CHAPTER 6: UTILITY SERVICES

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6. PURPOSE

The purpose of the chapter is to give a strategic overview on how Tshwane can use the current infrastructure and other available renewable technologies in a sustainable manner to provide electricity, water and sanitation to its residents and large customers, whilst still aligning and complying with various applicable legislations.

6.1 Background

Urbanization creates specific challenges pertaining to the management of resources, particularly water and energy. Cities face tremendous challenges in planning for adequate potable water and electricity and providing them to all residents. Optimizing existing infrastructure and prioritizing the planning and implementation of infrastructure maintenance, renewal and expansion is fundamental to the City achieving its spatial vision of a restructured urban form. While the MSDF identifies broad priority investment areas, practical considerations require that engineering infrastructure be in place to allow for the densities proposed and to attract private investment towards building a more compact, efficient and livable city. The City of Tshwane anchored the collaborative strategy development process - Tshwane Vision 2055 on the Freedom Charter clause: “The people shall govern.” This principle was at the center of the formulation of the Tshwane Vision 2055 to provide a platform for Tshwane residents and the people of South Africa to exercise their power and rights by participating in the vision to remake South Africa’s Capital City. The revised MSDF (Utility Chapter) elaborates on the status and capacity of engineering infrastructural services in the City of Tshwane Metropolitan Municipality and identify areas where intervention is needed in the short, medium and long-term.

- Sustainability: Minimal environmental impact and respect for the value of natural systems.
- Quality of Life: The creation of places that enrich, uplift and inspire the human spirit.

6.2 INFORMANTS OF KEY DATA AND INDICATORS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>VARIABLE</th>
<th>ASSESSMENT</th>
</tr>
</thead>
<tbody>
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TSHWANE MSDF FOR COMMENT SEPTEMBER 2019
<table>
<thead>
<tr>
<th>Utility Services</th>
<th>Water and Sanitation</th>
<th>The country has reached the point where the availability of water in new development zones can no longer be guaranteed.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Expanding agricultural sector will mean facing the same constraints.</td>
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<tr>
<td></td>
<td></td>
<td>There are many municipalities unable to foster local economic development, owing to their lack of ability to provide a reliable supply of water.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The scale of the risk posed by climate change is influenced by, amongst others, the quality of housing and infrastructure in a city and the extent to which urban planning and land-use management have successfully ensured risk reduction within urban construction and expansion.</td>
</tr>
<tr>
<td></td>
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<td>Water Commission, Framework towards Water Sensitive Spatial Planning and Land Use Management (2:2019)</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td>Around 77% of South Africa's energy needs are directly derived from coal and 92% of coal consumed on the African continent is mined in South Africa. South Africa was the sixth top hard coal producer in 2009.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The electricity supply crisis, prompted decision-makers to respond with greater urgency to the capacity shortage that had been threatening to emerge for some time.</td>
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</tbody>
</table>
6.3 REFLECTING ON THE IDP

The MSDF needs to be a spatial translation of the IDP’s intended outcomes. Part of achieving this is through an understanding of how the IDP addresses matters around electricity, water and sanitation. The IDP Needs are a section of the IDP document where a record of the submissions made by citizens with regards to community-identified needs for the foreseeable financial year/s. Delivering high-quality basic services is priority number 11 and includes the following action plans:

- Fixing potholes and maintaining all municipal roads;
- Providing access to electricity, potable water and sanitation;
- Conducting weekly door-to-door refuse collection in formal and informal areas and
- Prioritising the regular maintenance and refurbishment of municipal infrastructure.

The following is a reflection of the submissions that were made for the 2017-2021 IDP. The four most important needs identified by wards per department are as follows:

- Roads and transport – Roads, storm water and public transport;
- Utility services - Water, sanitation and electricity;
- Community and social services – Clinics, community halls, sport and recreation; and

- Housing and Human settlements – Housing and formalization of informal settlements

This therefore requires that a large proportion of the financial resources in terms of the budget should be allocated towards these services. The main challenge with regard to the Utility service remain, reliance on Eskom and Rand water for provision of bulk water and electricity.
6.4 POLICY CONTEXT

6.4.1 Global, National and Provincial Policy Context


In terms of Section 152 (1) (b), local government is mandated to ensure provision of services to communities in a sustainable manner. Citizens also have a right "to an environment that is not harmful to their health or wellbeing" (Section. 26(1), s. 24(a) of the Constitution). The Constitution gives municipalities the obligation to ensure that municipal services are delivered in a sustainable way.

