## MASTER PLAN FINAL DRAFT REPORT

# DEVELOPMENT OF AN ELECTRICAL INFRASTRUCTURE MASTER PLAN FOR MATJHABENG LOCAL MUNICIPALITY

## HDA/FS/2019/002

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| | | |
|---|---|---|
| HDA | - | Housing Development Agency |
| DHS | - | Department of Human Settlements |
| GIS | - | Geographic Information System |
| GLS | - | GLS Consulting |
| IDP | - | Integrated Development Plan |
| MLM | - | Matjhabeng Local Municipality |
| NMP | - | Network Master Plan/Planning |
| PIP | - | Project Implementation Plan |
| PSC | - | Programme Steering Committee |
| PSP | - | Professional Service Provider |
| SDF | - | Spatial Development Framework |
| TOR | - | Terms of Reference |

## 1. BACKGROUND

Matjhabeng Local Municipality (MLM) is located in the north-west of the Lejweleputswa District in the Free State Province. The Municipality covers approximately 5700 km². The study area is limited to that part of the municipality containing the towns (and all their townships) as shown in Figure 1-1 below.

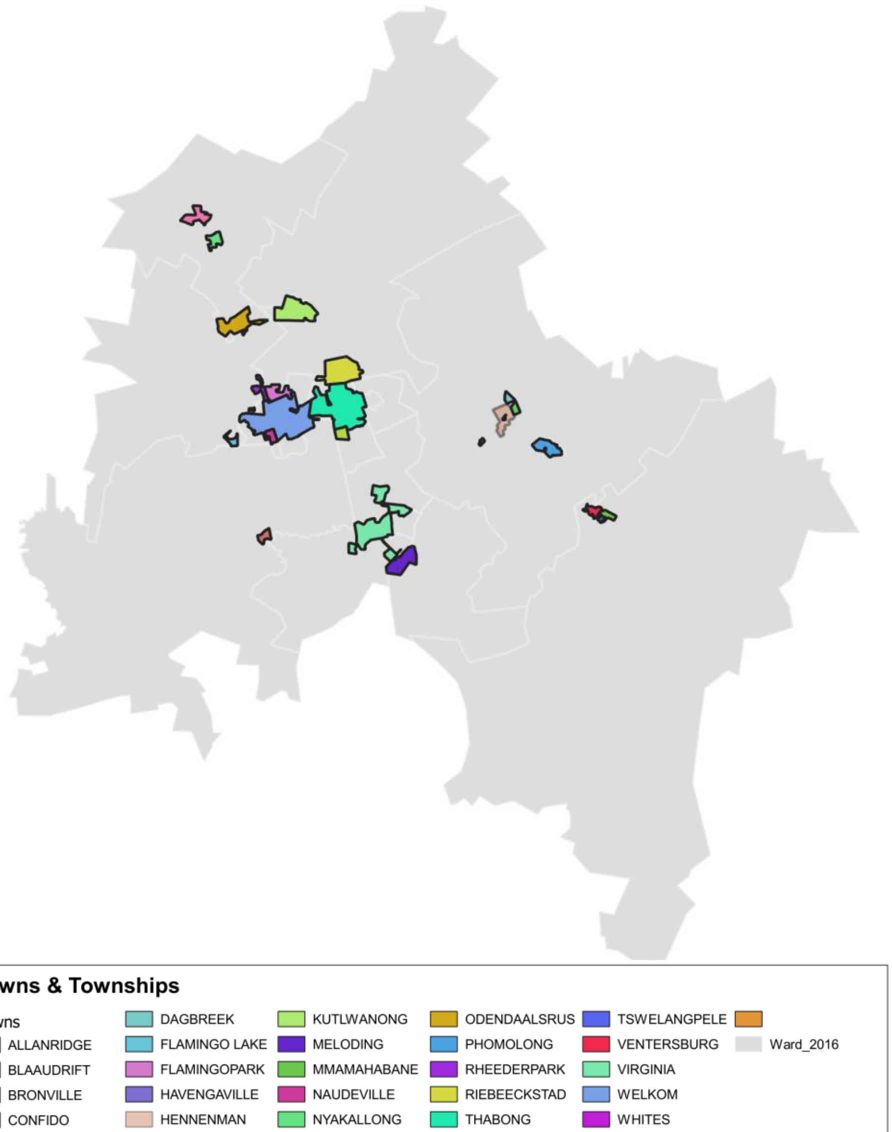



Figure 1-1: Matjhabeng LM Study Area

Welkom is the second-largest city in the Free State province, and it provides the highest order of social, economic and recreational facilities in the sub-region. It is located approximately 140 km northeast of Bloemfontein, the provincial capital. In its immediate sub-region, Matjhabeng is surrounded by a number of gold mines. These mines form a major part of the spatial character of the region and contribute significantly to the economy of the area. The municipality's electricity reticulation network consists out of a combination of high, medium and low voltage (44kV / 11kV / 6.6kV) lines with ancillary substations and infrastructure.

The Housing Development Agency (HDA) has been appointed by the National Department of Human Settlements (DHS) to assist with the Human Settlements component of the National Mining Towns Intervention. The objectives of the human settlements component of the intervention require the transformation of the mining towns through the creation of sustainable integrated human settlements. Currently, the intervention has focused on fast-tracking and supporting existing human settlement projects in the mining town areas. The human settlement planning and project pipeline development work requires accurate planning of the required infrastructure to ensure the necessary impact and transformation in the mining towns to ensure the creation of integrated sustainable human settlements.

In 2018, the HDA in consultation with Matjhabeng Local Municipality embarked on a programme to develop the infrastructure master plan for the municipality. The Master Plan is in 3 phases, which are done separately. The first phase is the water and sanitation (completed) and the second is the Energy Masterplan. The main focus of the Energy Master Plan is to consolidate and coordinate the planning actions of Matjhabeng LM. The purpose of the Master Plan is to present an acceptable electrical infrastructure development plan to the Municipality in order to assist with the implementation of projects that will ensure the improvement and sustainability of the current infrastructure. The Master Plan should be seen as a step in a continuous process of project identification and prioritisation, design, allocation of funding, and development of an electrical infrastructure asset management programme.

HDA has subsequently appointed Dihlase and GLS Consulting for development of 10-Year Infrastructure Master Plan (Electrical) for Matjhabeng Local Municipality.

## 2. PURPOSE AND OBJECTIVES OF THE PROJECT

The main objective of the study is to formulate the Network Master Plan (NMP) for the distribution network in Matjhabeng Area of Supply (Excluding Eskom Area of Supply) and developing a network investment strategy.

The formulated development plans shall be of high quality, informative, realistic and having considered environmental aspects (Where Strategic Environmental Assessment has been done, Client can request this from Eskom); safety and health; cost effective and aimed at alleviating operational and maintenance constraints.

# 3. PROJECT APPROACH AND METHODOLOGY

The Terms of Reference (TOR) requires a number of activities and associated outcomes. To effectively address all the requirements as stated within the TOR, GLS will follow the fundamental approach with the basic stages as outlined in Figure 3-1 below. Table 3-1 outlines the breakdown of the task details, activities and associated outcomes / deliverables. Refer to Annexure A for a more detailed approach and methodology.

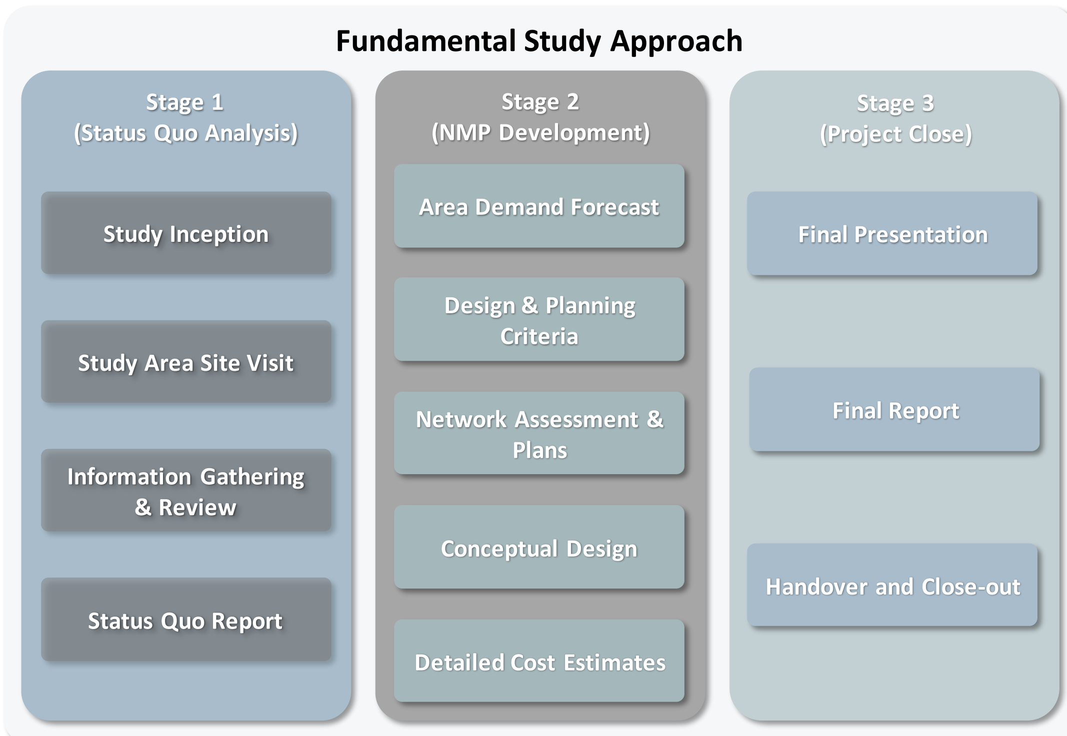



Figure 3-1: Fundamental Study Approach

Table 3-1: Detailed Tasks Breakdown

| No. | Task | Key Activities | Scope of Work | Outcomes / Deliverables |
|---|---|---|---|---|
| **1** | Status Quo Analysis | Study Inception and Kick-off | i. Identification of all stakeholders and confirmation of project specific roles interaction requirements.<br>ii. Set-up of effective communication channels.<br>iii. Confirmation of the general project approach and methodology.<br>iv. Confirmation of interaction with stakeholders (Project management, Project steering committee, workshop and meeting schedules etc.).<br>v. Confirming the study area and scope of work.<br>vi. The agreement on software and systems to be used during the study and the format in which deliverables and supporting information should be provided.<br>vii. Identify and confirm stakeholder input meetings/workshops and information requirements in order to initiate the project. | a) The outcome of this activity will be a common understanding of the project requirements, scope of work and alignment with Matjhabeng and HDA's needs and project resources<br>b) Details of the various stakeholders and agreed interface requirements.<br>c) Status quo report. |
| | | Information Gathering and Review | i. Collect sufficient project supporting information for the various study phases.<br>ii. Review all obtained information to provide a solid platform on which the project will be based. | a) Study area background information<br>b) Electrical network information<br>c) Existing standards and reports<br>d) Demand information<br>e) Existing distribution capital program<br>f) Existing line routes and substation sites<br>g) Once all information has been obtained and reviewed, the work plan and project program will be verified and updated if required. |
| **2** | NMP Development | Area Demand Forecast | i. Identify and understanding the existing land use<br>ii. Locating existing large power users<br>iii. Establish demand for the existing system and confirming base assumptions with the existing load<br>iv. Identify and locate future developments<br>v. Interpretation and integration of the SDF<br>vi. Model Demand Side Management Initiatives (if | a) Long-term, Spatial Demand Forecast for the Study Area<br>b) Workshop the demand forecast<br>c) Demand forecast report, which will eventually form part of the final study report |

| No. | Task | Key Activities | Scope of Work | Outcomes / Deliverables |
|---|---|---|---|---|
| | | | identified)<br>vii. Forecast demand | |
| | | Design and Planning Criteria | i. Review and confirm Design and Planning Criteria, Standards and Guidelines applicable to the study<br>ii. Discuss and agree to the required parameters, philosophies and technologies | a) Design criteria report detailing the design criteria to be applied during the concept design |
| | | Network Assessment and Plans | i. Establish and update the existing network model<br>ii. Incorporated the developed demand forecast into the existing model<br>iii. Identify and define the network problems by assessing the existing network capability and analysing the shortcomings to cater for the forecasted demand through load flow and contingency simulation studies<br>iv. Identify various network renewal, strengthening and expansion alternatives within a workshop environment with the Matjhabeng Energy Department. | a) Workshop the outcomes of the network assessment and the identified alternatives.<br>b) A yearly phased list of strengthening and network improvement proposals that will ensure Long-term network adequacy in terms of load growth and network performance,<br>c) Geographic diagrams showing the intended topology and configuration changes to the existing network (plan book in hardcopy and GIS softcopy)<br>d) Geographical presentation of possible line routes and substation sites to be surveyed. |
| | | Detailed Costs Estimates | i. Perform cost estimates of the technically successful alternatives<br>ii. Develop a phased master plan capital program (CAPEX). | a) Project list<br>b) Master plan CAPEX |
| **3** | Project Close | Master Plan Report | i. Submit a draft final report for inputs and comments<br>ii. Conduct a final presentation for final inputs and comments<br>iii. Submit final study report | a) Final Master Plan Study Report |

# 4. NETWORK PLANNING PHILOSOPHY AND CRITERIA

## 4.1 Network Planning Philosophy

The network planning philosophy is a set of overarching guiding principles that the network planner shall apply when contemplating future investment in the electrical network.

It is important to note that there are non–negotiable regulations that all electricity users and distributors shall comply with, as discussed in the Standards and Guidelines section. These regulations shall be considered when doing network planning and form the minimum planning requirements for all electrical networks.

The network planning philosophy can be divided into ten core philosophies, as indicated in Figure 4-1, which shall be analysed and considered by the network planner.

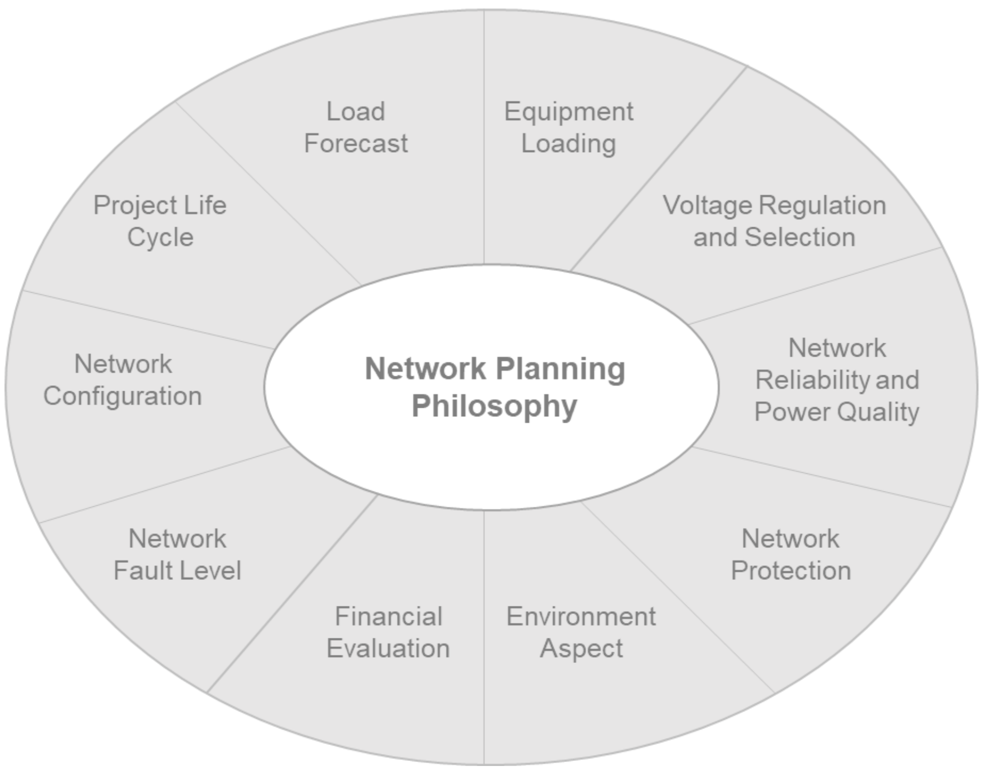



Figure 4-1: Core Network Planning Philosophies

Table 4-1 lists the core network planning philosophies and a description of each of these philosophies to be used as a guideline for all network planners.

Table 4-1 Description of the Core Network Philosophies

| Core Network Philosophies | Description of Core Philosophies |
|---|---|
| **Voltage Regulation and Selection** | The voltage regulation philosophy focuses on network voltage deviations to ensure that the network meets the minimum regulatory requirements.<br>Only standard voltages should be used based on the voltage selection philosophy. All non-standard voltage should be replaced by standard ones when strengthening or refurbishment is taking place. The optimum voltage which will minimize the loss and increase transfer capability shall be selected. |
| **Equipment Loading** | No electrical equipment shall be loaded above its designed rating under normal network configurations. Exception can be made for temporary abnormal conditions. |
| **Network Configuration** | An optimal network configuration shall enhance ease of control, reliability of the system and increase the protection of the network. |
| **Network Reliability and Power Quality** | Network reliability entails the evaluation of the network investment decisions by quantifying in economic terms the benefits of improving reliability by comparing different alternatives.<br>Note that Matjhabeng Local Municipality designs its' distribution systems as meshed networks with a N-1 contingency planning philosophy to ensuring that the loss of any one component of the network will not result in the loss of supply to any customers.<br>The network planners should select reliability levels or alternative expansion / reinforcement plans based on capital costs, customer outage costs, O&M and losses cost.<br>Power quality is mandated by NRS 048-2:2008 and shall be complied to. Each of the voltage quality parameters is described in NRS 048-2:2008 and, where appropriate, compatibility levels, limits, and assessment methods are specified. These compatibility levels and limits provide measures of acceptable voltage quality at the point of supply to end customers of electricity utilities. |
| **Network Protection** | The network shall be adequately protected via standard protection philosophies to protect equipment as well as personal safety of staff. |
| **Network Fault Level** | No equipment shall be subjected to a fault level higher than the manufacturers rating of the equipment. |
| **Load Forecast** | The agreed philosophy done by Matjhabeng Local Municipality is to do a geographical demand forecast where the location, the year and the demand are known. The network shall be planned for different scenarios namely, low, medium and high. |
| **Project Life Cycle** | All aspects of the realization of a project shall be included. All parties are to be consulted (primary plant, secondary plant and field services) and the project life phases shall be well understood and documented. |
| **Environmental Aspect** | For all new infrastructure environmental constraints within the area shall be considered. Alternatives shall be taken into consideration to find a balance between environmental and network requirements. |
| **Financial Evaluation** | The financial aspect of the project including both the execution of the project as well as the life cycle of the project shall be considered. Therefore, a balance should be drawn to determine the best option according to budgetary requirements. |

### 4.2 Standards and Guidelines

The planning criteria must comply with the following regulatory and licensing requirements:

- The Network Code within the South African Grid Code,
- The Electricity Regulations Act,
- The Distribution Code

Note that the NRS048 code is also used for quality of supply purposes and reliability studies.

#### 4.2.1 The South African Grid Code (Version 10.0, August 2019)

The South African (Transmission) Grid code is an important reference for all planners. Distribution Network Planners need to be aware of the various chapters within the South African Grid Code.

Among the chapters, the relevant ones for distribution network are the Tariff code and the network code. The distribution planners should be familiar with these chapters as they define how costs are recovered and also depict the technical requirements on the transmission network for voltages, reliability and quality of supply for the transmission network that supplies the distribution network.

The South African Grid Code: Network Code focuses on the Transmission Network Service Provider (TNSP) and customer technical (QOS, reliability and system capacity) network requirements. It is broken down into sections defining connection conditions (for generators, distributors and end-use customers), defining technical design requirements applicable to the service providers and finally defining the TS development process and methodology.

#### 4.2.2 The Electricity Regulation Act No.4 of 2006

The electricity regulation Act No. 4 of 2006 provides the following:

- It establishes a national regulatory framework for the electricity supply industry,
- It makes the National Energy Regulator the custodian and enforces the national electricity regulatory framework,
- It provides for licenses and registration as the manner in which generation, transmission, distribution, reticulation trading and the import and export of electricity are regulated, and
- It regulates the reticulation of electricity by municipalities; and provides for matters connected therewith.

Matjhabeng Local Municipality as an authorized Licensee for distribution of Electricity is required, by law, to ensure that all the license requirements are fulfilled. MLM is thus legally responsible for the distribution of electricity at all voltages less than and including 132kV within its supply area.

The Distributor is required to provide electricity through the distribution network in a non-discriminatory cost manner to third parties. The act specifically mentions the distributor's responsibility in terms of upgrade and strengthening to support the access of the network to the third party.

### 4.2.3 The Distribution Code (Version 6.1, August 2019)

The distribution code includes 8 chapters for which the following is discussed:

- Distribution system connection process and procedures,
- Responsibilities of the distributors,
- Responsibilities of customers and/or users,
- Distribution system technical requirements,
- Distribution system planning and development,
- Network investment criteria, and
- Embedded generators connection conditions.

The above aspects can be summarized as below:

Table 4-2: Distribution Code Descriptors

| Distribution point of focus | Description |
|---|---|
| **Distribution system connection and procedures** | Makes provision for the exchange of information between the Distributor and the customer at various stages of the Planning and connection process as well as the operational phase of commissioning. |
| **Responsibilities of the distributors** | Describes the dos and don'ts of the distributors. Amongst these responsibilities, the distributor should make capacity available and provide open and non-discriminatory access to all customers. The Distributor should advise potential users of the expected reliability of its network. The Distributor shall be responsible for the planning, design and engineering specifications of the work required for the distribution system connection or expansion. |
| **Responsibilities of customers and / or users** | Describes the responsibilities of the customers. Amongst these responsibilities, the customer should be responsible for the removal and the reinstallation of any privately-owned equipment for the distributor to perform the installation work that the customer has requested. |
| **Distribution system technical requirements** | Describes the following requirements:<br>Protection, Quality of Supply (Voltage harmonics and inter-harmonics, Voltage flicker, voltage unbalance, voltage dips, interruptions, voltage regulation, frequency, voltage surges and switching disturbances), load power factor, earthing requirements, distribution network interruption performance indices, losses in the distribution system, equipment requirements. |
| **Distribution system planning and development** | Depicts the framework for distribution network planning development. A distributor licensee should annually compile a 10-year load forecast at the Distributor's incoming points of supply including Distributor's cross-boundary connections. The Distributor is responsible for compiling network development plan with a minimum window period of five years and reviewed every 3 years. These plans should include the relevant activities such as electrification and refurbishment. |

| Distribution point of focus | Description |
|---|---|
| **Network Investment Criteria** | Describes the investment criteria (e.g. on shared network, investments shall be evaluated on the least-life-cycle economic cost where investments made by the distributors shall be evaluated on a least life-cycle distributor cost.); the least economic cost criteria for shared network investments, for standard dedicated customer connections, for premium customer connection; strategic investments and international criteria for international connections. |
| **Embedded Generators connection conditions** | Describes the responsibilities of Embedded generators to distributors, responsibilities of distributors to the Embedded Generators, provision of planning information and connection point technical requirements. |

### 4.2.4 The NRS 048 – Quality of Supply

While the NRS 048 -2 provides utilities with compatibility levels for reporting Power Quality to the National Electricity Regulator of South Africa (NERSA), NRS 048-4 recommends network planning levels for use by utilities in planning to achieve the required compatibility. The planning levels of these parameters apply to: Voltage Regulation, Harmonics, Voltage Flicker, Voltage Unbalance, Voltage Dips and Interruptions.

The following sections discuss the voltage regulation and reliability network aspect as explained in NRS 048-2 report. More details can be sourced from the NRS 048 documents.

#### 4.2.4.1 Voltage Regulation

The voltage regulation is described in NRS 048 part 2: Voltage characteristics, compatibility levels, limits and assessment methods.

- **Standard and Declared Voltages**

For customers supplied at <500V, the standard voltage shall be 400 V phase to phase, 230 V phase to neutral.

For customers supplied at other voltage levels (>500 V), the magnitude of the declared voltage shall be as specified in the supply agreement. Unless otherwise specified in the supply agreement, the declared voltage shall be nominal.

- **Compatibility levels**

For all LV supplies <500 V Matjhabeng Local Municipality needs to provide a standard voltage of 400/230 V, with a maximum variation of ±10%.

For any system voltage ≥ 500 V, the supply voltage shall not deviate from the declared voltage by more than 5% for any period longer than 10 consecutive minutes.

Table 4-3 Deviation from standard or declared voltages

| Voltage level [V] | Compatibility level [%] |
|---|---|
| **Voltage < 500V** | ±10% |
| **Voltage ≥ 500V** | ±5% |

- **Limits**

The NRS 048 – 2 reserves maximum voltage limits to reach the values as depicted in Table 4-4 below.

Table 4-4 Maximum deviation from standard or declared voltages

| Voltage level [V] | Compatibility level [%] |
|---|---|
| **Voltage < 500V** | ±15% |
| **Voltage ≥ 500V** | ±10% |

In view of the above regulation, the network planner should keep in mind that the network regulation principle is to ensure that the voltages supplied to customers result in acceptable appliance utilization voltages.

The network planner when using the regulation should understand the power system and the equipment within the network before making a call on the planning limits. In essence of the above, a "±15%" change may damage customer equipment hence cannot be applicable within certain conditions.

#### 4.2.4.2 Reliability of Supply

Reliability of supply is a subset of quality of supply. Supply interruptions are divided into 4 categories: forced interruptions, voluntary customer load reductions, planned interruptions and involuntary customer load reductions. Interruptions shall be further classified as either momentary interruptions or sustained interruptions.

Network interruption performance indices (SAIDI, SAIFI, MAIFI, CAIDI, etc.) are used to provide measures of one of the following reliability and availability of supply related areas.

- Availability of supply – the average duration of an interruption of supply experienced by the customer
- Reliability of supply – how frequently on average an interruption of supply is experienced by the customer

- Restoration of supply – the percentage of customers that had their supply restored within a specified target timer after an interruption (based on NRS 047 requirements)
- Worst served customers – the percentage of individual customers that receive poor network interruption performance levels
- MV and HV transformer unavailability – the average duration of interruption of supply that affects the MV/LV and HV/MV transformers only.
- Network reliability – the frequency of interruptions occurring on network normalized to 100 km.

These measures are often used as triggers to identify problematic networks below the average regional or national continuity indices. These indices are often affected by non – firm networks and substations that feed large areas where many customers (e.g. > 100) are affected by network faults.

Moreover NRS 048 – 6 categorizes worst customer measures based on the following conditions:

- Percentage of customers with single supply sustained interruptions of longer than 18 hours per annum per event,
- Percentage of customers experiencing 60 or more sustained interruptions per annum.
- Percentage of customers experiencing 30 or more individual supply sustained interruptions and that also last longer than 18 hours each per annum.

Additional to the mentioned indices, the following major events should also be reported as per required by NRS 048 -6:

**Major event criteria A:**

- More than 5000 customers are affected and are without supply for 18 hours or longer due to a single event.
- More than 500 MVA hours of the aggregated HV supply side ratings of the downstream installed transformer capacity are off for 2 hours or longer.

**Major event criteria B:**

- More than 10% of the installed customer base of the distributor licensee is without supply for 12 hours or longer.
- More than 10% installed MVA transformer base of the distributor licensee is without supply for 12 hours or longer.

**Major event criteria C:**

- The criteria shall be defined by the distributor licensee as part of its internal performance management and reporting process.

### 4.3 Network Planning Criteria

Network Planning Criteria are a set of standards applied to maintain network adequacy and reliability that are used as a planning tool to protect the interest of all network users. The criteria are also applied to protect networks against instability.

Amongst other planning requirements, the current distribution network master plan will focus on the following:

- Voltage regulation and voltage selection,
- Equipment loading,
- Fault level,
- Network configuration

To assess the network against these requirements, the following studies will be performed:

- Steady – state load flow analysis,
- Contingency analysis, and
- Fault level analysis

These studies will be performed for both the existing networks and the Network Development Plans to ensure adherence.

#### 4.3.1 Voltage regulation

##### 4.3.1.1 Steady – State Voltage at normal conditions

The steady-state criteria apply to the normal continuous behaviour of a network and cover post – disturbance behaviour once the network has settled. When planning a network, it is necessary to access the reactive power requirements under light and heavy load to ensure that the reactive demand placed on supply infrastructure, be it to absorb or generate reactive power, and does not exceed the capability of the supply source.

As per the section 3.4, the NRS 048 – Quality of Supply provides us with the voltage regulation as below:

- For voltages <500 V the standard voltage is 400 V three phase or 230 V single phase.
- For voltages >500 V the standard voltage is the declared voltage.

For all LV supplies <500 V Matjhabeng LM needs to provide a standard voltage of 400/230 V, with a maximum variation ±10%. Older 380/220 V contracts are no longer valid and do not need to be enforced.

Table 4-5: Steady - State Voltage Regulation Limits

| 1 Voltage level [V] | 2 Compatibility level [%] |
|---|---|
| 3 **Voltage < 500V** | 4 ±10% |
| 5 **Voltage ≥ 500V** | 6 ±5% |

For any system voltage ≥ 500 V, the supply voltage shall not deviate from the declared voltage by more than 5% for any period longer than 10 consecutive minutes, the network shall be designed to achieve a continuous network voltage at a user's connection not exceeding the design limit 105% of nominal and falling below 95% of nominal voltage during normal and maintenance conditions.

For any system voltage < 500 V, the supply voltage shall not deviate from declared voltage by more than 10% for any period longer than 10 consecutive minutes.

#### 4.3.1.2 Contingency Criteria

The voltage limits that will be used for a single contingency were between 0.925 p.u. and 1.075 p.u. applicable to sub transmission networks.

The network shall be designed to achieve a steady-state voltage within:

- ±5% of the nominal voltage during normal conditions
- ±8% of the nominal voltage during planned maintenance conditions and
- ±10% of the nominal voltage during un-planned outage conditions

### 4.3.2 Voltage Selection Criteria

The Matjhabeng Local Municipality sub-transmission is supplied from ESKOM through 1 Intake point at 132 kV and the distribution network is supplied from ESKOM through 11 Intake points at 6.6 kV and 11 kV voltage levels.

The following sub – transmission standard voltage levels are proposed for any new Intake points:

- 132 kV

The following distribution standard voltages are proposed:

- 11 kV
- 6.6 kV (only in areas where it already exists)
- 400 V/ 230 V (for LV Reticulation)

#### 4.3.3 Conductor Selection Criteria

The Matjhabeng Local Municipality generally uses underground cables for the reticulation network. To achieve maximum cost efficiency in the installation of conductors, standard overhead conductor and underground cable sizes have been selected. This will facilitate minimum stock holdings and purchase prices, giving the users the least cost network.

The standard conductor size (and cable size) that is equal to, or greater than that required for the extension or reinforcement.

Table 4-6: Proposed Underground Cable and Overhead Line Conductor sizes

| Conductor | Type | Rate (Amp) |
|---|---|---|
| **120mm$^2$ 3c Cu XLPE** | Underground Cable | 325 |
| **120mm$^2$ 3c Al XLPE** | Underground Cable | 255 |
| **185mm$^2$ 3c Cu XLPE** | Underground Cable | 410 |
| **185mm$^2$ 3c Al XLPE** | Underground Cable | 320 |
| **300 mm$^2$ 3c Cu XLPE** | Underground Cable | 520 |
| **300 mm$^2$ 3c Al XLPE** | Underground Cable | 420 |
| **630 mm$^2$ 1c Cu XLPE (HV) also 11kV** | Underground Cable | 625 |
| **Mink** | Overhead Line | 209 |
| **Rabbit** | Overhead Line | 240 |
| **Dog** | Overhead Line | 360 |
| **Tiger** | Overhead Line | 420 |
| **Wolf** | Overhead Line | 470 |
| **Lynx** | Overhead Line | 520 |
| **Chickadee** | Overhead Line | 530 |
| **Panther** | Overhead Line | 560 |
| **Bear** | Overhead Line | 650 |
| **Kingbird** | Overhead Line | 710 |
| **Tern** | Overhead Line | 830 |
| **Zebra** | Overhead Line | 860 |

#### 4.3.4 Substation Size and Transformer Selection Criteria

New substations will usually be established when the load reaches 25% of the estimated saturation load in a defined supply zone. In the interim, Distribution Switching Stations may be established to supply the load from bordering substations to delay capital investment.

Table 4-7 outlines the guideline for firm substation sizes that will be used for the study.

Table 4-7: Firm Substation Sizes Guidelines

| Firm Capacity [kVA] | Number of Transformers | Area Type |
|---|---|---|
| **40,000** | 2 x 40 MVA | Industrial / CBD / High Density Residential |
| **30,000** | 2 x 30 MVA | Medium Density Residential |
| **20,000** | 2 x 20 MVA | Low Density Residential / Rural Area |

Table 4-8 outlines the standard transformer sizes for the distribution network.

Table 4-8: Standard Distribution Transformer Sizes

| Type | Rate [kVA] |
|---|---|
| **Pole mounted** | 50 |
| **Pole mounted** | 100 |
| **Pole mounted** | 250 |
| **Mini substation** | 315 |
| **Mini substation** | 500 |
| **Mini substation** | 630 |
| **Mini substation** | 1000 |

### 4.3.5 Equipment Loading: Thermal Rating Limits

The thermal ratings of network components shall not be exceeded under normal or emergency operating conditions when calculated on the following basis:

#### 4.3.5.1 Distribution Transformers

Transformers are capable of significant and short-term overloads because of the thermal inertia of the core. The main concern however is with cyclic loading and the effect of extended periods of overload on the life of the transformer insulation since ageing effect is cumulative. If the transformer has cooling equipment, the rating above nominal with cooling is enhanced considerably and the effect of hot spot temperatures mitigated. It is permissible to overload the transformer for short periods on the basis that for the remainder of the time the use of life will be less than normal.

For each class of transformer, general limitations on current and temperature are recommended as listed in IEC354 Loading Guide for Oil-Immersed Transformers. These values provide a broad “operating envelope” which may be greatly affected by the following:

- Load Profile (Duration and Peak)
- Ambient Conditions
- Assumption of transformer thermal characteristics
- Voltage limitations and
- Capability of transformer accessories

It is thus recommended that the nameplate thermal rating is used for planning purposes. Once a specific transformer approaches its nameplate thermal loading limits, an informed decision, backed by physical measurements and sample tests, should be made with regard to the upgrade strategy.

Under normal conditions, the thermal loading of the transformers should not exceed the nominal manufacturer's name plate rating. In the case where more than one customer is supplied from a transformer, a project should be initiated when the distribution transformer reaches 80% of its capacity. For cases where the distribution supplies a single customer, the planner should inform the customer when the transformer reaches 80% of its capacity.

Under contingencies, the thermal loadings should not exceed the nominal manufacturer's name plate rating by 20%.

#### 4.3.5.2 Switchgear

Normal manufacturer's name plate rating.

#### 4.3.5.3 Overhead Lines

Under normal condition, the thermal loading of the overhead line should not exceed the nominal manufacturer's name plate rating. The overhead line rating based ambient temperature under normal conditions is 75 °C. The planner should initiate a project when the thermal loading on the line reaches 100% of its normal condition rating.

Under contingencies (emergency), the overhead line rating based ambient temperature is 90 °C. The thermal loading of the overhead line should not exceed its emergency rating. For high temperature conductors, the temperature under contingency conditions is 180 °C.

#### 4.3.5.4 Cables

Normal cyclic rating, with maximum operating temperatures of 90 °C for XLPE cables; 70 °C for 11kV paper insulated cables.

Under normal condition, the thermal loading of the cable should not exceed the nominal manufacturer's name plate rating. The planner should initiate a project when the thermal loading on the line reaches 100% of its normal condition rating.

Under contingencies (emergency), the thermal loading of the overhead line should not exceed its emergency rating.

### 4.3.6 Fault Rating Limits

For safety reasons, the fault rating of any equipment shall not be less than the fault level in that part of the network at any time and for any normal network configuration.

The maximum fault levels on Matjhabeng Local Municipality networks depend on the network and substation configuration and the upstream fault level. Table 4-9 outlines the maximum faults level to be considered when planning for the network.

Table 4-9: Fault Level Limits

| Voltage Level [kV] | Fault Level Limits [kVA] |
| --- | --- |
| **132** | 31.5 |
| **44** | 31.5 |
| **11** | 31.5 |
| **6.6** | 31.5 |

Equipment owned by the Matjhabeng Local Municipality are designed to withstand these fault levels for 1 second. Depending on the new configuration of the network the above fault levels might change. A fault level analysis check should be done to re-adjust the fault level. Projects should be initiated where the fault current level exceeds 90% of the fault current level rating of equipment.

### 4.3.7 Simulation Program

The study analysis will be done using PowerFactory 2020 (or later release) software for the distribution network.

### 4.3.8 Distribution network constraints

The distribution network constraints can be divided into categories of three conditions:

- Constrained network,
- Network nearing limits, and
- Not constrained.

Table 4-10 illustrates these constraints under normal conditions with a colour coding system to distinguish easily were constrained networks need strengthening.

Table 4-10: The distribution network constraints

| Criteria | Red | Orange | Green |
|---|---|---|---|
| **MV Voltage** | **≤ 90% and > 105%** | **> 90% and < 95%** | **≥ 95% and < 105%** |
| **Maximum thermal line loading** | **≥ 100%** | **> 80% and < 100%** | **< 80%** |

- Red indicates that the voltage and/or thermal limits have been violated and that no additional load can be connected on these networks.
- Orange indicates that a limited amount of load can be connected before limits are reached, however measures need to be put in place to avoid the limits being violated.
- Green indicates that the network is capable of supplying load and that the limits have not been reached.

### 4.3.9 Network Reliability

The Matjhabeng Local Municipality will plan and design its networks to the N-1 criteria. Within Distribution networks there may be a time delay to allow the manual reconfiguration of the network to transfer load.

The Matjhabeng Local Municipality distribution network area is characterized mainly by urban distribution feeders that supply the area via cables.

#### 4.3.9.1 Urban Distribution Feeders

Distribution feeders in urban areas shall be planned and designed so that, for a substation feeder circuit or exit cable fault, the load of that feeder can be transferred to adjacent feeders by manual network reconfiguration.

Where practical, the network shall be planned and designed so that, in the event of failure of a substation transformer, all the load of that transformer can be transferred to other transformers within the same substation and adjacent substations.

The above planning objectives will be achieved by:

- Planning distribution cables in a ring configuration with the capacity to supply the entire load from either side of the cable ring.
- Planning transformation substations for firm transformer capacity,
- Defining substation supply zones, with no cross feeding between substations.
- Planning for switching station configuration with firm supply sources.

#### 4.3.9.2 Rural Distribution Feeders

The radial nature of rural distribution feeders normally precludes the application of contingency criteria to these feeders. However, where reasonably achievable, interconnection between feeders shall be provided, and reclosers and sectionalizers shall be installed to minimise the extent of outages.

#### 4.3.9.3 Load Security

For established security criteria, loads are categorized in four classes namely Category “A, B, C and D”. These are defined as follow:

- Category A: Load that should not be disconnected for any one system outage (fault or maintenance),
- Category B: Load that should not be disconnected for more than 90 seconds for any one system event,
- Category C: Load that should not be disconnected for more than 2 hours for any one system even, and
- Category D: Load that may have to be disconnected for any single system event until faulty equipment has been replaced or maintained.

