38	R30 000.00
52	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF NOREE JOOD LE ROUX JONIOR HOUSE	38	R30 000.00
53	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF VAN REENS	38	R30 000.00
54	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF CJ ROUX SKUILTE HOUSE	38	R30 000.00
55	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF SOEKERSHOF 3	36	R30 000.00
56	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF QUDE BLY EN RY	35	R30 000.00
57	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF VINKRIVIER LAERSKOOL	35	R30 000.00
58	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF DR CASO	35	R30 000.00
59	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF GOREE ROAD 1	35	R30 000.00
60	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF ANTON	35	R30 000.00
61	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF MONT BLOIS HOUSE 1	34	R30 000.00
62	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF DASSIEHOEK HOUSE 1	34	R30 000.00
63	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF DASSIEHOEK HOUSE 2	33	R30 000.00

Robertson Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
64	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF KLAASVOOGDS PUMP 4	32	R30 000.00
65	Distribution Transformer	Pole Mounted	11kV/230V	10kVA	PTRF ROODEHOOGTE KWEKERY HOUSE 1	32	R30 000.00
66	Distribution Transformer	Pole Mounted	11kV/400V	10kVA	PTRF BUITEHOF PUMP 2	32	R30 000.00
67	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF PIKKIE PUMP 4	49	R35 000.00
68	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF 2 WOLVENDRIFT D ZEEMAN Jnr	48	R35 000.00
69	Distribution Transformer	Pole Mounted	11kV/230V	15kVA	PTRF HIGHLANDS FARM HOUSE 4	46	R35 000.00
70	Distribution Transformer	Pole Mounted	11kV/230V	15kVA	PTRF MADEBA WORKER HOUSES 1	46	R35 000.00
71	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF 1 WOLVENDRIFT CLAASSEN	45	R35 000.00
72	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF RETREAT VAN ZYL WERKER HOUSEE	45	R35 000.00
73	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF VREDELUS STORE	45	R35 000.00
74	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF VAALVERDRIET WORKER HOUSES 1	45	R35 000.00
75	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF BUSHMAN PUMP	44	R35 000.00
76	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF KLAASVOOGDS GAME RESERVE HOUSE 2	40	R35 000.00
77	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF GOUDMYN LEEN & JANNY KLEER 2	39	R35 000.00
78	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF WANSBECK OOS HANNES ERASMUS WORKERS HOUSES 1	39	R35 000.00
79	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF TIERHOEK PUMP 1	39	R35 000.00
80	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF PAKKIE PUMP 2	39	R35 000.00
81	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF WHIPE 2	38	R35 000.00
82	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF JACKSON PUMP 1	38	R35 000.00
83	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF NO NAME WORKER HOUSES	38	R35 000.00
84	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF GOUDMYN PUMP	38	R35 000.00
85	Distribution Transformer	Pole Mounted	11kV/400V	15kVA	PTRF FRAAI UITZICHT PUMP 1	35	R35 000.00
86	Power Transformer	Double Wind	66kV/11kV	15MVA	TRANSFORMER 1 - Power Transformer	38	R4 500 000.00
87	Power Transformer	Double Wind	66kV/11kV	15MVA	TRANSFORMER 2 - Power Transformer	38	R4 500 000.00