Water Services Act (108 of 1997)

The main objectives of this Act are to provide for: (a) the right of access to basic water supply and the right to basic sanitation necessary to secure sufficient water and an environment not harmful to human health or well-being.

National Water Act (36 of 1998)

The National Water Act (36 of 1998), read together with the Water Services Act (108 of 1997) provides that, among other things, the Minister has to monitor and ensure compliance with all applicable national standards pertaining to water quality.

Environmental Management Act (107 of 1998)

The core environmental principle of National Environmental Management Act is to promote ecologically sustainable development through the conservation and sustainable utilization of natural resources. NEMA requires for certain departments to develop Environmental Management Plans (mostly national departments); Environmental Implementation Plans (mostly province) and Environmental Management Frameworks, mostly local government (Section 24(3).

Key to the EMF is identifying environmentally sensitive areas and areas where certain land uses are most compatible or incompatible with environmental opportunities (Driver, et al., 2011, p. 48). On local level, NEMA requires that the impact of development on the environment is regulated through Environmental Impact Assessments (EIA) which was at the time an existing legal tool as it became mandatory in 1989 after the Environmental Conservation Act 73 of 1989 was enacted.
**Municipal Systems Act (32 of 2000)**

The Act, sets out legislation that enables municipalities to uplift their communities by ensuring access to essential services. The Act defines the legal nature of a municipality as including the community and clarifies the executive and legislative powers of municipalities. It seeks to boost effective local government by establishing a framework for municipal planning, performance management and use of resources.

**National Energy Regulator Act, 2004 (40 of 2004)**

NERSA is a regulatory authority mandated to regulate the energy industry (electricity, piped gas and petroleum pipeline industries) in terms of the Electricity Regulatory Act No 4 of 2006, Gas Act (Act 48 of 2001) and Petroleum Pipelines Act, 2003 (Act No 60 of 2003). The mission of NERSA is to regulate the energy industry in accordance with government laws and policies, standards and international best practices in support of sustainable and orderly development.

**Electricity Regulatory Act No 4 of 2006**

Electricity Regulation Act, 2006 strive to ensure that the interests and needs of present and future electricity customers and end users are safeguarded and met, having regard to the governance, efficiency, effectiveness and long-term sustainability of the electricity supply industry within the broader context of economic energy regulation in the Republic.

**National Groundwater Strategy 2010**

The strategy reports that decision makers in the fields of climate change, rural poverty alleviation and related fields did not always have adequate information about the way in which groundwater can assist them. As a result, spatial planning documents rarely consider groundwater, even where groundwater is a potential major factor in continued economic development (DWAF, 2010, p. 11). Furthermore, the lack of understanding of the spatial elements of groundwater has also led to widespread deteriorations of groundwater quality.

The strategy blamed land use linked to various sectors such as mining, industrial activities, effluent from municipal wastewater treatment works, storm water runoff from urban and especially informal settlements (where adequate sanitation facilities are often lacking), return flows from irrigated areas, effluent discharge from industries, etc.” (DWAF, 2010, p. 24). These land use activities contributed to high levels of electric conductivity in several regions making groundwater to be brackish or even saline (DWAF, 2010, p. 18).
The Sustainable Development Goals (SDGs) of 2015

Attaining a high level of infrastructure means developments should be done sustainably and in line with the global standards and applicable laws and policies. The Sustainable Development Goals (SDGs) are a collection of 17 global goals set by the United Nations General Assembly in 2015 for the year 2030. The Sustainable Development Goals are:

- No Poverty
- Zero Hunger
- Good Health and Well-being
- Quality Education
- Gender Equality
- Clean Water and Sanitation
- Affordable and Clean Energy
- Decent Work and Economic Growth
- Industry, Innovation and Infrastructure
- Reducing Inequality
- Sustainable Cities and Communities
- Responsible Consumption and Production
- Climate Action
- Life Below Water
- Life On Land
- Peace, Justice, and Strong Institutions
- Partnerships for the Goals

The goals are broad based and interdependent. The 17 sustainable development goals each have a list of targets that are measured with indicators.