### 4.3.10 Project Life Cycle

A minimum 10-year load growth needs to be considered for MV networks. However, if in doubt the larger conductor size needs to be used. The backbone conductor / cable of a distributor should be planned to suit the load for the next 20 years.

The network planner should ensure that all aspects of the realization of a project are included. This is to say that all parties are consulted (primary plant, secondary plant and field services) and also that the project life phases are well understood and documented.

# 5. DEMAND FORECAST

## 5.1 Demand Forecast Approach and Methodology

### 5.1.1 Demand Forecast Approach

The demand forecast approach followed the basic stages and activities outlined in Figure 5-1 below. Sections within this report will refer to this approach, supported by activity details.

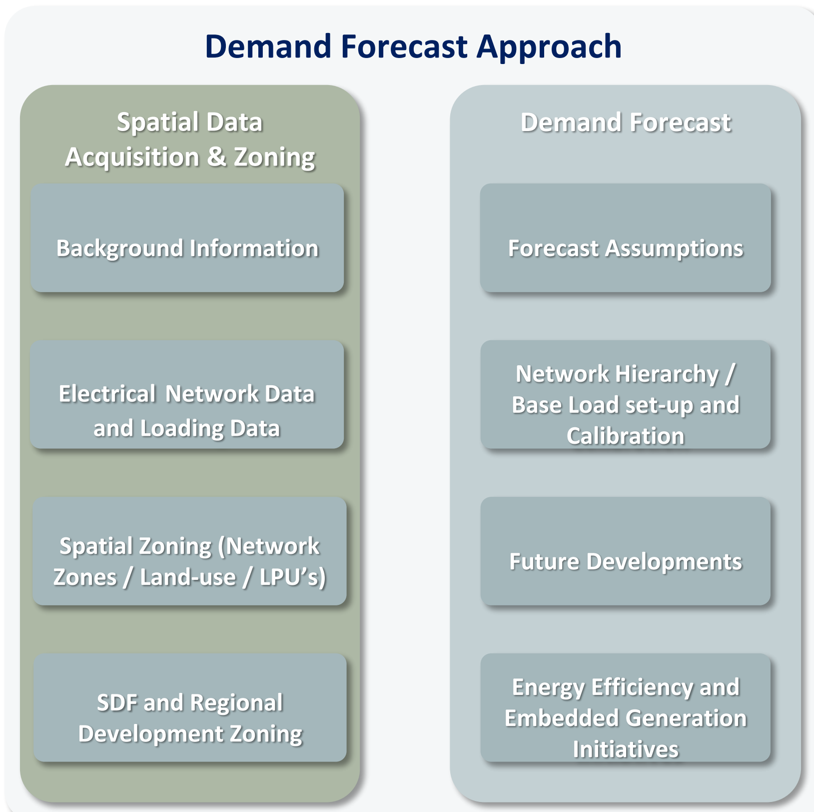



Figure 5-1: Demand Forecast Approach

**Spatial Data Acquisition and Zoning**

Spatial data form a key component of a spatial electricity demand forecast study. As one of the building-blocks it is vital that the initial identification of existing data sources be understood.

The objective of the spatial zoning of the study area is thus to spatially reference existing information, and where possible create new information to support the development of the spatial demand forecast. Existing data will be prepared for geometrical and topological correctness after which it will be integrated within a geodatabase together with newly created spatial data using GLS Albion.

**Demand Forecast**

The objective of this task is to utilize the information gathered to develop a long-term electricity demand for the entire study area, with the aim of determining the present and future electricity requirements of electrical end-users in the study area to ultimately reconcile this with the available resources and electrical services. Depending on available information, the forecast can provide demand projections on a substation or feeder basis with diversified summations back to substation, supply area, transmission stations, country level or other specified areas.

### 5.1.2 Demand Forecast Methodology

Figure 5-2 provides a high-level block diagram presentation of the basic methodology followed when developing the demand forecast. The methodology consists of various activities required to establish the forecast and can be grouped into two main sections, i.e. base load definition and forecast.

The base load definition consists of all the activities required to extract and manipulate data to be used to define the study area. The development of the forecast is the second component and covers the forecasting of load into the future. As can be seen from the Figure 5-2, the effort required to complete the base load definition is much more than completing the actual forecast.

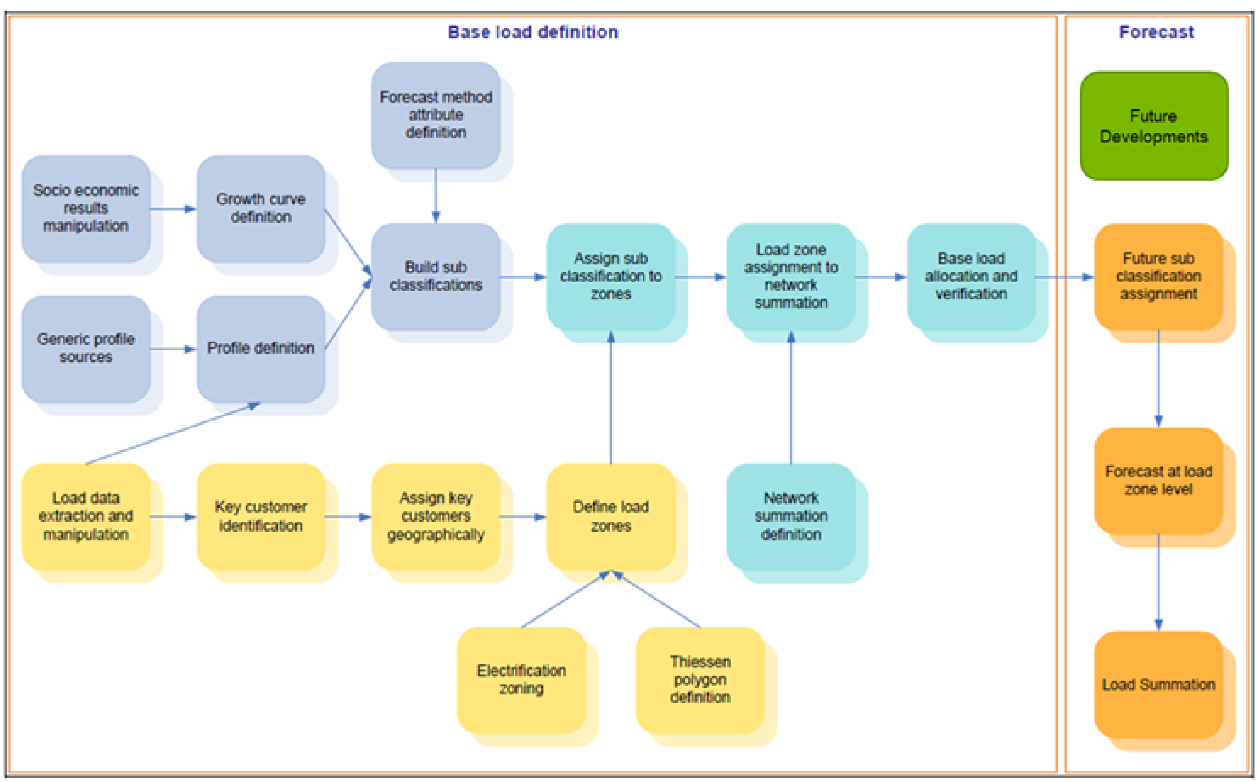



Figure 5-2: Demand Forecast Methodology

The base load definition activities of Figure 5-2 can be grouped into load identification, sub-class definition and base load calibration.

**Load Identification**

This activity allows for the identification of known loads (i.e. Key Customers / Large Power Users) within the study area. The remainder of the area is then zoned into homogeneous load zones, e.g. residential area, commercial area, retail area, etc. Furthermore, known developments and spatial development framework are used to ensure that current zones take future changes into account.

**Sub-class Definition**

This activity of the base load definition allows for the definition of the different customer types within the study area and defining their associated typical daily profiles using historical load data and generic profiles. Typical growth curves are also defined for the type of consumers forming part of the study area. On completion of the sub-class definition exercise, a library of sub-classes will be created. Each sub-class should associate daily profiles with growth curves and provide forecast specific parameters for the type of customers forming part of the study area. The sub-class library needs to be sufficient to describe all customers forming part of the study.

As part of the study, the existing sub-classes will be evaluated and assessed to be re-calibrated to reflect the current reality.

**Base Load Calibration**

In this activity, each load zone is assigned a specific sub-class according to the customer type within the particular load zone. For each load zone defined an expected start load is specified. This is done by using measured values (measured feeder loads), subtracting known values (key customers for which load information is available) and estimating the remaining loads on the feeder in order to match the measured load as close as possible. As part of this activity the load forecast for each of the individual load zones will calculated.

Furthermore, using network schematic diagrams and the geographical network information, a parent-child relationship is defined. This is meant to indicate how load is to be summated. Using the load zones created as well as the network definition one can allocate load zones to specific points in the summation hierarchy and thus specific supply point, i.e. feeder, substation, etc. Having allocated load zones to specific supply points, the assumptions made in the sub-class definition activity are refined to ensure that the summated load zone demand matches the measured supply point demand. This is to ensure the reliability and accuracy of the forecasted future demand.

Once the base load has been successfully calibrated, the future forecast is developed considering future land use as well as new loads.

**Forecast**

The forecast simulates how existing areas are expected to grow and develop into the future. As mentioned above, this is achieved by considering the natural growth of the existing load zones as well as the expected future land use which is informed by the spatial development framework (SDF). Furthermore, new developments/applications are also considered. The demand forecast is thus developed by effecting these to the identified load zones and summating according to summation hierarchy.

## 5.2 Data Acquisition and Interpretation

This section provides a summary of the fundamental information sources that were used in the development of the forecast. The section also discusses how the acquired data was used. Customer sector assumptions used to calculate existing and future demand is also introduced.

The data required to develop the forecast fall into the categories defined below:

- **Background and Spatial Data:** Topographic features (Roads, Rivers, Water bodies, Built-up areas, Land-use or land cover, etc.), Cadastral data as well as the preferred Spatial Reference System.
- **Electrical Network Data:** Distribution Network schematic diagrams and spatial location of the networks. Knowing the spatial location of electricity assets assist in relation to existing and future demand allows for a more effective approach to network strengthening and expansion planning.
- **Power System Demand Data:** Load data per substation. This information confirms the departure point for the forecast and allows for the adjustment of customer sector demand and energy characteristics.
- **Future Developments Data:** Future developments spatial location, customer type (i.e. land use), expected maximum demands, expected start year and duration for development.

The following sections provide some additional background to the above categories:

### 5.2.1 Background and Spatial Data

Spatial zoning is performed to spatially reference existing information and where possible, create new information to support the development of the spatial demand forecast. Existing data will be prepared for geometrical and topological correctness after which it will be integrated within a geodatabase together with newly created spatial data using GLS Albion.

The following are main data categories that are used and integrated to form a spatial view; the basis of a geographical demand forecast.

- Topographical Information,
- Spatial Development Framework (SDF),
- Existing Network information, and
- Satellite Imagery,

### 5.2.2 Electrical Network Data

One of the objectives of the study is to forecast the distribution demand based on known customer loads and future growth assumptions. To achieve this, it is necessary to adequately and accurately represent the existing network both schematically and spatially. To facilitate this task Matjhabeng LM shared schematics and spatial diagrams representing the network as they know it. Figure 5-3 illustrates the spatial representation of the existing distribution network for the Welkom Area.

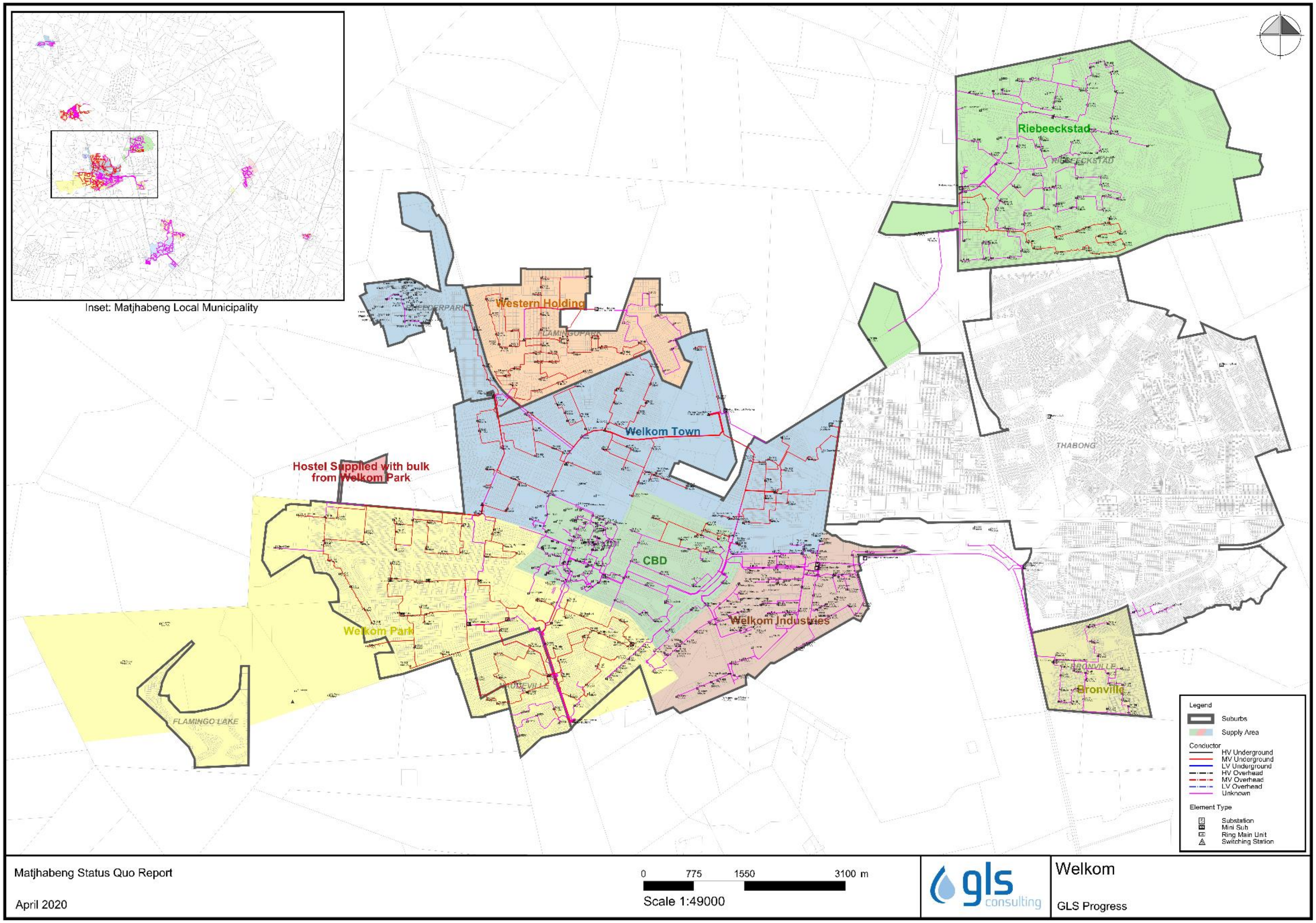



Figure 5-3: Matjhabeng LM Network (Welkom Area)

### 5.2.3 Power System Demand Data

Additional information such as recorded maximum demand information for the different substations and Eskom Intake points were also received from Matjhabeng LM electricity department. In instances where substation information was unavailable or incomplete. This historical data was used to better understand the typical size of the demand for customers on the Matjhabeng LM network.

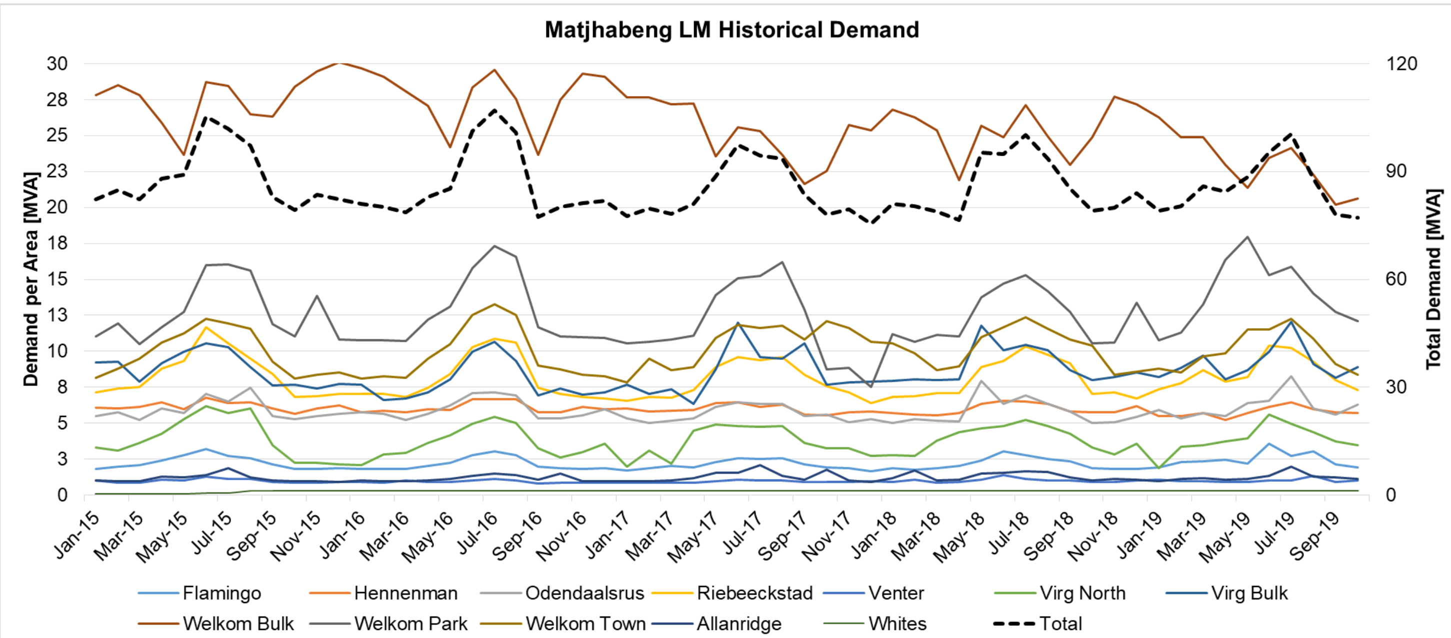



Figure 5-4: Matjhabeng LM Historical Demand

The peak demand has largely remained the same since 2015, hovering around 100 MVA with the least peak demand of 97 MVA in 2017 and maximum peak demand of 106 MVA in 2016. Table 5-1 outlines the Intake substation loading at the time of Matjhabeng LM peak demand for the year 2019 (July 2019). It should further be noted that the Welkom Bulk intake supplies the Welkom CBD and Welkom Industries substation, with peak loading of 14.7 MVA and 9.8 MVA, respectively.

Table 5-1: Matjhabeng LM Intake Substation Loading at Peak

| Intake Substation | Demand [MVA] |
|---|---|
| **Flamingo** | 2.7 |
| **Hennenman** | 6.5 |
| **Odendaalsrus** | 8.3 |
| **Riebeeckstad** | 10.2 |
| **Venter** | 1.0 |
| **Virginia North** | 5.0 |
| **Virginia Bulk** | 12.1 |

| Intake Substation | Demand [MVA] |
|---|---|
| **Welkom Bulk** | 24.1 |
| **Welkom Park** | 15.9 |
| **Welkom Town** | 12.3 |
| **Allanridge** | 2.0 |
| **Whites** | 0.3 |
| **Total** | **100.3** |

## 5.3 Key Drivers Impacting Future Demand and Energy Growth

### 5.3.1 Natural Growth

The Matjhabeng LM population has been on the decline since 1996 with a growth rate of -2.85% for the period 1996 – 2001 and slightly slowing down to -0.04% for the period 2001 – 2011 [1]. However, the population increased to 429 113 in 2016 [1]. In the similar period, the average size of households slightly reduced from 3.1 to 2.9. Without any other information going into the future, it is assumed that this trend will continue in the short-medium term. Furthermore, there is a trend of backyard dwellings which results in having more than just one household in one yard and therefore, increased demand growth.

### 5.3.2 Future Developments

Apart from the Municipal and HDA-led residential developments, the Municipality has received several private sector-led developments. These development projects primarily incorporate residential, commercial, business and industrial land uses, resulting in an expansion of the real estate and construction sectors. These future developments will also contribute to the future demand growth.

### 5.3.3 Technology

With the increasing electricity prices, having increased by 147 % between 2007 and 2016, and with a somewhat unreliable supply of electricity, there is a shift to renewable energy amongst high income residential consumers and industrial/commercial consumers. Furthermore, consumers and appliances alike are using energy more efficiently because of technological advancements.

## 5.4 Demand Forecast Development

The demand forecast is deterministic in nature and was performed within the PowerGLF application, which is a spatially based application where the existing and predicted future load areas are zoned, as demonstrated in previous sections, and the resulting loads are summated taking load characteristics and diversity into account, for each uniquely defined load zone.

### 5.4.1 Base Load Definition

#### 5.4.1.1 Load Identification

The study area was zoned into homogeneous load zones as per the defined sub-classes / land use. Furthermore, known developments and spatial development framework are used to ensure that current load zones take future changes into account. Figure 5-5 is a spatial illustration of the identified load zones as per the different land-uses. A total of 524 load zones were identified, inclusive of the future developments and SDF.

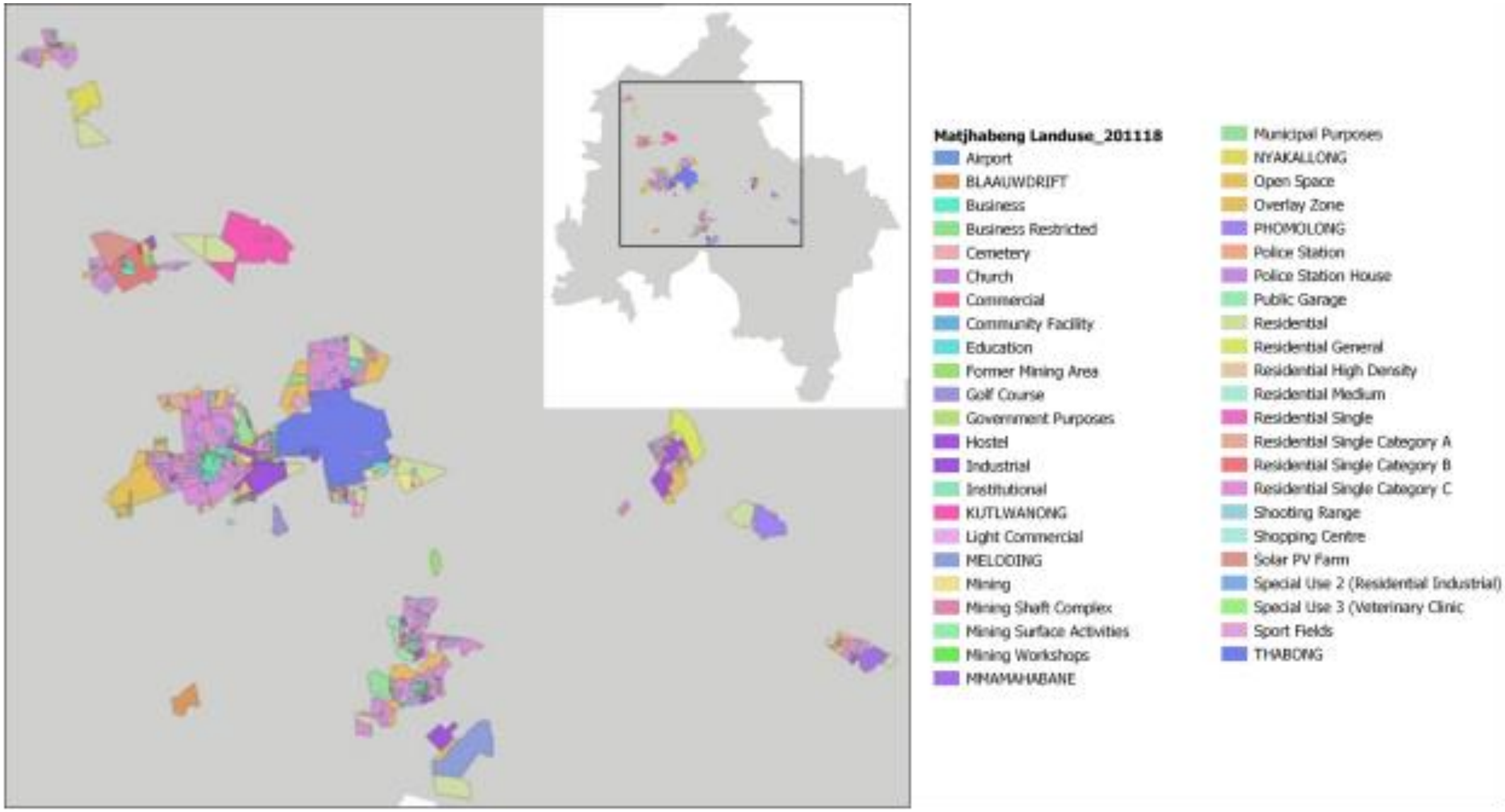



Figure 5-5: Matjhabeng LM Zoned Land Use

#### 5.4.1.2 Sub-Class Definition

Based on the different customer types (i.e. existing land use) within the study area, several sub-classes were defined to be associated with each customer type. Associated typical daily profiles were also defined. Furthermore, depending on factors such as demographics and/or economic activities and income, typical growth curves were also defined for the type of consumers forming part of the study area. For instance, high-income household will typically have a different saturation load than say a medium-income household. Which in turn will be different from a low-income household. Table 5-2 lists the sub-classes that were defined for this study and their respective saturation load densities (kVA/Ha).

Table 5-2: Sub-class Definition and Associated Saturation Load Densities

| Sub-Class | Sat. Load Density (L) | Sat. Load Density (M) | Sat. Load Density (H) |
|---|---|---|---|
| **Accommodation Complex** | 18.0 | 18.54 | 19.10 |
| **Business** | 45 | 46.35 | 47.74 |
| **Community Facility** | 4.5 | 4.64 | 4.77 |
| **Education** | 16.2 | 16.69 | 17.19 |
| **Government Purposes** | 72 | 74.16 | 76.38 |
| **Industrial (Low Industrial)** | 18 | 18.54 | 19.10 |
| **Industrial (Medium Industrial)** | 27 | 27.81 | 28.64 |
| **Industrial (High Industrial)** | 36 | 37.08 | 38.19 |
| **Institutional** | 45 | 46.35 | 47.74 |
| **Municipal Purposes** | 45 | 46.35 | 47.74 |
| **Open Space** | 0 | 0.00 | 0.00 |
| **Public Garage** | 0.9 | 0.93 | 0.95 |
| **Residential 1A (Low Income, Medium Density)** | 27.0 | 27.81 | 28.64 |
| **Residential 2A (Low Income, High Density)** | 18.0 | 18.54 | 19.10 |
| **Residential 1B (Medium Income, Medium Density)** | 36.0 | 37.08 | 38.19 |
| **Residential 2B (Medium Income, High Density)** | 18.0 | 18.54 | 19.10 |
| **Residential 1C (High Income, Low Density)** | 22.5 | 23.18 | 23.87 |
| **Residential 2C (High Income, Medium Density)** | 45.0 | 46.35 | 47.74 |
| **Residential 1D (Mix, Medium Density)** | 36.0 | 37.08 | 38.19 |
| **Residential 2D (Mix, High Density)** | 54.0 | 55.62 | 57.29 |

**S-Curves**

Curves were chosen to simulate a specific sub-class / land use “road” to saturation.  The normalized annual peak load estimate per year is mathematically defined as follow:

$$f(n) = \frac{1}{(1+10C)} \times ((2+10C) \times \left(A + \frac{(1-A)}{\left(1+10Ce^{-B/n}\right)}\right) - 1)$$

Where:

- n indexes the year,
- A defines the starting point of the S curve (for an existing load the parameter A would be determined by calculating the existing load as a percentage of the saturation load),
- B defines the time till saturation, and
- C is a number between 1 and 10 that manipulates the initial growth pattern, where 1 is defined as strong initial growth an 10 results in slow initial growth,

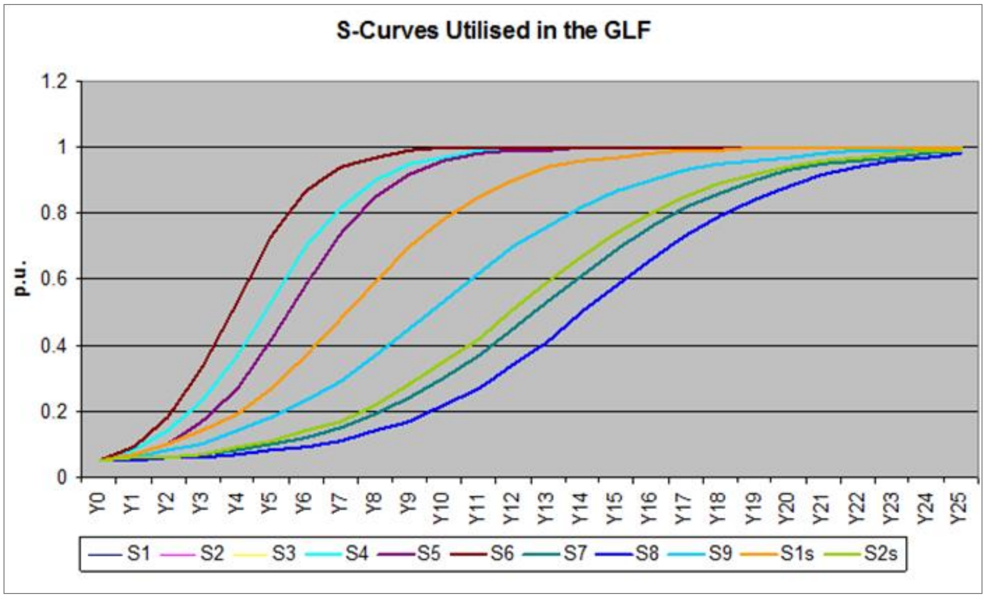



Figure 5-6: Load Category S-Curve

The different land-use types were assigned different S-curves. The allocation of S-Curves was based on experience in other utilities and should be sufficient to describe the growth pattern.

#### 5.4.1.3 Base Load Calibration

Using network schematic diagrams and the geographical network information, a parent-child relationship was defined. This was meant to indicate how load is to be summated. Using the load zones created as well as the network definition, the identified load zones are allocated to specific points in the summation hierarchy and thus specific supply point, i.e. substation, MTS, Intake Point etc. Figure 5-7 shows a portion of the developed hierarchy for the year 2019.

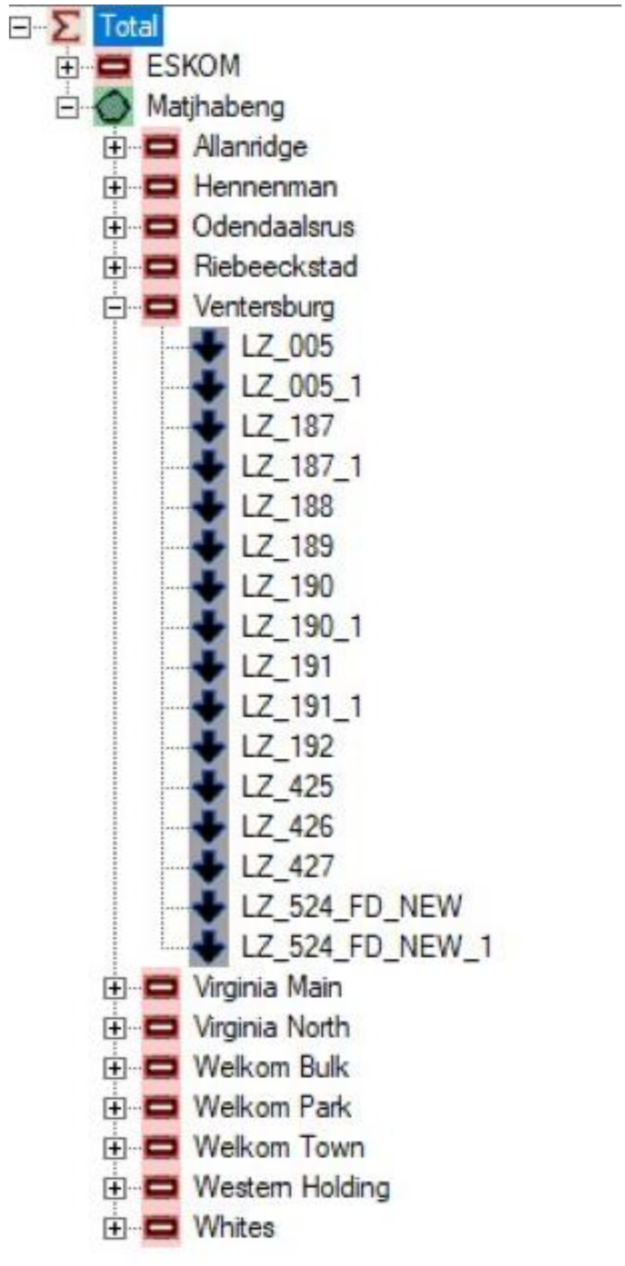



Figure 5-7: Network Summation Hierarchy

The LZ_ID (e.g., LZ_427) represents a specific land zone which can be geo-referenced within the study area. Each identified load zone is assigned a specific sub-class according to the customer type within the particular load zone. Furthermore, each load zone is assigned expected base year load. This is done by using measured values (measured substation and/or Intake points loads) and estimating the loads on the substation in order to match the measured load as close as possible. As part of this activity the load forecast for each of the individual load zones is calculated.

Having summated the forecast of the individual load zones within the network hierarchy, the base year load of each supply node (i.e. substation) should match the measured maximum demand for that particular supply node. However, more often than not the first attempt will not match the measured values. This is mainly due to incorrect saturation loads defined for the sub-classes. As such, the assumptions made in the sub-class definition activity are refined to ensure that the summated load zone demand matches the measured supply point demand. This ensures the reliability and accuracy of the forecasted future demand. A base load demand of 100 MVA for the year 2019 (July) is used in this study.

### 5.4.2 Demand Forecast

The long-term demand forecast is deterministic in nature and is based on a number of assumptions as summarised in the previous sections. The demand forecast is further based on the natural growth of the existing load zones and predicted spatial location of future load, guided specifically by aspects such as the predicted future developments.

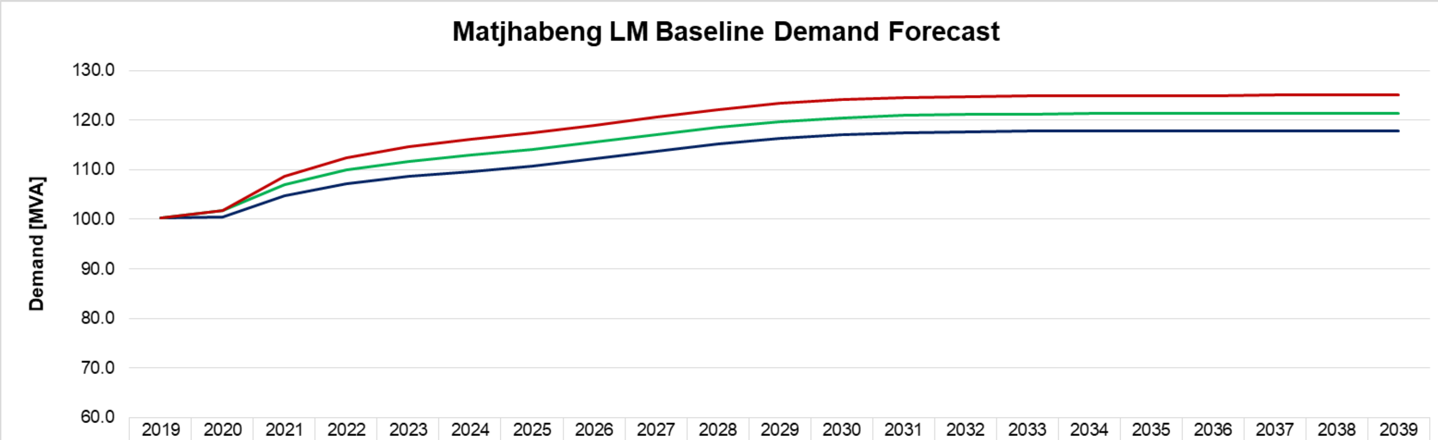
The demand forecast is thus developed by effecting these to the identified load zones and summating according to summation hierarchy. The forecast should thus be interpreted as the future view, based on the current understanding and interpretation of the variables shaping the future. Therefore, as the variables change, so will the forecast, and the longer into the future the forecast is, the more unpredictable the variables.

#### 5.4.2.1 Baseline Demand

The baseline demand only considers how the existing base load will grow into the future without considering any of the future developments. In other words, if everything remains as is, how will the demand look like into the future.

When developing the sub-class saturation loads, 3% - 5% margins were allowed to cater for the varied consumptions of the different customers within the same sub-class. Figure 5-8 shows the resultant baseline demand. It is forecasted that the demand will grow from a base of approximately 103 MVA in 2019 to approximately 118 MVA, 121 MVA and 125 MVA, for the low, likely and high scenarios, respectively.

The growth on the baseline demand is as a result of the built-up areas that have not yet reached their saturation, with the assumption that they will saturate going into the future. The lower bound of the sub-class will result in a relatively flat growth rate at an annual average of 0.82%. The likely and higher bound have an average annual growth rate of 0.97 % and 1.12 %.




| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low | 100.3 | 100.4 | 104.7 | 107.1 | 108.6 | 109.7 | 110.8 | 112.2 | 113.7 | 115.2 | 116.3 | 117.0 | 117.4 | 117.6 | 117.7 | 117.8 | 117.8 | 117.8 | 117.8 | 117.8 | 117.8 |
| Likely | 100.3 | 101.9 | 107.0 | 109.9 | 111.6 | 112.9 | 114.1 | 115.5 | 117.1 | 118.6 | 119.8 | 120.5 | 120.9 | 121.1 | 121.3 | 121.3 | 121.3 | 121.4 | 121.4 | 121.4 | 121.4 |
| High | 100.3 | 101.7 | 108.6 | 112.4 | 114.6 | 116.1 | 117.4 | 118.9 | 120.6 | 122.2 | 123.3 | 124.1 | 124.5 | 124.8 | 124.9 | 125.0 | 125.0 | 125.0 | 125.0 | 125.0 | 125.0 |

Figure 5-8: Matjhabeng LM Baseline Demand Forecast

#### 5.4.2.2 Future Developments

From workshops held with the Matjhabeng LM Development Planning officials, 64 potential future developments were identified most of which are residential with some commercial and industrial in between. Furthermore, from the layouts of the residential developments there were indications of other landuses such as Business, Education, Community Facility, Sport Field etc., which were subsequently considered as being part of the developments.