Robertson Replacement Transformer Data

No	Type	Type	Voltage	Size	Name	Age	Replacement Cost
88	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF STEENBOKS VLAKE	48	R35 000.00
89	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF 1 VIRA	47	R35 000.00
90	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF JACKSON HOUSEE	43	R35 000.00
91	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF 2 WOLVENDRIFT CLAASSEN	36	R35 000.00
92	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF AGTER DIE KLIP GUESTHOUSE FARM	36	R35 000.00
93	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF JOHANNES DE WET STORE	36	R35 000.00
94	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF STEENBOKS 2	36	R35 000.00
95	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF ASHTON LINE 31	35	R35 000.00
96	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF DE ERF WORKERS HOUSES	35	R35 000.00
97	Distribution Transformer	Pole Mounted	11kV/230V	16kVA	PTRF KRANSKOP MAIN HOUSE 2	35	R35 000.00
98	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF KLAASVOOGDS LINE 3	34	R35 000.00
99	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF BO LANGVERWACHT	34	R35 000.00
100	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF 1 WOLVENDRIFT JOHAN VILJOEN	34	R35 000.00
101	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF VOORSPOED BOERDERY KRUISPAD PUMP 2	34	R35 000.00
102	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF RHEBOBSKRAAL 2	34	R35 000.00
103	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF SAND LANE PUMP	33	R35 000.00
104	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF 1 VAN ZYL	33	R35 000.00
105	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF WAKKERSTROOM	32	R35 000.00
106	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF JANEZA TELKOM	32	R35 000.00
107	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF RIVER CABINS	32	R35 000.00
108	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF ZEVENBERG PUMP 3	32	R35 000.00
109	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF KLIPDRIFT MAIN HOUSE 1	32	R35 000.00
110	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF KLIPDRIFT WINERY	32	R35 000.00
111	Distribution Transformer	Pole Mounted	11kV/400V	16kVA	PTRF VINKRIVIER IGNASIUS DU PLESSIS PUMP 2B	32	R35 000.00

Robertson Replacement Transformer Data							
No	Type	Type	Voltage	Size	Name	Age	Replacement Cost
112	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	TRANSFORMER	48	R160 000.00
113	Distribution Transformer	Pole Mounted	11kV/400V	200kVA	PTRF SARATOGA PUMP	47	R160 000.00
114	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	TRF DEWILGEN DANIE & DISE PUMP 2	45	R160 000.00
115	Distribution Transformer	Ground Mounted	11kV/400V	200kVA	TRF HIGHLANDS FARM PUMP 1	43	R160 000.00
116	Distribution Transformer	Pole Mounted	11kV/400V	20kVA	PTRF DE ERF 2	50	R40 000.00
117	Distribution Transformer	Pole Mounted	11kV/400V	20kVA	PTRF STREETLIGHT	48	R40 000.00
118	Distribution Transformer	Pole Mounted	11kV/400V	250kVA	PTRF TAKKAP	43	R170 000.00
119	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF LANGWERWACHT PUMP	54	R40 000.00
120	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF 3 ZANDVLIET	49	R40 000.00
121	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF STEVEN PUMP	47	R40 000.00
122	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF MOUNTAIN VIEW PUMP 1	46	R40 000.00
123	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF VILJOENSDRIF RIVER CRUISES	45	R40 000.00
124	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF KLIPDRIFT PUMP 1	45	R40 000.00
125	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF FRIKANA FARM PUMP 1	45	R40 000.00
126	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF DIE WIE	45	R40 000.00
127	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF QUANDO	44	R40 000.00
128	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF BILLY KLOPPERS HOUSE 2	43	R40 000.00
129	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF OUNOOD 1	43	R40 000.00
130	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF 5 ZANDVLIET	42	R40 000.00
131	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF 3 LANGVERWACHT	41	R40 000.00
132	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF WANSBECK OOS HANNES ERASMUS	39	R40 000.00
133	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF 3 CONCORDIA FARM	38	R40 000.00
134	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF ALMOND GROVE	38	R40 000.00
135	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF WJ DE WET WEL VAN PUMP 3	38	R40 000.00
136	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF ST KILDA GERRIT VAN DEVENTER STORES	38	R40 000.00