Spatial Planning and Land Use Management Act (Act 16 of 2013)

In terms of (Section 21) SPLUMA requirements, MDSF responds to the following with regard to engineering services:

d) Identify current and future significant structuring and restructuring elements of the spatial form of the municipality, including development corridors, activity spines and economic nodes where public and private investment will be prioritized and facilitate

h) Identify, quantify and provide location requirements of engineering infrastructure and services provision for existing and future development needs for the next five years

j) Include a strategic assessment of the environmental pressures and opportunities within the municipal area, including the spatial locating of environmental sensitivities, high potential agricultural land and coastal access strips, where applicable;
National Development Plan Vision 2030

The National Development Plan (NDP) envisages that, by 2030, South Africa will have made headway in transitioning to an environmentally sustainable, climate change resilient, low-carbon and just society (Chapter Five of the NDP). This will be done by promoting economic growth, social equity and environmental sustainability. The project will assist in giving effect to the proposals contained in the Chapter Five of the National Development Plan. The goals include ensuring that by 2030:

- All South Africans have access to affordable, reliable and safe drinking water;
- Universal access to hygienic sanitation;
- At least 90 percent of South Africans have access to grid electricity, with the remainder accessing electricity from off-grid resources; and
- Improved productivity of infrastructure and increased levels of public and private investment to a combined 30 percent of GDP.

One of the task of the National Planning Commission is to convene high-level dialogue meetings and wider stakeholder meetings to facilitate a process to reach a social compact between the key social partners, namely, government, business, labor and civil society. The social compact will involve an agreed vision and pathway for a low-carbon and climate-resilient society, whilst at the same time addressing poverty, inequality and unemployment.

6.5 SUSTAINABLE INFRASTRUCTURE FRAMEWORK

Population growth, migration and urbanization trends demand an increase in infrastructure development, especially in emerging economies and developing countries. Attaining a high level of infrastructure means developments should be done in a sustainably and in line with the global standards and applicable laws and policies. Five key infrastructure areas crucial to sustainable development are discussed below:

- Energy Infrastructure

Energy is the driving force behind almost everything people do but the generation of electricity has serious environmental impacts. Many forms of generation increase the concentration of greenhouse gasses, create health hazards, create dangerous wastes, or damage water quality.

- Transportation

Transportation is responsible for 25% of global greenhouse gas emissions. Road transport is the dominant source of transportation-related greenhouse gas emissions, accounting for 80% of the total (UNEP, 2005). Airplanes are responsible for an additional 13%, with the remainder
from ship and rail transport (UNEP, 2002). The contributions from transportation are also rising faster than in any other sector, and rapid motorization in the form of more cars and trucks is the principal cause (Sperling & Salon, 2002).

- **Waste Management**

Waste management involves the collection, transport, processing and disposal of waste materials produced by human activity. The most basic waste management involves collection and disposal. Increasingly, waste is also processed to reduce volume, produce energy, reduce hazards, or gather material for recycling. Waste can be managed in several ways:

- **Landfill**: Though land filling of waste can be done successfully, it can also lead to windblown garbage, vermin, and leachate that pollutes groundwater. Landfills also create methane, though this can be tapped as a fuel source.

- **Incineration**: Incineration involves the burning of waste. Incineration occurs on the small scale. Incineration can also be used to generate electricity and heat however most of the energy is lost to the atmosphere. Incineration creates toxic gasses and ash which must then be disposed of. Toxic emissions include dioxins and mercury compounds, both very harmful to the environment.

- **Reduction**: Waste reduction can involve the compaction of existing waste, but increasingly involves resource recovery. This includes reusing and recycling. Recycling is also known as secondary resource recovery. Recycling involves the reprocessing of material that would otherwise be considered waste. The most commonly recycled materials are aluminum, plastics, papers, and cardboards. On problem with recycling is that in many markets virgin resources are actually cheaper than the recycled alternatives. However, there are significant environmental savings to be realized through recycling. Recycling can be conducted by getting consumers to separate their waste or the recyclables can be separated out later.