Indicative start-up dates for the individual developments were shared during the discussed during the workshops. However, considering the uncertainty of the future, it was necessary to factor in some variation to the development take-up rates in order to determine the resulting impact on the future demand. Table 5-3 lists the future developments that were considered for the study.

Table 5-3: Future Developments Considered

| Load_ID | Land-Use_Description | Area Description | Area (Per Hectare) | Number of Units | Start Year of Elect | Substation Area |
|---|---|---|---|---|---|---|
| **LZ_201_1** | Residential | North of Killarny Street Ext.3<br>Additional 250 HH | 87.44 | 250 | 2022 | Allanridge |
| **LZ_503_FD_NEW** | Residential | Allanridge Ext 3, South of Killarney St<br>Existing site to be converted to 749 new smaller unit and 256 townhouses | 65.57 | 1005 | 2022 | Allanridge |
| **LZ_205** | Residential | Allanridge Ext. 2<br>Additional 191 HH (GAP housing) | 50.49 | 191 | 2023 | Allanridge |
| **LZ_169_1918** | Business | Previously Taxi Rank converted to Business | 0.41 | | 2022 | Bronville |
| **LZ_477_SDF** | Residential | Extension 15 (Not enough supply available at Orange substation _vandalized) | 22.57 | 250 | 2022 | Bronville |
| **LZ_497_FD_1** | Commercial | Shopping Centre (Stand 8) | 4.76 | 5 | 2023 | CBD |
| **LZ_498_FD_1** | Commercial | Cronje Dev | 4.62 | 5 | 2023 | CBD |
| **LZ_499_FD_1** | Commercial | Toyota Show Room | 1.53 | 2 | 2023 | CBD |
| **LZ_521_FD_NEW** | Residential | HENNENMAN LAND RESTITUTION PROJECT | 22.79 | 100 | 2022 | Hennenman |
| **LZ_406_1_8312** | Business | ERF/Stand1/8312 | 0.64 | | 2022 | KUTLWANONG |
| **LZ_406_14111** | Industrial | ERF/Stand 14111 ( Industrial site converted to a educational purpose site) | 6.25 | | 2022 | KUTLWANONG |
| **LZ_406_14116** | Industrial | ERF/Stand 14116 ( Industrial site converted to a educational purpose site) | 0.70 | | 2022 | KUTLWANONG |
| **LZ_406_15599** | Business | ERF/Stand 15599 | 0.08 | | 2022 | KUTLWANONG |
| **LZ_406_15602** | Business | ERF/Stand 15602 | 0.08 | | 2022 | KUTLWANONG |
| **LZ_406_15604** | Business | ERF/Stand 15604 | 0.08 | | 2022 | KUTLWANONG |
| **LZ_406_15606** | Business | ERF/Stand 15606 | 0.08 | | 2022 | KUTLWANONG |
| **LZ_406_1993/1** | Public Garage | Ward 11: Bronville entrance Stand 1993/1 | 0.30 | | 2022 | KUTLWANONG |
| **LZ_406_1993/R** | Business | Ward 11: Bronville entrance Stand 1993/R | 0.15 | | 2022 | KUTLWANONG |
| **LZ_406_33685** | Business | ERF/Stand 133685 | 0.02 | | 2022 | KUTLWANONG |
| **LZ_406_33686** | Business | ERF/Stand 133686 | 0.02 | | 2022 | KUTLWANONG |
| **LZ_406_8077** | Industrial | ERF/Stand 8077 | 0.37 | | 2022 | KUTLWANONG |
| **LZ_406_8078** | Industrial | ERF/Stand 8078 | 0.57 | | 2022 | KUTLWANONG |
| **LZ_406_8079** | Industrial | ERF/Stand 8079 | 0.58 | | 2022 | KUTLWANONG |
| **LZ_406_8080** | Industrial | ERF/Stand 8080 | 0.37 | | 2022 | KUTLWANONG |
| **LZ_511_FD_NEW_1** | Commercial | Shopping Centre (Next to the stadium) | 2.54 | 3 | 2022 | KUTLWANONG |
| **LZ_512_FD_NEW** | Residential | Police Station House | 6.37 | 100 | 2023 | KUTLWANONG |
| **LZ_513_FD_NEW_1** | Community Facility | Police Station | 0.72 | 1 | 2023 | KUTLWANONG |
| **LZ_508_FD_NEW** | Residential | No Figures for number of units | 158.62 | 2900 | 2025 | KUTLWANONG |
| **LZ_509_FD_NEW** | Residential | | 247.59 | 2900 | 2025 | KUTLWANONG |
| **LZ_509_FD_NEW_Bus** | Residential | 4.8% of the area is dedicated future business use | 10.77 | 11 | 2025 | KUTLWANONG |
| **LZ_509_FD_NEW_Com.F** | Residential | 5.5% of the area is dedicated future community facility use | 12.44 | 12 | 2025 | KUTLWANONG |
| **LZ_509_FD_NEW_Edu** | Residential | 7.5% of the area is dedicated future educational use | 16.99 | 17 | 2025 | KUTLWANONG |
| **LZ_509_FD_NEW_Munic.P** | Residential | 1% of the area is dedicated future municiality purpose | 2.14 | 2 | 2025 | KUTLWANONG |
| **LZ_510_FD_NEW_1** | Residential | No Figures for number of units/remaider of 285 on map layout | 127.03 | 970 | 2025 | KUTLWANONG |
| **LZ_514_FD_NEW_1** | Commercial | | 67.29 | 67 | 2028 | KUTLWANONG |
| **LZ_302_2170** | Business | ERF/Stand 2170 | 0.12 | | 2023 | MELODING |
| **LZ_519_FD_NEW_1** | Commercial | Shopping Centre (Expansion of Checkers) | 3.20 | 3 | 2024 | MELODING |

| Load_ID | Land-Use_Description | Area Description | Area (Per Hectare) | Number of Units | Start Year of Elect | Substation Area |
|---|---|---|---|---|---|---|
| **LZ_520_FD_NEW** | Residential | Hostel development | 254.29 | 3000 | 2025 | MELODING |
| **LZ_525_FD_NEW** | Residential | | 40.83 | 591 | 2022 | MMAMAHABANE |
| **LZ_403_2184** | Municipal Purposes | ERF/Stand 2184 ( Initial site dedicated to Municipal purpose, converted to business site) | 0.34 | | 2023 | MMAMAHABANE |
| **LZ_504_FD_Bus** | Residential | 3.6% of the area is dedicated future business use | 1.75 | 2 | 2022 | NYAKALLONG |
| **LZ_504_FD_NEW_1** | Residential | Eskom Area, 446 sites with 100 units left to be developed and electrified | 7.66 | 100 | 2022 | NYAKALLONG |
| **LZ_505_FD_NEW** | Residential | Stand 3285, 3826<br>School land converted to for residential land use with a potential of 60 units, soon to be formalized | 3.40 | 60 | 2022 | NYAKALLONG |
| **LZ_399_3827** | Public Garage | ERF/Stand 3827 | 0.20 | | 2023 | NYAKALLONG |
| **LZ_399_3828** | Business | ERF/Stand 3828 | 0.18 | | 2023 | NYAKALLONG |
| **LZ_506_FD_NEW** | Residential | Le Clusa 70 (Medium term objective) | 194.41 | 1000 | 2025 | NYAKALLONG |
| **LZ_507_FD_NEW_1** | Industrial | Solar PV Farm (Only requires a small amount of supply from Munic, the rest will be generated by PV Plants) | 343.03 | 343 | 2025 | Odendaalsrus |
| **LZ_405_10283** | Business | ERF/Stand 10283 | 1.45 | | 2022 | PHOMOLONG |
| **LZ_405_8943** | Business | Ward 10 :ERF/Stand 8943 | 0.04 | | 2022 | PHOMOLONG |
| **LZ_405_8944** | Business | Ward 10 :ERF/Stand 8944 | 0.04 | | 2022 | PHOMOLONG |
| **LZ_405_8945** | Business | Ward 10 :ERF/Stand 8945 | 0.04 | | 2022 | PHOMOLONG |
| **LZ_522_FD_NEW** | Residential | | 187.48 | 1675 | 2022 | PHOMOLONG |
| **LZ_522_FD_NEW_Com.F** | Residential | 3.8% of the area is dedicated future community facility use | 4.78 | 5 | 2022 | PHOMOLONG |
| **LZ_522_FD_NEW_Complex** | Residential | 6.7% of the area is dedicated future accommadation complex | 8.54 | 9 | 2022 | PHOMOLONG |
| **LZ_522_FD_NEW_Edu** | Residential | 11.4% of the area is dedicated future educational use | 14.51 | 15 | 2022 | PHOMOLONG |
| **LZ_523_FD_NEW_1** | Commercial | Shopping Centre | 7.52 | 8 | 2026 | PHOMOLONG |
| **LZ_030_1** | Residential | RIEBEECKSTAD MILITARY VETERANS | 2.04 | 20 | 2022 | Riebeeckstad |
| **LZ_035_4991** | Industrial | Riebeeckstad industrial area Stand 4991 | 0.13 | | 2022 | Riebeeckstad |
| **LZ_035_5061** | Industrial | Riebeeckstad industrial area Stand 5061 | 0.31 | | 2022 | Riebeeckstad |
| **LZ_035_5062** | Industrial | Riebeeckstad industrial area Stand 5062 | 0.35 | | 2022 | Riebeeckstad |
| **LZ_035_5063** | Industrial | Riebeeckstad industrial area Stand 5063 | 0.29 | | 2022 | Riebeeckstad |
| **LZ_035_5072** | Industrial | Riebeeckstad X1 Stand 5072 | 0.26 | | 2022 | Riebeeckstad |
| **LZ_035_4985** | Industrial | Ward 25: industrial area Stand 4985 | 0.16 | | 2023 | Riebeeckstad |
| **LZ_035_4986** | Industrial | Ward 25: industrial area Stand 4986 | 0.15 | | 2023 | Riebeeckstad |
| **LZ_035_4989** | Industrial | Riebeeckstad industrial area Stand 4989 | 0.17 | | 2023 | Riebeeckstad |
| **LZ_035_4990** | Industrial | Riebeeckstad industrial area Stand 4990 | 0.13 | | 2023 | Riebeeckstad |
| **LZ_037** | Residential | Riebeeckstad (Norman Street) | | 120 | 2023 | Riebeeckstad |
| **LZ_045** | Residential | Riebeeckstad (Lusette Street) | | 78 | 2023 | Riebeeckstad |
| **LZ_502_FD_1** | Residential | | 121.77 | 1000 | 2025 | Riebeeckstad |
| **LZ_480_FD** | Community Facility | New Stadium(Next to Bongani Hosital) | 63.26 | 63 | 2028 | Riebeeckstad |
| **LZ_478_FD** | Residential 2A (Low Income, High Density) | Freedom Square | 12.12 | 500 | 2022 | THABONG |
| **LZ_515_FD_NEW_1** | Residential | Former Minning area | 892.80 | 100 | 2022 | THABONG |
| **LZ_527_FD_NEW** | Residential | Thabong Hostel Upgrade | 24.04 | 424 | 2022 | THABONG |
| **LZ_478_FD_10284** | Business | ERF/Stand 10284 | 1.80 | | 2023 | THABONG |
| **LZ_478_FD_10285** | Business | ERF/Stand 10285 | 0.61 | | 2023 | THABONG |

| Load_ID | Land-Use_Description | Area Description | Area (Per Hectare) | Number of Units | Start Year of Elect | Substation Area |
|---|---|---|---|---|---|---|
| **LZ_005_1** | Residential | | 6.45 | 150 | 2022 | Ventersburg |
| **LZ_524_FD_NEW** | Residential | | 16.24 | 1000 | 2025 | Ventersburg |
| **LZ_516_FD_NEW_1** | Residential Single Category C | Kitty Area(Bottom portion)-Initial starts at 237 with a potential growth of up to 500 units witihin the area | 72.76 | 500 | 2022 | Virginia Main |
| **LZ_517_FD_NEW** | Residential | Kitty Area(Top portion)-Initial starts at 361 with a potential growth of up to 600 units witihin the area | 43.34 | 600 | 2022 | Virginia Main |
| **LZ_Virginia Pump** | Industrial | Virginia Purification Plant | 23.40 | | 2023 | Virginia Main |
| **LZ_Virginia Vasco Eng.** | Industrial | Virginia Vasco Engineering (Plastic) | 0.36 | | 2023 | Virginia Main |
| **LZ_518_FD_NEW_1** | Commercial | Checkers Phase 2 | 1.97 | 2 | 2025 | Virginia Main |
| **LZ_218_1** | Residential | | 75.07 | 361 | 2023 | Virginia North |
| **LZ_092_3/6560** | Municipal Purposes | Voorspoed X8 Stand 3/6560 | 0.53 | | 2022 | Welkom Industries |
| **LZ_092_6/6560** | Municipal Purposes | Voorspoed X8 Stand 6/6560 | 0.63 | | 2022 | Welkom Industries |
| **LZ_092_6347** | Industrial | Voorspoed X8 Stand 6347 | 2.00 | | 2022 | Welkom Industries |
| **LZ_092_8/6560** | Municipal Purposes | Voorspoed X8 Stand 8/6560 | 2.15 | | 2022 | Welkom Industries |
| **LZ_092_9099** | Industrial | Voorspoed East / X24 Stand 9099 | 0.51 | | 2022 | Welkom Industries |
| **LZ_092_9132** | Municipal Purposes | Voorspoed X8 Stand 9132 | 10.00 | | 2022 | Welkom Industries |
| **LZ_092_9137** | Municipal Purposes | Voorspoed X8 Stand 9132 | 4.44 | | 2022 | Welkom Industries |
| **LZ_092_9138** | Industrial | Voorspoed East Stand 9138 | 0.82 | | 2022 | Welkom Industries |
| **LZ_092_9139** | Road & Streets | Voorspoed East Stand 9139 | 0.42 | | 2022 | Welkom Industries |
| **LZ_481_FD_1** | Residential | Student Accommadation | 41.47 | 918 | 2022 | Welkom Industries |
| **LZ_Power Road** | Industrial | Power Road Pump Station | 0.32 | | 2022 | Welkom Industries |
| **LZ_479_FD_1** | Industrial | Thabong Purification Plant | 6.22 | 6 | 2023 | Welkom Industries |
| **LZ_487_FD** | Industrial | Witban Plant( Purification) | 6.03 | 6 | 2023 | Welkom Industries |
| **LZ_488_FD_1** | Commercial | Golf Course | 105.03 | 105 | 2023 | Welkom Industries |
| **LZ_491_FD_1** | Commercial | Koppie Alleen Road | 2.22 | 2 | 2023 | Welkom Industries |
| **LZ_Witban Pump 1** | Industrial | Witban Pump 1 | 1.65 | | 2023 | Welkom Industries |
| **LZ_Witban Pump 2** | Industrial | Witban Pump2 | 1.65 | | 2023 | Welkom Industries |
| **LZ_483_FD_1** | Industrial | | 1.35 | 1 | 2024 | Welkom Industries |
| **LZ_482_FD** | Light Commercial | Commercial site converted to a low industrial area | 1.08 | 1 | 2028 | Welkom Industries |
| **LZ_485_FD** | Industrial | | 0.51 | 1 | 2028 | Welkom Industries |
| **LZ_486_FD** | Industrial | | 2.23 | 2 | 2028 | Welkom Industries |
| **LZ_Klippan** | Industrial | Klippan Purification Plant | 34.31 | | 2021 | Welkom Park |
| **LZ_Major Pump** | Industrial | Major Pump Station | 10.49 | | 2022 | Welkom Park |
| **LZ_Toronia Pump** | Industrial | Toronia Pump Station | 31.95 | | 2022 | Welkom Park |
| **LZ_492_FD** | Residential | Die Dewel | 20.32 | 529 | 2023 | Welkom Park |
| **LZ_495_FD_1** | Commercial | | 2.59 | 3 | 2024 | Welkom Park |
| **LZ_352_1** | Residential | Reahola Hostel (Mining Hostel converted to family units) | 10.49 | 590 | 2025 | Welkom Park |
| **LZ_496_FD_1** | Commercial | | 3.21 | 3 | 2025 | Welkom Park |
| **LZ_489_FD_1** | Commercial | Shooting Range | 4.88 | 5 | 2026 | Welkom Park |
| **LZ_083_10629** | Industrial | Reitz Park X39 Stand 10629 | 0.21 | | 2022 | Welkom Town |
| **LZ_083_10630** | Industrial | Reitz Park X39 Stand 10630 | 0.22 | | 2022 | Welkom Town |

| Load_ID | Land-Use_Description | Area Description | Area (Per Hectare) | Number of Units | Start Year of Elect | Substation Area |
|---|---|---|---|---|---|---|
| **LZ_083_10631** | Industrial | Reitz Park X39 Stand 10631 | 0.22 | | 2022 | Welkom Town |
| **LZ_083_10632** | Industrial | Reitz Park X39 Stand 10632 | 0.23 | | 2022 | Welkom Town |
| **LZ_083_10633** | Industrial | Reitz Park X39 Stand 10633 | 0.23 | | 2022 | Welkom Town |
| **LZ_083_10634** | Industrial | Reitz Park X39 Stand 10634 | 0.23 | | 2022 | Welkom Town |
| **LZ_083_10635** | Industrial | Reitz Park X39 Stand 10635 | 0.23 | | 2022 | Welkom Town |
| **LZ_083_10636** | Industrial | Reitz Park X39 Stand 10636 | 0.28 | | 2022 | Welkom Town |
| **LZ_083_10637** | Industrial | Reitz Park X39 Stand 10637 | 0.21 | | 2022 | Welkom Town |
| **LZ_083_10638** | Industrial | Reitz Park X39 Stand 10638 | 0.36 | | 2022 | Welkom Town |
| **LZ_083_10639** | Industrial | Reitz Park X39 Stand 10639 | 0.11 | | 2022 | Welkom Town |
| **LZ_085_12/7814** | Industrial | Reitz Park X15 Stand 12/7814 | 0.10 | | 2022 | Welkom Town |
| **LZ_085_13/7814** | Industrial | Reitz Park X15 Stand 13/7814 | 0.10 | | 2022 | Welkom Town |
| **LZ_085_14/7814** | Industrial | Reitz Park X15 Stand 14/7814 | 0.12 | | 2022 | Welkom Town |
| **LZ_085_15/7814** | Industrial | Reitz Park X15 Stand 15/7814 | 0.14 | | 2022 | Welkom Town |
| **LZ_085_Ext2** | Residential | NAUDEVILLE EXT 2 | | 318 | 2022 | Welkom Town |
| **LZ_086_7838** | Municipal Purposes | Voorspoed X24 Stand 7838 ( Initial site dedicated to Municipal purpose, converted to an industrial site) | 13.24 | | 2022 | Welkom Town |
| **LZ_144_7066** | Residential | ERF/Stand 7066 | 1.34 | | 2022 | Welkom Town |
| **LZ_147_5460** | Public Garage | Dagbreek X4 Stand 5460 | 3.03 | | 2022 | Welkom Town |
| **LZ_494_FD** | Residential | | 12.30 | 480 | 2023 | Welkom Town |
| **LZ_494_FD_2066** | Community Facility | ERF/Stand 2066 | 27.43 | | 2023 | Welkom Town |
| **LZ_494_FD_2069** | Business | ERF/Stand 2069 | 0.20 | | 2023 | Welkom Town |
| **LZ_073_1** | Municipal Purposes | Extension 17 | 114.75 | 115 | 2025 | Welkom Town |
| **LZ_493_FD_1** | Commercial | Constantia Road | 3.19 | 3 | 2025 | Welkom Town |
| **LZ_061** | Residential | Rheeder Park Ext.2 | 41.25 | 900 | 2022 | Western Holding |
| **LZ_062_Ext3** | Residential | Flaming Park X3 | | 52 | 2022 | Western Holding |
| **LZ_065_Ext4** | Residential | Flaming Park X4 | | 42 | 2022 | Western Holding |
| **LZ_068_Ext5** | Residential | Flaming Park X5 | | 14 | 2022 | Western Holding |
| **LZ_500_FD** | Residential | Flamingo Park Ext.2 | 38.21 | 300 | 2022 | Western Holding |
| **LZ_501_FD** | Residential | Lotgeval (The area set to be gradually electrified in the next 10 years) | 31.35 | 4000 | 2030 | Western Holding |

Three scenarios were considered, i.e., Low, Likely and High. The scenarios were constituted as follows:

**High Scenario**

- High Development rate scenario;
- Developments start as per the indicative start date with 60% developed;
- Fully developed within 4 years;

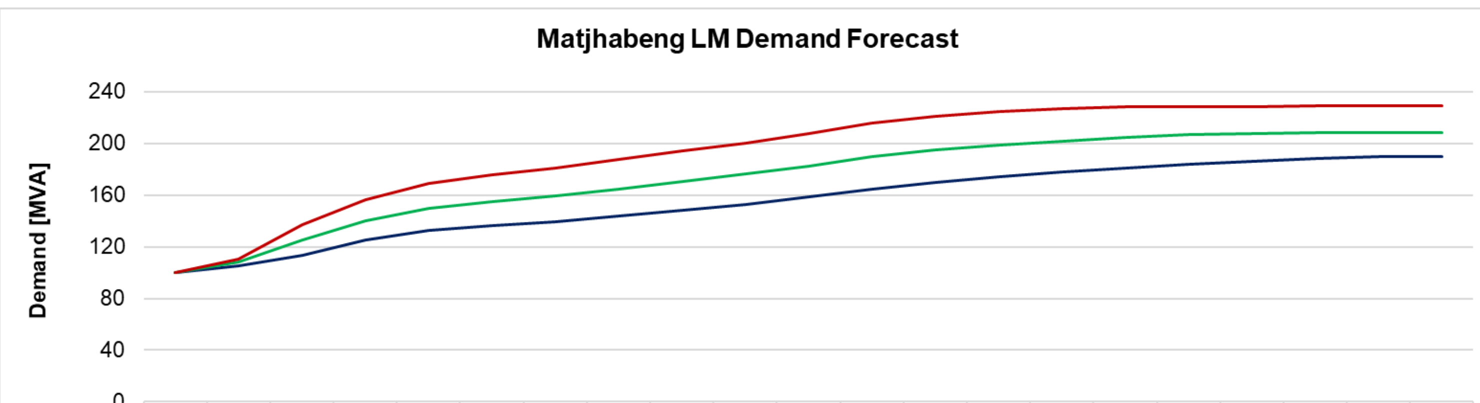
**Medium Scenario**

- Medium Development rate scenario;
- Developments start as per the indicative start date with 40% developed;
- Fully developed within 6 years;

**Low Scenario**

- Medium Development rate scenario;
- Developments start as per the indicative start date with 20% developed;
- Fully developed within 8 years;

The graphs in Figure 5-9 provide the developed demand forecast results. It is forecasted that the demand will grow from a base of approximately 100 MVA in 2019 to a High Scenario of approximately 229 MVA. The Low Scenario is forecasted to reach approximately 190 MVA and the Likely (Medium) Scenario is forecasted to reach approximately 209 MVA by 2039. The average growth rate per annum over the period of 20 years for the low, likely and high scenarios are 3.09%, 3.62% and 4.18%, respectively.




| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low | 100 | 105 | 114 | 125 | 133 | 136 | 140 | 144 | 148 | 153 | 158 | 164 | 170 | 174 | 178 | 181 | 184 | 186 | 188 | 189 | 190 |
| Likely | 100 | 108 | 125 | 140 | 150 | 155 | 159 | 165 | 171 | 176 | 183 | 190 | 195 | 199 | 202 | 205 | 207 | 208 | 208 | 208 | 209 |
| High | 100 | 110 | 137 | 156 | 169 | 175 | 181 | 188 | 195 | 200 | 207 | 216 | 221 | 224 | 227 | 228 | 229 | 229 | 229 | 229 | 229 |

Figure 5-9: Matjhabeng LM Demand Forecast

#### 5.4.2.3 Impact on Intake Points and Substations

Table 5-4 illustrate the impact of the demand forecast on the notified maximum demands (NMDs) of the respective intake points and the installed capacities of different substations. As it can be seen from the table, more intake points (marked in red) are forecasted to exceed the known NMDs.

Table 5-4: Intake Point / Substation Forecast

| Intake / Sub Name | Installed Capacity / NMD | Firm Capacity | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Allanridge | 1.6 | | 2.0 | 1.7 | 2.9 | 4.9 | 6.3 | 7.1 | 7.8 | 8.3 | 8.5 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 |
| Bronville | | | 4.0 | 5.0 | 5.4 | 5.6 | 5.8 | 5.9 | 6.0 | 6.0 | 6.0 | 6.1 | 6.1 | 6.1 | 6.1 | 6.1 |
| CBD | 40 | 20 | 14.1 | 15.6 | 18.4 | 19.0 | 19.1 | 19.1 | 19.1 | 19.1 | 19.2 | 19.2 | 19.3 | 19.4 | 19.7 | 19.7 |
| Hennenman | 6 | | 6.5 | 6.7 | 7.4 | 7.6 | 7.7 | 7.7 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 |
| Odendaalsrus | 9 | | 8.3 | 7.3 | 7.9 | 8.2 | 8.4 | 8.6 | 8.8 | 8.9 | 9.0 | 9.2 | 9.3 | 9.4 | 9.8 | 10.0 |
| Riebeeckstad | 14 | | 10.8 | 12.7 | 15.7 | 16.3 | 16.6 | 17.0 | 17.2 | 18.6 | 21.9 | 24.5 | 27.6 | 29.7 | 32.4 | 32.4 |
| Ventersburg | 1.2 | | 1.4 | 1.2 | 1.7 | 2.0 | 2.3 | 3.3 | 5.3 | 6.4 | 7.1 | 7.7 | 8.1 | 8.2 | 8.2 | 8.2 |
| Virginia Main | 14 | | 12.1 | 13.2 | 18.6 | 23.7 | 24.8 | 25.5 | 26.2 | 26.7 | 27.1 | 27.4 | 27.6 | 27.8 | 27.9 | 27.9 |
| Virginia North | 8 | | 5.6 | 6.2 | 7.9 | 8.3 | 8.6 | 9.2 | 9.5 | 9.7 | 9.8 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| Welkom Bulk | 30 | | 24.7 | 28.3 | 33.5 | 35.8 | 41.5 | 42.5 | 43.1 | 43.8 | 45.0 | 46.4 | 47.4 | 48.2 | 49.4 | 49.4 |
| Welkom Industries | 40 | 20 | 10.7 | 12.9 | 15.3 | 17.0 | 22.8 | 23.7 | 24.3 | 25.0 | 25.9 | 27.3 | 28.2 | 28.9 | 29.8 | 29.8 |
| Welkom Park | 20 | | 17.9 | 19.6 | 24.3 | 29.5 | 30.7 | 31.4 | 32.0 | 33.1 | 33.8 | 34.2 | 34.5 | 34.8 | 35.1 | 35.1 |
| Welkom Town | 15 | | 12.3 | 15.3 | 17.8 | 18.9 | 20.5 | 21.5 | 22.1 | 22.8 | 23.4 | 23.7 | 23.8 | 24.0 | 24.2 | 24.2 |
| Western Holding | 3.5 | | 3.6 | 4.0 | 6.1 | 8.1 | 9.1 | 9.7 | 10.3 | 10.6 | 10.7 | 10.7 | 12.8 | 18.0 | 25.6 | 25.7 |
| Whites | 0.5 | | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |

## 6. CONDITION ASSESSMENT

Major portions of the Matjhabeng LM networks have been in service for many years and are approaching or have exceeded their design life. Such networks may begin to exhibit degradation in reliability performance, reduced safety margins, functional inadequacy, obsolescence or general deterioration.

The technical field inspection was conducted to obtaining basic equipment information and evaluated equipment status and condition on site. This included visiting the various stations within the municipality and assessing the condition of the assets utilised by the municipality and the spare equipment. The regions visited include: Allan Ridge, Hennenman, Odendaalsrus, Ventersburg, Virginia and Welkom.

The substation inspections focused on primary equipment within all distribution substations and switching stations as well as the substation yard, land and buildings, batteries and battery chargers. These included:

- Power and Auxiliary Transformers,
- Neutral Earthing Transformers,
- Surge Arrestors,
- Indoor and Outdoor Circuit Breakers,
- Isolators,
- Battery Bank,
- General structure and substation earthing,
- Internal and External Fencing.
- The overall condition of the building,

Figure 6-1: Condition Assessment Site Inspection Pictures

Figure 6-1 shows some of the pictures that were taken at the different sites during inspection. General findings and comments:

- At some substations, vegetation control was overdue with long grass everywhere with rubbish lying around in the station yards,
- A few substation buildings and roof have structural damage and / or water damage on ceiling and walls,
- A number of panels have water damage and rusted,
- Mechanical covers missing or damaged on a number of panels,
- Battery banks with minor acid leaks,
- There are a number of open excavation trenches (Inside / Outside substation perimeter) that are not marked with danger tape, dangerous,
- Aged equipment, i.e., switchgears and circuit breakers,
- Rusted and oil leaks on transformers, switchgears, switching panels, etc.
- No silica gel in the transformer breather,
- Faulty meter readings or panel display not working,
- Missing breaker units,
- Poor or no lighting or loose light fitting in substation building,
- Switchgear lever mechanism not working, held-up by rope or wire,
- Partially burnt panels,
- Missing gates at substation yards or buildings and damaged substation fence / palisade,
- Rodent infestation in substation building,
- Damaged cable trunking or tearing cable insulation.

## 7. NETWORK DEVELOPMENT PLANS

The objective of this task was to assess the adequacy of the existing Matjhabeng LM network to cater for the forecasted load. Furthermore, the assessment identified where, when and at what capacity the distribution infrastructure should be developed.

### 7.1 Existing Network

The Matjhabeng Local Municipality is currently wholly supplied from Eskom via 12 bulk intake points with voltages of 6.6kV (4), 11kV (7) and 132kV (1). The municipality is responsible for supplying the town areas whilst the mines, townships and farms areas are supplied directly from Eskom.

Furthermore, there are reports of vandalism in some areas and the network is generally aged, with infrastructure commissioned as far back as 1954. There are no meters on the Matjhabeng network, however, the electricity department has indicated that the network is constrained with limited or no capacity for additional demand connection.

#### 7.1.1 Allanridge (including Nyakallong)

- Allanridge town is supplied by Matjhabeng LM from a 6.6kV Intake Point from Eskom. The notified maximum demand (NMD) for the intake point is 2MVA and the recorded maximum demand (MD) for 2019 was 2 MVA which was recorded in the month of July.
- The Matjhabeng customer base in Allanridge is mainly residential, however, there is a mine (Target Gold Mine) in the area which is supplied directly from Eskom.
- Furthermore, the Nyakallong Township is also supplied directly from Eskom with mainly residential customer base.

#### 7.1.2 Hennenman (including Phomolong and Whites)

- The Hennenman and Whites areas. Hennenman town is supplied by Matjhabeng LM from two (2) Intake Points from Eskom, i.e., 11kV Hennenman Main and 11kV Whites.
- The notified maximum demand (NMD) for the 11kV Hennenman Main intake point is 6MVA and the recorded maximum demand (MD) for 2019 was 6.5MVA which was recorded in the month of July, exceeding the NMD.
- The NMD for the 11kV Whites intake point is 0.315MVA and the recorded MD for 2019 was 0.315MVA which was recorded in the month of July.
- Matjhabeng customer base in Hennenman is mainly residential including some small holdings.

- Furthermore, the Meloding Township is supplied directly from Eskom's Hennenman Rural 132kVsubstation with mainly residential customer base.

### 7.1.3 Odendaalsrus (including Kutlwanong)

- Matjhabeng LM area of supply in the Odendaalsrus area is supplied by Matjhabeng from a 11kV Odendaalsrus Intake Point from Eskom. The notified maximum demand (NMD) for the intake point is 9MVA and the recorded maximum demand (MD) for 2019 was 8.3 MVA which was recorded in the month of July.
- The Matjhabeng customer base in Odendaalsrus is mainly residential with some farms, however, there is a mine (Anglo Geduld Mine) in the area which is supplied directly from Eskom.
- Furthermore, the Kutlwanong Township is also supplied directly from Eskom's Kutlwanong 132kV substation with mainly residential customer base.

### 7.1.4 Ventersburg (including Mmamahabane and Tswelangpele)

- Ventersburg town is supplied by Matjhabeng LM from the 11kV Ventersburg Intake Points from Eskom.
- The notified maximum demand (NMD) for the 11kV Ventersburg intake point is 1.2MVA and the recorded maximum demand (MD) for 2019 was 1.4MVA which was recorded in the month of August, exceeding the NMD.
- The Matjhabeng customer base in Ventersburg is mainly residential.
- The Mmamahabane and Tswelangpele Townships are supplied directly from Eskom's Hennenman Rural 132kV substation via a 22kV feeder with mainly residential customer base.

### 7.1.5 Virginia (including Meloding)

- Virginia town is supplied by Matjhabeng LM from two (2) Intake Points from Eskom, i.e. 11kV Virginia Town (Bulk) and 11kV Virginia North.
- The notified maximum demand (NMD) for the 11kV Virginia Town (Bulk) intake point is 14MVA and the recorded maximum demand (MD) for 2019 was 12.1MVA which was recorded in the month of July.
- The NMD for the 11kV Virginia North intake point is 8MVA and the recorded MD for 2019 was 5.6MVA which was recorded in the month of June.
- The Matjhabeng customer base in Virginia is mainly residential. However, there are mining areas around the town which are supplied directly from Eskom.

- Furthermore, the Meloding Township is supplied directly from Eskom's Meloding 132kV substation which is supplied from Theseus MTS with mainly residential customer base.

### 7.1.6 Welkom (including Bronville and Thabong)

- Within Matjhabeng LM's area of supply, the Welkom area is supplied by a total of seven (7) distribution substations.
- Furthermore, the Matjhabeng LM area of supply is supplied by from five (5) Intake Points from Eskom, i.e., 132kV Welkom Bulk, 6.6kV Welkom Park, 6.6kV Welkom Town, 6.6kV Western Holdings and 11kV Riebeeckstad.
- The notified maximum demand (NMD) for the 132kV Welkom Bulk intake point is 30MVA and the recorded maximum demand (MD) for 2019 was 26.3 MVA which was recorded in the month of January. The 132kV Welkom Bulk intake is supplied from Eskom's Everest MTS with two incomers, however, currently only one is operational.
- The NMD for the 6.6kV Welkom Park intake point is 20MVA and the recorded MD for 2019 was 17.9 MVA which was recorded in the month of May.
- The NMD for the 6.6kV Welkom Town intake point is 15MVA and the recorded MD for 2019 was 12.3 MVA which was recorded in the month of July.
- The NMD for the 6.6kV Western Holdings intake point is 3.5MVA and the recorded MD for 2019 was 3.6MVA which was recorded in the month of June, exceeding the NMD.
- The NMD for the 11kV Riebeeckstad intake point is 14MVA and the recorded MD for 2019 was 10.4MVA which was recorded in the month of June.
- The Matjhabeng customer base in Welkom is a good combination of residential, commercial and industrial customers. However, there are mining areas around the town which are supplied directly from Eskom (including Anglo Erfdeel, Anglo Dakbaarheid, Duiker, New Steyn and Brand Gold South).
- The Bronville Township is supplied via a 11/6.6kV substation.
- Furthermore, the Thabong Township is supplied directly from Eskom's Thabong Bulk and Thabong East 132kV substations which are supplied from Leander MTS with mainly residential customer base.

## 7.2 Proposed Network Development

The existing network was then evaluated against the forecasted demand to assess if the existing network will be able to supply the future demand and to identify any potential network constraints. The proposed network developments are discussed in the subsections below per customer centre areas. Only substations that are violating the Network Planning Criteria are discussed and the proposed alleviation intervention subsequently outlined.

### 7.2.1 Allanridge 6.6kV Intake Area

Figure 7-1 shows the Allanridge Intake demand forecast in relation to the NMD and Table 7-1 outlines the Allanridge feeder loadings.

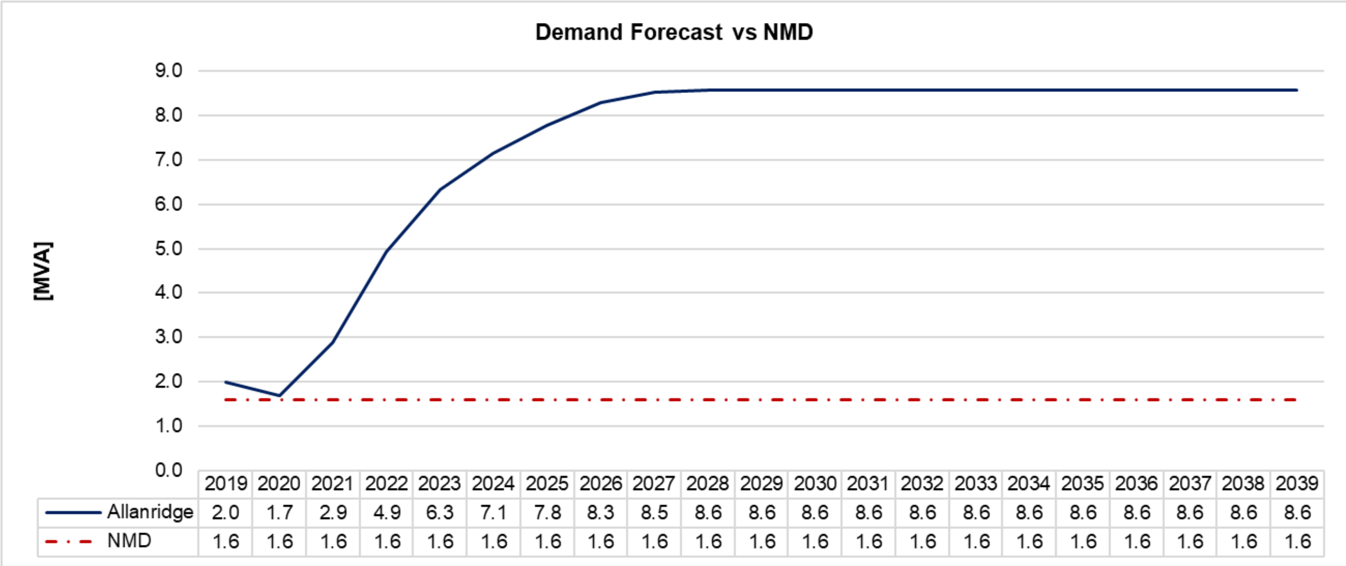
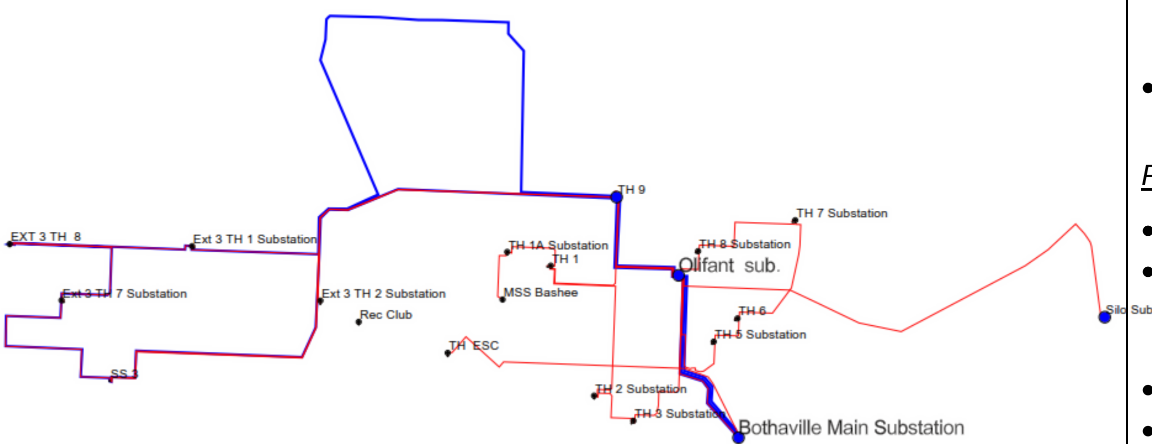



Figure 7-1: Allanridge Intake Demand Forecast vs NMD

Table 7-1: Allanridge Intake Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Olifants_Bay 11_6.6kV busbar | 2.7 | 0 | 0.34 | 0.21 | 0.88 | 2.58 | 3.83 | 4.55 | 5.12 | 5.57 | 5.75 | 5.79 | 5.79 | 5.79 | 5.79 | 5.79 |
| Olifants_Bay 13_6.6kV busbar | 2.7 | 0 | 0.37 | 0.23 | 0.27 | 0.52 | 0.68 | 0.76 | 0.84 | 0.90 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| Olifants_Bay 5 & 6_6.6kV busbar | 5.4 | 2.7 | 0.57 | 0.61 | 0.77 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 |
| Olifants_Bay 9 & 10_6.6kV busbar | 5.4 | 2.7 | 0.80 | 0.78 | 1.00 | 1.03 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 | 1.04 |
| Bothaville - Olifants Feeders | 2.7 | 0 | 1.99 | 1.68 | 2.89 | 4.92 | 6.34 | 7.14 | 7.78 | 8.30 | 8.51 | 8.56 | 8.56 | 8.56 | 8.56 | 8.56 |

Table 7-2: Allanridge Area Proposed Network Development Plans

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


</td><td>

**1. Allanridge 6.6kV Intake**

*Status:*

- The demand has exceeded 1.6 MVA NMD.
- The Eskom substation has a 1 x 5 MVA and a 1 x 20 MVA transformers installed, with the 5 MVA transformer dedicated to Matjhabeng load.
- The demand is forecasted to exceed the 5 MVA transformer capacity by year 2023.