Robertson Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
137	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF ZANDBERG MOUNTAIN WORKERS HOUSES	38	R40 000.00
138	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF KLIPDRIFT HOUSE 3	38	R40 000.00
139	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF KLEIN KLASIE	38	R40 000.00
140	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF AURET	38	R40 000.00
141	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF IAN HOUSE	38	R40 000.00
142	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF PUMP 4	38	R40 000.00
143	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF BOESMAN PUMP	38	R40 000.00
144	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF PREVOYANCE WORKERS HOUSES 2	38	R40 000.00
145	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF GOUDMYN VILJOENDRIF	37	R40 000.00
146	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF RENNIE RETIEF PUMP 1	37	R40 000.00
147	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF MORCEAUX	36	R40 000.00
148	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF OESTERVANGER PUMPHOUSE	36	R40 000.00
149	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF DW PUMP 2	36	R40 000.00
150	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF DIE LAAITJIE PUMP 1	36	R40 000.00
151	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF GOEDE PAS WOUTER DE WET WORKERS HOUSES 3	36	R40 000.00
152	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF KLIPDRIFT WORKER HOUSES 2	35	R40 000.00
153	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF PREVOYANCE WORKERS HOUSES 1	35	R40 000.00
154	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF KLEINFONTEIN HOUSE 1	35	R40 000.00
155	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF HOUTBAAI 5	34	R40 000.00
156	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF EILANDIA PLASE DIE HEUWEL PUMP	34	R40 000.00
157	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF 2 WOLVEN DRIFT KOBUS LE ROUX	33	R40 000.00
158	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF DE FONTEIN FRIKKIE J BURGER	33	R40 000.00
159	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF RUSTICUS WINE CELLAR PUMP 1	33	R40 000.00
160	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF HOUSEE	33	R40 000.00

Robertson Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
161	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF EXCELSIOR PUMP 1	32	R40 000.00
162	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF RANDRIVIER BOERDERY PUMP 1	32	R40 000.00
163	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF DW LODGE	32	R40 000.00
164	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF VREDELUS WORKERS HOUSES	32	R40 000.00
165	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF NOREE JOOD LE ROUX JONIOR PUMP 1	32	R40 000.00
166	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF ISA BEAU PUMP 2	32	R40 000.00
167	Distribution Transformer	Pole Mounted	11kV/400V	25kVA	PTRF FARMWERF PUMP 2	32	R40 000.00
168	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	TRANSFORMER	37	R170 000.00
169	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	TRANSFORMER	49	R170 000.00
170	Distribution Transformer	Ground Mounted	11kV/400V	300kVA	TRF KEURKLOOF QUARRY	48	R170 000.00
171	Distribution Transformer	Pole Mounted	11kV/400V	30kVA	PTRF 1 JOHNNY BERGER	41	R50 000.00
172	Distribution Transformer	Pole Mounted	11kV/400V	30kVA	PTRF ARABELLA WORKER HOUSES 2	36	R50 000.00
173	Distribution Transformer	Pole Mounted	11kV/400V	30kVA	PTRF DIE HEUWEL WORKER HOUSES 1	36	R50 000.00
174	Distribution Transformer	Pole Mounted	11kV/400V	315kVA	PTRF HOKAAI PUMP 2	37	R170 000.00
175	Mini Substation	With RMU	11kV/400V	315kVA	MS GELDEBLOM	36	R402 500.00
176	Mini Substation	With RMU	11kV/400V	315kVA	MS DE WAAL HOSTEL	33	R402 500.00
177	Mini Substation	Without RMU	11kV/400V	315kVA	MS 2 BUITEKANK STR	33	R402 500.00
178	Mini Substation	With RMU	11kV/400V	315kVA	MS 1 WATSONIA STR	32	R402 500.00
179	Mini Substation	With RMU	11kV/400V	315kVA	MS LE ROUX	32	R402 500.00
180	Mini Substation	With RMU	11kV/400V	315kVA	MS HERBERG	32	R402 500.00
181	Mini Substation	With RMU	11kV/400V	315kVA	MS NASSAU STR	32	R402 500.00
182	Distribution Transformer	Ground Mounted	11kV/400V	400kVA	Hospitaal Substation	75	R200 000.00
183	Distribution Transformer	Ground Mounted	11kV/400V	400kVA	Industriale Substation	39	R200 000.00
184	Distribution Transformer	Ground Mounted	11kV/400V	500kVA	Wavern Substation	41	R250 000.00
185	Distribution Transformer	Ground Mounted	11kV/400V	500kVA	Reitz Street Substation	35	R250 000.00