- **Composting and Digesting**: Organic wastes, including sewage, is typically composted or digested. Technologies vary widely, but the general goal is to eliminate pathogens, physically breakdown waste, and produce soil and clean water. These methods almost always involve aerobic and anaerobic bacteria as a breakdown agent. Until recently composting has been largely an individual undertaking, but “green bin” programs are being initiated in many areas. The soil produced from such projects can be sold at a profit. Sewage treatment systems usually contain three stages. Primary treatment removes inorganic debris and breaks up solids, secondary treatment settles out
solids and allows the breakdown of pathogens, and tertiary treatment renders the waste free of all pathogens. Sewage treatment also produces great quantities of methane gas, which can be used to create electricity.

✓ Land Use Planning

The planning process impacts how communities use their land, and how they grow and develop over time. All too often land use planning is carried out on an ad-hoc basis with development decisions being made in isolation from considerations of the long-term and consideration of the community landscape. This has led to urban forms that are pre-disposed to sprawl, car focused networks and separation of living, working and leisure spaces; the public realm deteriorates and opportunities for nature and social interaction decline. Sustainable infrastructure demands planning that is efficient, helps support or create closer knit neighborhoods and the sense of community with them, and preserves natural systems that existed on the land prior to human development.

Two methods, currently popular used to support more sustainable planning decisions are ‘Smart Growth’ and ‘New Urbanism’. These two approaches are very similar. Both encourage the development of high density neighborhoods with a diversity of land-use, housing types and integrated transport solutions.

The commonality between these two approaches, and those characteristics that mark sustainable planning processes are the development of neighborhood’s that are good places to live and where most of life’s requirements are provided within walking distance in a place that inspires those that live there and promotes community spirit. The aim is to develop a quality of life that promotes well-being and lifts the human spirit.

✓ Smart Growth

This model arose out of the realization that sprawl-based models come with long term costs as infrastructure is allowed to decay in downtown cores and reconstructed at the edge of the growing region, and municipalities are faced with large maintenance bills for the road infrastructure. Such planning leads to long commutes and neighborhoods that are not easily served by transit, while brownfields sit empty within older areas with established infrastructure already in place.

In general, smart growth aims to revitalize city centers by making them better places to live, supports the quality of life in established communities, and presents a model of new development based on mixed use, transit use, and pedestrian spaces. There are several principles that are found within smart growth planning processes:
- Mixed Land Uses: A mix of commercial, business and retail uses reduces the need for people to travel. Mixed use areas can then be pedestrian friendly as space is not needed for cars. Public transit is easier to plan as passenger numbers remain stable throughout the day. The constant presence of people means an area is safer, encourages community life and increases the opportunities for business bringing more tax revenue and higher property price. As mixed use is still illegal or discouraged in many places there are many opportunities for development of such areas.

- Compact Building Design: By increasing densities means the required population base for local business and transit success is provided. Compact building design also allows more open space to be preserved for recreation, storm-water mitigation and places for nature. These designs decrease ecological footprint as less energy is required for heating and cooling. It is also much cheaper to provide services to densely developed neighbourhoods.

- A Range of Housing Opportunities and Choices: Sustainable communities are diverse, provide housing for such communities means providing a mixture of high density and lower density housing choices. This also helps to create a balance of green space and business districts. A variety of housing choices introduces other forms of neighbourhood diversity as well, including a mix of age groups and lifestyles.

- Walkable Neighbourhoods: Walkability is created by mixing land uses, building compactly, and creating safe and inviting pedestrian corridors. In many ways this is a return to past patterns of development; before the mid-20th century shortest trips were made on foot. This pattern of development carries many unexpected benefits; lower transportation costs, greater social interaction, improved health, and environmental benefits.

- Foster Distinctive, Attractive Communities with a Strong Sense of Place: Defined neighbourhoods with a strong identity improve the sense of community and increase the desirability of a place. Natural and manmade features can be used to create the borders of such communities, and development should reflect the surrounding landscape. Local business and building styles are encouraged over generic “big box” development. Architectural innovation is to be encouraged. These communities are scaled to their surroundings to create a sense of “home”.