*Proposed:*

- Year 2021: Increase the NMD to 7 MVA.
- Year 2023: Replace the 5MVA transformer with a 1 x 10MVA transformer to increase capacity. (if Eskom wants a 20 MVA transformer, they will have to cover the remainder of the cost).
- Year 2023: Request the Intake point to be on the HV side.
- Year 2025: Increase the NMD to 8.6 MVA.

**2. Bothaville – Olifants Feeders**

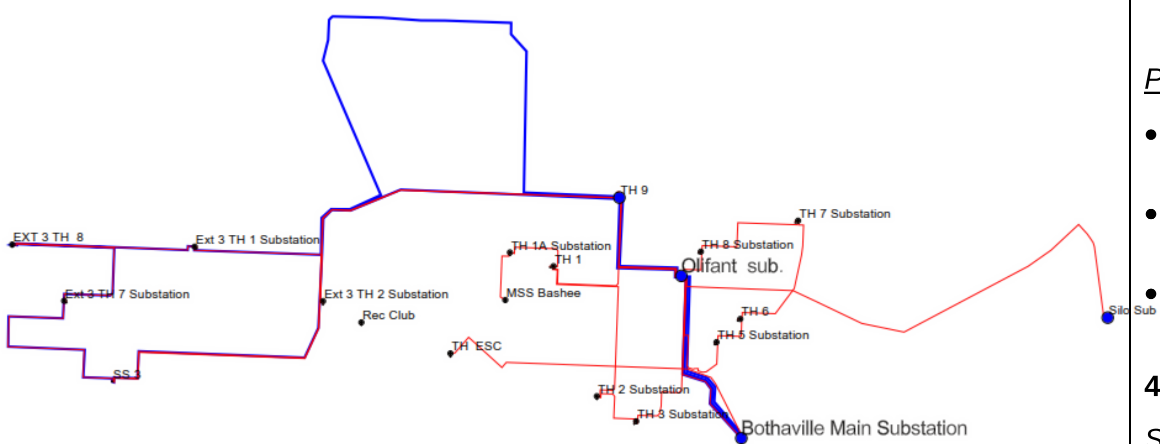
*Status:*

- Supplied by 2x95 $mm^2$ PILC Copper; with one cable stolen and therefore no firm capacity.
- The demand is forecasted to exceed the installed capacity by year 2021;

*Proposed:*

- Year 2022: Upgrade the cable to ±800 m, 2x185 mm2 PILC Copper to increase capacity;
- Year 2023: Install a 3$^{rd}$ ±800 m, 185 mm2 PILC Copper cable to maintain firm capacity;

</td></tr>
</table>

| Networks | Description |
|---|---|
|  | **3. Olifants_Bay 11 Feeder**<br>*<u>Status:</u>*<br>• Supplied by 95 mm$^2$ PILC Copper without firm capacity;<br>• The demand is forecasted to exceed the installed capacity by year 2023;<br>*<u>Proposed:</u>*<br>• Year 2022: Upgrade the cable to 185 mm$^2$ PILC Copper to increase capacity;<br>• Year 2022: Create a feeder ring (±8000 m) with Olifants_Bay 13 feeder;<br>• Year 2022: Requires ±9 additional 500 kVA minisubs to cater for additional demand.<br>**4. Olifants_Bay 13 Feeder**<br>*<u>Status:</u>*<br>• Supplied by 95 mm$^2$ PILC Copper without firm capacity;<br>*<u>Proposed:</u>*<br>• Year 2022: Upgrade the cable to 185 mm2 PILC Copper to increase capacity;<br>• Year 2022: Create a feeder ring (±8000 m) with Olifants_Bay 11 feeder<br>**5. Refurbishments**<br>• Ex Afrox Plant switchgear is aged, has signs of water damage and requires refurbishment<br>• Transformer House Ring Bay 3, 4 and 6 switchgear is aged and requires refurbishment |

### 7.2.2 Hennenman 11kV Intake Area

Figure 7-2 shows the Hennenman Intake demand forecast in relation to the NMD and Table 7-3 outlines the associated feeder loadings.

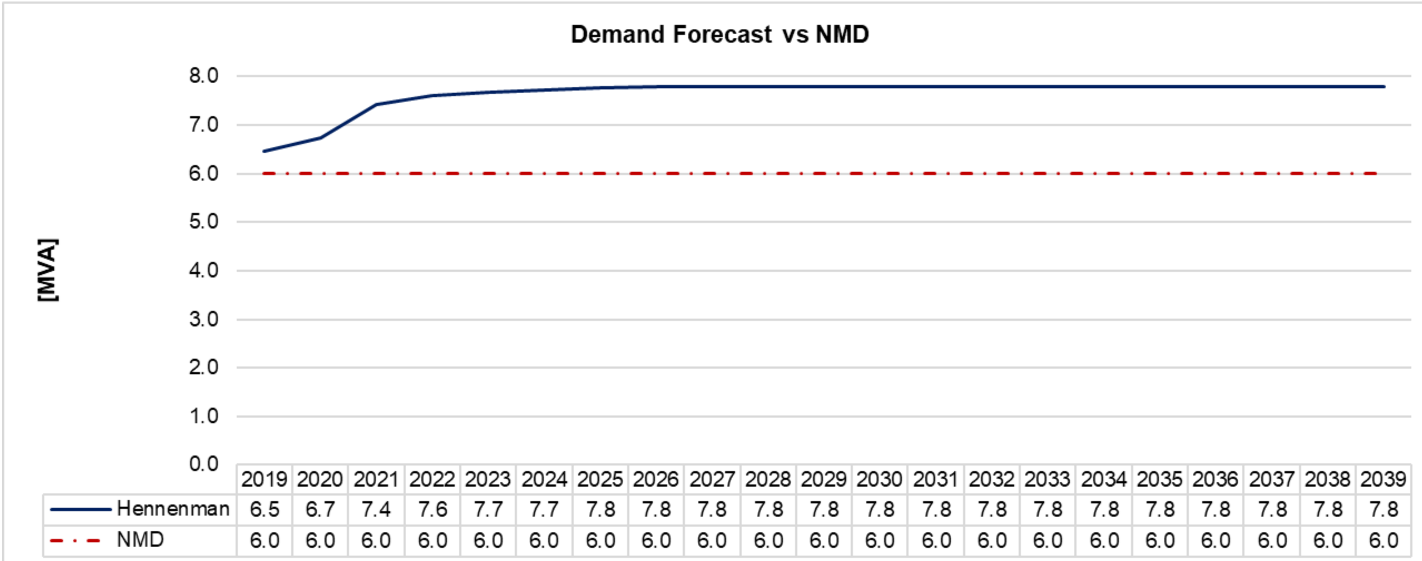



Figure 7-2: Hennenman Intake Demand Forecast vs NMD

Table 7-3: Hennenman Intake Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hennenman_Bay 1 | 7.8 | 0.0 | 2.01 | 2.04 | 2.16 | 2.17 | 2.17 | 2.17 | 2.17 | 2.17 | 2.17 | 2.17 | 2.17 | 2.17 | 2.17 | 2.17 |
| Hennenman_Bay 2 | 4.6 | 0.0 | 0.45 | 0.55 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 |
| Hennenman_Bay 4 | 9.1 | 4.6 | 4.70 | 4.76 | 5.06 | 5.10 | 5.11 | 5.11 | 5.11 | 5.11 | 5.11 | 5.11 | 5.11 | 5.11 | 5.11 | 5.11 |
| Hennenman_Bay 4 | 6.2 | 0.0 | 2.82 | 2.86 | 3.04 | 3.06 | 3.06 | 3.06 | 3.06 | 3.06 | 3.06 | 3.06 | 3.06 | 3.06 | 3.06 | 3.06 |
| Hennenman_Bay 9 | 3.2 | 0 | 1.22 | 1.53 | 1.78 | 1.90 | 1.96 | 2.01 | 2.05 | 2.06 | 2.07 | 2.07 | 2.07 | 2.07 | 2.07 | 2.07 |

Table 7-4: Hennenman Area Proposed Network Development Plans

| Networks | Description |
|---|---|
|  | **1. Hennenman 11kV Intake**<br>*Status:*<br>• The demand has exceeded the 6 MVA NMD;<br>• The Eskom substation has a 1 x 15 MVA transformer installed<br>*Proposed:*<br>• Year 2022: Increase the NMD to 7.8 MVA.<br>• Year 2026: Increase the NMD to 7 MVA.<br>• Year 2030: Increase the NMD to 8.2 MVA.<br>**2. Feeder Rings**<br>*Status:*<br>• The Hertzog Sub feeder ring is supplied by 2 x 30 $mm^2$ PILC Copper from Main Substation<br>• However, portions of the network have been stolen resulting in the feeder being unable to sustain the load.<br>• Overhead lines running to the plots are depleted<br>• Furthermore, the entire towns network is very old and requires upgrading<br>*Proposed:*<br>• Year 2022: Construct a new ±10000 m, OHL Mink conductor ring around the town various substations on 11kV overhead lines |

### 7.2.3 Odendaalsrus 11kV Intake Area

Figure 7-3 shows the Odendaalsrus Intake demand forecast in relation to the NMD and Table 7 1 outlines the respective feeder areas loadings.

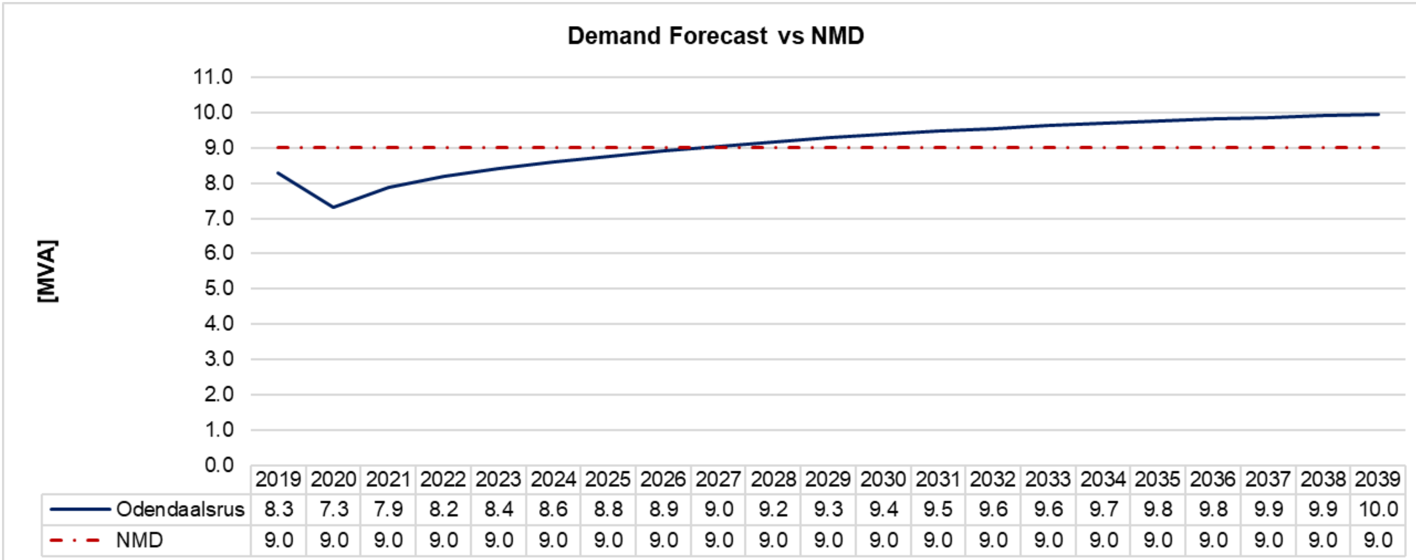
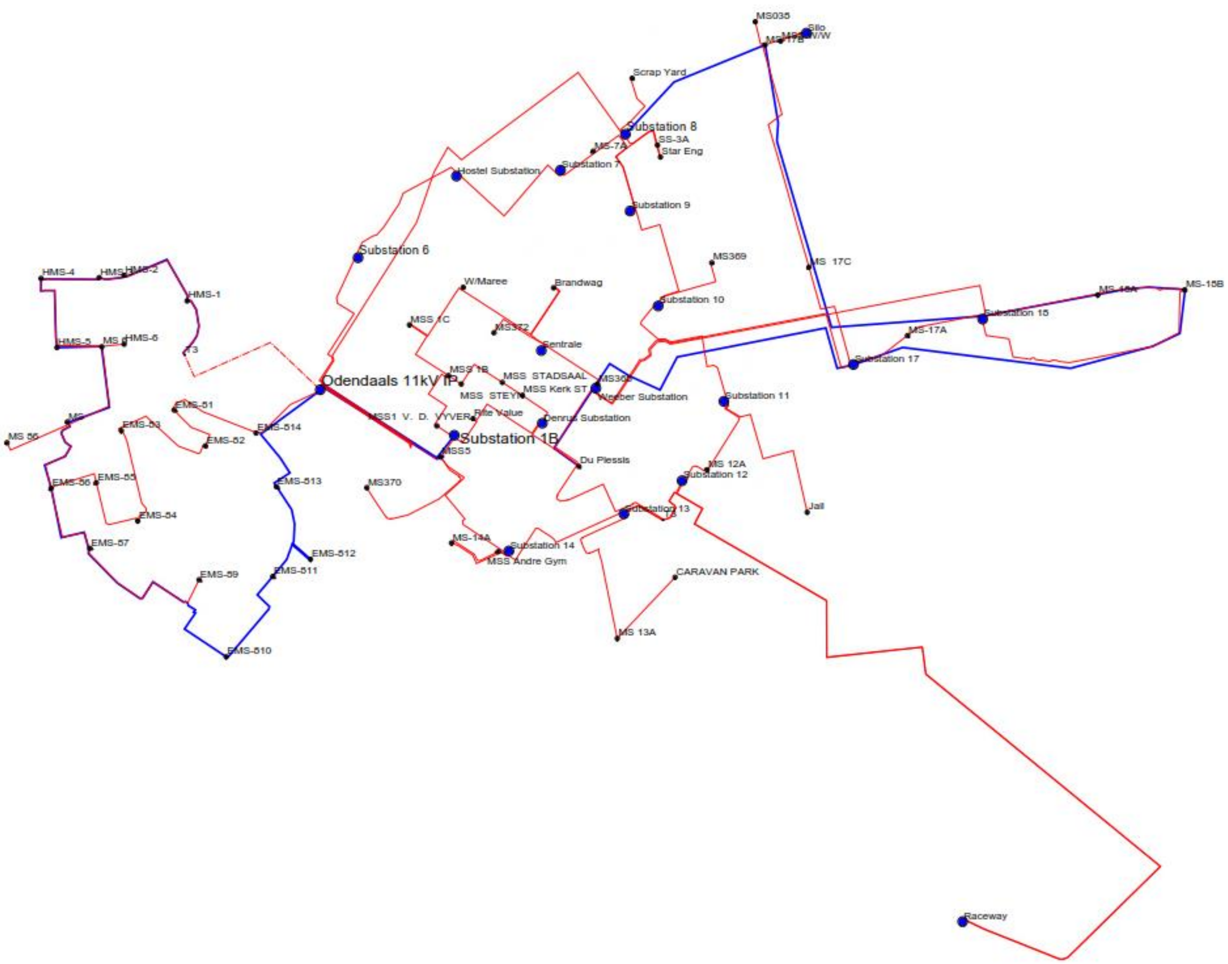



Figure 7-3: Odendaalsrus Intake Demand Forecast vs NMD

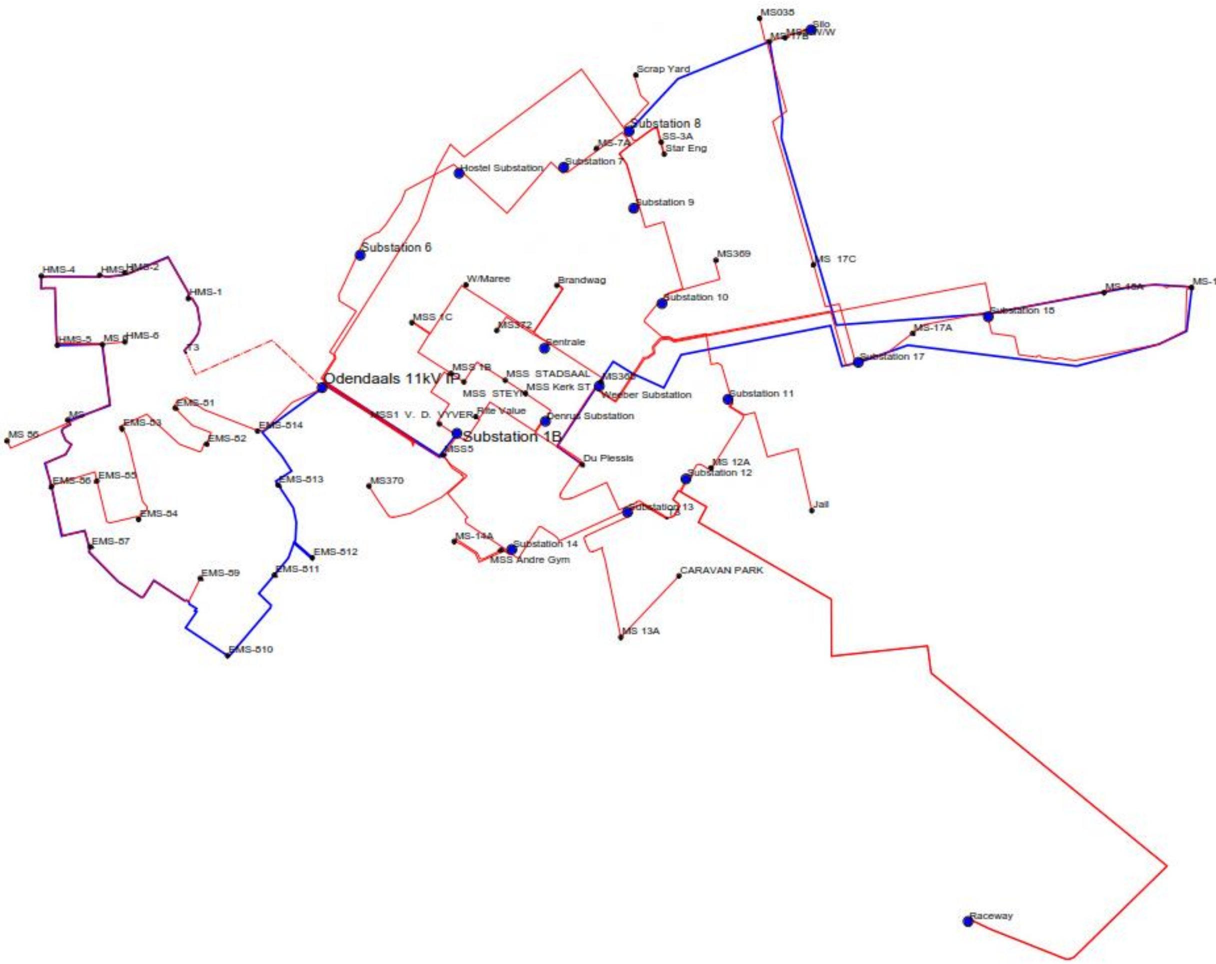
Table 7-5: Odendaalsrus Intake Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SS-1A_Bay 12 | 1.94 | 0 | 0.66 | 0.79 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 | 0.82 |
| SS-1A_Bay 2 & 11 | 1.94 | 0 | 1.04 | 1.26 | 1.29 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 | 1.30 |
| SS-1A_Bay 8 | 3.32 | 0 | 0.74 | 0.92 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 |
| SS-1A_Bay 9 | 3.32 | 0 | 1.74 | 2.05 | 2.18 | 2.22 | 2.24 | 2.24 | 2.24 | 2.24 | 2.24 | 2.24 | 2.24 | 2.24 | 2.24 | 2.24 |
| Bay 4 | 3.51 | | 4.55 | 3.81 | 3.89 | 3.95 | 4.01 | 4.09 | 4.18 | 4.28 | 4.37 | 4.47 | 4.56 | 4.65 | 4.99 | 5.18 |

Table 7-6: Odendaalsrus Area Proposed Network Development Plans

| Networks | Description |
|---|---|
|  | **1. Odendaalsrus 11kV Intake**<br>*Status:*<br>• The demand is forecasted to exceed the 9 MVA NMD by year 2028<br>• The Eskom substation has a 1 x 10 MVA transformers installed, with no firm capacity.<br>• Considering Eskom's 1.2 MVA load, the demand has exceeded the 80% thermal capacity of the transformer,<br>• With just the Matjhabeng load, the demand is forecasted to exceed the 80% thermal capacity 0f the transformer by year 2022 and is forecasted to be loaded at 100% of the thermal capacity by year 2039.<br>*Proposed:*<br>• Year 2025: Install a $2^{nd}$ 10 MVA transformer to increase capacity. (if Eskom wants a bigger size transformer, they will have to cover the remainder of the cost).<br>• Year 2028: Increase the NMD to 10 MVA.<br>**2. Odendaalsrus Feeder 1**<br>*Status:*<br>• The feeder is a meshed network of mainly 95 $mm^2$ PILC Copper.<br>*Proposed:*<br>• Year 2022: Upgrade the backbone cable to ±8000 m 185 $mm^2$ PILC Copper to ensure reliability. |

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>

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**3. Odendaalsrus Feeder Bays 2 & 11 Ring (Hospital Park)**

<u>*Status:*</u>

- The feeder is supplied by a OHL Fox conductor and 35 mm$^2$ XLPE Copper. This limits the capacity of the feeder to the capacity of the 35 mm$^2$ XLPE cable.
- However, the one portion connecting Main substation to Hospital Park is no longer present. Therefore, no firm or back-feeding capacity.
- An interconnector now connected between Hospital Park and Eldorie Park rings to create a new feeder bay 2 and 3 (Eldorie park and Hospital park).

<u>*Proposed:*</u>

- Year 2022: Replace the 35 mm$^2$ XLPE Copper cable with ±4000 m Fox conductor OHL to increase capacity and maintain firm capacity. Connect from T3 through to EMS-81.

**4. Odendaalsrus Feeder Bay 12 (Eldorie Park)**

<u>*Status:*</u>

- The feeder is supplied by a 95 mm$^2$ XLPE Copper and 35 mm$^2$ XLPE Copper cables. This limits the capacity of the feeder to the capacity of the 35 mm$^2$ XLPE cable.
- There is no firm capacity.
- An interconnector now connected between Hospital Park and Eldorie Park rings to create a new feeder bay 2 and 3 (Eldorie park and Hospital park).

<u>*Proposed:*</u>

- Year 2022: Replace the 35 mm$^2$ XLPE Copper cable

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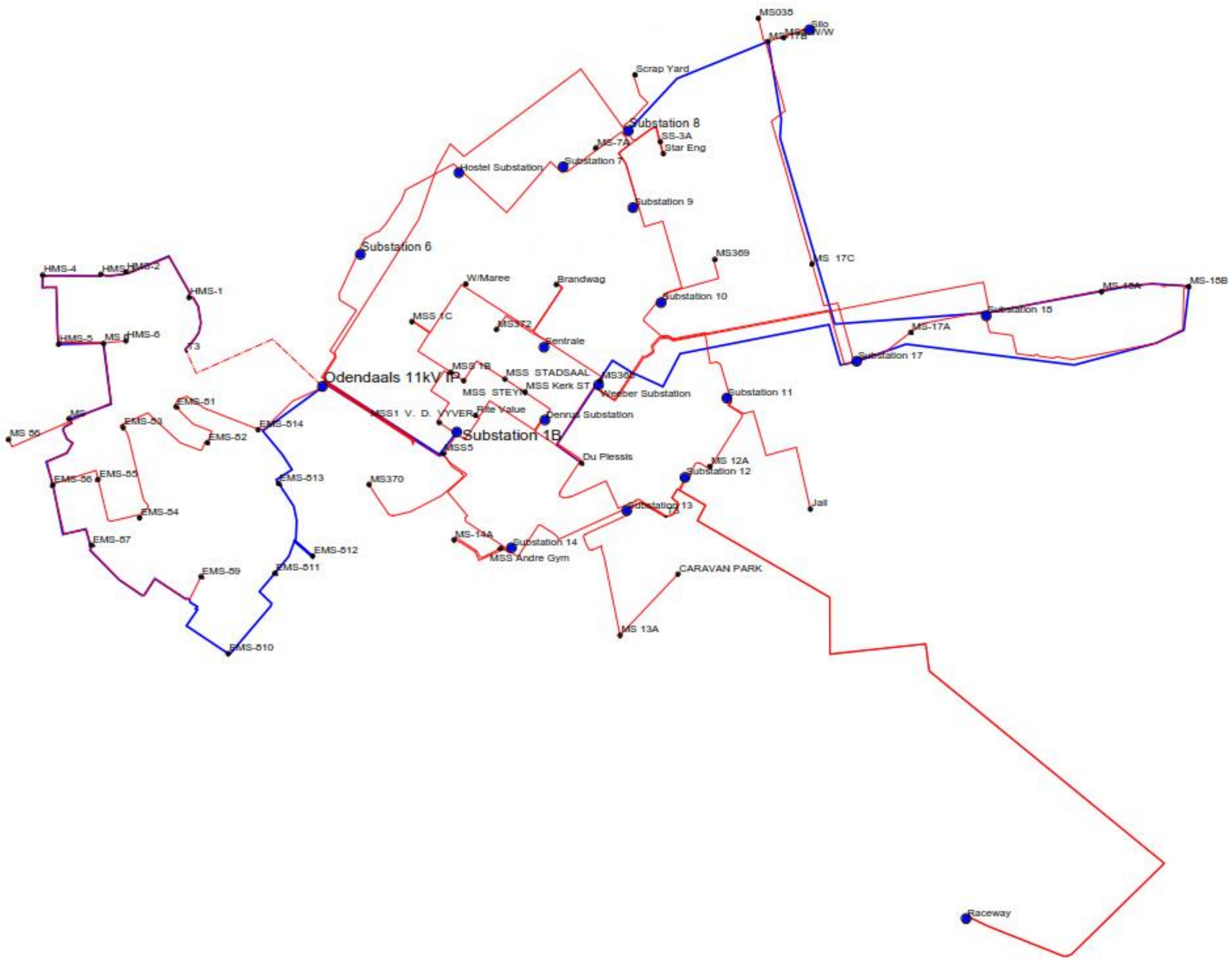
</table>

| Networks | Description |
|---|---|




with ±4000 m Fox conductor OHL to increase capacity and maintain firm capacity. Connect from T3 through to EMS-81.

**5. Odendaalsrus Feeder Bay 4 (Substation 1B & MSS5)**

*Status:*

- The feeder is supplied by a OHL Fox conductor and 95 mm$^2$ XLPE Copper.
- Furthermore, the OHL Fox conductor portion of the conductor also supplies Feeder Bay 4 (MSS5).
- The OHL Fox conductor portion is overloading as it feeds the entire central town.

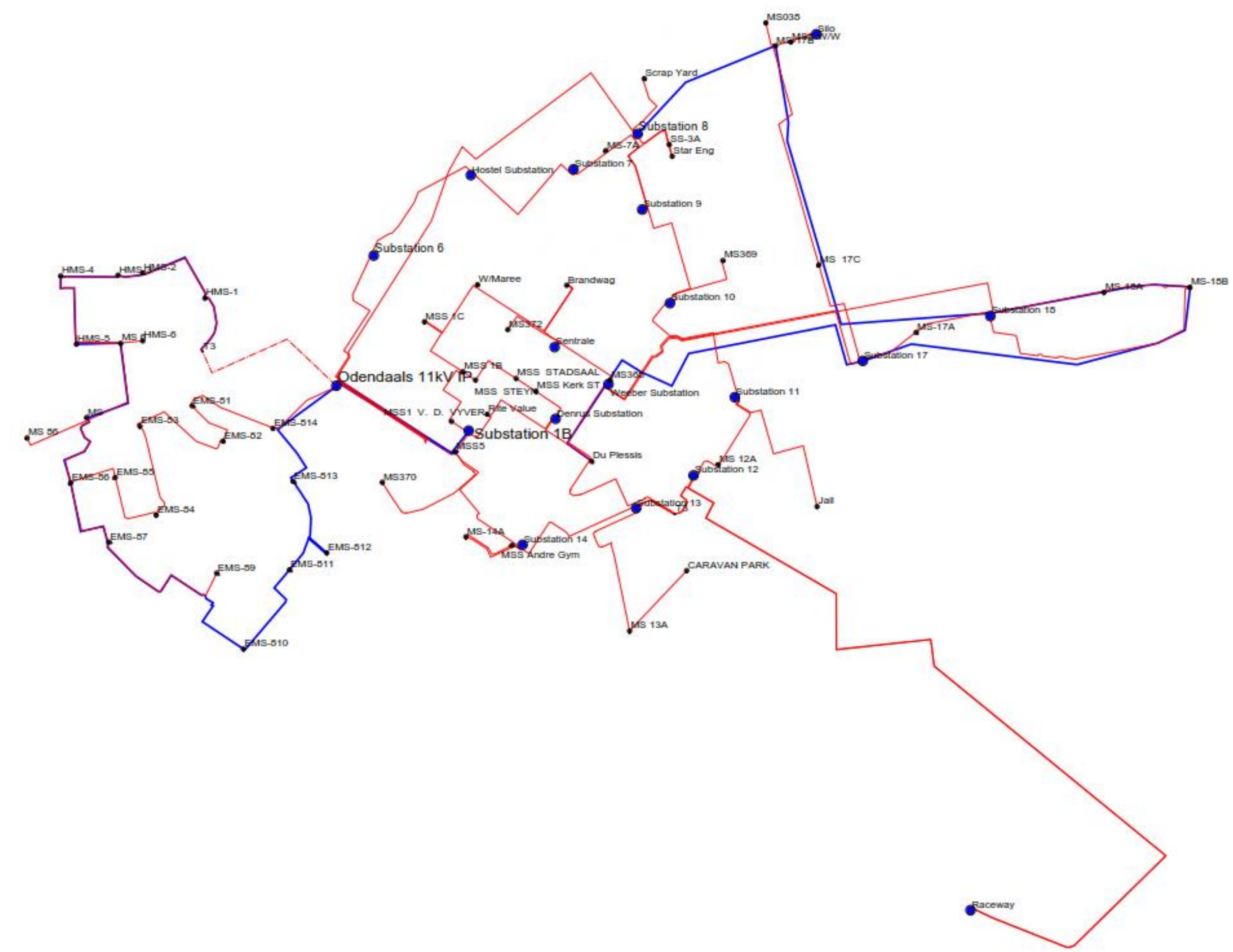
*Proposed:*

- Year 2022: Replace the OHL Fox conductor with a ±650 m with a Chicadee conductor OHL to increase capacity.
- Year 2023: Construct a 2$^{nd}$ ±650 m, Chicadee conductor OHL to ensure firm capacity, with ±100 m, 2x95 mm$^2$ XLPE Copper one terminating at MSS5 and the other at Sub 1B.

**6. Odendaalsrus Feeder Bay 9 (Substation 8)**

*Status:*

- The feeder is supplied by a 185 mm$^2$ XLPE Copper cable, with interconnection to Weeber substation via Sub 17 and Sub 18, and Sub 10 via Sub 9.
- Substation 18 network running from MS 18A (MV side currently not functioning) through 18 B back to Substation 17's lines are drenched with water and currently are not online as they cannot perform maintenance on the lines

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


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- Line between Substation 8 and MS 17B stolen
- Line between Weeber substation and Substation 18 not online, breaker in Weeber substation vandalised
- Weeber substation to Du Plessis lie also drenched in water and not online

*Proposed:*

- Year 2022: Replace the 95 mm$^2$ XLPE Copper cable with ±3000 m OHL Chicadee conductor connecting from Sub 18 – MS18A – MS18B – MS17A – Sub 17.
- Year 2022: Replace the stolen cable with a new ±800 m OHL Chicadee conductor connecting from Sub 8 – MS 17B. Extend the OHL Chicadee (±1600 m) conductor from MS17B – MS17C – Sub 17.
- Year 2022: Replace the stolen cable with a new ±2200 m OHL Chicadee conductor connecting from Sub 18 – Weeber
- Year 2022: Install a new breaker at Weeber substation
- Year 2022: Install a new ±500 m OHL Chicadee conductor connecting from Weeber – Du Plessis

**7. Refurbishments:**

- The condition of the switchgears in Substation 1A are in poor condition, a lot of the units are aged and utilise oil as an extinguishing agent which poses a risk of possible explosion if a fault is not adequately cleared
- The Feeder Bays for Eskom Incomer 2, SS1B, Hospital park 1, MSS5 Feeder, Substation 6, Eldorie 1 and Hospital park 2 are all aged and in bad condition

</td></tr>
</table>

### 7.2.4 Ventersburg 11kV Intake Area

Figure 7-4 shows the Ventersburg Intake demand forecast in relation to the NMD and Table 7-7 outlines the associated feeder areas loadings.