Robertson Replacement Transformer Data							
No	Type	Type	Voltage	Size	Name	Age	Replacement Cost
186	Distribution Transformer	Ground Mounted	11kV/400V	500kVA	Nestle Substation	38	R250 000.00
187	Distribution Transformer	Ground Mounted	11kV/400V	500kVA	Post Office Substation	36	R250 000.00
188	Mini Substation	With RMU	11kV/400V	500kVA	MS 2 WATSONIA STR	32	R250 000.00
189	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF SHEILAM	60	R46 000.00
190	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF 1 WOLVENDRIFT CLAASSEN	51	R46 000.00
191	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF 1 GROENLAND	48	R46 000.00
192	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF MIDDELFARM	48	R46 000.00
193	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF PROSPECT DE WET FAMILY MAIN HOUSE	45	R46 000.00
194	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF KLAASVOOGDS COTTAGE 1	45	R46 000.00
195	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF Jan no 1	44	R46 000.00
196	Distribution Transformer	Ground Mounted	11kV/400V	50kVA	TRF DEWILGEN DANIE & DISE PUMP 1	43	R40 000.00
197	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF VINKRIVIER IGNASIUS DU PLESSIS STORE	43	R46 000.00
198	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF RHOBOKSKRAAL 4	43	R46 000.00
199	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF OILIFANT 5	43	R46 000.00
200	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF ARBEIDSGENOT PUMP 2	43	R46 000.00
201	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF LANGVERWACHT HOUSEE	43	R46 000.00
202	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF TANAGRA	42	R46 000.00
203	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF ROODEHOOGTE	42	R46 000.00
204	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF GOEDEREEDE GASTEHOUSE	42	R46 000.00
205	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF CLERMONT STORE 1	42	R46 000.00
206	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF 2 GROENLAND	41	R46 000.00
207	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF HOOPSRIVIER PRIMARY	41	R46 000.00
208	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF KLIPDRIF HOUSEE	41	R46 000.00
209	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF ROSENDAL HOUSE 1	40	R46 000.00

Robertson Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
210	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF 3 DANTJIE ZEEMAN	39	R46 000.00
211	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF WEL VAN PAS WOUTER DE WET WORKERS HOUSES 2	39	R46 000.00
212	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF PROSPECT DE WET FAMILY PUMP 1	39	R46 000.00
213	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF SANDY LANE 2	39	R46 000.00
214	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF 3 EYONA	38	R46 000.00
215	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF MARAISDAL	38	R46 000.00
216	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF AGTER DIE KLIP	38	R46 000.00
217	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF DE ERF 1	38	R46 000.00
218	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF EDUARD BRUWER HOUSE 1	38	R46 000.00
219	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF PROEFFARM WORKERS HOUSES	37	R46 000.00
220	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF VILJOENDRIFT PUMP 3	37	R46 000.00
221	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF FJ Du TOIT GOUDMYN PUMP 2	37	R46 000.00
222	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF BERGFARM ASSEGAI HOUSE	37	R46 000.00
223	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF ROODEZANT PUMP	36	R46 000.00
224	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF DE ERF PUMP	36	R46 000.00
225	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF FRANCE 1	36	R46 000.00
226	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF BARRY LE ROUX WORKER HOUSES	36	R46 000.00
227	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF HERMAN	36	R46 000.00
228	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF NERINA GUEST FARM PUMP 04	36	R46 000.00
229	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF 4 JACQUES	35	R46 000.00
230	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF 2 VIRA	35	R46 000.00
231	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF BLOK 2 APPLKOSE	35	R46 000.00
232	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF SONSKYN PUMP	35	R46 000.00
233	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF GERIE & JANE CLAASSEN 2	34	R46 000.00