- Preserve Open Space, Farmland, Natural Beauty and Critical Environmental Areas: Open spaces are important for both social and ecological functions. Preserving important habitats,
community space, farm lands, wetlands, and other critical elements of the landscape, contribute to the character of a neighbourhood, the environmental integrity of the landscape and provide animal and plant habitat, combat air pollution, filter runoff, and control wind and noise.

- Strengthen and Direct Development towards Existing Communities: Directing growth towards existing communities and downtowns preserves open space and maximizes the value of existing infrastructure maximized. Developing within communities also improves quality of life within that community as goods and services are added. Service provision becomes more cost effective as density increases.

- Provide a Variety of Transportation Choices: As congestion and gridlock becomes a larger and larger problem, there is a growing movement to get people out of their cars. A mix of automobile infrastructure, rapid transit, bike lanes, and pedestrian friendliness can greatly increase the efficiency of travel.

- Encourage Community and Stakeholder Collaboration: As people spend more time in their community they will need to have more input in to the decisions that develop their community. Participation in the ongoing planning processes that all communities undertake will increase support for smart growth.

- Historic preservation: The past in creating a sense of place. Preserving historical sites helps to maintain identity, provides a sense of pride about the factors that created the community. Historical structures can be incorporated into new development and serve new purposes. Historical preservation can focus on buildings of artistic merit, archetypes of a design style, scenes of important historical events, and the past processes that helped create the communities’ identity.

- New Urbanism

New Urbanism shares many characteristics with Smart Growth, the focus is on walkability and people rather than car centered planning and development. The principles of New Urbanism are:

- Walkability: A neighbourhood should have most things required for living in it within a 10-minute walk. The streetscape should reflect this by being pedestrian friendly in design and free of cars as much as possible.

- Connectivity: An interconnected street network disperses traffic and eases walking. A hierarchy of narrow streets, boulevards and alleys also increases the pleasure of walking.

- Mixed-use and diversity: Within buildings, between blocks and within neighbourhoods helps the delivery of the walkability of
the neighbourhood. Diverse neighbourhoods make a vibrant community more likely and will support more business activity.

- Mixed housing: A range of types, sizes and prices increases social diversity.

- Quality architecture and urban design: Community pride and a sense of place is enhanced if the living environment is attractive and comfortable. Human scale architecture & beautiful surroundings nourish the human spirit.

- Traditional neighbourhood structure: This means having an edge, public space at the centre, a public realm that is high quality in appearance and is designed as civic art. The neighbourhood should also have a transect that moves from dense in the centre to less dense at the edge, including the consideration of natural habitat into the urban area.

- Increased Density: Having people and services close together increases liveability and walkability in the neighbourhood.

- Smart Transportation: A network of high quality mass transit options connecting towns and neighbourhoods. This in combination with local networks that encourage a greater use of bicycles, rollerblades, scooters, and walking as daily transportation.

6.6 ELECTRICITY

6.6.1 Current Status

Most of the City’s (Tshwane Metropolitan Municipality) electricity comes from Eskom, supplying at various substations both Transmission and Distribution bulk through 11 infeed stations, namely: -
The City of Tshwane has notified maximum demand (NMD) of 2137 MVA and the current demand is 1935 MVA (= 90.5% of the NMD). Three of the Infeed’s (Njala, Kwagga and Rietvlei) account to 92% of the Load and 76% of the NMD from Eskom. Eskom as the main supplier of energy relies on coal fired power stations to produce electricity. Main Infeed stations are discussed below.

✓ **Rietvlei**

Rietvlei is the Southern infeed point for the City of Tshwane (CoT) network with current NMD of 250MVA, transformers upgraded from 2x125MVA to 2x250MVA to stabilize the electrical network in the south. The infeed station supplies the Centurion area by means of two 250MVA transformers being fed from the Eskom network (Thuso Substation). Thuso substation is supplied via two 400 kV transmission lines from Apollo and Pluto Transmission substations. The entire Rietvlei system comprises of (Waterkloof, NIVS, Kentron, Piet Geers, Brakfontein, Olievenhoutbosch, Kosmosdal, New Kosmosdal, Cornwall Hill, Raslouw, and Eldoraigne) substations. This infeed station is subdued to heavy network loadings in winter, due to rapid growth in the southern part of the COT area during the last few years.