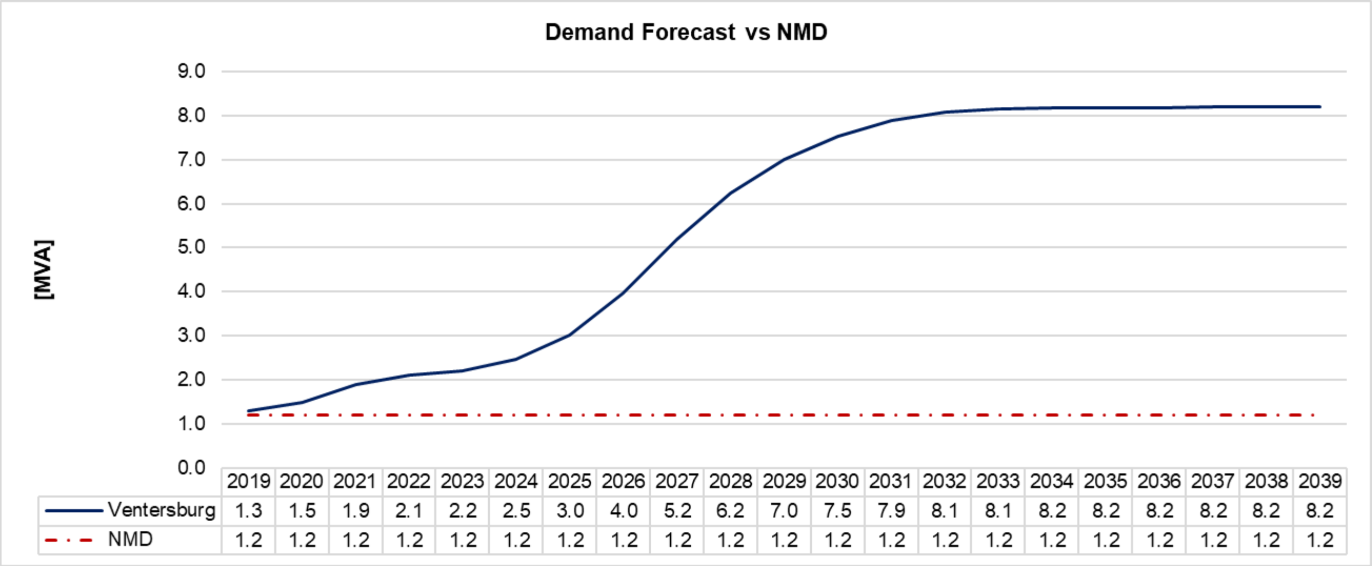
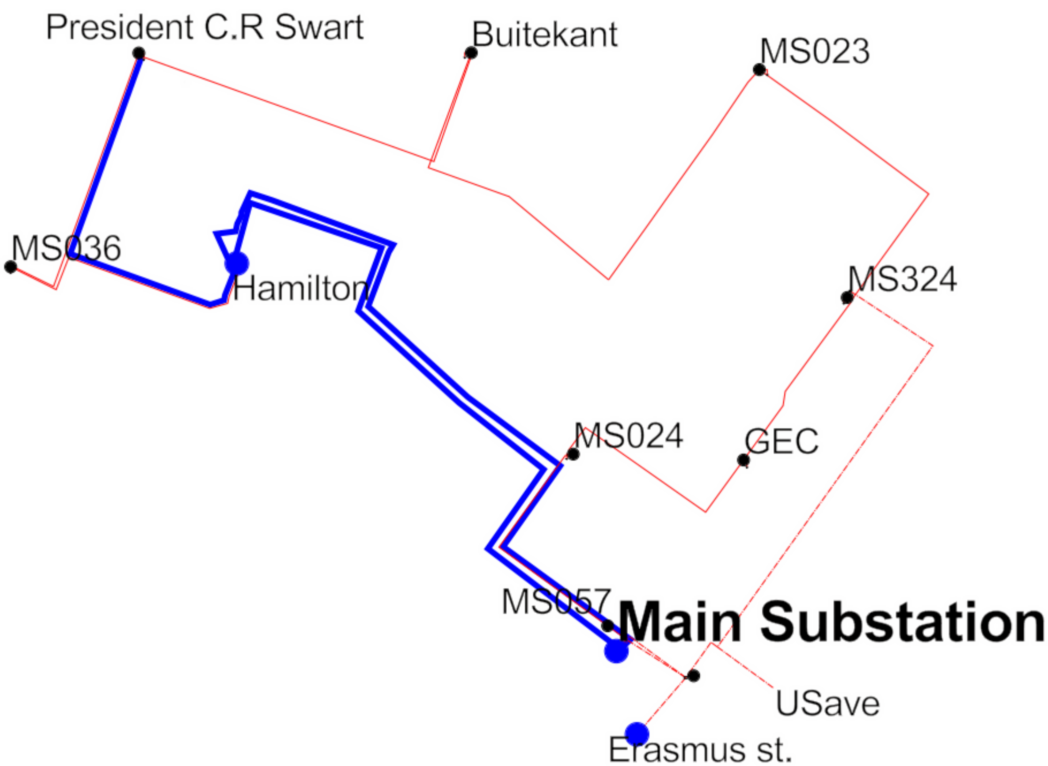


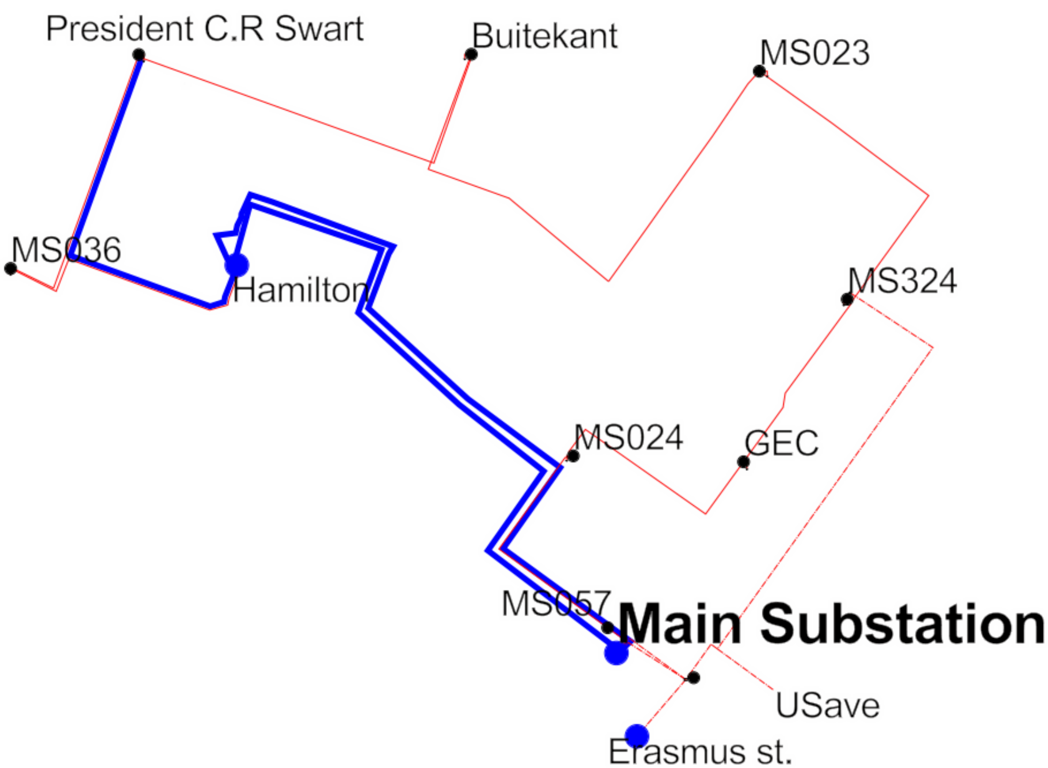

Figure 7-4: Ventersburg Intake Demand Forecast vs NMD

Table 7-7: Ventersburg Intake Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 2 & 3_11kV busbar | 4.6 | 0 | 1.05 | 0.84 | 1.18 | 1.37 | 1.67 | 2.59 | 4.59 | 5.75 | 6.43 | 7.01 | 7.43 | 7.56 | 7.57 | 7.57 |
| Bay 4_11kV busbar | 3.6 | 0 | 0.34 | 0.34 | 0.55 | 0.67 | 0.72 | 0.73 | 0.74 | 0.74 | 0.74 | 0.74 | 0.74 | 0.74 | 0.74 | 0.74 |

Table 7-8: Ventersburg Area Proposed Network Development Plans

| Networks | Description |
|---|---|
|  | **1. Ventersburg 11kV Intake**<br><br>*Status:*<br><br>• The demand has exceeded the 1.2 MVA NMD<br><br>*Proposed:*<br><br>• Year 2021: Increase the NMD to 3 MVA.<br>• Year 2026: Increase the NMD to 7 MVA.<br>• Year 2030: Increase the NMD to 8.2 MVA.<br><br>**2. Ventersburg Bay 2 & 3_11kV Feeder**<br><br>*Status:*<br><br>• The feeder ring is supplied by 2 x 70 mm2 XLPE Copper;<br>• However, the feeder for Main Substation – Hamilton was lost in a veld fire<br>• The demand is forecasted to exceed the firm capacity by year 2028.<br><br>*Proposed:*<br><br>• Year 2021: Replace the damaged cable running to Hamilton substation with a new ±1400 m, OHL Mink conductor.<br>• Year 2021: Upgrade the President CR Swart – Buitekant line to ±750 m, OHL Mink conductor<br>• Year 2021: Upgrade the Buitekant – MS023 line to ±1100 m, OHL Mink conductor<br>• Year 2026: Install 5 x 500 kVA mini-subs to cater for additional load<br>• Year 2028: Install a 3rd cable, ±1500 m, 70 $mm^2$ XLPE, Cu from Ventersburg to President CR Swart street to create a 3- |

| Networks | Description |
|---|---|
|  | legged ring, to strengthen the ring.<br>**3. Refurbishment:**<br>• The general condition of the Ventersburg Main Substation is poor and severely aged. The infrastructure has been operational for many decades with many of the conductors in the network being 6mm$^2$ Copper cables fed by severely aged switchgears<br>• The switchgear units which require attention include; the USave and Eskom Feeder Bays which require refurbishment<br>• The substation transformers show evidence of oil leaks and previous burns on the bushings |

### 7.2.5 Virginia Area

#### 7.2.5.1 Virginia Main 11kV Intake Area

Figure 7-5 shows the Virginia Main Intake demand forecast in relation to the NMD and Table 7-9 outlines the associated feeder areas loadings.

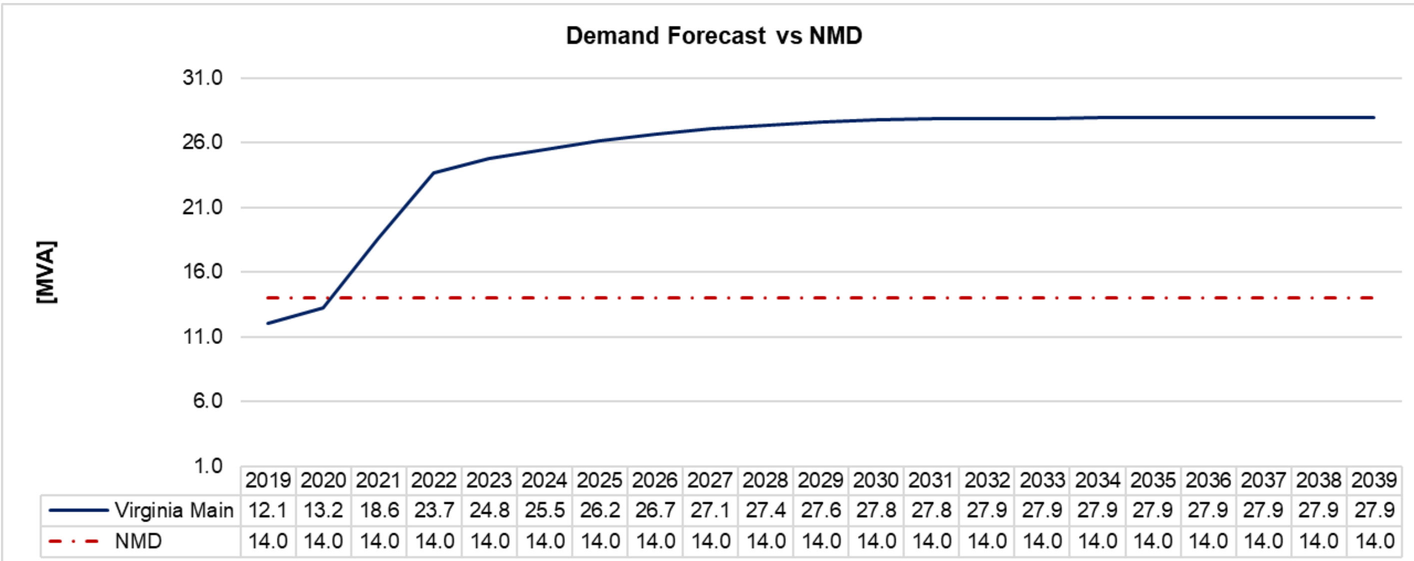
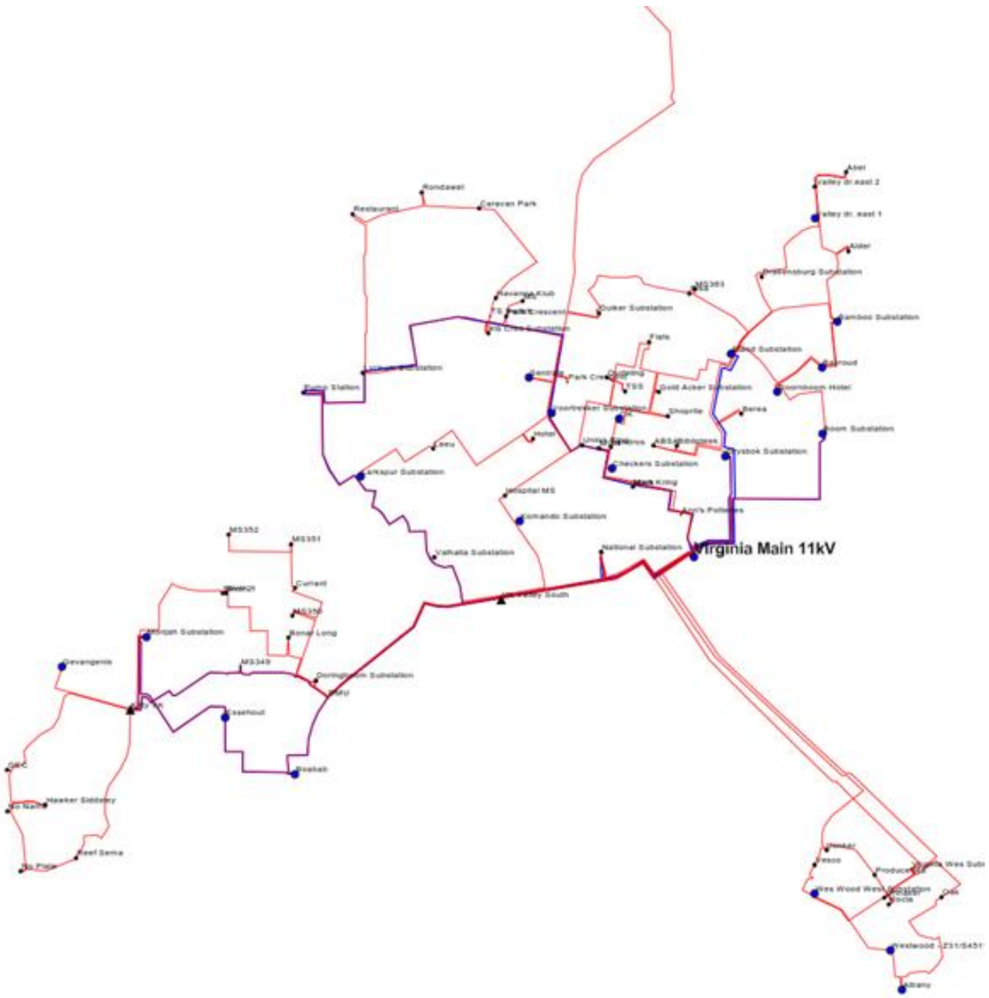


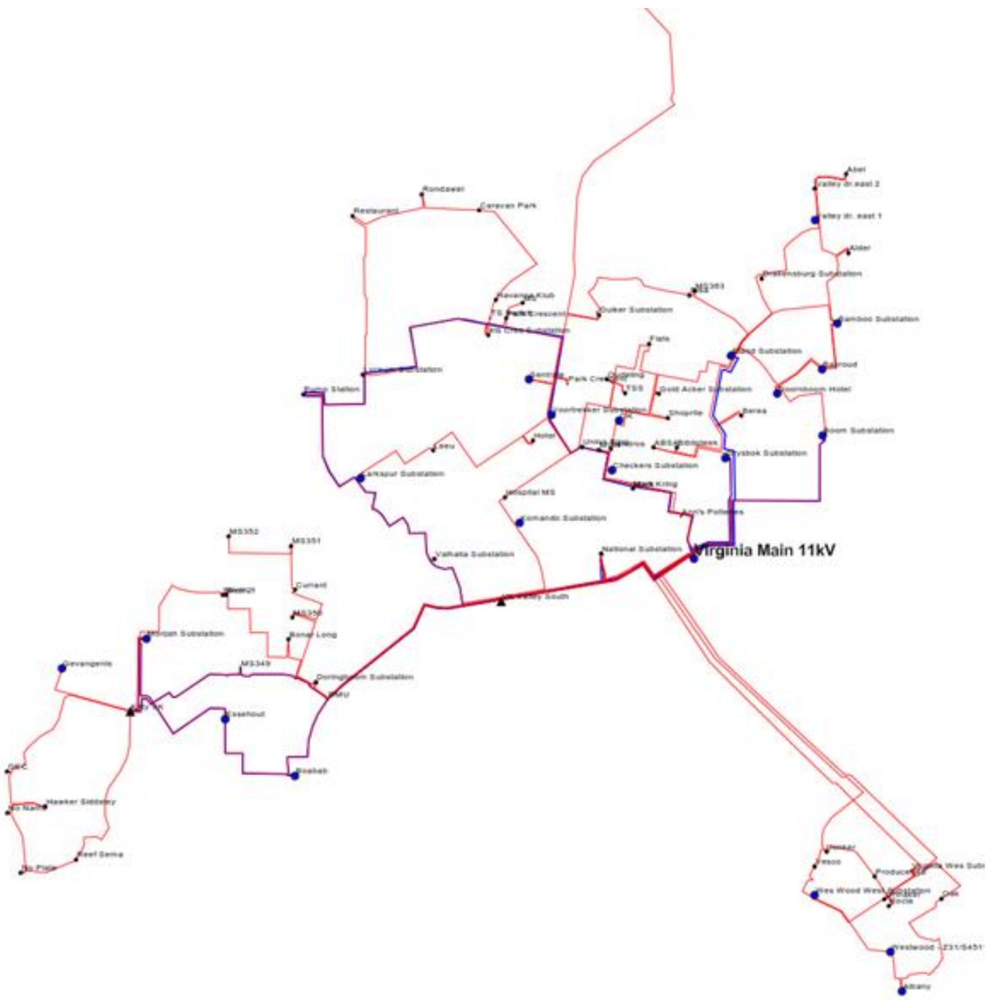

Figure 7-5: Virginia Main Intake Demand Forecast vs NMD

Table 7-9: Virginia Main Intake Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Virginia Main Feeder 1&3 (2x35) | 9.0 | 4.5 | 4.71 | 4.87 | 6.05 | 6.20 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 | 6.22 |
| Virginia Main Feeder 2&14 | 9.0 | 4.5 | 2.20 | 2.22 | 2.67 | 2.84 | 2.90 | 2.92 | 2.92 | 2.93 | 2.93 | 2.93 | 2.93 | 2.93 | 2.93 | 2.93 |
| Virginia Main Feeder 6&8 | 9.0 | 4.5 | 2.87 | 2.99 | 3.73 | 5.27 | 5.29 | 5.30 | 5.30 | 5.30 | 5.30 | 5.30 | 5.30 | 5.30 | 5.30 | 5.30 |
| Virginia Main Feeder 9&10 | 9.0 | 4.5 | 0.16 | 0.61 | 2.24 | 3.96 | 4.73 | 5.12 | 5.38 | 5.45 | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 |
| Virginia Main Feeder 7&13 | 13.4 | 9.0 | 2.59 | 2.59 | 3.14 | 4.23 | 4.31 | 4.47 | 4.74 | 5.04 | 5.27 | 5.44 | 5.57 | 5.65 | 5.70 | 5.70 |

Table 7-10: Virginia Main Area Proposed Network Development Plans

| Networks | Description |
|---|---|
|  | **1. Virginia Main 11kV Intake**<br>*Status:*<br>• The demand is forecasted to exceed the 14 MVA NMD by year 2021<br>• The Eskom substation has a 1 x 20 MVA transformer installed, with no firm capacity.<br>• The demand is forecasted to exceed the installed transformer capacity by year 2022.<br>*Proposed:*<br>• Year 2021: Increase the NMD to 20 MVA.<br>• Year 2022: The demand will require an upgrade of the transformer. Replace the 20 MVA transformer with a 30 MVA transformer.<br>• Year 2024: Increase the NMD to 24 MVA.<br>**2. Virginia Main Feeder Bay 1&3**<br>*Status:*<br>• The feeder ring is supplied by 2 x 95 $mm^2$ PILC Copper, with the demand exceeding the firm capacity.<br>• Although it is interconnected to other feeders, the reliability thereof cannot be ascertained.<br>*Proposed:*<br>• Year 2022: Given that networks are old, upgrade the 95 $mm^2$ PILC Cu cables to ±5500 m, 2x185 $mm^2$ PILC Cu.<br>**3. Virginia Main Feeder Bay 6&8**<br>*Status:* |

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


</td><td>

- The feeder ring is supplied by 2 x 95 mm$^2$ PILC Copper, with the demand forecasted to exceed the firm capacity year 2022.

*Proposed:*

- Year 2022: Given that networks are old, upgrade the 95 mm$^2$ PILC Cu with ±9800 m, 150 mm$^2$ PILC Copper to strengthen the ring and maintain firm capacity.

**4. Virginia Main Feeder Bay 9&10**

*Status:*

- The feeder ring is supplied by 2 x 95 mm$^2$ PILC Copper, with the demand forecasted to exceed the firm capacity year 2023.

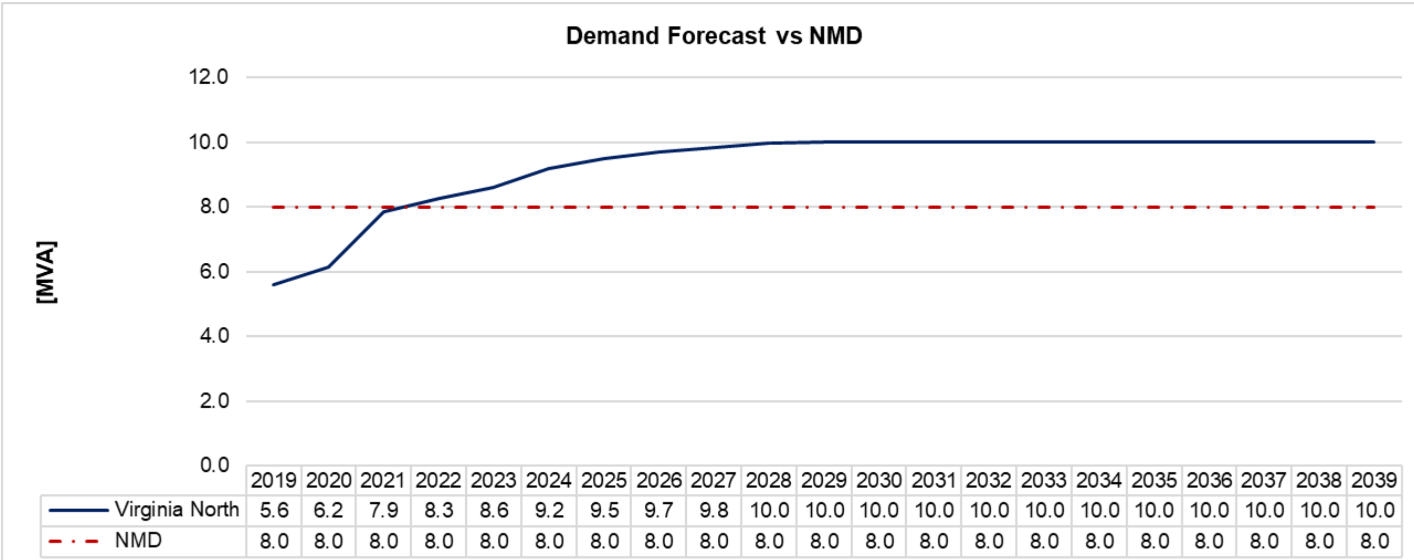
*Proposed:*

- Year 2024: Given that networks are old, upgrade the 95 mm2 PILC Cu with ±1100 m, 150 mm2 PILC Copper to strengthen the ring and maintain firm capacity.

</td></tr>
</table>

### 7.2.5.2 Virginia North 11kV Intake Area

Figure 7-6 shows the Virginia North Intake demand forecast in relation to the NMD and Table 7-11 outlines the associated feeder areas loadings. As shown on the results below, no network development interventions are required.




| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Virginia North | 5.6 | 6.2 | 7.9 | 8.3 | 8.6 | 9.2 | 9.5 | 9.7 | 9.8 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| NMD | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 | 8.0 |

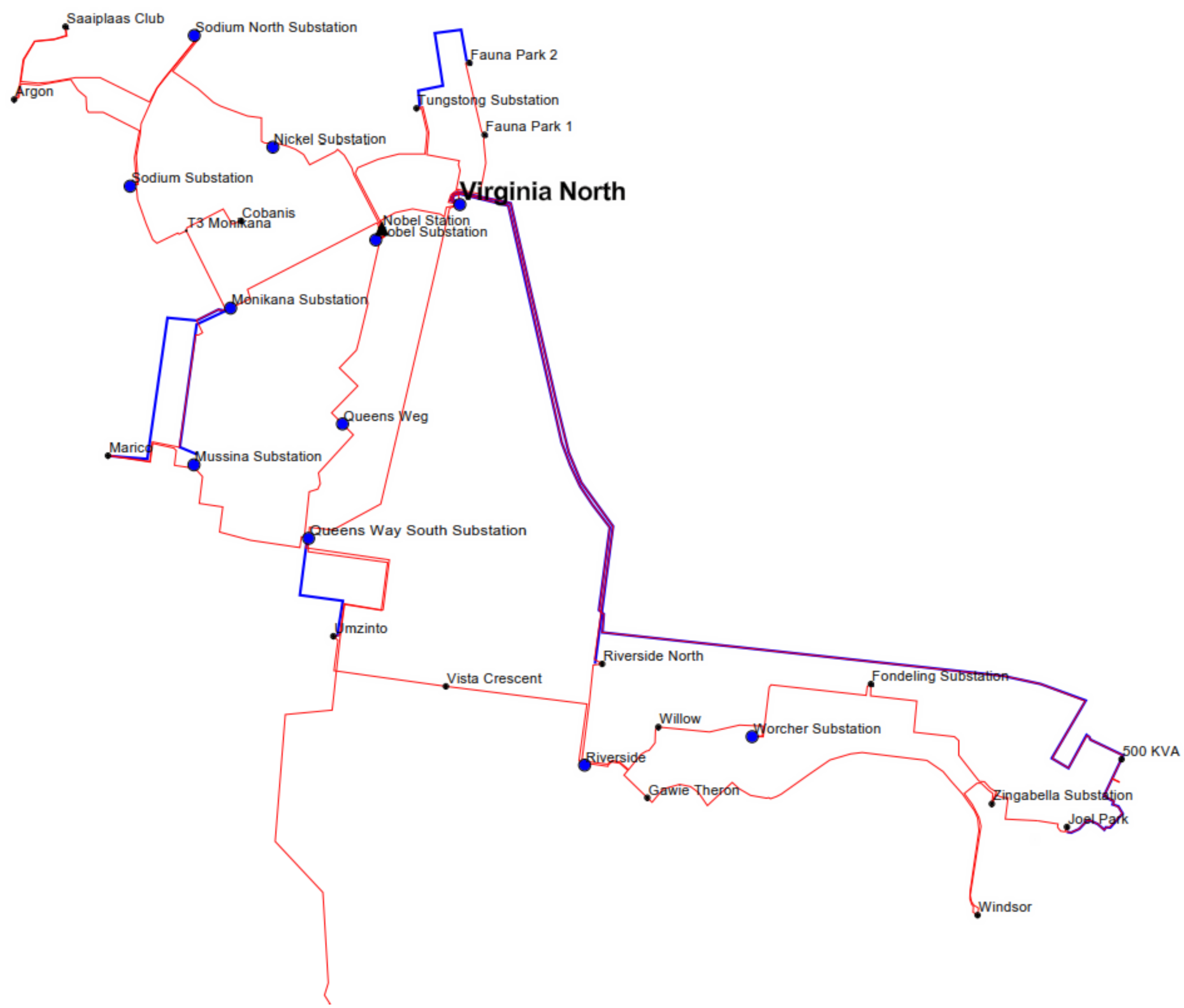
Figure 7-6: Virginia North Intake Demand Forecast vs NMD

Table 7-11: Virginia North Intake Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Virginia North_Bay 1 | 5.5 | 0.0 | 0.31 | 0.33 | 0.41 | 0.42 | 0.46 | 0.54 | 0.59 | 0.62 | 0.64 | 0.66 | 0.66 | 0.66 | 0.66 | 0.66 |
| Virginia North_Bay 3 & 4 | 11 | 5.5 | 1.85 | 2.00 | 2.53 | 2.62 | 2.82 | 3.29 | 3.56 | 3.71 | 3.85 | 3.95 | 3.98 | 3.99 | 3.99 | 3.99 |
| Virginia North_Bay 4 & 9 | 11 | 5.5 | 2.04 | 2.16 | 2.80 | 3.05 | 3.14 | 3.17 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 | 3.18 |
| Virginia North_Bay 5 & 10 | 11 | 5.5 | 1.45 | 1.76 | 2.20 | 2.27 | 2.28 | 2.28 | 2.28 | 2.28 | 2.28 | 2.28 | 2.28 | 2.28 | 2.28 | 2.28 |

Table 7-12: Virginia North Intake Feeders Demand Forecast

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>




</td><td>

**1. Virginia North 11kV Intake**

*<u>Status:</u>*

- The demand is forecasted to exceed the 8 MVA NMD by year 2022
- The Eskom substation has a 1 x 20 MVA transformer installed, with no firm capacity.

*<u>Proposed:</u>*

- Year 2022: Increase the NMD to 10 MVA.

**2. Virginia North Feeder Bay 1**

*<u>Status:</u>*

- The feeder is supplied by 1 x 95 mm$^2$ XLPE Copper, with no firm capacity.

*<u>Proposed:</u>*

- Year 2022: Install a ±800 m, 95 mm$^2$ XLPE Cu interconnector from Fauna Park 2 – Tungsteng Sub.

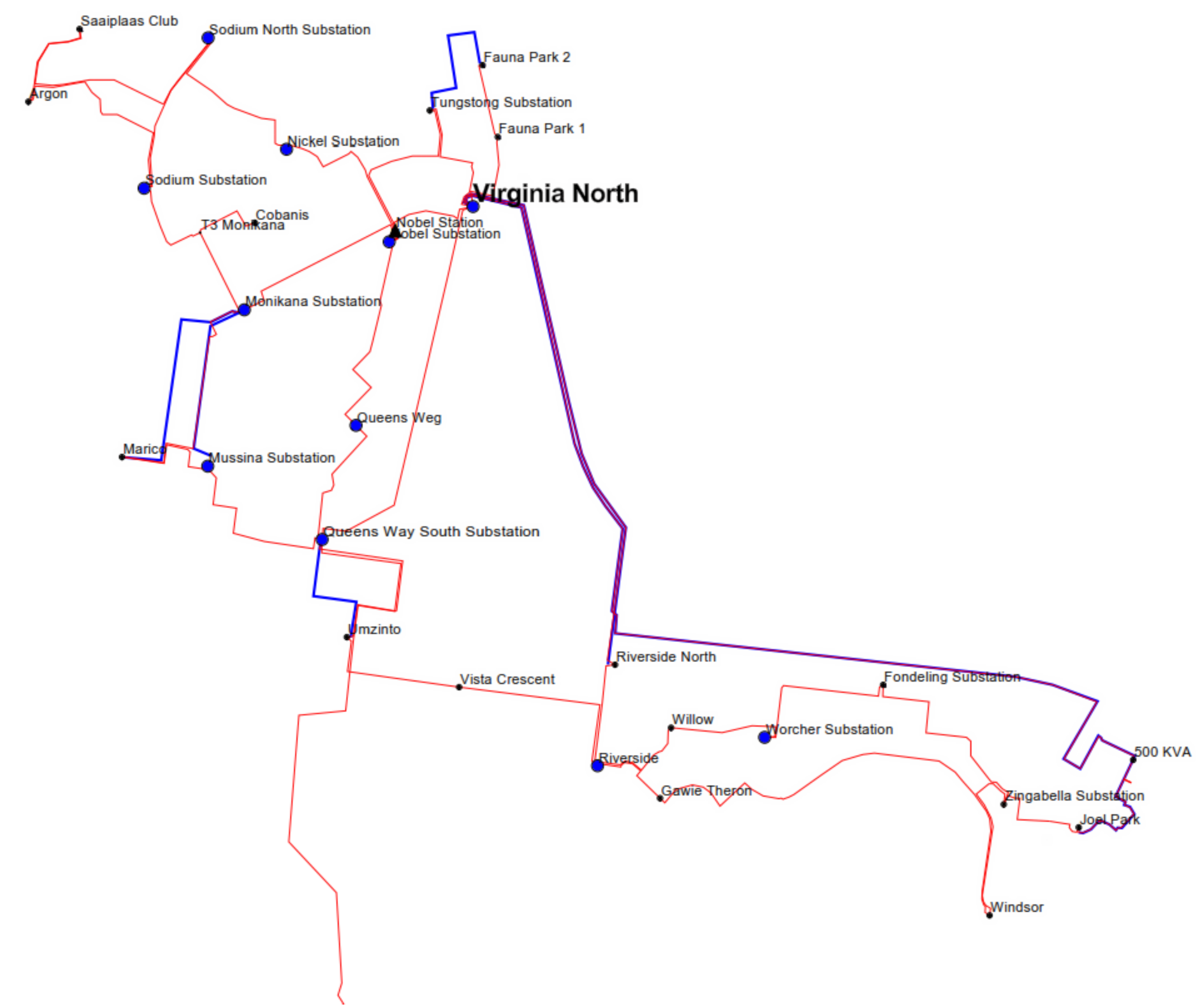
**3. Virginia North Feeder Bays 4&9**

*<u>Status:</u>*

- The feeder ring is supplied by 2 x 95 mm2 XLPE Copper.
- However, the cable from Queens Way South – Umzinto is stolen.
- Also, the cable from Mussina – Marico – Monikana is stolen.

*<u>Proposed:</u>*

</td></tr>
</table>

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


</td><td>

- Year 2022: Install a ±850 m, Hare OHL from Queens Way South – Umzinto.
- Year 2022: Install a ±1300 m, Hare OHL from Mussina – Marico – Monikana.

**4. Virginia North Feeder Bays 5&10**

*Status:*

- The feeder ring is supplied by 2 x 95 mm2 XLPE Copper.
- However, the cable from Virginia North – Joel Park (Feeder Bay 5) is stolen, no longer a ring between Bay 5 and 10

*Proposed:*

- Year 2022: Install a ±5000 m, Hare OHL from Virginia North – Joel Park (Feeder Bay 5) to close the ring.
- Year 2022: Install a ±2200 m, Hare OHL from Virginia North – Riverside North (Feeder Bay 10) to close the ring.

**5. Refurbishments:**

- General condition of the switchgears in the Virginia North Substation is good
- Service records from an inspection on Virginia North Substation showed Switchgears for Feeder Bay 7 & 8 require oil

</td></tr>
</table>

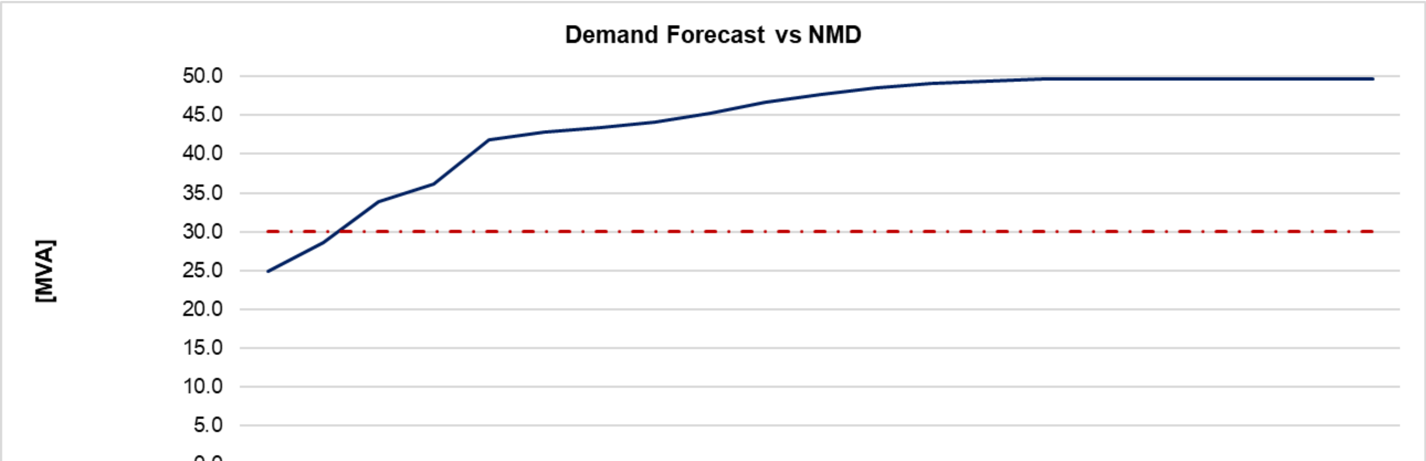
### 7.2.6 Welkom Area

The Welkom area is supplied by five (5) intake points, these are discussed below.

#### 7.2.6.1 Welkom Bulk 132kV Intake Area

Welkom Bulk Intake is supplied from Eskom's Everest MTS and it supplies Welkom CBD and Welkom Industries substations at 132 kV. Figure 7-7 illustrates the Welkom Bulk Intake demand forecast in relation to the NMD. From Figure 7-7, the demand is forecasted to exceed the 30 MVA NMD by the year 2021. It is therefore proposed that the Welkom Bulk Intake NMD be increased as follows:

- Year 2022: Increase NMD to 45 MVA
- Year 2028: Increase NMD to 50 MVA




| | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 | 2038 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Welkom Bulk | 24.9 | 28.6 | 33.8 | 36.1 | 41.8 | 42.8 | 43.4 | 44.1 | 45.3 | 46.7 | 47.7 | 48.5 | 49.1 | 49.4 | 49.6 | 49.7 | 49.7 | 49.7 | 49.7 | 49.7 | 49.7 |
| NMD | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |

Figure 7-7: Welkom Bulk Intake Demand Forecast vs NMD

***Welkom Industries 132/6.6kV Substation***

Figure 7-8 shows the Welkom Industries substation demand forecast in relation to the installed and firm capacities, and Table 7-13 outlines the associated feeder areas loadings. From Figure 7-8 it can be seen that the forecasted demand is still within the firm and installed capacities of the substation. Furthermore, from Table 7-13 it can be seen that switching station SS 6 is forecasted to exceed its firm capacity by year 2033. However, given that the study period is for the next 10 years and the immediate pressing needs, this is left out to be covered in the next update of the master plan.