Robertson Replacement Transformer Data

No	Type	Type	Voltage	Size	Name	Age	Replacement Cost
234	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF 3 WOLVENDRIFT JOHAN VILJOEN	34	R46 000.00
235	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF McGREGOR PADSTAL PUMP	34	R46 000.00
236	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF DIE VLAKTE FARM STORE 1	34	R46 000.00
237	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF OU FARM BAKSTENE	33	R46 000.00
238	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF DANIE	33	R46 000.00
239	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF KLEINFARM PUMP 1	33	R46 000.00
240	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF KLEINFARM PUMP 2	33	R46 000.00
241	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF KLIPDRIFT PUMP 5	33	R46 000.00
242	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF BILLY KLOPPERS DIE POORD PUMP 1	32	R46 000.00
243	Distribution Transformer	Pole Mounted	11kV/400V	50kVA	PTRF DULIT PUMP	32	R46 000.00
244	Distribution Transformer	Pole Mounted	3.3kV/400V	5kVA	PTRF MOUNT VIEW WORKER HOUSES 3	42	R5 000.00
245	Distribution Transformer	Ground Mounted	11kV/400V	75kVA	TRF WJ DE WET WEL VAN PAS STORE	49	R70 000.00
246	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF VAN LOOVEN PUMP 2	47	R70 000.00
247	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF ALMOND GROVE WORKERS HOUSES	45	R70 000.00
248	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF CLARISE WOLD ERASMUS HOUSE	45	R70 000.00
249	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF SILVERSTRAND KAFEE	45	R70 000.00
250	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF BOLAND PUMP 1	45	R70 000.00
251	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF PUMP 3	44	R70 000.00
252	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF 3 GOEDVERWACHT LANDGOED	43	R70 000.00
253	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF RABIESDAL CALIE RABIE	43	R70 000.00
254	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF DIRK & SUZANNE APPELDRIF PUMP	40	R70 000.00
255	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF LE GRAND CHASSEUR PUMP 4	40	R70 000.00
256	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF SARATOGA PUMP 2	39	R70 000.00
257	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF GOUDMYN STEPH MALHERB	39	R70 000.00
258	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF NO NAME PUMP 1	38	R70 000.00

Robertson Replacement Transformer Data							
No	**Type**	**Type**	**Voltage**	**Size**	**Name**	**Age**	**Replacement Cost**
259	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF PAUL FARM	38	R70 000.00
260	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF GOUMYN PUMP 4	37	R70 000.00
261	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF PROSPECT PUMP	37	R70 000.00
262	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF REVEIRA	36	R70 000.00
263	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF VAALVERDRIET PUMP 1	36	R70 000.00
264	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF KLIPLAPA HOUSE	36	R70 000.00
265	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF SILVERSTRAND 1	35	R70 000.00
266	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF VILJOENSDRIF STORE	33	R70 000.00
267	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF VOORSPOED BOERDERY NOREE HOUSE	32	R70 000.00
268	Distribution Transformer	Pole Mounted	11kV/400V	75kVA	PTRF BERGZICHT LEVEY FOURIE	32	R70 000.00
						Total (Excl VAT)	R25 350 500.00

Table 15: Robertson Transformer Replacement Schedule

7.9 GENERAL

- The table below provides a list of recommended projects to be undertaken to address the aging networks and regulatory changes. These projects will assist in ensuring a stable and continuous electrical supply to the consumers, available capacity for future demand growth, compliance with the Supply License requirements, OHS Act and Supply Authority Electrical Regulations, with the added advantage of reduced electrical losses and maintenance costs:

Ward	Type	Total	2016/17	2017/18	2019/20
All	Install 11 kV Capacitors	R 220,000	R 100,000	R 120,000	
8,4	Upgrade LV lines	R 212,000	R 106,000	R 106,000	
7;11;12	Upgrade of LV lines	R 212,000	R 106,000	R 106,000	
5	Upgrade of LV lines	R 212,000	R 106,000	R 106,000	
9,10,11	Upgrade of LV lines	R 212,000	R 106,000	R 106,000	
1 ; 2; 3; 5	Upgrade of LV lines	R 212,000	R 106,000	R 106,000	
11;7;12	Replace 11 kV Oil Insulated Switchgear	R 477,000	R 159,000	R 318,000	
9 & 10	Replace 11 kV Oil switchgear	R 318,000	R 159,000	R 159,000	
6 ;1;2;3	Replace 11 kV Oil Insulated Switchgear (RMU's)	R 636,000	R 318,000	R 318,000	
9;10	Install 11 kV switchgear - Steeg substation Main Road	R 371,000	R 371,000		
4 & 8	Replace 11 kV Line Mirtle Rigg	R 381,600	R 381,600		
8	Upgrade 11 kV line to Angora	R 750,000	R 400,000	R 350,000	
8	Upgrade 11 kV line to Stormsvlei and Kapteindrift	R 750,000	R 400,000	R 350,000	
5;6;11;8	Replace 66 kV Switchgear (Goudmyn and Le Chasseur Substations)	R 1,091,800	R 530,000	R 561,800	
5	Reroute Mc Gregor 11 kV line at Mc Gregor Sportfields	R 636,000	R 636,000		
7;11;12	Install 11 kV switchgear in Brinks substation	R 720,800	R 720,800		
1 ; 2; 3; 5;6	Replace 11 kV Oil Insulated Switchgear	R 1,696,000	R 848,000	R 848,000	
5	Upgrade 11 kV line to Buitekanstraat, Mc Gregor	R 1,378,000	R 954,000	R 424,000	
11	Upgrade Goedemoed 11 kV line	R 1,802,000	R 954,000	R 848,000	
10	Upgrade 11 kV line Stockwill	R 2,120,000	R 1,060,000	R 1,060,000	
7	Upgrade 11 kV line to Poortjieskloof	R 2,120,000	R 1,060,000	R 1,060,000	
9;11	Upgrade Ashton 11 kV line	R 2,120,000	R 1,060,000	R 1,060,000	
5	Upgrade Mc Gregor / Boesmansrivier 11 kV line	R 2,120,000	R 1,060,000	R 1,060,000	

Ward	Type	Total	2016/17	2017/18	2019/20
All	Upgrade Eskom Supplies to Robertson, Noree, Montagu. Bonnievale, Mc Gregor, Ashton,	R 4,100,000	R 1,200,000	R 1,600,000	R 1,300,000
12	Upgrade 11 kV line to Montagu Springs and Baden	R 2,544,000	R 1,272,000	R 1,272,000	
1;2;3	Upgrader 11 kV cable feeder from White Street substation to Van Zyl Street Hospital substation	R 1,484,000	R 1,484,000		
5	Electrification Projects	R 4,698,250	R 2,000,000	R 2,000,000	R 698,250
4 & 8	Upgrade Bonnievale Main Substation	R 4,200,000	R 3,000,000	R 1,200,000	
ALL	Mc Gregor Behuising	R 6,233,000	R 3,233,000	R 3,000,000	
9 & 10 & 11	Replace 11 kV Switchgear Ashton Main substation	R 5,500,000	R 4,000,000	R 1,500,000	
1;2;3;5;6;9; 11	Replace 66 kV Transformers at Robertson Main Substation	R 7,208,000	R 7,208,000		

Table 16: Recommended projects to be undertaken for the ageing networks

Appendix 1 - ERACS Network Study Data

1] ASHTON CURRENT PEAK DEMAND STUDY DATA
2] BONNIEVALE CURRENT PEAK DEMAND STUDY DATA
3] GOUDMYN CURRENT PEAK DEMAND STUDY DATA
4] LE CHASSEUR CURRENT PEAK DEMAND STUDY DATA
5] MCGREGOR CURRENT PEAK DEMAND STUDY DATA
6] MONTAGU CURRENT PEAK DEMAND STUDY DATA
7] NOREE CURRENT PEAK DEMAND STUDY DATA
8] ROBERTSON CURRENT PEAK DEMAND STUDY DATA

Appendix 2 - ERACS Network Study Results

1] ASHTON CURRENT PEAK DEMAND STUDY RESULTS

2] BONNIEVALE CURRENT PEAK DEMAND STUDY RESULTS

3] GOUDMYN CURRENT PEAK DEMAND STUDY RESULTS

4] LE CHASSEUR CURRENT PEAK DEMAND STUDY RESULTS

5] MCGREGOR CURRENT PEAK DEMAND STUDY RESULTS

6] MONTAGU CURRENT PEAK DEMAND STUDY RESULTS

7] NOREE CURRNET PEAK DEMAND STUDY RESULT

8] ROBERTSON CURRENT PEAK DEMAND STUDY RESULTS

Appendix 3 – Schedule of Drawings

ASHTON

1. **285200KE0/ASH01** EXISTING 11KV NETWORK (MARCH 2015)
2. **285200KE0/ASH02** 11KV SINGLE LINE SCHEMATIC WITH OPEN POINTS (MARCH 2015)
3. **285200KE0/E/ASH01** ERACS CURRENT PEAK DEMAND SIMULATION (MARCH 2015)
4. **285200KE0/E/ASH02** ERACS 5 YEAR FORECAST SIMULATION (MARCH 2015)
5. **285200KE0/E/ASH03** ERACS 10 YEAR FORECAST SIMULATION (MARCH 2015)
6. **285200KE0/E/ASH04** ERACS 15 YEAR FORECAST SIMULATION (MARCH 2015)