### Table 1: Tshwane Infeed Stations

<table>
<thead>
<tr>
<th>INFEED STATIONS (S)</th>
<th>REGION</th>
<th>NOTIFIED MAXIMUM DEMAND NM (MVA)</th>
<th>CURRENT LOAD 2018 (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kwagga</td>
<td>3</td>
<td>950</td>
<td>906</td>
</tr>
<tr>
<td>Njala</td>
<td>6</td>
<td>775</td>
<td>707</td>
</tr>
<tr>
<td>Rietvlei</td>
<td>4</td>
<td>250</td>
<td>168</td>
</tr>
<tr>
<td>Hartebeespoort</td>
<td>Madibeng</td>
<td>40</td>
<td>44</td>
</tr>
<tr>
<td>Kameeldrift</td>
<td>5</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>Tribor</td>
<td>7</td>
<td>60</td>
<td>45</td>
</tr>
<tr>
<td>Refilwe</td>
<td>5</td>
<td>5</td>
<td>5.1</td>
</tr>
<tr>
<td>Cullinan</td>
<td>5</td>
<td>5</td>
<td>3.5</td>
</tr>
<tr>
<td>Rethabiseng</td>
<td>7</td>
<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>Brayton</td>
<td>5</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Hammanskraal</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL LOAD</strong></td>
<td></td>
<td>2137</td>
<td>1935 (90.5%)</td>
</tr>
</tbody>
</table>

*Source: City of Tshwane energy and electricity long term (20 years) Master plan 2018*
The additional capacity required for the southern supply area is supplied either by Kwagga or Njala, via Lyttelton switchyard. A 150MVA line supplies the western part and a radial 150 MVA line supplies Waterkloof to the north. The supply system consists of 4 substations and has mainly residential with a fair portion of commercial and industrial consumers. This area has tremendous potential for developments.

The graph below shows the transformers loading at Rietvlei / Thuso Substation (Eskom) for the period 14-21 July 2019 (Monday to Sunday), which is a winter loads. From this graph it can be seen that from Monday to Friday evening peak loading (17:30 – 20:00) exceeds the notified maximum demand of 250 MVA, while the morning peak loading (06:00 – 08:00) approaches 250 MVA.

**Njala**

Njala infeed Substation is fed from Eskom’s Apollo 400/275kV Transmission station via 2x275KV lines. The notified maximum demand of Njala is 775MVA whereas the installed capacity at Njala is 1000MVA via 4x250MVA 275/132kV transformers. Njala Substation then supplies the Tshwane Eastern area by means of three 300 MVA double circuit power lines consisting of the Mooikloof, Highlands and Wingate line. The entire Njala system comprises of (Wingate, Aries, Kloofzicht, Highlands, Willows, Mooikloof, Lynnwood and Wapadrand) and one switching station (Scientia).
The current operation boundaries of the Njala system are at Njala-Wingate, Waltloo-Derdepoort and Eland-Scientia. The majority of the load in this area is residential with a mix of a commercial sector to support the vast number of residential consumers as well as numerous home offices. The load on the Njala system indicates ample growth. This is mainly due to the extensive development to the eastern suburbs of CoT and Centurion side of the CoT area.

The graph below shows the combined lines loading of Apollo Njala 275kV lines for the period 14-21 July 2019 (Monday to Sunday), which is a winter load. From this graph it can be seen that from Monday to Friday evening peak loading (17:30 – 20:00) increases from +450 MVA to +650 MVA (difference of +200MVA), while the morning peak loading (06:00 – 08:00) increase by +100 MVA.

Njala supports the Rietvlei system via the Lyttelton Switchyard. The drop in load after 2016 is due to the upgrading of Rietvlei infeed station (additional 125MVA).
Kwagga (PTA West – Region 3)

Kwagga infeed station is fed from Eskom’s Minerva 400/275kV Transmission station via 2x275KV lines. The installed capacity at Kwagga is 1200MVA via 4x300MVA 275/132kV transformers which belongs to the City of Tshwane. Kwagga was commissioned in 1972 with a notified maximum demand of 100 MVA, upgraded in 1973 to 300MVA and ultimately upgraded to 900 MVA.