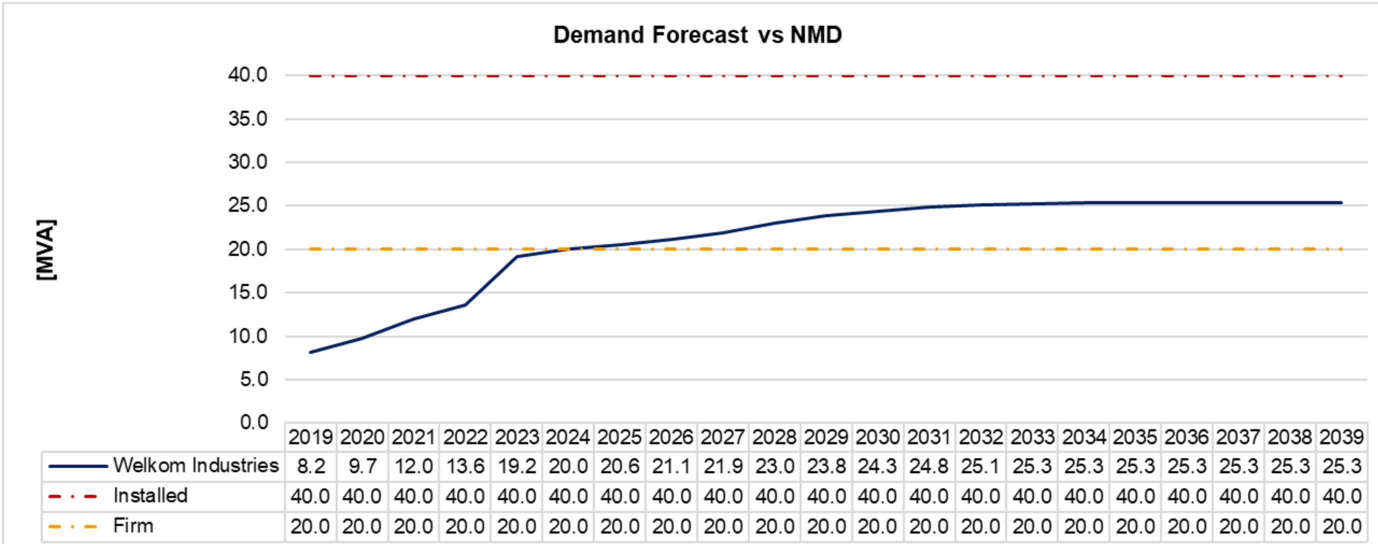
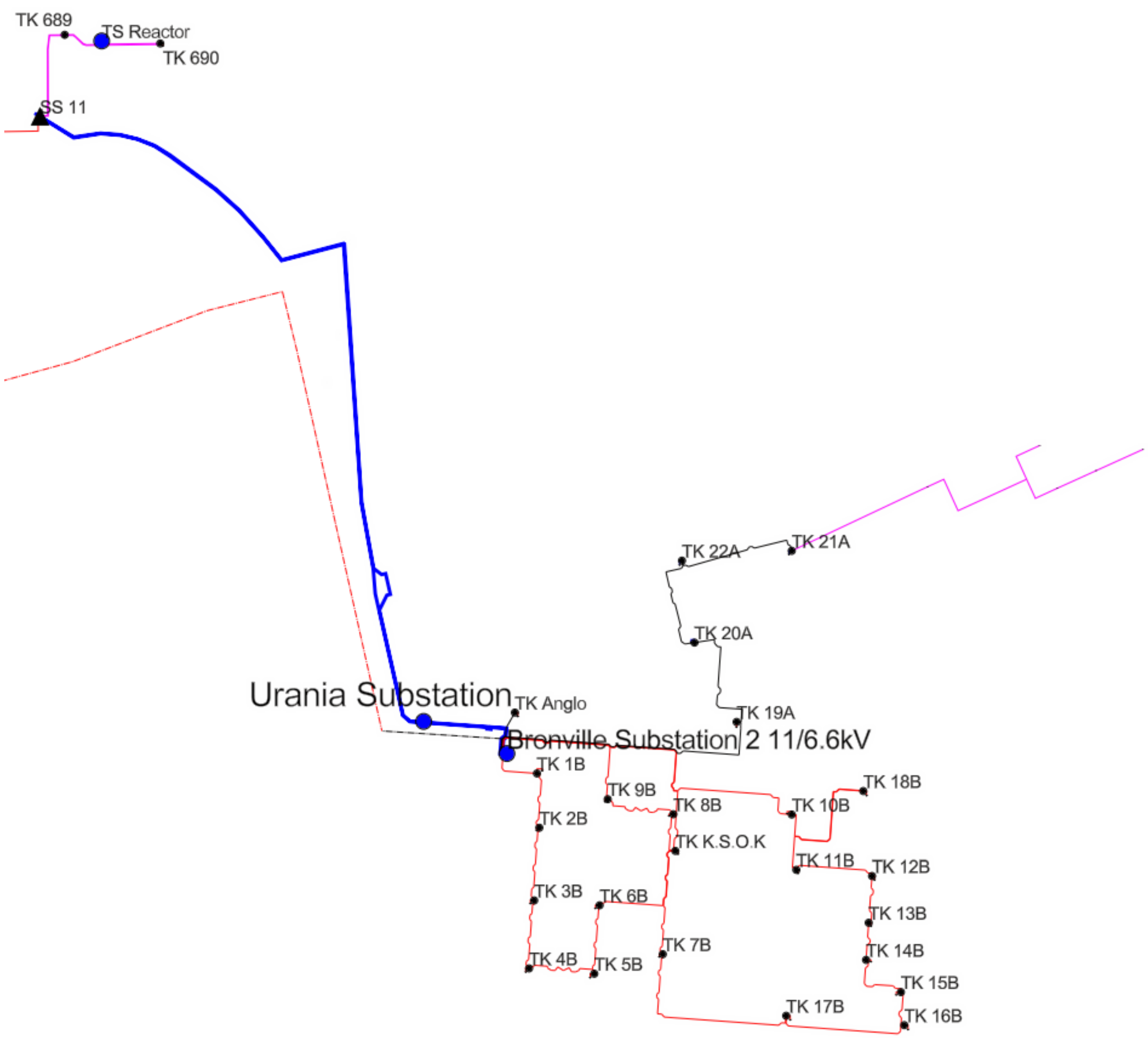



Figure 7-8: Welkom Industries Substation Demand Forecast vs Installed and Firm Capacities

Table 7-13: Welkom Industries Substation Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 16 &17_Meter Panel 2 | 10.7 | 5.4 | 1.03 | 1.17 | 1.32 | 1.37 | 1.39 | 1.40 | 1.40 | 1.41 | 1.44 | 1.46 | 1.48 | 1.50 | 1.52 | 1.52 |
| Bay 19, 21 &20_Meter Panel 3 | 8.3 | 4.2 | 1.29 | 1.50 | 1.84 | 1.99 | 2.08 | 2.11 | 2.13 | 2.20 | 2.36 | 2.61 | 2.79 | 2.92 | 3.11 | 3.11 |
| Bay 7_Meter Panel 1 | 5.3 | 0 | 0.56 | 0.76 | 0.92 | 0.98 | 1.00 | 1.01 | 1.01 | 1.01 | 1.01 | 1.03 | 1.06 | 1.07 | 1.10 | 1.10 |
| SS 1 Knoppie Alleen | 12.5 | 8.3 | 2.78 | 3.25 | 4.13 | 4.79 | 5.10 | 5.20 | 5.23 | 5.38 | 5.70 | 6.19 | 6.55 | 6.81 | 7.20 | 7.20 |
| SS 6 12th | 12.5 | 8.3 | 3.04 | 3.66 | 4.48 | 5.13 | 5.60 | 6.33 | 6.80 | 7.22 | 7.77 | 8.43 | 8.86 | 9.14 | 9.54 | 9.54 |
| SS11_Bay 6 & 19 | 13.7 | 6.9 | 0.02 | 0.02 | 0.07 | 0.15 | 5.23 | 5.27 | 5.29 | 5.29 | 5.29 | 5.30 | 5.31 | 5.31 | 5.32 | 5.32 |

Table 7-14: Welkom Industries Area Proposed Network Development Plans

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>
</td><td>

**1. Welkom Industries 132/6.6kV Substation**

*Status:*

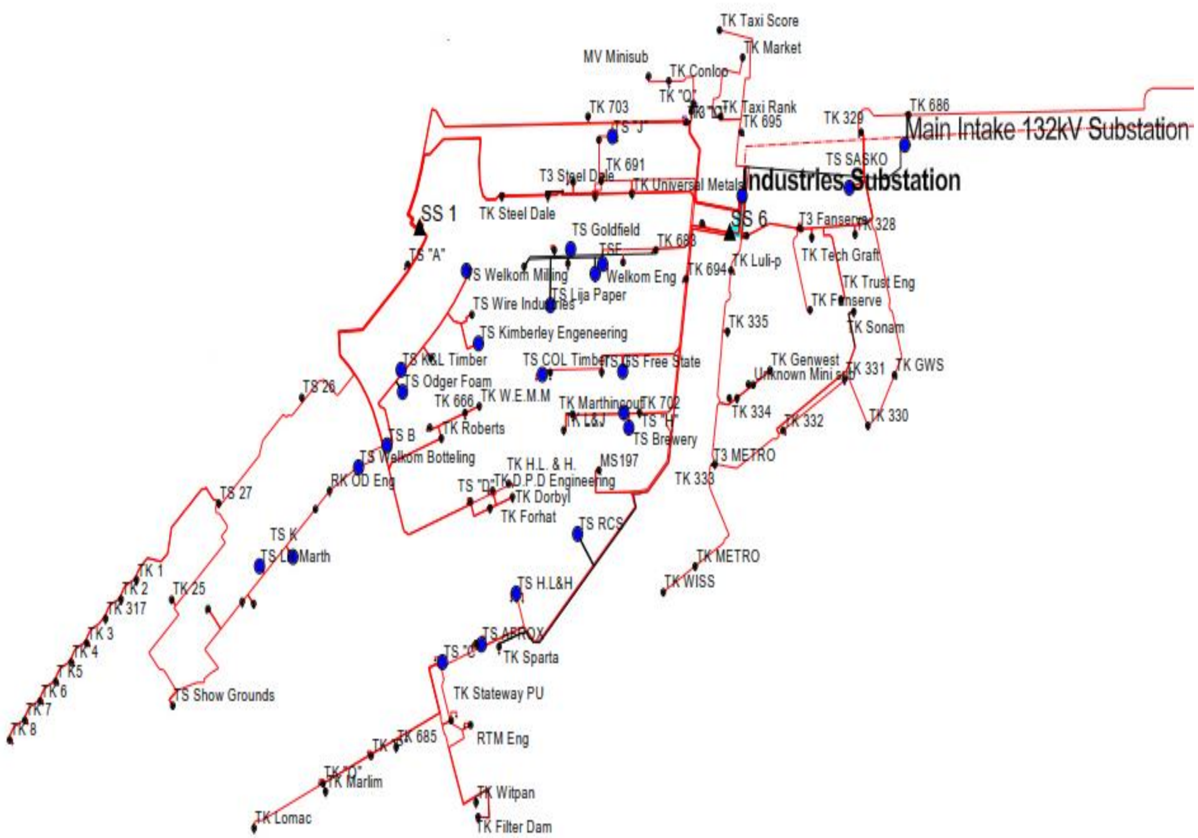
- The substation has 2x20MVA transformers installed
- The demand is forecasted to exceed the firm capacity and the 20 MVA NMD by year 2023

*Proposed:*

- Year 2023: Install a 3rd cable, ±2500 m, 150 mm$^2$ XLPE, Cu to create a three-legged ring to maintain firm capacity
- Year 2023: Supply Bronville substation from Urania substation with ±1000 m, Chicadee OHL
- Year 2023: Supply the 5MVA Thabong Purification Plant from the newly built Urania Substation with ±4000 m, Chicadee OHL from Urania substation to SS11.

</td></tr>
</table>

| Networks | Description |
|---|---|




## 2. Welkom Park SS6 Switching Station

*Status:*

- The switching station is supplied by 3 x 150 $mm^2$ XLPE Copper;
- The demand is forecasted to exceed the firm capacity by year 2028;

*Proposed:*

- Year 2028: Install a 4th cable on the SS 6 Feeder (Spare), ±200 m, 150 mm2 XLPE, Cu to maintain firm capacity;

## 3. Refurbishments:

- New Industries incomer 1 and 2 are aged and are missing their covers, they require refurbishment. This includes Bronville overhead line, TK 695 Feeder Bays as well.
- All three switchgears for SS 6 Feeder Bays are in poor condition and will require refurbishment
- The 20MVA transformer shows signs of oil leaks on several point of the transformer
- The Ferranti tap changer has fallen and was left damaged on the substation grounds
- SS 11 has removed breakers and damaged substation interior, refurbishment will be required on some switchgears

### *Welkom CBD 132/6.6 kV Substation*

Figure 7-9 shows the Welkom CBD substation demand forecast in relation to the installed and firm capacities, and Table 7-15 outlines the associated feeder areas loadings. From Figure 7-9 it can be seen that the forecasted demand is still within the firm and installed capacities of the substation.

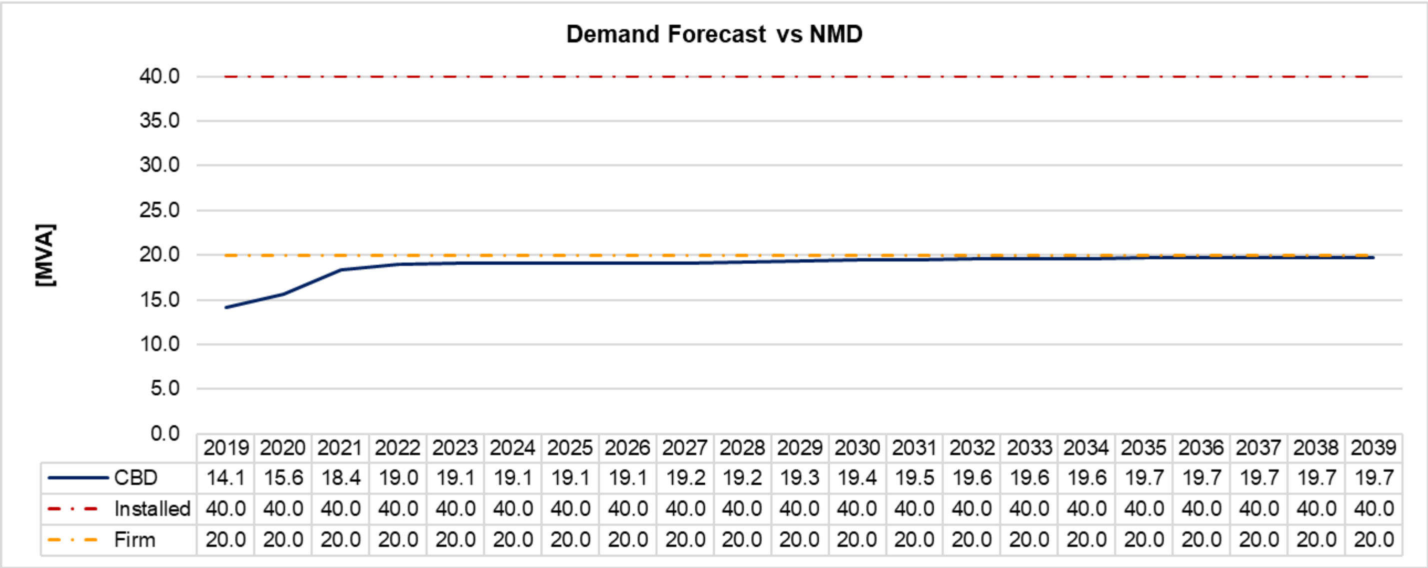


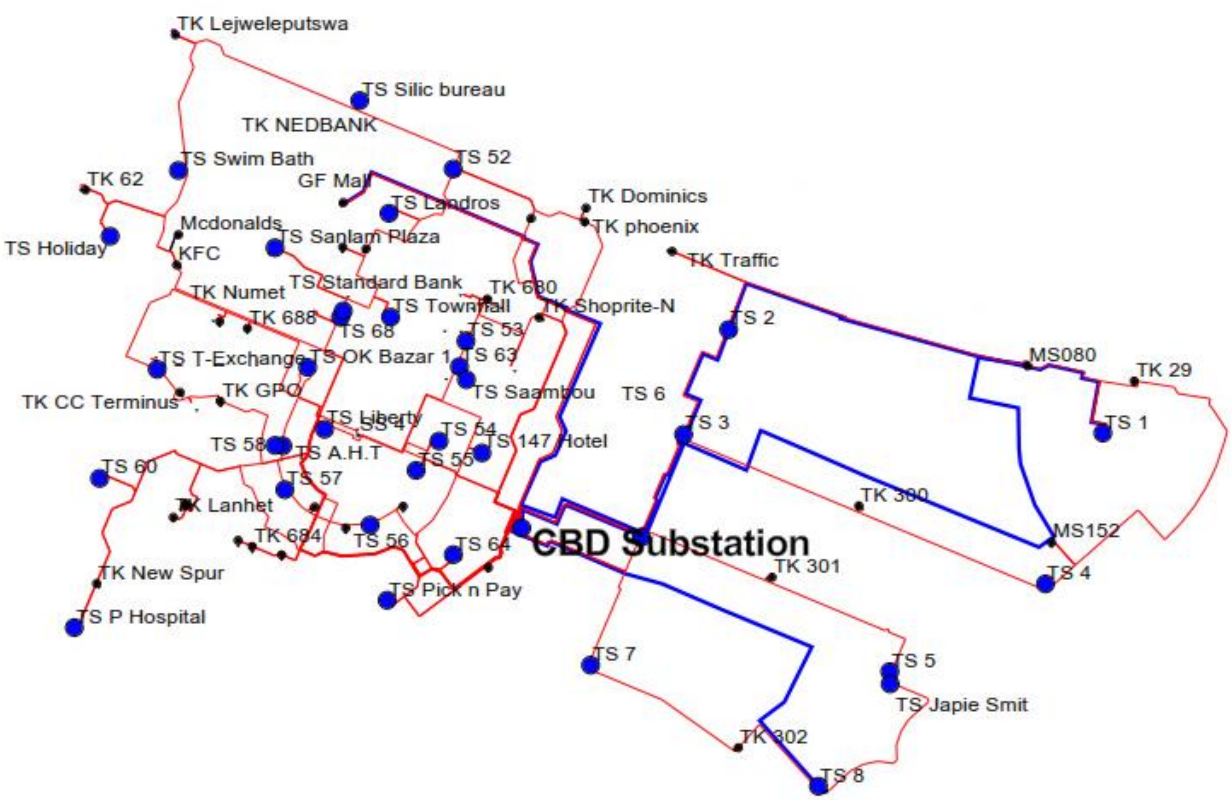

Figure 7-9: Welkom CBD Substation Demand Forecast vs Installed and Firm Capacities

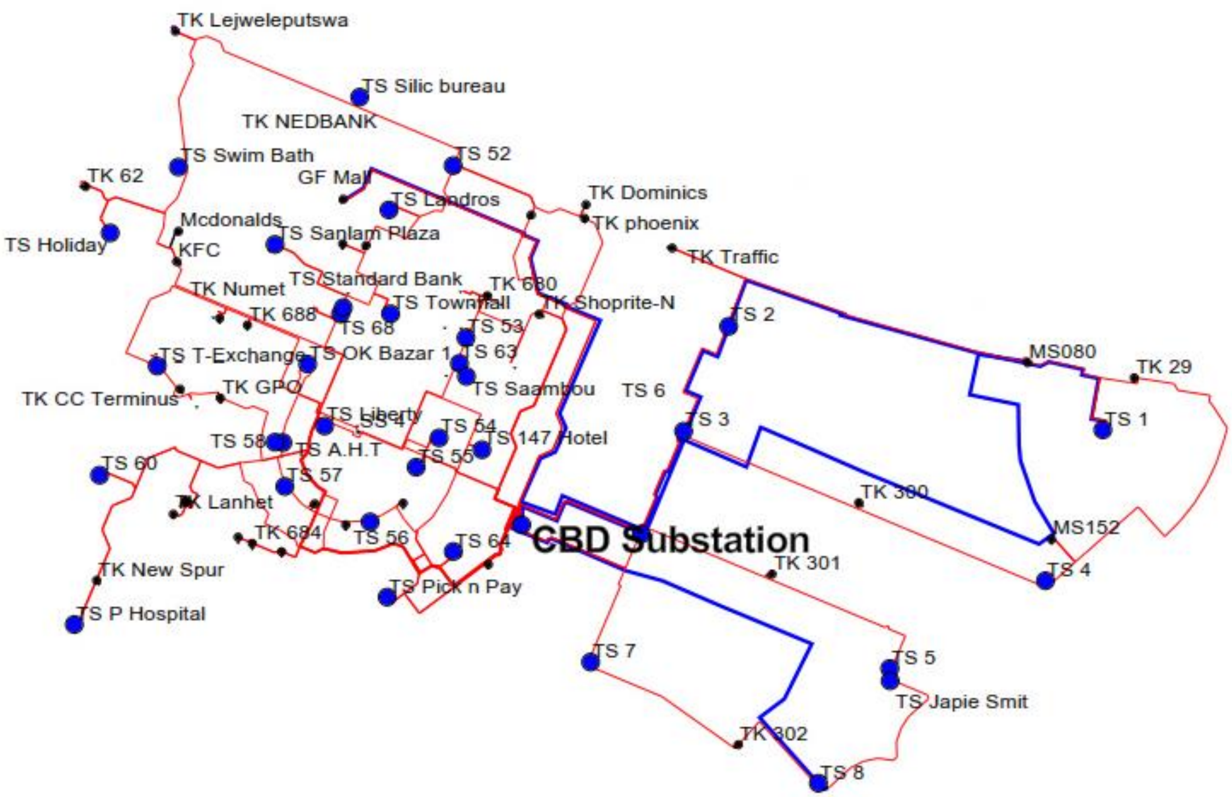
Table 7-15: Welkom CBD Substation Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 10 &13_6.6 kV busbar | 8.3 | 4.2 | 0.05 | 0.07 | 0.09 | 0.09 | 0.10 | 0.10 | 0.10 | 0.10 | 0.11 | 0.15 | 0.21 | 0.28 | 0.43 | 0.43 |
| Bay 11 &12_6.6 kV busbar | 8.3 | 4.2 | 1.01 | 1.01 | 1.23 | 1.31 | 1.34 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 |
| Bay 20_6.6 kV busbar | 9.3 | 4.6 | 5.31 | 5.54 | 5.69 | 5.75 | 5.78 | 5.78 | 5.78 | 5.78 | 5.79 | 5.79 | 5.79 | 5.79 | 5.79 | 5.79 |
| Bay 4 &19_6.6 kV busbar | 8.3 | 4.2 | 3.51 | 4.18 | 5.27 | 5.43 | 5.45 | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 | 5.46 |
| Bay 5 &18_6.6 kV busbar | 8.3 | 4.2 | 0.82 | 0.87 | 1.01 | 1.08 | 1.11 | 1.12 | 1.12 | 1.12 | 1.12 | 1.15 | 1.20 | 1.25 | 1.38 | 1.38 |
| Bay 6 &17_6.6 kV busbar | 8.3 | 4.2 | 0.13 | 0.17 | 0.21 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 |

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 7 &16_6.6 kV busbar | 5.5 | 2.7 | 3.07 | 3.64 | 4.58 | 4.70 | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 | 4.71 |
| Bay 8 & 15_6.6 kV busbar | 8.2 | 4.1 | 1.01 | 1.01 | 1.23 | 1.31 | 1.34 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 | 1.35 |
| Bay 9 &14_6.6 kV busbar | 8.3 | 4.2 | 0.50 | 0.51 | 0.61 | 0.66 | 0.67 | 0.67 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 | 0.68 |

Table 7-16: Welkom CBD Substation Proposed Network Development Plans

| Networks | Description |
|---|---|
|  | **1. Welkom CBD Bay 20 Feeder**<br>*Status:*<br>• The feeder ring is supplied by 2 x 180 mm2 XLPE Copper;<br>• The demand has exceeded the firm capacity;<br>*Proposed:*<br>• Year 2021: Install a 3rd cable, ±1500 m, 180 mm$^2$ XLPE, Cu to maintain firm capacity;<br>**2. Welkom CBD Feeder Bays 4&19**<br>*Status:*<br>• The feeder ring is supplied by 2 x 150 mm2 XLPE Copper;<br>• The demand is forecasted to exceed the firm capacity by year 2021;<br>*Proposed:*<br>• Year 2021: Install a 3rd cable, ±2500 m, 150 mm$^2$ XLPE, Cu to create a three-legged ring to maintain firm capacity;<br>• Year 2021: The cable to run along Zomba St, Paul St, Nyala St, Oboe St, Reitz St, Loop St, Church St, Jan Hofmeyer Rd and terminate at MS080.<br>**3. Welkom CBD Feeder Bays 7&16**<br>*Status:*<br>• The feeder ring is supplied by 2 x 70 mm$^2$ XLPE Copper; |

| Networks | Description |
|---|---|
|   | • The demand has exceeded the firm capacity;<br><br>*Proposed:*<br><br>• Year 2021: Install a 3rd cable, ±1300 m, 70 mm² XLPE, Cu from CBD substation to William street to create a three-legged ring to maintain firm capacity;<br><br>**4. Refurbishments:**<br><br>• The general condition of the switchgears within CBD Substation is good<br>• Major concerns on the 132/6.6kV transformer which has signs of oil leaks at various points of the transformer, these points are also evident on the Ferranti tap changer |

### 7.2.6.2 Welkom Park 6.6kV Intake Area

Figure 7-10 shows the Welkom Park Intake demand forecast in relation to the NMD, and Table 7-17 outlines the associated feeder areas loadings.

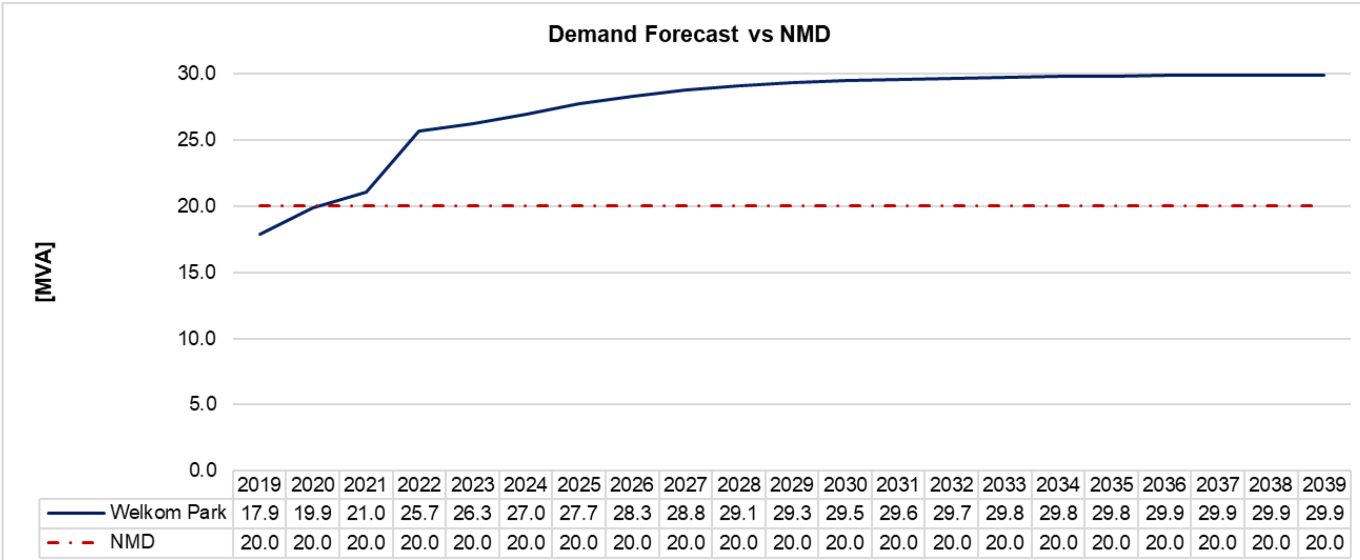
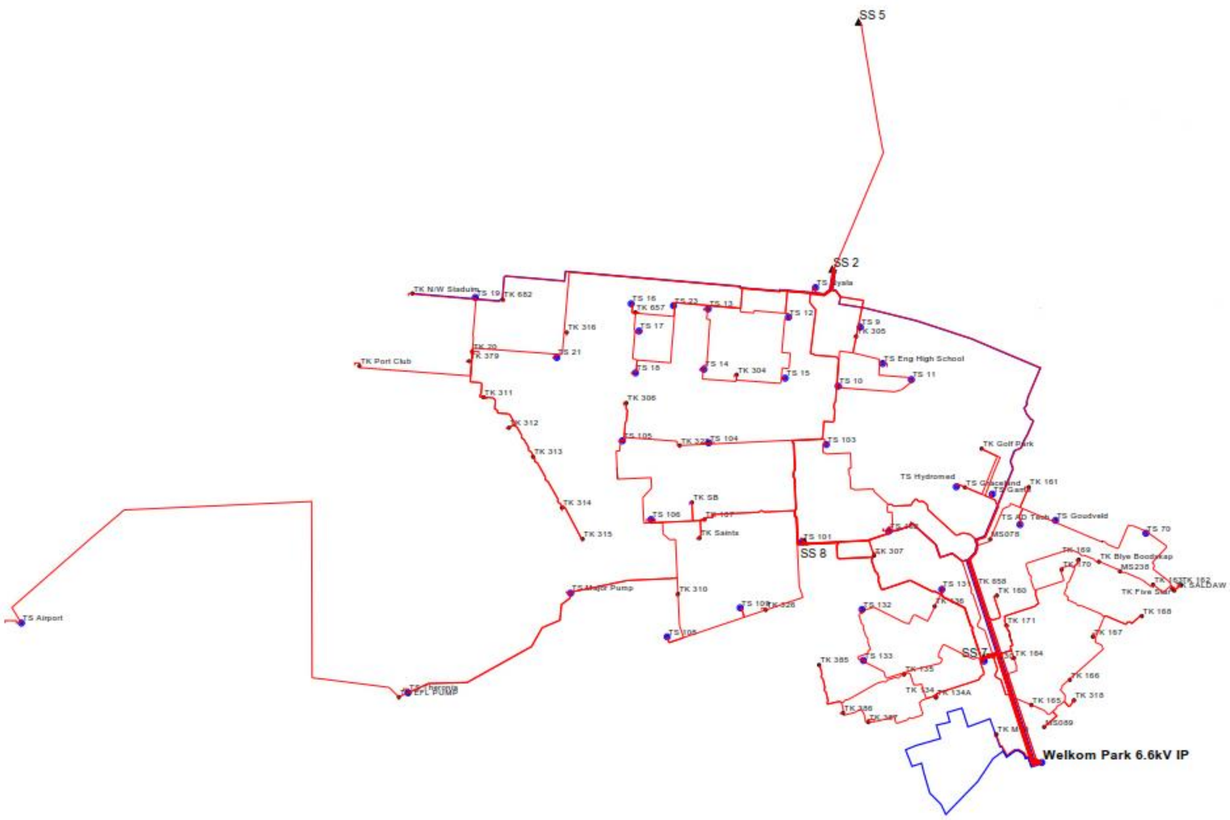



Figure 7-10: Welkom Park Intake Demand Forecast vs NMD

Table 7-17: Welkom Park Intake Feeders/Switching Stations Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 13 &14_Meter Panel 4 | 8.3 | 4.2 | 0.41 | 0.49 | 0.52 | 0.53 | 0.53 | 0.54 | 0.54 | 0.54 | 0.55 | 0.58 | 0.61 | 0.63 | 0.68 | 0.68 |
| Bay 19 | 4.1 | 0 | 0.88 | 0.88 | 0.88 | 1.28 | 2.29 | 2.86 | 3.19 | 3.49 | 3.71 | 3.78 | 3.78 | 3.79 | 3.79 | 3.79 |
| Bay 19, 20, 21 &22_Meter Panel 3 | 5.4 | 2.7 | 1.19 | 1.24 | 1.53 | 1.57 | 1.58 | 1.58 | 1.62 | 1.74 | 1.81 | 1.85 | 1.89 | 1.92 | 1.94 | 1.94 |
| SS 2 Milner | 8.3 | 4.2 | 4.98 | 5.14 | 6.44 | 6.61 | 6.64 | 6.64 | 6.86 | 7.42 | 7.73 | 7.92 | 8.10 | 8.25 | 8.34 | 8.34 |
| SS 7 Gawthorne | 18.9 | 13.6 | 8.76 | 9.82 | 12.24 | 14.54 | 14.67 | 14.73 | 14.75 | 14.76 | 14.76 | 14.76 | 14.79 | 14.83 | 14.98 | 14.99 |
| SS 8 MT Frere | 16.7 | 12.5 | 2.66 | 2.97 | 3.68 | 5.98 | 5.99 | 6.00 | 6.04 | 6.16 | 6.23 | 6.27 | 6.31 | 6.34 | 6.36 | 6.36 |

Table 7-18: Welkom Park Area Proposed Network Development Plans

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


</td><td>

**1. Welkom Park 6.6kV Intake**

*Status:*

- The demand is forecasted to exceed the 20 MVA NMD by year 2021
- The Eskom substation has 3x15 MVA transformers.

*Proposed:*

- Year 2022: Increase the NMD to 30 MVA.
- Year 2024: Increase the NMD to 35 MVA.
- Year 2025: Construct a new Rheedepark substation to de-load Welkom Park intake by supplying SS2 switching station (±9 MVA)

**2. Welkom Park Bay 19 Feeder**

*Status:*

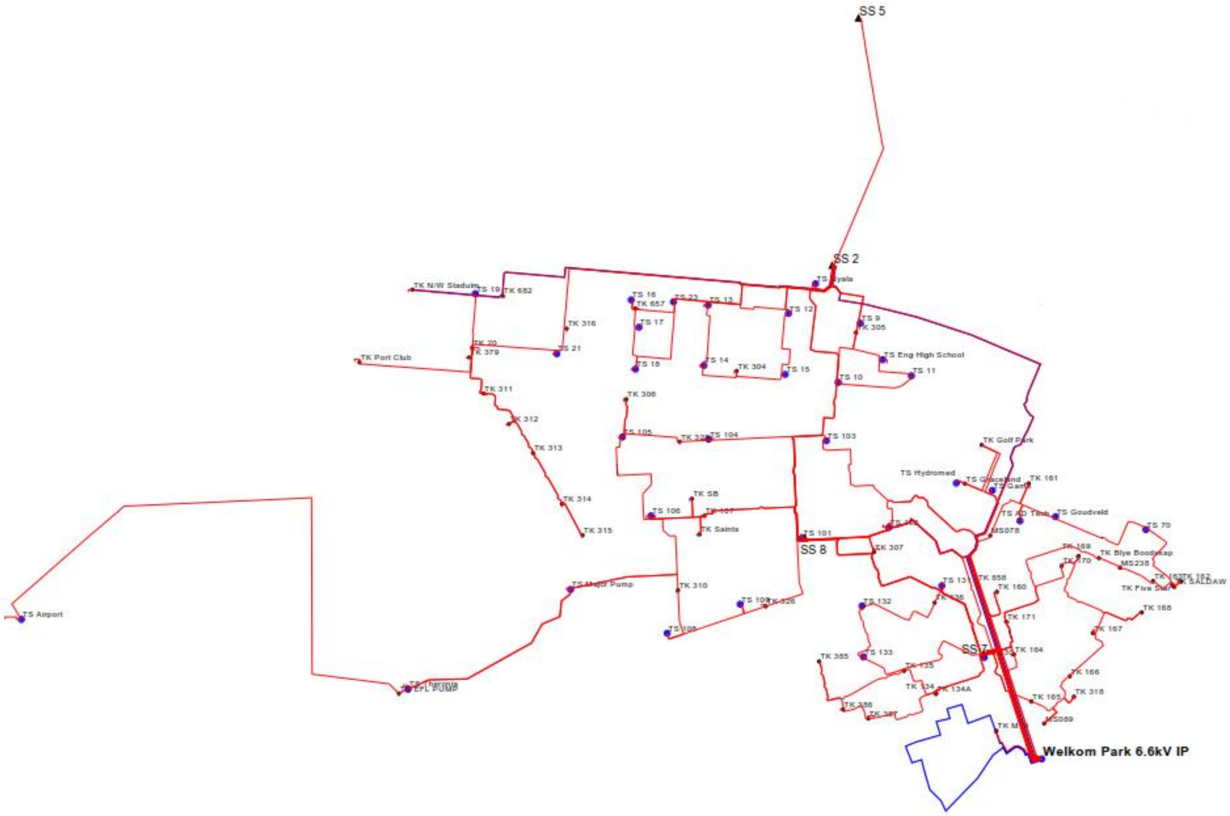
- The feeder is supplied by 1 x 95 $mm^2$ XLPE Copper; without firm capacity;

*Proposed:*

- Year 2022: Install a new ring of, ±2000 m, 150 $mm^2$ XLPE, Cu to strengthen the feeder;
- Year 2023: Install 2 x 500 kVA mini-subs to cater for additional load;
- Year 2025: Install 2 x 500 kVA mini-subs to cater for additional load;
- Year 2027: Install 2 x 500 kVA mini-subs to cater for additional load;
- Year 2029: Install 2 x 500 kVA mini-subs to cater for additional load;

</td></tr>
</table>

| Networks | Description |
| --- | --- |




**3. Welkom Park Feeder Bays 20&21**

*Status:*

- The feeder is supplied by 2 x 95 mm$^2$ XLPE Copper;
- However, the feeder portion supplying the one leg of the ring is faulty and has properties built on top of it, therefore inaccessible;

*Proposed:*

- Year 2022: Install a new ±2200 m, 95 mm$^2$ XLPE, Cu cable from Welkom Park substation to TS102 to replace the damaged cable and ensure firm capacity;

*Refurbishments:*

- The Welkom Park Substation switchgears utilise oil as an extinguishing agent. There is evidence of oil leaks on several of the units
- The Feeder Bays which require attention include; Eskom Incomer 1, 2 and 4, All three SS 2 Feeder Bays, SS 8 Feeder Bays 2 & 3
- TK Naudeville and TS 102 Feeder Bays have missing breaker units

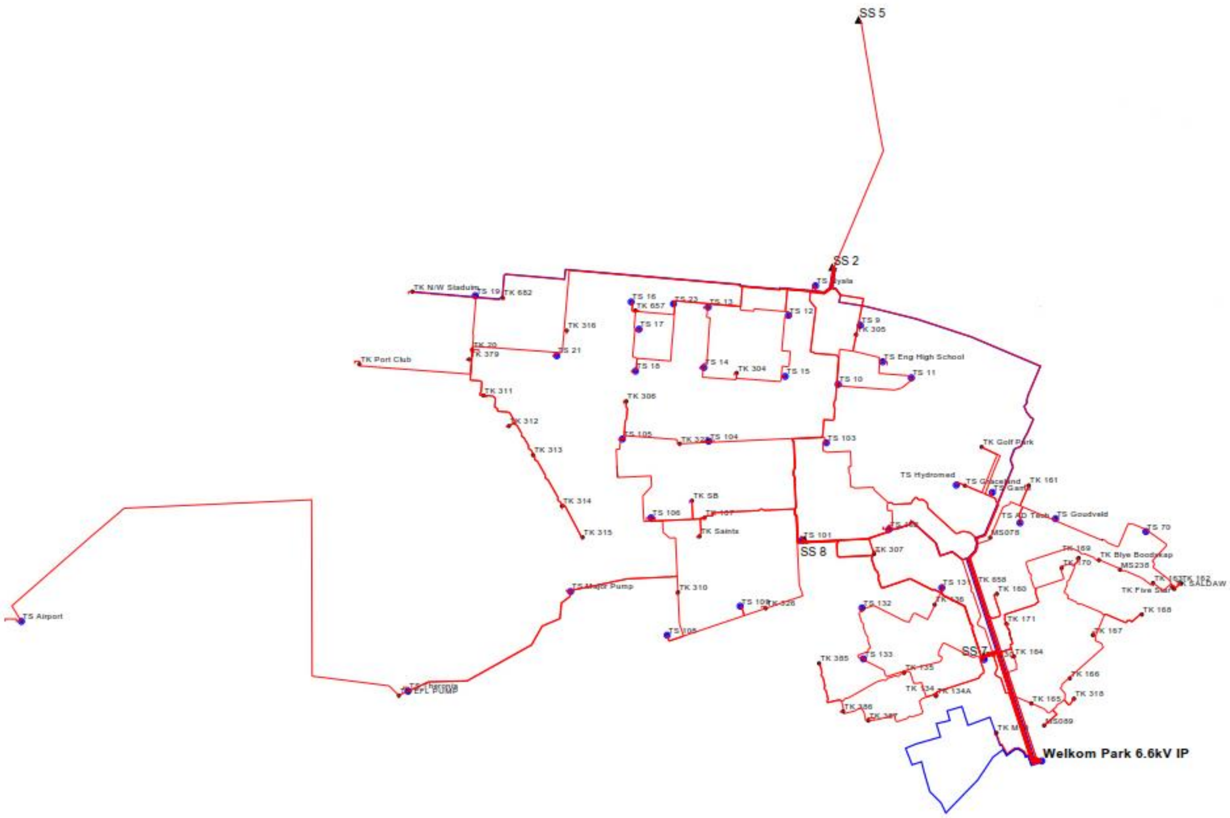
**4. Welkom Park SS2 Switching Station**

*Status:*

- The switching station is supplied by 3 x 150 mm$^2$ XLPE Copper, with only two online and the 3rd one stolen
- The demand has exceeded the firm capacity;

*Proposed:*

- Year 2022: Install a 3rd cable, ±5400 m, 150 mm$^2$ XLPE, Cu from Welkom Park substation to SS2 switching

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


</td><td>

station to replace the stolen cable and maintain firm capacity,

- Year 2022: To further alleviate the congestion on the internal rings supplied from SS2, construct a new ±3200 m, 70 mm$^2$ XLPE from SS2 switching station to TK stadium,
- Year 2025: Install ±2800 m, 3x240 mm$^2$ XLPE, Cu cables from the proposed Rheedepark substation to SS2 switching station;