BONNIEVALE

1. **285200KE0/BON01** EXISTING 11KV NETWORK (MARCH 2015)
2. **285200KE0/BON02** 11KV SINGLE LINE SCHEMATIC WITH OPEN POINTS (MARCH 2015)
3. **285200KE0/E/BON01** ERACS CURRENT PEAK DEMAND SIMULATION (MARCH 2015)
4. **285200KE0/E/BON02** ERACS 5 YEAR FORECAST SIMULATION (MARCH 2015)
5. **285200KE0/E/BON03** ERACS 10 YEAR FORECAST SIMULATION (MARCH 2015)
6. **285200KE0/E/BON04** ERACS 15 YEAR FOECAST SIMULATION (MARCH 2015)

GOUDMYN

1. **285200KE0/GOU01** EXISTING 11KV NETWORK (MARCH 2015)
2. **285200KE0/E/GOU01** ERACS CURRENT PEAK DEMAND SIMULATION (MARCH 2015)
3. **285200KE0/E/GOU02** ERACS 5 YEAR FORECAST SIMULATION (MARCH 2015)
4. **285200KE0/E/GOU03** ERACS 10 YEAR FORECAST SIMULATION (MARCH 2015)
5. **285200KE0/E/GOU04** ERACS 15 YEAR FOECAST SIMULATION (MARCH 2015)

LE CHASSEUR

1. **285200KE0/LEC01** EXISTING 11KV NETWORK (MARCH 2015)
2. **285200KE0/E/LEC01** ERACS CURRENT PEAK DEMAND SIMULATION (MARCH 2015)
3. **285200KE0/E/LEC02** ERACS 5 YEAR FORECAST SIMULATION (MARCH 2015)
4. **285200KE0/E/LEC03** ERACS 10 YEAR FORECAST SIMULATION (MARCH 2015)
5. **285200KE0/E/LEC04** ERACS 15 YEAR FORECAST SIMULATION (MARCH 2015)

MCGREGOR

1. **285200KE0/MCG01** EXISTING 11KV NETWORK (MARCH 2015)
2. 2**85200KE0/E/MCG01** ERACS CURRENT PEAK DEMAND SIMULATION (MARCH 2015)
3. **285200KE0/E/MCG02** ERACS 5 YEAR FORECAST SIMULATION (MARCH 2015)
4. **285200KE0/E/MCG03** ERACS 10 YEAR FORECAST SIMULATION (MARCH 2015)
5. **285200KE0/E/MCG04** ERACS 15 YEAR FORECAST SIMULATION (MARCH 2015)

MONTAGU

1. **285200KE0/MON01** EXISTING 11KV NETWORK (MARCH 2015)
2. **285200KE0/MON02** 11KV SINGLE LINE SCHEMATIC WITH OPEN POINTS (MARCH 2015)
3. **285200KE0/E/MON01** ERACS CURRENT PEAK DEMAND SIMULATION (MARCH 2015)

4. **285200KE0/E/MON02** ERACS 5 YEAR FORECAST SIMULATION (MARCH 2015)
5. **285200KE0/E/MON03** ERACS 10 YEAR FORECAST SIMULATION (MARCH 2015)
6. **285200KE0/E/MON04** ERACS 15 YEAR FORECAST SIMULATION (MARCH 2015)
7. **285200KE0/E/MON05** ERACS GOLF DEVELOPMENT ADDED SIMULATION (MARCH 2015)