From Kgwagga Substation the city center is supplied by two 300 MVA overhead power lines from Kwagga to Bellom. The rest of the supply area is fed by means of one 150 MVA line to the west (Atteridgeville), one 150 MVA line to the south (Zebra) and one 300 MVA line to the north (Gomsand). Pretoria West power station is currently connected to Kwagga via two 150 MVA power lines.

The load is basically concentrated on the commercial side due to the city center. The entire Kwagga system comprises of (Atteridgeville, Saulsville, Boom Street, Capital Park, Dam, Edmund, Gomsand, Mayville, Orchards, Zwartkops, Princess Park, Skinner, Tunnel, Claudius, Bellom, Parktown, Pretoria West Industrial and Zebra).

Figure 6: Njala Infeed Load Profile
Source: City of Tshwane energy and electricity long term (20 years) Master plan 2018

The graph below shows the combined lines loading of Minerva Kwagga 275kV lines for the period 14-21 July 2019 (Monday to Sunday), which is a winter load. It can be seen that from Monday to Friday evening peak loading (17:30 – 20:00) increases from +627 MVA to +765 MVA (difference of +138MVA), while the morning peak loading (06:00 – 08:00) increase by +45MVA.
City of Tshwane owns and operates two power stations, namely Rooiwal and Pretoria West Power Stations. These two power stations when in operation generate approximately 10 percentage of the Tshwane load. The power stations are mainly used as peaking plants especially in winter. Kwagga’s load profile depicts that of an almost saturated load. This is due to the fact that Kwagga primarily supplies the City Centre.

The drop in load is also in accordance with the upgrading and commissioning of Rietvlei (2016) and Wildebees (2023-24). It is recommended that Kwagga be operated at 95% of its installed firm capacity in order to prolong its life span.

6.6.2 REGIONAL ANALYSIS AND PLANNED PROJECTS

Tshwane consists of 7 planning regions each with their own unique characteristics, opportunities and challenges.

✓ Region 1

The northern part of the region accommodates a third of the City’s population in low-income settlements that includes subsidized housing and informal settlements. Region 1 bulk electricity network consists of 1 infeed station, 13 132/11kV substations, and 14 satellite substations.

The City of Tshwane 2055 vision for Region 1 includes the following planned projects:

- Rainbow Junction
Rainbow Junction is the implementation and delivery of a new 550,000m² mixed use economic node in the City of Tshwane’s Zone of Choice 6km from CBD on 140ha Greenfield site. The approved mixed basket of integrated land uses of this unique address comprises office and corporate parks, 1,200 high-density residential units, a spread of extensive retail development, including a high-street shopping precinct and a regional shopping-center, hotels with conference facilities, clean energy industry aligned with the City’s commitment to environmentally sustainable development, community facilities such as a private hospital, and other tailored commercial opportunities.

- **Automotive Supplier Park**

The Automotive Supplier Park in Rosslyn will cater for the logistics needs of OEMs (original equipment manufacturers) and component suppliers to the automotive industry. The OEM’s have several common suppliers that are located throughout the country all delivering separately to each OEM. An opportunity exists to consolidate the separate delivery of goods to OEM’s to achieve economic benefits. The Auto City concept acts as an enabler to ensure critical mass is achieved so as to gain the potential benefits of subsidized utilities, reduced rental, consolidated logistical flows, bulk infrastructure improvements and dedicated logistics hubs; not to mention a key attraction for foreign direct investment as well as establishing the Gauteng Province as an ‘area of choice’ for the automotive manufacturing sector. The following substations have been upgraded to support planned developments in Region 1:

- Orchards 132/11kV substation (commissioned 2015)
- Wolmer 132/11kV substation (commissioned 2015)
- K1 132/11kV substation (commissioned 2016)
- New K2 132/11kV substation (commissioned 2015)
- K3 132/11kV substation (commissioned 2016)

- **REGION 2**

Region 2 has three main zones – the urban north zone, central and eastern agriculture and conservation zones, and the southern zone. The region, while urban in character, is not integrated with the larger urban environment of the City. The central and eastern parts of the region fall outside the urban edge and are rural in character with a low population density while the southern part of Region 2 is a low density formally developed suburban area, with well-developed nodes of economic activity.