**5. Welkom Park SS7 Switching Station**

_Status:_

- The switching station is supplied by 3 x 150 mm$^2$ XLPE Copper;
- The demand has exceeded the firm capacity and is forecasted to exceed the installed capacity by year 2022;

_Proposed:_

- Year 2022: Install a 4$^{th}$ cable, ±950 m, 240 mm$^2$ XLPE, Cu to increase capacity;
- Year 2022: Install ±2500 m, 3x240 mm$^2$ XLPE, Cu cables from the proposed Rheedepark substation to SS2 switching station;

</td></tr>
</table>

### 7.2.6.3 Welkom Town 6.6kV Intake Area

Figure 7-11 illustrates the Welkom Town Intake demand forecast in relation to the NMD, and Table 7-19 outlines the associated feeder and switching station areas loadings. From Figure 7-11, the demand is forecasted to exceed the 15 MVA NMD by year 2022. It is therefore proposed that the Welkom Town Intake NMD be increased as follows:

- Year 2022: Increase NMD to 17 MVA
- Year 2025: Increase NMD to 18.9 MVA

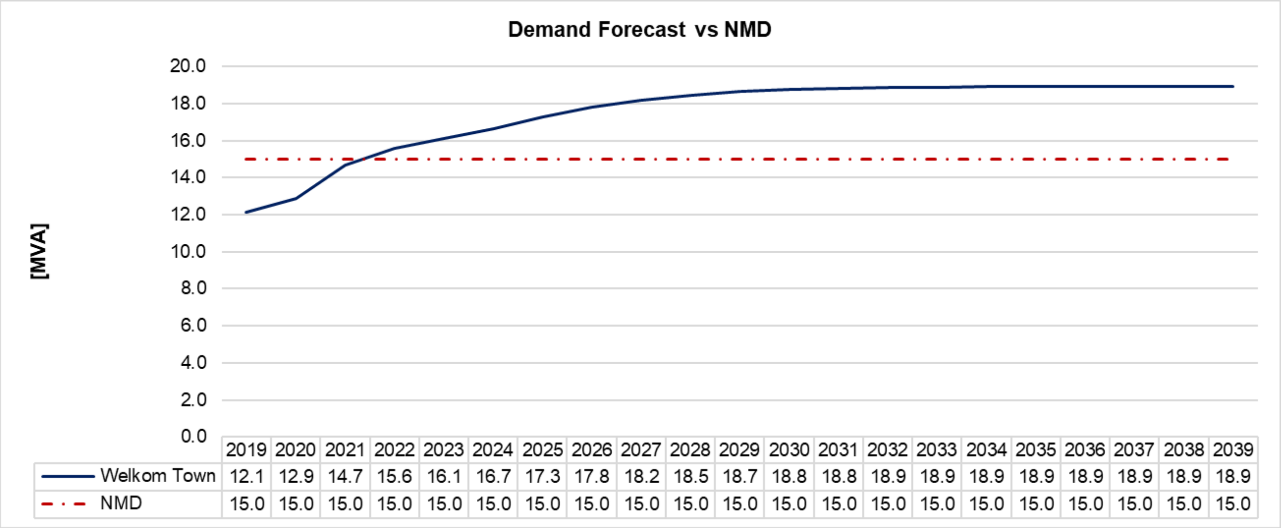
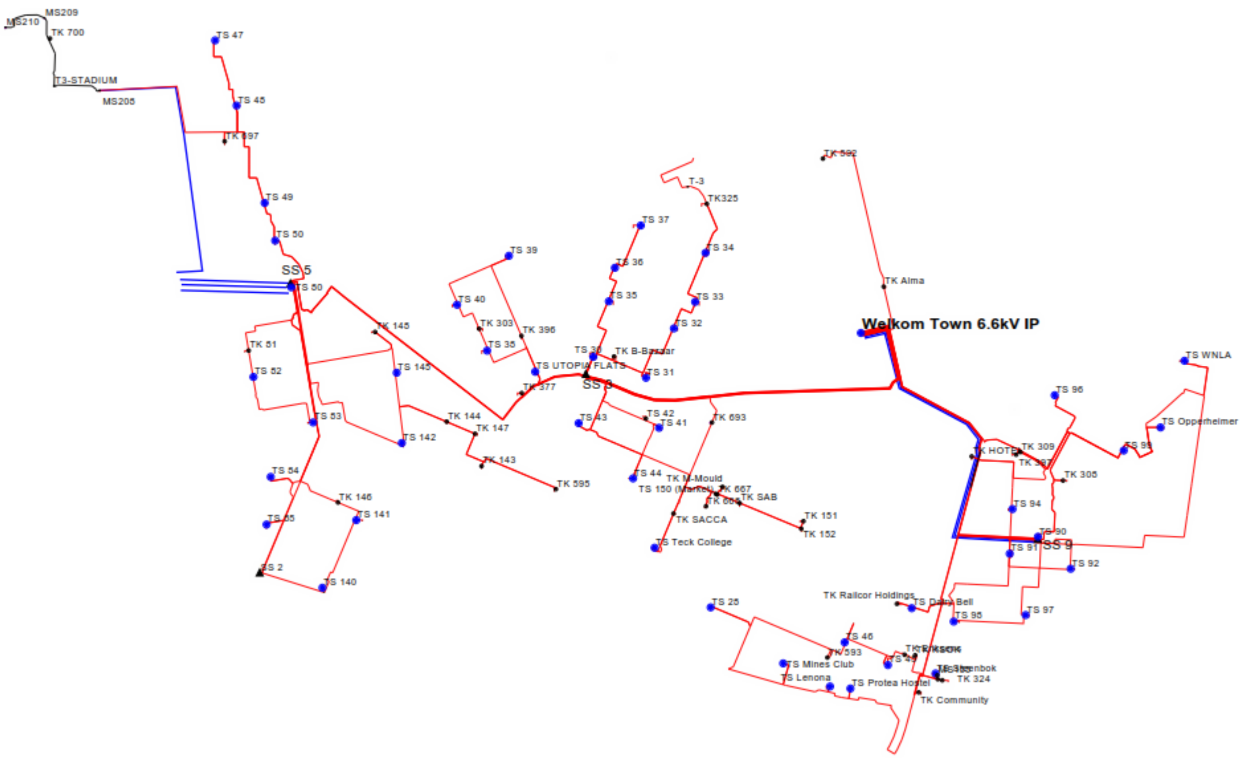


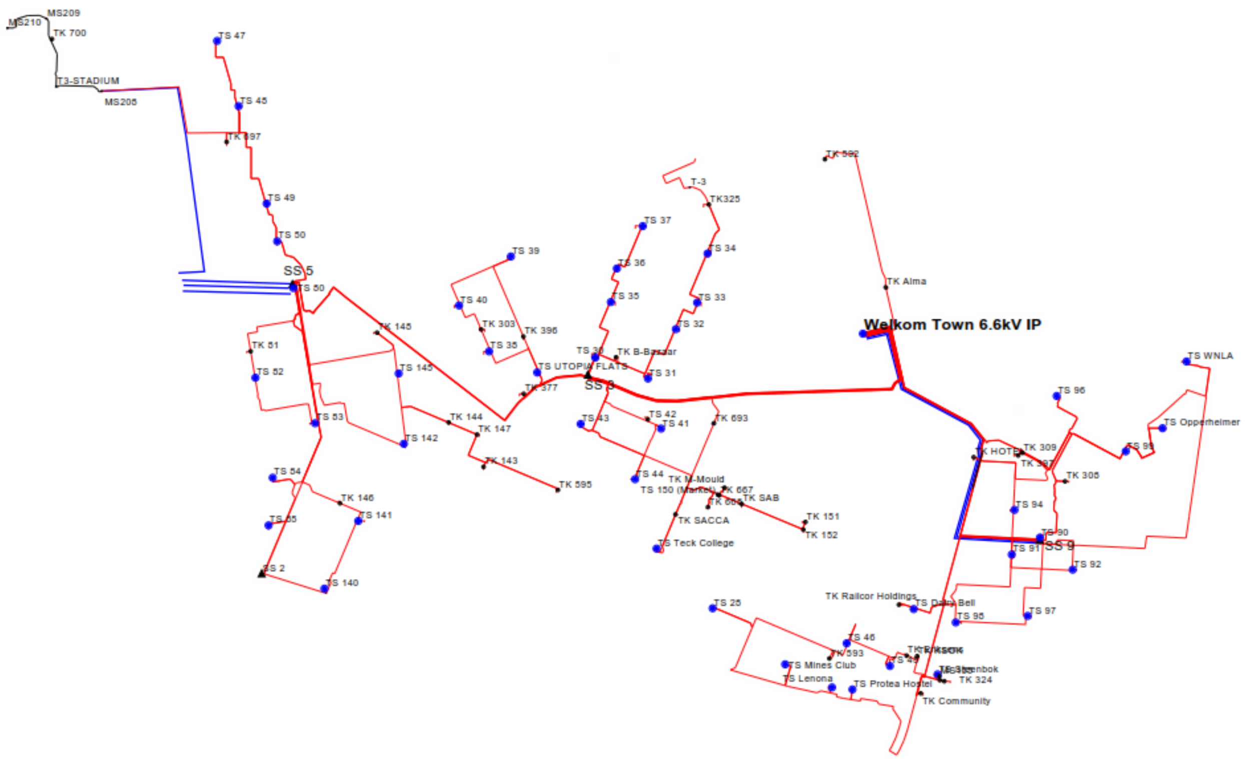

Figure 7-11: Welkom Town Intake Demand Forecast vs NMD

Table 7-19: Welkom Town Intake Feeders/Switching Stations Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 12_6.6 kV busbar | 3.3 | 0 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| Bay 18 &19_6.6 kV busbar | 6.6 | 3.3 | 1.07 | 1.10 | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 | 1.13 |
| SS 3 Tempest | 8.3 | 4.2 | 2.39 | 2.95 | 3.63 | 3.79 | 3.85 | 3.89 | 3.92 | 3.93 | 3.95 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 |
| SS 5 Milner | 8.3 | 4.2 | 5.72 | 6.54 | 7.39 | 7.51 | 7.52 | 7.53 | 7.53 | 7.53 | 7.53 | 7.53 | 7.53 | 7.53 | 7.53 | 7.53 |
| SS 9 Twist | 12.5 | 8.3 | 2.72 | 4.37 | 5.43 | 6.24 | 7.82 | 8.70 | 9.36 | 10.10 | 10.77 | 11.14 | 11.38 | 11.55 | 11.77 | 11.77 |

Table 7-20: Welkom Town Area Proposed Network Development Plans

| Networks | Description |
|---|---|
|  | **1. Welkom Town 6.6kV Intake**<br>*Status:*<br>• The demand has exceeded the 15 MVA NMD;<br>• The Eskom substation has 1x12.5 + 1x15 MVA transformers.<br>• The demand is forecasted to exceed 80% of the transformer thermal capacity by year 2026.<br>*Proposed:*<br>• Year 2022: Increase the NMD to 20 MVA.<br>• Year 2025: Construct a new Rheedepark substation to de-load Welkom Town intake by supplying SS 5 switching station (±8 MVA)<br>**2. Welkom Town SS9 Switching Station**<br>*Status:*<br>• The switching station is supplied by 3 x 150 $mm^2$ XLPE Copper, with only two online and the 3rd one stolen<br>• The demand has exceeded the firm capacity and is forecasted to exceed the installed capacity by year 2024;<br>*Proposed:*<br>• Year 2022: Install a 3rd cable, ±2200 m, 150 $mm^2$ XLPE, Cu from Welkom Town substation to SS9 switching station to replace the stolen cable and maintain firm capacity, |

| Networks | Description |
| --- | --- |
|  | • Year 2025: Install a 4th cable, ±2200 m, 150 mm² XLPE, Cu from Welkom Town substation to SS9 switching station to further strengthen the switching station and maintain firm capacity,<br><br>**3. Refurbishments:**<br><br>• The general state of condition of the switchgears in Welkom Town Substation is poor<br>• Switchgears which are leaking oil and are in poor condition include; SS 5 Feeder Bay 3, SS 2 Feeder Bay, Eskom Incomer 2, NEC, All three SS 3 Feeder Bays, TS Oppenheimer and TK Alma Feeder Bays |

### 7.2.6.4 Western Holding 6.6kV Intake Area

Figure 7-12 illustrates the Western Holding Intake demand forecast in relation to the NMD, and Table 7-21 outlines the associated feeder and switching station areas loadings. From Figure 7-12, the demand has exceeded the 3.5 MVA NMD by year 2022. It is therefore proposed that the Western Holding Intake NMD be increased as follows:

- Year 2022: Increase NMD to 10 MVA
- Year 2030: Increase NMD to 20 MVA
- Year 2035: Increase NMD to 22 MVA

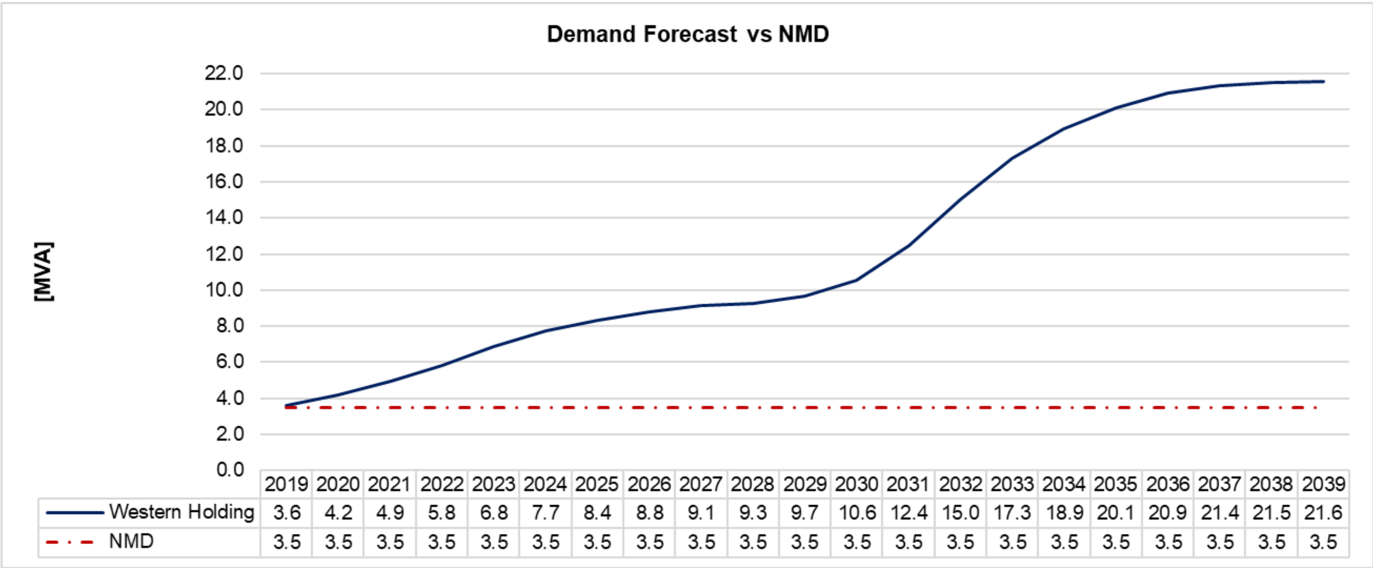
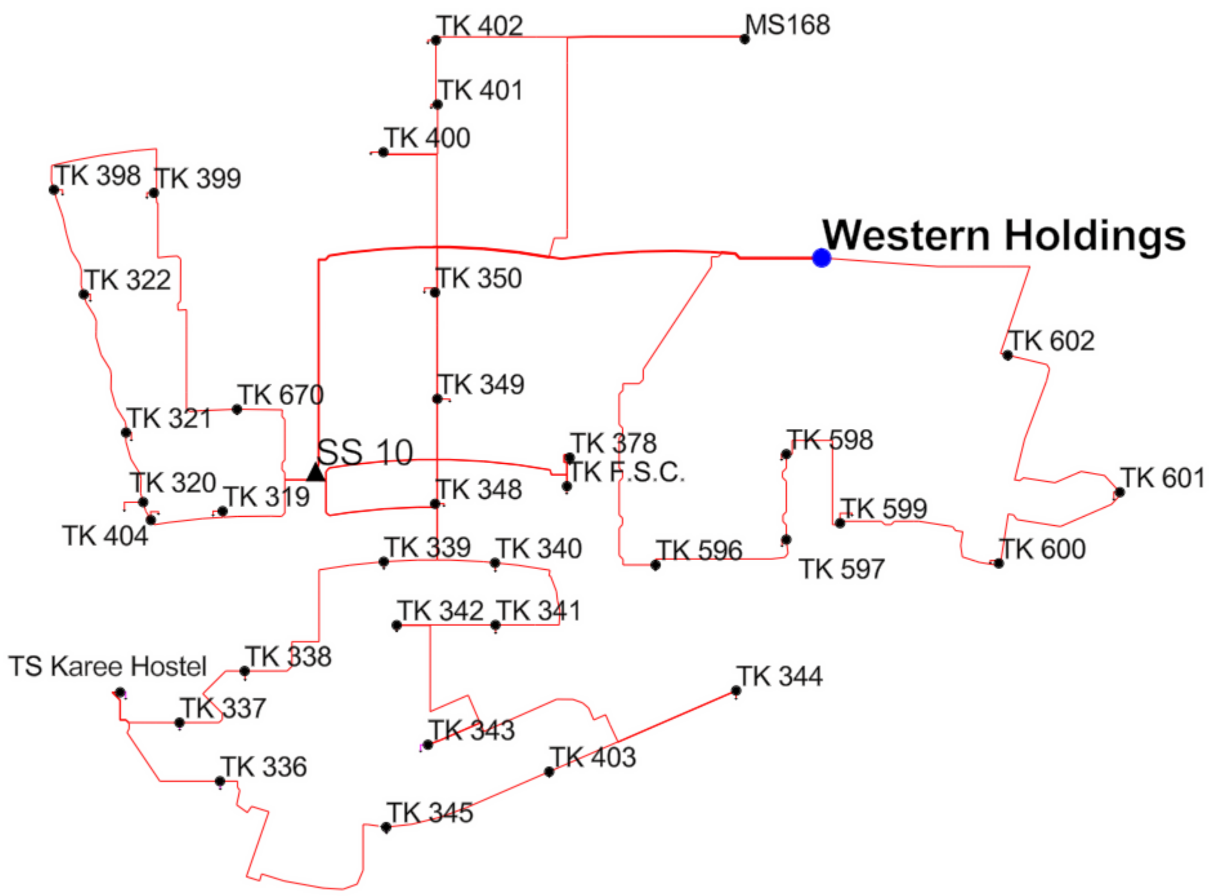



Figure 7-12: Western Holding Intake Demand Forecast vs NMD

Table 7-21: Western Holding Intake Feeders/Switching Stations Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 1, 2, 3, 4 a_6.6 kV busbar | 3.3 | 0 | 1.19 | 1.54 | 2.42 | 2.76 | 2.94 | 3.09 | 3.21 | 3.25 | 3.25 | 3.25 | 5.33 | 10.52 | 18.20 | 18.25 |
| SS 10 Mooitoekoms | 14.1 | 9.4 | 2.42 | 2.45 | 3.74 | 5.31 | 6.15 | 6.63 | 7.06 | 7.39 | 7.49 | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 |

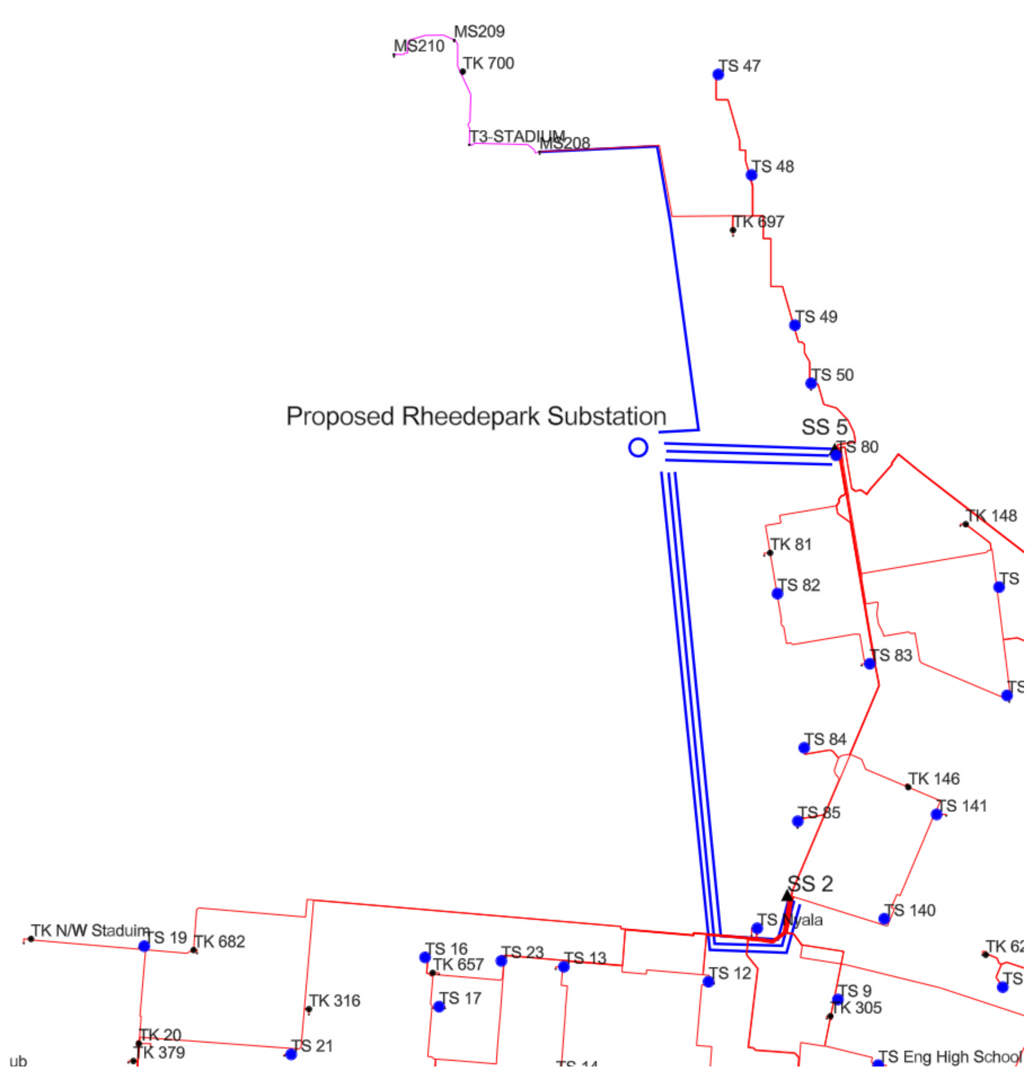
Table 7-22: Western Holding Area Proposed Network Development Plans

| Networks | Description |
|---|---|
|  | **1. Western Holding 6.6kV Intake**<br>*Status:*<br>• The demand has exceeded the 3.2 MVA NMD;<br>• The major contributor to the growth is the Rheedepark Ext2 development that was assigned to Western Holding as well as the Lotgeval development that comes in 2029,<br>*Proposed:*<br>• Year 2022: Increase the NMD to 10 MVA.<br>• Year 2025: Construct a new Rheedepark substation to de-load Western Holdings intake by supplying the Rheedepark Ext2 (±5 MVA) Development as well as the Lotgeval development (±15 MVA);<br>**2. Refurbishments:**<br>• The Western Holdings Substation switchgears are in relatively poor condition with several units missing their covers<br>• This includes SS 10 and Eskom incomer Feeder Bays. |

#### 7.2.6.5 Proposed New Rheedepark Substation

A new substation in the vicinity of Rheedepark is proposed to de-load Welkom Park, Welkom Town and Western Industries. The substation is proposed to have dual voltages, 6.6kV and 11kV. The 6.6kV will supply the existing 6.6kV networks from Welkom Park and Welkom Town, i.e., SS2 SwS and SS5 SwS, respectively. The 11kV will supply all the new developments.

Table 7-23: Rheedepark Area Proposed Network Development Plans

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr>
<td>


</td>
<td>

**1. Rheedepark 44kV Intake**

*<u>Proposed:</u>*

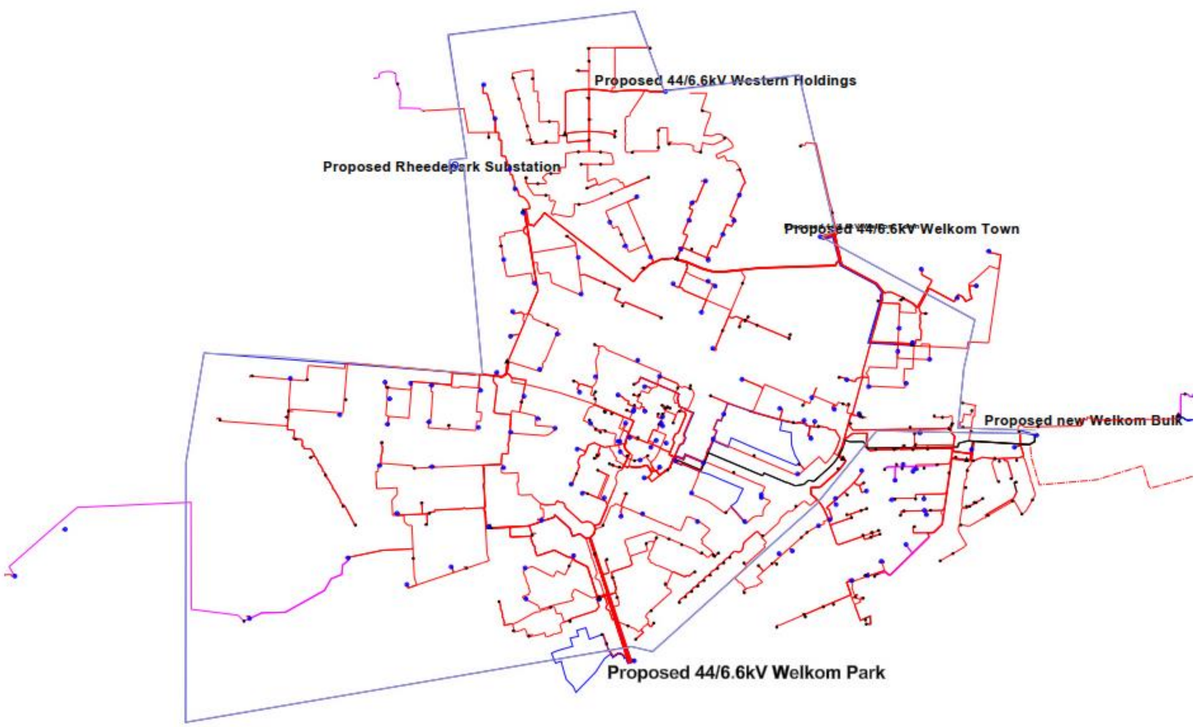
<ul>
<li>Year 2025: Construct a new Rheedepark 44/11/6.6kV, 3x30MVA substation (27°57'14.57"S, 26°42'58.60"E)</li>
<li>Year 2025: Loop-in and loop-out of the Euclid – Holding Mills 44kV lines ±3000 m, 2 x Chicadee OHL</li>
<li>Year 2025: Install 6.6kV, ±2800 m, 3x240 mm2 XLPE, Cu cables from the proposed Rheedepark substation to SS2 switching station;</li>
<li>Year 2025: Install 6.6kV, ±1800 m, 3x240 mm2 XLPE, Cu cables from the proposed Rheedepark substation to SS5 switching station;</li>
<li>Year 2025: The Rhedepark Exts developments will a three-legged ring with a total length of ±13000 m of 150 mm2 XLPE, Cu cables, with approximately 15 x 500kVA mini-subs.</li>
<li>Year 2030: Construct a new Lotgeval 11kV switching station to supply the Lotgeval development;</li>
<li>Year 2030: The proposed switching station is to be supplied by 2 x Double-circuit Chicadee OHL to ensure 18MVA firm capacity;</li>
<li>Year 2030: Construct approximately 15000 m of 11kV, Chicadee OHL to supply the anticipated demand;</li>
<li>The Lotgeval demand will require a total of 39 x 500kVA mini-subs installed as follows:
<ul>
<li>Year 2030: 19 x 500 kVA</li>
<li>Year 2033: 12 x 500 kVA</li>
<li>Year 2035: 8 x 500 kVA</li>
</ul>
</li>
</ul>
</td>
</tr>
</table>

#### 7.2.6.6 Welkom Area Intakes Consolidation

It is proposed that multiple intake points in the Welkom area be consolidated into three intake points. Furthermore, it is proposed that the lower intake points be converted into 44kV substations. This will help the municipality to have better operational and maintenance flexibility. Figure 7-13 illustrates the proposed 44 kV ring.


Figure 7-13: Proposed Welkom 44kV Ring

Table 7-24: Welkom Area Intake Consolidation Proposed Network Development Plans

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>
</td><td>

**1. Proposed New Welkom Park 44/6.6kV Substation**

*Proposed:*

- Year 2027: Construct a new Welkom Park 44/6.6kV, 2x20MVA substation next to the existing intake point to take over the load of the existing intake point.
- Year 2027: At Welkom Bulk Intake point, introduce transformation by constructing new 132/44kV, 2x40MVA transformer with only 1x40MVA transformer installed
- Year 2027: Construct a new Welkom Bulk – Welkom Park 44kV, ±5600 m, Chicadee OHL
- Year 2027: Construct a new Western Holding – Welkom Town 44kV, ±3500 m, Chicadee OHL

**2. Proposed New Welkom Town 44/6.6kV Substation**

*Proposed:*

- Year 2029: Construct a new Welkom Town 44/6.6kV, 2x20MVA substation next to the existing intake point to take over the load of the existing intake point.
- Year 2029: Construct a new Welkom Bulk – Welkom Town 44kV, ±4000 m, Chicadee OHL

**3. Proposed Western Holding 44/6.6kV Substation**

*Proposed:*

- Year 2031: Construct a new Western Holding 44/6.6kV, 2x10MVA substation next to the existing intake point to take over the load of the existing intake point.
- Year 2031: Construct a new Rheedepark – Western Holding 44kV, ±5000 m, Chicadee OHL

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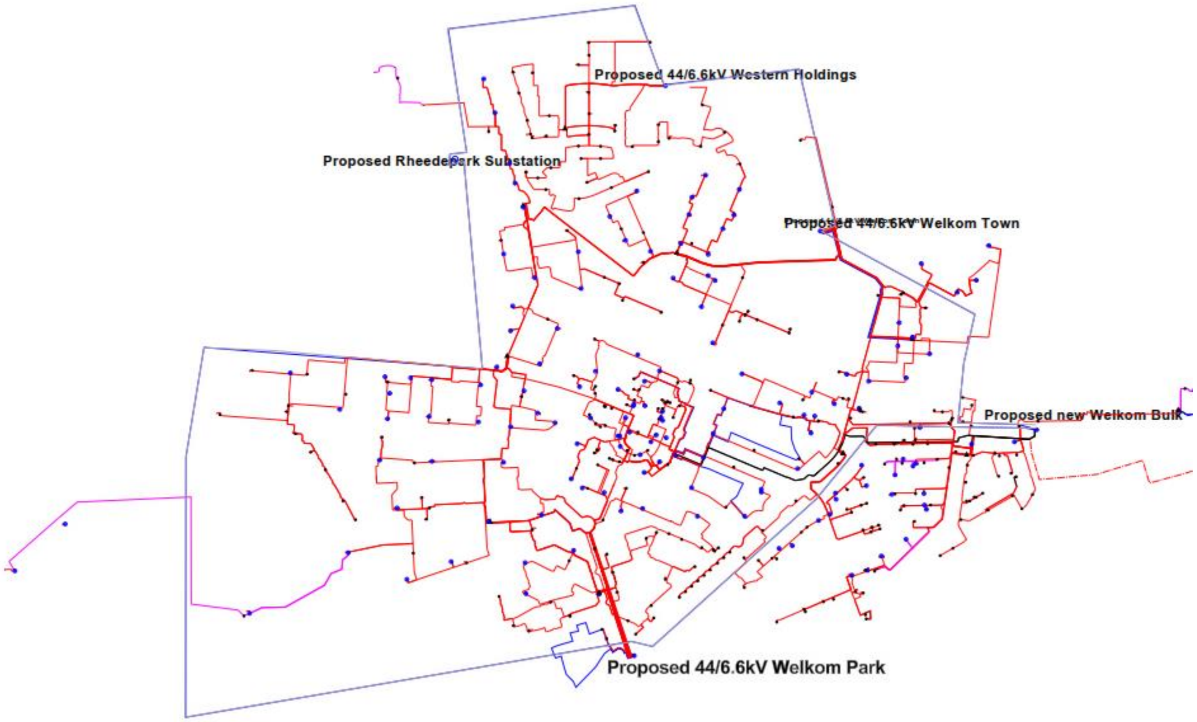
</table>

| Networks | Description |
| --- | --- |
|  | • Year 2031: At Welkom Bulk Intake point, install the 2nd 132/44kV, 40MVA transformer.<br>• Year 2031: Construct a new Western Holding – Welkom Town 44kV, ±3500 m, Chicadee OHL<br>**4. Proposed Welkom Park – Rheedepark 44kV OHL**<br>*Proposed:*<br>Year 2032: To close the 44kV ring, construct a new Welkom Bulk – Welkom Town 44kV, ±15000 m, Chicadee OHL |

### 7.2.6.7 Riebeeckstad 11kV Intake Area

Figure 7-14 shows the Welkom Park Intake demand forecast in relation to the NMD, and Table 7-25 outlines the associated feeder areas loadings.

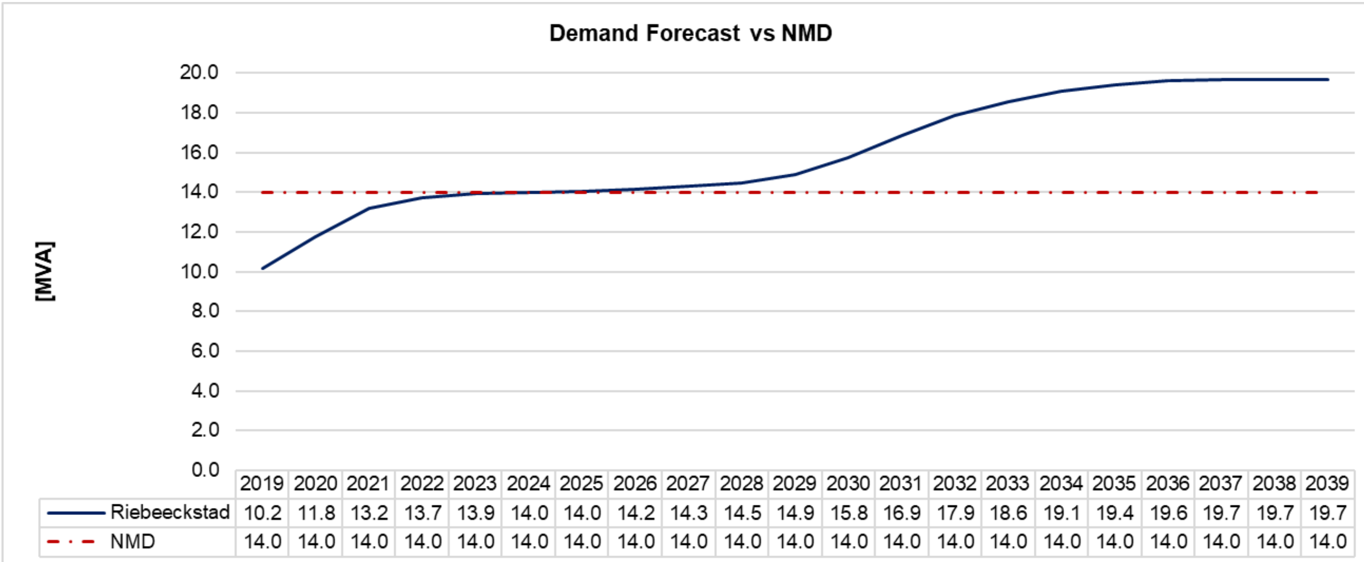
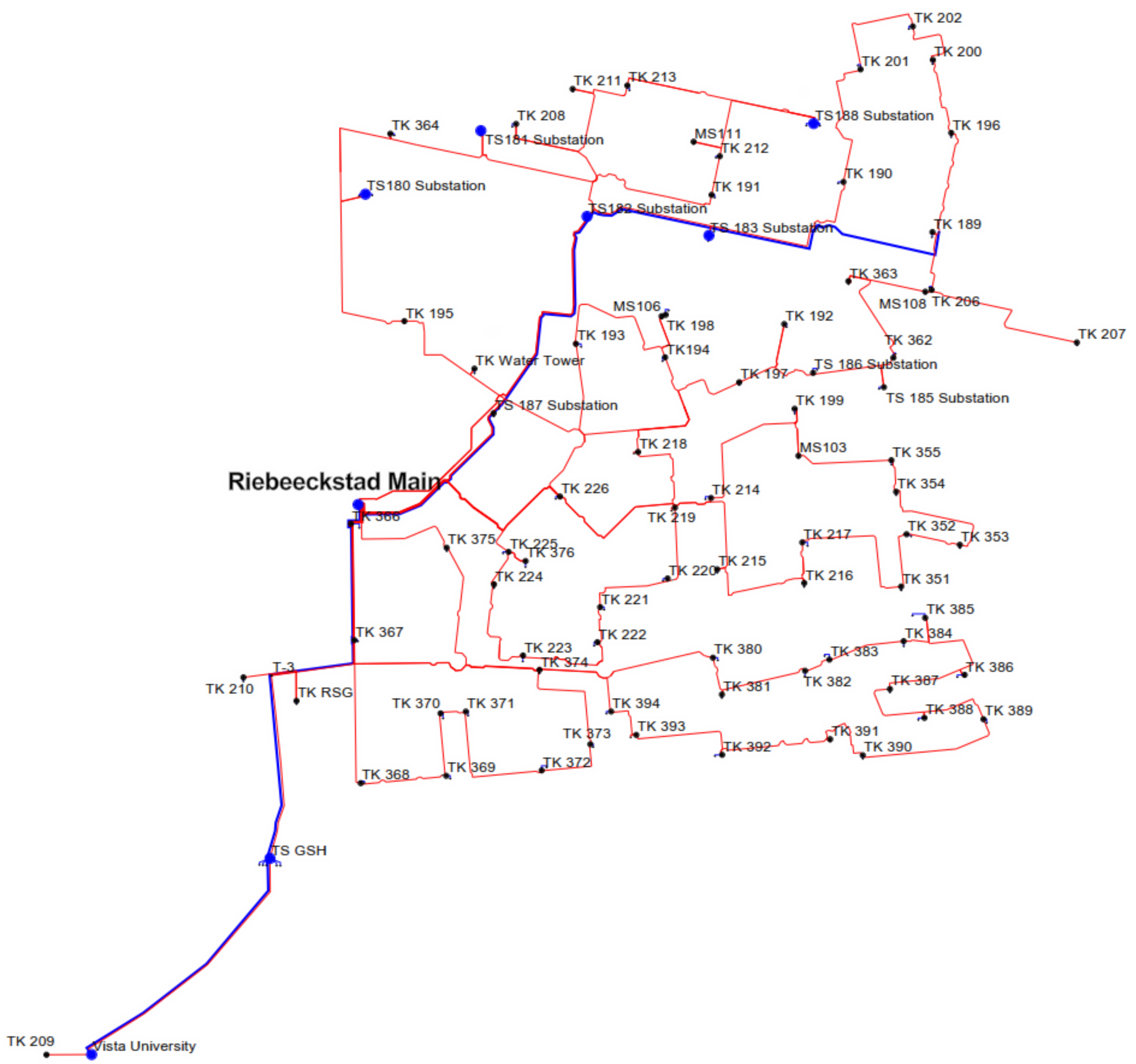



Figure 7-14: Riebeeckstad Intake Demand Forecast vs NMD

Table 7-25: Riebeeckstad Intake Feeders Demand Forecast

| Feeder ID | Installed | Firm | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2035 | 2039 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bay 10 & 11_Meter Panel 1 | 11.1 | 5.5 | 2.61 | 2.89 | 3.63 | 3.73 | 3.74 | 3.74 | 3.74 | 3.74 | 3.74 | 3.74 | 3.74 | 3.74 | 3.74 | 3.74 |
| Bay 12 & 13_Meter Panel 1 | 9.1 | 4.6 | 2.43 | 2.99 | 3.76 | 3.87 | 3.91 | 3.93 | 3.94 | 3.95 | 3.95 | 3.96 | 3.96 | 3.96 | 3.96 | 3.96 |
| Bay 14 &15_Meter Panel 2 | 9.1 | 4.6 | 1.14 | 1.30 | 1.63 | 1.68 | 1.69 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 | 1.70 |
| Bay 16 &17_Meter Panel 2. | 9.1 | 4.6 | 1.01 | 1.21 | 1.48 | 1.56 | 1.62 | 1.69 | 1.73 | 1.75 | 1.77 | 2.54 | 4.46 | 5.54 | 7.28 | 7.28 |
| Bay 19_Meter Panel 1 | 5.5 | 0.0 | 0.84 | 0.89 | 0.94 | 0.96 | 0.96 | 0.96 | 0.96 | 1.95 | 5.15 | 7.00 | 8.11 | 9.09 | 10.11 | 10.11 |
| Bay 4 & 5_Meter Panel 1 | 9.1 | 4.6 | 1.59 | 2.09 | 2.55 | 2.70 | 2.77 | 2.79 | 2.81 | 2.82 | 2.82 | 2.82 | 2.82 | 2.82 | 2.82 | 2.82 |
| Bay 6 & 7_Meter Panel 1 | 9.1 | 4.6 | 1.65 | 1.83 | 2.31 | 2.39 | 2.50 | 2.69 | 2.80 | 2.86 | 2.91 | 2.96 | 2.97 | 2.97 | 2.97 | 2.97 |

Table 7-26: Riebeeckstad Proposed Network Development Plans

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


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**1. Riebeeckstad 11kV Intake**

<u>*Status:*</u>

- The demand is forecasted to exceed the 14 MVA NMD by year 2021.
- The Eskom substation has 1x20 MVA transformers with no firm capacity, and the demand is forecasted to exceed the installed capacity by year 2027.