NOREE

1. **285200KE0/NOR01** EXISTING 11KV NETWORK (MARCH 2015)
2. **285200KE0/E/NOR01** ERACS CURRENT PEAK DEMAND SIMULATION (MARCH 2015)
3. **285200KE0/E/NOR02** ERACS 5 YEAR FORECAST SIMULATION (MARCH 2015)
4. **285200KE0/E/NOR03** ERACS 10 YEAR FORECAST SIMULATION (MARCH 2015)
5. **285200KE0/E/NOR04** ERACS 15 YEAR FORECAST SIMULATION (MARCH 2015)

ROBERTSON

1. **285200KE0/ROB01** EXISTING 11KV NETWORK (MARCH 2015)
2. **285200KE0/ROB02** 11KV SINGLE LINE SCHEMATIC WITH OPEN POINTS (MARCH 2015)
3. **285200KE0/E/ROB01** ERACS CURRENT PEAK DEMAND SIMULATION (MARCH 2015)
4. **285200KE0/E/ROB02** ERACS 5 YEAR FORECAST SIMULATION (MARCH 2015)
5. **285200KE0/E/ROB03** ERACS 10 YEAR FORECAST SIMULATION (MARCH 2015)
6. **285200KE0/E/ROB04** ERACS 15 YEAR FORECAST SIMULATION (MARCH 2015)

Appendix 4 – Eskom Plant Risk

Langeberg Municipality : Notified demand for each point of delivery						
	Bonnievale	**Montagu**	**Ashton**	**Robertson**	**Macgregor**	**Noree**
NMD	**10 000**	**9 000**	**12 000**	**34 000**	**2 700**	**6 000**

Plant Risks for each substation

Bonnievale

- Loss of Transformer 66/11kV (20MVA) – No alternative supply towards Bonnievale.
- Loss of 66kV Ashton-Bonnievale line – Supply Bonnievale load from 66kV Swellendam-Bonnievale line.

Montagus

- Loss of Transformer 1 66/11kV (20MVA) – Supply Montagu load from Transformer 2 66/11kV (10MVA), busy to upgrade Transformer 2 from 5 – 10MVA.
- Loss of 66kV Ashton-Montagu line – No alternative supply towards Montagu.
- Loss of 132kV Klipdrif-Ashton/Boskloof-Klipdrif line – Supply Montagu load from Vryheid S/S during winter periods. During summer periods, Barrydale needs to be switched off and Montagu will need to go into rotational load blocks with Ashton depending on the load during the fault.

Ashton

- Loss of Transformer 11 66/11kV (20MVA) – Supply load from Transformer 12 66/11kV (5MVA), Ashton to reduce load.
- Loss of 132kV Klipdrif-Ashton/Boskloof-Klipdrif line – Supply Montagu load from Vryheid S/S during winter periods. During summer periods, Barrydale needs to be switched off and Montagu will need to go into rotational load blocks with Ashton depending on the load during the fault.

Robertson

- Loss of 66kV Klipdrif-Uitspan line – Supply Robertson from 66kV Hex-Noree line during certain periods of the year from June-September.
- Loss of 132kV Ashton-Klipdrif/Boskloof-Klipdrif line - Supply Robertson from 66kV Hex-Noree line during certain periods of the year from June – September.

Noree

- Loss of 66kV Hex-Noree line – Supply Noree from 66kV Klipdrif-Uitspan line.

McGregor

- Loss of 132kV Bacchus-Vryheid line – No alternative supply towards McGregor.

Bonnievale

- Loss of 66kV Ashton-Montagu/Montagu-Barrydale line – In future will be possible to supply Bonnievale from Buffelspoort 22kV feeder, busy installing voltage regulators.

- Loss of 132kV Klipdrif-Ashton/Boskloof-Klipdrif line – Supply Montagu load from Vryheid S/S during winter periods. During summer periods, Barrydale needs to be switched off and Montagu will need to go into rotational load blocks with Ashton depending on the load during the fault.

- Loss of Transformer 66/22kV (10MVA) – In future will be possible to supply Bonnievale from Buffelspoort 22kV feeder, busy installing voltage regulators.

- Loss of Barrydale Munic 1 22kV Breaker – Supply Bonnievale from alternative 22kV feeder.