<u>*Proposed:*</u>

- Year 2022: Increase the NMD to 20 MVA.
- Year 2023: Install a 2nd 20 MVA transformer to have firm capacity.
- Year 2023: Request the intake point to be on the HV.
- Year 2027: Increase the NMD to 32.4 MVA.
- Year 2030: Install a 3rd 20 MVA transformer to maintain firm capacity.

**2. Riebeeckstad Bay 16&17 Feeder**

<u>*Status:*</u>

- The feeder is supplied by 2 x 95 mm$^2$ XLPE Copper;
- The demand is forecasted to exceed firm capacity by year 2034;

<u>*Proposed:*</u>

- Year 2034: Install a new cable of, ±6000 m, 95 mm$^2$ XLPE, Cu to create a three-legged ring and maintain firm capacity;
- Year 2028: Install 3 x 500 kVA mini-subs to cater for additional load

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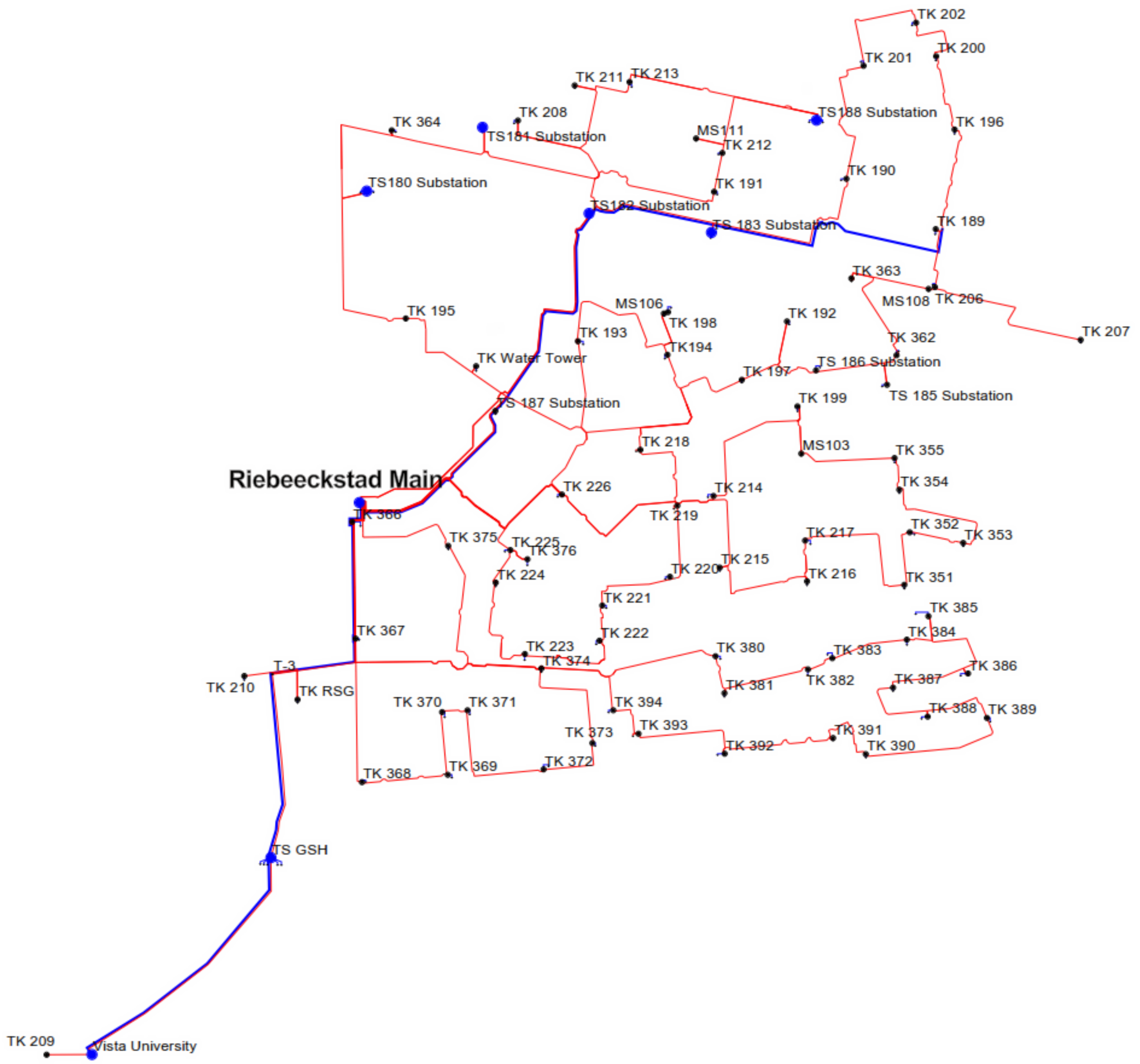
</table>

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


</td>
<td>

- Year 2030: Install 4 x 500 kVA mini-subs to cater for additional load
- Year 2032: Install 3 x 500 kVA mini-subs to cater for additional load
- Year 2035: Install 2 x 500 kVA mini-subs to cater for additional load

**3. Riebeeckstad Bay 19 Feeder**

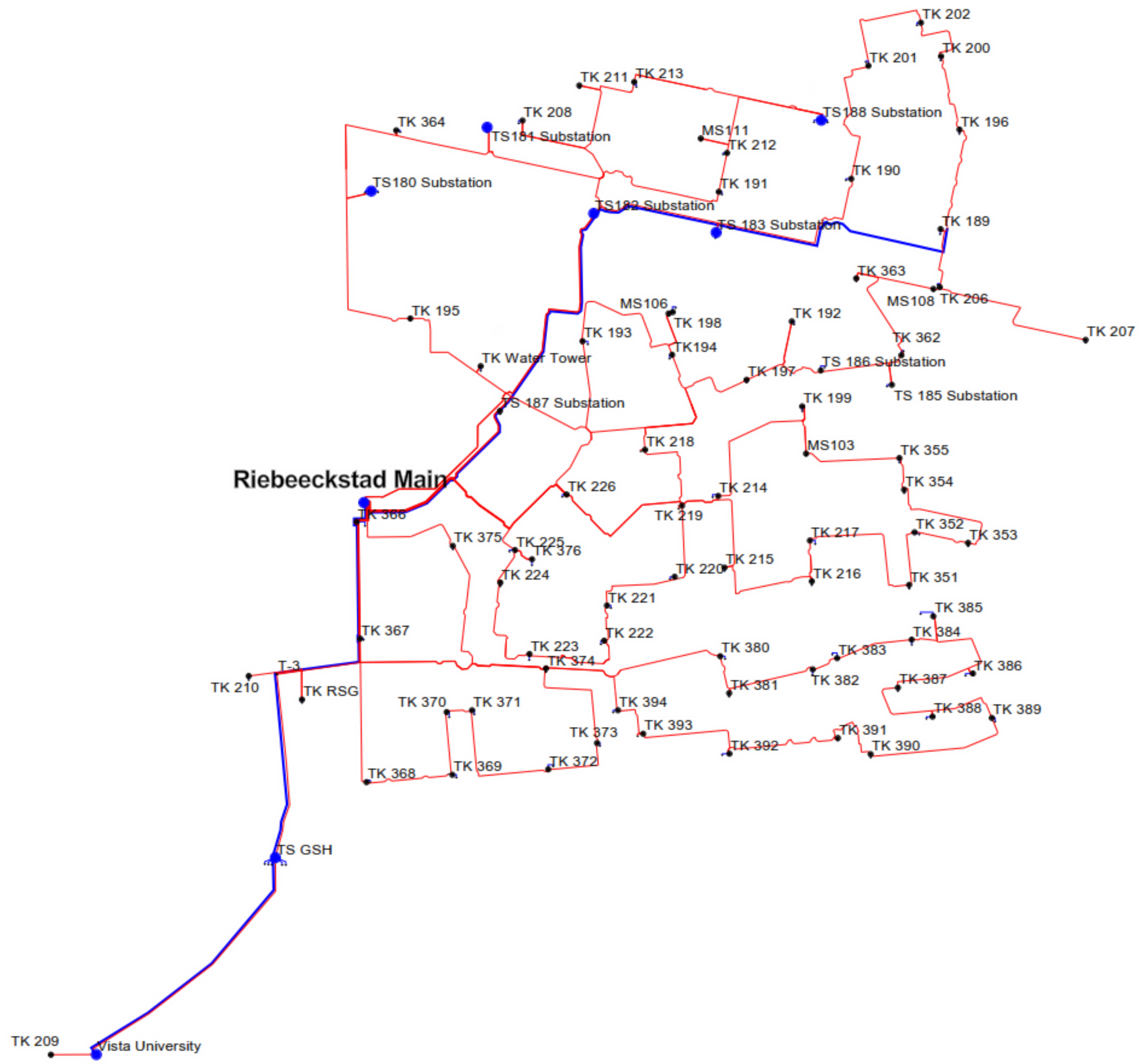
<u>*Status:*</u>

- The feeder is supplied by 1 x 95 mm$^2$ XLPE Copper with no firm capacity;
- The demand is forecasted to exceed the installed capacity by year 2028;

<u>*Proposed:*</u>

- Year 2027: Construct a new Bongani switching station to supply the college, hospital, Bongani multi-storey accommodation, stadium, etc.
- Year 2027: Install 2 x ±4000 m, Chicadee OHL from Riebeeckstad to the proposed Bongani SwS,
- Year 2027: Install 5 x 500 kVA mini-subs to cater for additional load
- Year 2028: Install 5 x 500 kVA mini-subs to cater for additional load
- Year 2029: Install 3 x 500 kVA mini-subs to cater for additional load
- Year 2030: Install 3 x 500 kVA mini-subs to cater for additional load
- Year 2031: Install 2 x 500 kVA mini-subs to cater for additional load
- Year 2032: Install 2 x 500 kVA mini-subs to cater for additional load

</td></tr>
</table>

<table>
<tr><th>Networks</th><th>Description</th></tr>
<tr><td>


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**4. Refurbishments**

- The general condition of the switchgears in Riebeeckstad Substation is relatively poor with many of the units missing their covers
- The Feeder Bays which require refurbishment include Eskom Incomer 2, Eskom Incomer 1, TK 183 Feeder Bay
- The substation transformer is rusted and shows signs of leaking oil

</td></tr>
</table>

## 8. CAPITAL COST ESTIMATES

Capital projects were identified through analysis and assessment of the network strengthening, expansion and reliability requirements. The costing of capital projects was done by using standard equipment cost, contained in an equipment library. Table 8-1 tabulates the developed project list.

The equipment's per unit cost considered is inclusive of Labour and Transport costs. Furthermore, a 10 % Contingency and a 7.5 % Consultant Fee were assumed.

Table 8-1: Project List

| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| **2021** | Allan Ridge | Buffalo Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 7 MVA. | **0** |
| **2022** | Allan Ridge | Olifants Substation | Upgrade feeder cable | Cable | Refurbishment | Upgrade the cable to 185 $mm^2$ PILC Copper to increase capacity; | **979** |
| **2022** | Allan Ridge | Olifants Substation | Additional Ring | Feeder | Reliability | Create a feeder ring (±8000 m) with Olifants_Bay 13 feeder | **4834** |
| **2022** | Allan Ridge | Olifants Substation | Additional Mini Substation | Mini Substation | Strengthening | Add ±9 additional 500 kVA minisubs to cater for additional demand | **3334** |
| **2022** | Allan Ridge | Olifants Substation | Upgrade feeder cable | Cable | Refurbishment | Upgrade the cable to 185 mm2 PILC Copper to increase capacity | **289** |
| **2022** | Allan Ridge | Olifants Substation | Additional Ring | Feeder | Reliability | Create a feeder ring (±8000 m) with Olifants_Bay 11 feeder | **4834** |
| **2022** | Allan Ridge | Buffalo Substation | Replace Cable | Cable | Reliability | Upgrade the cable to ±800 m, 2x185 mm2 PILC Copper to increase capacity; | **1673** |
| **2023** | Allan Ridge | Buffalo Substation | Replace Transformer | Transformer | Strengthening | Replace the 5MVA transformer with a 1 x 10MVA transformer to increase capacity. (if Eskom wants a 20 MVA transformer, they will have to cover the remainder of the cost). | **6915** |
| **2023** | Allan Ridge | Buffalo Substation | Feeder Bay Change | Feeder | Reliability | Request the Intake point to be on the HV side. | **0** |
| **2023** | Allan Ridge | Buffalo Substation | Install Cable | Cable | Reliability | Install a 3rd ±800 m, 185 mm2 PILC Copper cable to maintain firm capacity; | **836** |
| **2025** | Allan Ridge | Buffalo Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 8.6 MVA. | **0** |

| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| **2022** | Hennenman | Hennenman Main Substation | Install Cable | Cable | Reliability | Construct a new ±10000 m, OHL Mink conductor ring around the town various substations on 11kV overhead lines | **458** |
| **2022** | Odendaalsrus | Substation 1A | Upgrade feeder cable | Cable | Refurbishment | Upgrade the backbone cable to ±8000 m 185 $mm^2$ PILC Copper to ensure reliability | **3859** |
| **2022** | Odendaalsrus | Substation 1A | Replace Cable | Cable | Reliability | Replace the OHL Fox conductor with a ±650 m with a Chicadee conductor OHL to increase capacity. | **533** |
| **2022** | Odendaalsrus | Substation 1A | Replace Cable | Cable | Reliability | Replace the 35 $mm^2$ XLPE Copper cable with ±4000 m Fox conductor OHL to increase capacity and maintain firm capacity. Connect from T3 through to EMS-81. | **1664** |
| **2022** | Odendaalsrus | Substation 1A | Replace Cable | Cable | Reliability | Replace the OHL Fox conductor with a ±650 m with a Chicadee conductor OHL to increase capacity. | **433** |
| **2022** | Odendaalsrus | Substation 8 | Replace Cable | Cable | Reliability | Replace the 95 $mm^2$ XLPE Copper cable with ±3000 m OHL Chicadee conductor connecting from Sub 18 – MS18A – MS18B – MS17A – Sub 17. | **2000** |
| **2022** | Odendaalsrus | Substation 8 | Replace Cable | Cable | Reliability | Replace the stolen cable with a new ±800 m OHL Chicadee conductor connecting from Sub 8 – MS 17B. Extend the OHL Chicadee (±1600 m) conductor from MS17B – MS17C – Sub 17. | **1600** |
| **2022** | Odendaalsrus | Substation 8 | Replace Cable | Cable | Reliability | Replace the stolen cable with a new ±2200 m OHL Chicadee conductor connecting from Sub 18 – Weeber | **1467** |
| **2022** | Odendaalsrus | Weeber Park | Replace Switchgear | Switchgear | Reliability | Install a new breaker at Weeber substation | **807** |
| **2022** | Odendaalsrus | Weeber Park | Replace Cable | Cable | Reliability | Install a new ±500 m OHL Chicadee conductor connecting from Weeber – Du Plessis | **333** |
| **2023** | Odendaalsrus | Substation 1A | Additional Cable | Cable | Reliability | Construct a 2$^{nd}$ ±650 m, Chicadee conductor OHL to ensure firm capacity, with ±100 m, 2x95 $mm^2$ XLPE Copper one terminating at MSS5 and the other at Sub 1B. | **4935** |
| **2023** | Odendaalsrus | Substation 1A | Install Cable | Cable | Reliability | Construct a 2$^{nd}$ ±650 m, Chicadee conductor OHL to ensure firm capacity, with ±100 m, 2x95 $mm^2$ XLPE Copper one terminating at MSS5 and the other at Sub 1B. | **333** |
| **2025** | Odendaalsrus | Substation 1A | Additional Transformer | Transformer | Strengthening | Install a 2$^{nd}$ 10 MVA transformer to increase capacity. (if Eskom wants a bigger size transformer, they will have to cover the remainder of the cost). | **7165** |
| **2028** | Odendaalsrus | Substation 1A | Increase NMD | Substation | Strengthening | Increase the NMD to 10 MVA | **0** |
| **2022** | Riebeeckstad | Riebeeckstad Main Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 20 MVA. | **0** |

| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| **2023** | Riebeeckstad | Riebeeckstad Main Substation | Additional Transformer | Transformer | Strengthening | Install a 2nd 20 MVA transformer to have firm capacity. | **6915** |
| **2023** | Riebeeckstad | Riebeeckstad Main Substation | Feeder Bay Change | Feeder | Reliability | Request the intake point to be on the HV. | **0** |
| **2027** | Riebeeckstad | Riebeeckstad Main Substation | Additional Cable | Cable | Reliability | Install 2 x ±4000 m, Chicadee OHL from Riebeeckstad to the proposed Bongani SwS, | **3113** |
| **2027** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 5 x 500 kVA mini-subs to cater for additional load | **1852** |
| **2027** | Riebeeckstad | Riebeeckstad Main Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 32.4 MVA. | **0** |
| **2028** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 3 x 500 kVA mini-subs to cater for additional load | **1111** |
| **2028** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 5 x 500 kVA mini-subs to cater for additional load | **1852** |
| **2029** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 3 x 500 kVA mini-subs to cater for additional load | **1111** |
| **2030** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 4 x 500 kVA mini-subs to cater for additional load | **1482** |
| **2030** | Riebeeckstad | Riebeeckstad Main Substation | Additional Transformer | Transformer | Strengthening | Install a 3rd 20 MVA transformer to maintain firm capacity. | **6915** |
| **2030** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 3 x 500 kVA mini-subs to cater for additional load | **1111** |
| **2031** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2032** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 3 x 500 kVA mini-subs to cater for additional load | **1111** |

| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| **2032** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2034** | Riebeeckstad | Riebeeckstad Main Substation | Additional Cable | Cable | Reliability | Install a new cable of, ±6000 m, 95 $mm^2$ XLPE, Cu to create a three-legged ring and maintain firm capacity | **4060** |
| **2035** | Riebeeckstad | Riebeeckstad Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2021** | Ventersburg | Main Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 3 MVA. | **0** |
| **2021** | Ventersburg | Ventersburg Main Substation | Replace Cable | Cable | Reliability | Replace the damaged cable running to Hamilton substation with a new ±1400 m, OHL Mink conductor. | **641** |
| **2021** | Ventersburg | Ventersburg Main Substation | Replace Cable | Cable | Reliability | Upgrade the President CR Swart – Buitekant line to ±750 m, OHL Mink conductor | **343** |
| **2021** | Ventersburg | Ventersburg Main Substation | Replace Cable | Cable | Reliability | Upgrade the Buitekant – MS023 line to ±1100 m, OHL Mink conductor | **458** |
| **2026** | Ventersburg | Ventersburg Main Substation | Additional Cable | Cable | Reliability | Install a 3rd cable, ±1500 m, 70 $mm^2$ XLPE, Cu from Ventersburg to President CR Swart street to create a 3-legged ring, to strengthen the ring | **1865** |
| **2026** | Ventersburg | Main Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 7 MVA | **0** |
| **2026** | Ventersburg | Ventersburg Main Substation | Additional Mini Substation | Mini Substation | Strengthening | Install 5 x 500 kVA mini-subs to cater for additional load | **1852** |
| **2030** | Ventersburg | Main Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 8.2 MVA | **0** |
| **2021** | Virginia | Virginia Main Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 20 MVA | **0** |
| **2022** | Virginia | Virginia Main Substation | Additional Cable | Cable | Reliability | Install a 3rd cable, ±1400 m, 150 $mm^2$ XLPE from Virginia Main to Eland substation to strengthen the ring | **2098** |
| **2022** | Virginia | Virginia Main Substation | Replace Transformer | Transformer | Strengthening | The demand will require an upgrade of the transformer. Replace the 20 MVA transformer with a 30 MVA transformer | **0** |
| **2022** | Virginia | Virginia Main Substation | Upgrade Cable | Cable | Reliability | Given that networks are old, upgrade the 95 $mm^2$ PILC Cu cables to ±5500 m, 2x185 $mm^2$ PILC Cu | **5751** |

| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| **2022** | Virginia | Virginia Main Substation | Upgrade Cable | Cable | Reliability | Given that networks are old, upgrade the 95 mm$^2$ PILC Cu with ±9800 m, 150 mm$^2$ PILC Copper to strengthen the ring and maintain firm capacity | **6769** |
| **2022** | Virginia | Virginia North Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 10 MVA. | **0** |
| **2022** | Virginia | Virginia North Substation | Install Cable | Cable | Reliability | Increase the NMD to 10 MVA | **0** |
| **2022** | Virginia | Queens Way South | Replace Cable | Cable | Reliability | Install a ±850 m, Hare OHL from Queens Way South – Umzinto. | **472** |
| **2022** | Virginia | Mussina | Replace Cable | Cable | Reliability | Install a ±1300 m, Hare OHL from Mussina – Marico – Monikana. | **721** |
| **2022** | Virginia | Virginia North Substation | Replace Cable | Cable | Reliability | Install a ±800 m, 95 mm$^2$ XLPE Cu interconnector from Fauna Park 2 – Tungstong Sub. | **379** |
| **2022** | Virginia | Virginia North Substation | Replace Cable | Cable | Reliability | Install a ±5000 m, Hare OHL from Virginia North – Joel Park (Feeder Bay 5) to close the ring. | **2774** |
| **2022** | Virginia | Virginia North Substation | Replace Cable | Cable | Reliability | Install a ±2200 m, Hare OHL from Virginia North – Riverside North (Feeder Bay 10) to close the ring. | **1221** |
| **2024** | Virginia | Virginia Main Substation | Increase NMD | Substation | Strengthening | Increase the NMD to 24 MVA | **0** |
| **2024** | Virginia | Virginia Main Substation | Upgrade Cable | Cable | Reliability | Given that networks are old, upgrade the 95 mm$^2$ PILC Cu with ±1100 m, 150 mm$^2$ PILC Copper to strengthen the ring and maintain firm capacity | **760** |
| **2021** | Welkom | CBD | Additional Cable | Cable | Reliability | Install a 3$^{rd}$ cable to support Feeder Bay 20, ±1500 m, 180 mm$^2$ XLPE, Cu to maintain firm capacity | **2011** |
| **2021** | Welkom | CBD | Additional Cable | Cable | Reliability | Install a 3$^{rd}$ cable, ±2500 m, 150 mm$^2$ XLPE, Cu to create a three-legged ring to maintain firm capacity | **2946** |
| **2021** | Welkom | CBD | Additional Cable | Cable | Reliability | Install a 3$^{rd}$ cable, ±1300 m, 70 mm$^2$ XLPE, Cu from CBD substation to William street to create a three-legged ring to maintain firm capacity | **1779** |
| **2022** | Welkom | Welkom Park | Additional Ring | Feeder | Reliability | Install a new ring of, ±2000 m, 150 mm$^2$ XLPE, Cu to strengthen the feeder | **3543** |
| **2022** | Welkom | Welkom Town | Increase NMD | Substation | Strengthening | Increase the NMD to 20 MVA. | **0** |
| **2022** | Welkom | SS 9 Twist | Install Cable | Cable | Reliability | Install a 3$^{rd}$ cable, ±2200 m, 150 mm$^2$ XLPE, Cu from Welkom Town substation to SS9 switching station to replace the stolen cable and maintain firm capacity, | **1519** |
| **2022** | Welkom | Welkom Park | Install Cable | Cable | Reliability | Install a new ±2200 m, 95 mm$^2$ XLPE, Cu cable from Welkom Park substation to TS02 to replace the damaged cable and ensure firm capacity; | **1042** |

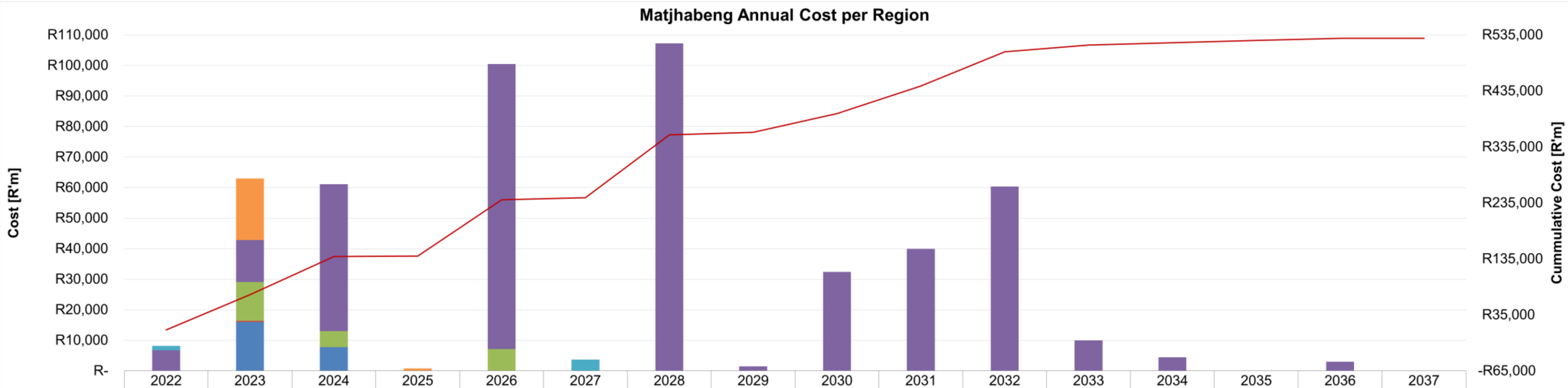
| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| **2022** | Welkom | SS 7 Gawthorne | Install Cable | Cable | Reliability | Install a 4th cable, ±950 m, 240 mm² XLPE, Cu to increase capacity; | **1482** |
| **2022** | Welkom | SS 2 Milner | Install Cable | Cable | Reliability | Install a 3rd cable, ±5400 m, 150 mm² XLPE, Cu from Welkom Park substation to SS2 switching station to replace the stolen cable and maintain firm capacity | **2984** |
| **2022** | Welkom | SS 2 Milner | Install Cable | Cable | Reliability | To further alleviate the congestion on the internal rings supplied from SS2, construct a new ±3200 m, 70 mm² XLPE from SS2 switching station to TK stadium, | **1768** |
| **2022** | Welkom | Welkom Bulk | Increase NMD | Substation | Strengthening | Increase NMD to 45 MVA | **0** |
| **2022** | Welkom | Welkom Bulk | Increase NMD | Substation | Strengthening | Increase NMD to 50 MVA | **0** |
| **2022** | Welkom | Welkom Park | Increase NMD | Substation | Strengthening | Increase the NMD to 30 MVA | **0** |
| **2022** | Welkom | Welkom Park | Install Cable | Cable | Reliability | Install a new ring of, ±2000 m, 150 mm² XLPE, Cu to strengthen the feeder; | **1381** |
| **2022** | Welkom | Western Holdings | Increase NMD | Substation | Strengthening | Increase the NMD to 10 MVA. | **0** |
| **2023** | Welkom | Welkom Park | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2023** | Welkom | Urania | Additional Cable | Substation | Strengthening | Supply the 5MVA Thabong Purification Plant from the newly built Urania Substation with ±4000 m, Chicadee OHL from Urania substation to SS11. | **35501** |
| **2023** | Welkom | Urania | Additional Cable | Cable | Strengthening | Supply Bronville substation from Urania substation with ±1000 m, Chicadee OHL | **3274** |
| **2023** | Welkom | Urania | Reinstate Substation | Substation | Strengthening | Install a 3rd cable, ±2500 m, 150 mm² XLPE, Cu to create a three-legged ring to maintain firm capacity | **7855** |
| **2023** | Welkom | Welkom Park | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2024** | Welkom | Welkom Park | Increase NMD | Substation | Strengthening | Increase the NMD to 35 MVA | **0** |
| **2025** | Welkom | Welkom Park | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2025** | Welkom | Welkom Town | Construct Substation | Substation | Strengthening | Construct a new Rheedepark substation to de-load Welkom Town intake by supplying SS 5 switching station (±8 MVA) | **0** |

| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| **2025** | Welkom | SS 2 Milner | Install Cable | Cable | Reliability | Install ±2800 m, 3x240 $mm^2$ XLPE, Cu cables from the proposed Rheedepark substation to SS2 switching station; | **5982** |
| **2025** | Welkom | Welkom Park | Costruct Substation | Substation | Strengthening | Construct a new Rheedepark substation to de-load Welkom Park intake by supplying SS2 switching station (±9 MVA) | **0** |
| **2025** | Welkom | Welkom Park | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2025** | Welkom | SS 9 Twist | Install Cable | Cable | Reliability | Install a $4^{th}$ cable, ±2200 m, 150 $mm^2$ XLPE, Cu from Welkom Town substation to SS9 switching station to further strengthen the switching station and maintain firm capacity, | **1216** |
| **2025** | Welkom | Western Holdings | Construct Substation | Substation | Strengthening | Construct a new Rheedepark substation to de-load Western Holdings intake by supplying the Rheedepark Ext2 (±5 MVA) Development as well as the Lotgeval development (±15 MVA); | **0** |
| **2025** | Welkom | Proposed Rheedepark Substation | Construct Substation | Substation | Strengthening | Construct a new Rheedepark 44/11/6.6kV, 3x30MVA substation (27°57'14.57"S, 26°42'58.60"E) | **46297** |
| **2025** | Welkom | Proposed Rheedepark Substation | Install Cable | Cable | Reliability | Loop-in and loop-out of the Euclid – Holding Mills 44kV lines ±3000 m, 2 x Chicadee OHL | **9602** |
| **2025** | Welkom | Proposed Rheedepark Substation | Install Cable | Cable | Reliability | Install 6.6kV, ±2800 m, 3x240 mm2 XLPE, Cu cables from the proposed Rheedepark substation to SS2 switching station; | **13104** |
| **2025** | Welkom | Proposed Rheedepark Substation | Install Cable | Cable | Reliability | Install 6.6kV, ±1800 m, 3x240 mm2 XLPE, Cu cables from the proposed Rheedepark substation to SS5 switching station; | **8424** |
| **2025** | Welkom | Proposed Rheedepark Substation | Install Cable | Cable | Reliability | The Rhedepark Exts developments will a three-legged ring with a total length of ±13000 m of 150 mm2 XLPE, Cu cables, with approximately 15 x 500kVA mini-subs. | **7183** |
| **2027** | Welkom | Welkom Park | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2027** | Welkom | Welkom Park | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2027** | Welkom | Proposed | Construct | Substation | Strengthening | Construct a new Welkom Park 44/6.6kV, 2x20MVA | **24543** |

| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| | | 44/6.6kV Welkom Park | Substation | | | substation next to the existing intake point to take over the load of the existing intake point. | |
| **2027** | Welkom | Proposed new Welkom Bulk | Construct Substation | Substation | Strengthening | At Welkom Bulk Intake point, introduce transformation by constructing new 132/44kV, 2x40MVA transformer with only 1x40MVA transformer installed | **66638** |
| **2027** | Welkom | Proposed new Welkom Bulk | Install Cable | Cable | Reliability | Construct a new Welkom Bulk – Welkom Park 44kV, ±5600 m, Chicadee OHL | **8962** |
| **2027** | Welkom | Proposed 44/6.6kV Western Holdings | Install Cable | Cable | Reliability | Construct a new Western Holding – Welkom Town 44kV, ±3500 m, Chicadee OHL | **5601** |
| **2028** | Welkom | SS 7 Gawthorne | Additional Cable | Cable | Reliability | Install a 4th Incomer feeder cable, ±950 m, 150 $mm^2$ XLPE, Cu to maintain firm capacity | **1500** |
| **2029** | Welkom | Welkom Park | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2029** | Welkom | Welkom Park | Additional Mini Substation | Mini Substation | Strengthening | Install 2 x 500 kVA mini-subs to cater for additional load | **741** |
| **2029** | Welkom | Proposed 44/6.6kV Welkom Town | Construct Substation | Substation | Strengthening | Construct a new Welkom Town 44/6.6kV, 2x20MVA substation next to the existing intake point to take over the load of the existing intake point. | **24543** |
| **2029** | Welkom | Proposed new Welkom Bulk | Install Cable | Cable | Reliability | Construct a new Welkom Bulk – Welkom Town 44kV, ±4000 m, Chicadee OHL | **6401** |
| **2030** | Welkom | Proposed Rheedepark Substation | Additional Mini Substation | Mini Substation | Strengthening | The Rhedepark Exts developments will a three-legged ring with a total length of ±13000 m of 150 mm2 XLPE, Cu cables, with approximately 15 x 500kVA mini-subs | **5557** |
| **2030** | Welkom | Proposed Rheedepark Substation | Construct Switching Station | Switching Station | Strengthening | Construct a new Lotgeval 11kV switching station to supply the Lotgeval development; | **7307** |
| **2030** | Welkom | Proposed Rheedepark Substation | Install Cable | Cable | Reliability | The proposed switching station is to be supplied by 2 x Double-circuit Chicadee OHL to ensure 18MVA firm capacity; | **20004** |
| **2030** | Welkom | Proposed Rheedepark Substation | Additional Mini Substation | Mini Substation | Strengthening | The Lotgeval demand will require a total of 39 x 500kVA mini-subs installed as follows: Year 2030: 19 x 500 kVA | **7038** |

| Proposed Year | Town | Substation | Project Description | Type | Category | Project Details | Tot Cost (xR1000) |
|---|---|---|---|---|---|---|---|
| **2031** | Welkom | Proposed 44/6.6kV Western Holdings | Construct Substation | Substation | Strengthening | Construct a new Western Holding 44/6.6kV, 2x10MVA substation next to the existing intake point to take over the load of the existing intake point. | **24543** |
| **2031** | Welkom | Proposed Rheedepark Substation | Install Cable | Cable | Reliability | Construct a new Rheedepark – Western Holding 44kV, ±5000 m, Chicadee OHL | **8002** |
| **2031** | Welkom | Proposed new Welkom Bulk | Additional Transformer | Transformer | Strengthening | At Welkom Bulk Intake point, install the 2nd 132/44kV, 40MVA transformer. | **25498** |
| **2031** | Welkom | Proposed 44/6.6kV Western Holdings | Install Cable | Cable | Reliability | Construct a new Western Holding – Welkom Town 44kV, ±3500 m, Chicadee OHL | **2334** |
| **2032** | Welkom | Proposed new Welkom Bulk | Install Cable | Cable | Reliability | To close the 44kV ring, construct a new Welkom Bulk – Welkom Town 44kV, ±15000 m, Chicadee OHL | **10002** |
| **2033** | Welkom | Proposed Rheedepark Substation | Additional Mini Substation | Mini Substation | Strengthening | The Lotgeval demand will require a total of 39 x 500kVA mini-subs installed as follows: Year 2033: 12 x 500 kVA | **4445** |
| **2035** | Welkom | Proposed Rheedepark Substation | Additional Mini Substation | Mini Substation | Strengthening | The Lotgeval demand will require a total of 39 x 500kVA mini-subs installed as follows: Year 2035: 8 x 500 kVA | **2964** |
| **Total** | | | | | | | **528 942** |

The graph of Figure 8-1 provides a yearly breakdown of the predicted capital cost estimates for the network development projects. The total cost of the projects amounts to R528.94 million.




| | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Virginia | R- | R20,184 | R- | R760 | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- |
| Ventersburg | R1,442 | R- | R- | R- | R- | R3,717 | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- |
| Welkom | R6,735 | R13,720 | R48,112 | R- | R93,289 | R- | R107,225 | R1,500 | R32,426 | R39,906 | R60,375 | R10,002 | R4,445 | R- | R2,964 | R- |
| Odendaalsrus | R- | R12,698 | R5,268 | R- | R7,165 | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- |
| Hennenman | R- | R458 | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- |
| Allan Ridge | R- | R15,944 | R7,751 | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- | R- |
| Cumulative Total | R8,177 | R71,180 | R139,227 | R139,987 | R240,441 | R244,157 | R356,348 | R360,812 | R394,349 | R443,762 | R504,879 | R516,733 | R521,178 | R525,238 | R528,942 | R528,942 |

Figure 8-1: Estimated CAPEX Annual Breakdown per Area

## 9. RECOMMENDATIONS

The following recommendations should be considered:

- Review and update the Master Plan when the SDF and Housing Sector plans are complete;
- Ensure that proper processes are followed before approving developments;
- Develop and enforce a service contribution policy;
- Consider converting all the intake points in the Welkom area to a higher voltage (44kV) substation with a single intake point at Welkom Bulk;
- Request to have intake points at a higher voltage;