The Wonderboom airport is also situated in Region 2. The region is characterized by low density settlements, with concentrations of
subsidized housing and informal settlements, limited economic activities, poor network of social infrastructure, limited retail facilities, limited investment by the private sector, and major backlogs in infrastructure provision. The region includes a few prominent land uses of strategic significance to the City of Tshwane and even on an international level that include:

- Onderstepoort Veterinary Research Institute
- Zone of Choice
- Dinokeng / Big Five Reserve

Region 2 bulk network consists of 4 132/11kV substations, and 5 satellite substations. Region 2 planned load growth for the next 20 years.

Currently, Region 2 does not have a strong economic base, but has limited economic activities namely, informal trade, community stokvels, Babelegi industrial park and recently developed shopping Centre.

As such, Region 2 is considered to be an area of consolidation which means the City of Tshwane will lead in the investment of socio-economic infrastructure in the Hammanskraal CBD so as to crowd in and direct public and private sector investment. The 2055 vision for Region 2 includes the following planned projects:

- Babelegi
- Hammanskraal CBD development
- Wonderboom airport

In order to cater planned developments in the Region, the new Hammanskraal 132/11kV substation is planned to supply these developments.

- **REGION 3**

Region 3 has a total of 23 wards that includes the Central business district (CBD), the Brooklyn and Hatfield metropolitan nodes. The eastern two-thirds of the region is mostly urbanized whereas the western third is mostly rural. The region hosts National Government
offices and forms the administrative heart of government with two of the three Tshwane stations of the Gautrain located in the region.

Three landmark sites - the Union Buildings, the Voortrekker Monument and the Freedom Park National Legacy site are located in this region. Region 3 also includes other prominent land uses of strategic significance to the City that include: The Inner City, Marabastad, Embassies, Nelson Mandela Development Corridor, Church Square, Brooklyn Metropolitan Node, Hatfield Metropolitan Node, Pretoria Industrial Township (including the Charlotte Maxeke Street and Soutter Street industrial areas), Fresh Produce Market, Capital Park Container Depot, and the Steve Biko Academic Hospital.

The south eastern area of the region accommodates middle and higher income groups while most of the low income groups are located in the west while high density residential developments are to the east of the Inner City in Sunnyside and Arcadia. The region contains some of the oldest townships in the greater Tshwane. The region is generally well provided with service infrastructure.

With developments rapidly moving closer to the provincially demarcated urban edge and towards the open space area to the west of the region, development pressure in this area is the rate at which bulk infrastructure can be provided to accommodate expansion. Region 3 bulk network consists of 1 infeed station, 17 132/11kV substations, 1 switching station and 27 satellite substations. Region 3 planned load growth for the next 20 years is as follows.

![Region 1 Load Growth](image)

*Figure 1: Region 1 Load Growth*

Source: City of Tshwane energy and electricity long term (20 years) Master plan 2018

According to the load growth the following projects were identified with the planned completion dates: -
<table>
<thead>
<tr>
<th>PROJECT NAME</th>
<th>START DATE</th>
<th>COMPLETION DATE</th>
<th>EXISTING CAPACITY</th>
<th>PLANNED CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacing all oil filled 132kV cables with XLPE in the City Centre</td>
<td>2018</td>
<td>2021</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Upgrade Bellom – Park Town 132kV line to 300MVA</td>
<td>2024</td>
<td>2026</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td>Upgrade Willows 132/11kV substation</td>
<td>2031</td>
<td>2033</td>
<td>70</td>
<td>80</td>
</tr>
<tr>
<td>Upgrade and Refurbish River 132/11kV substation</td>
<td>2023</td>
<td>2025</td>
<td>70</td>
<td>120</td>
</tr>
<tr>
<td>Upgrade Hatfield 132/11kV substation</td>
<td>2021</td>
<td>2023</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Upgrade Tunnel 132/11kV substation</td>
<td>2019</td>
<td>2022</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td>Upgrade Zebra 132/11kV substation</td>
<td>2023</td>
<td>2025</td>
<td>70</td>
<td>120</td>
</tr>
<tr>
<td>Upgrade Atteridgeville 132/11kV substation</td>
<td>2027</td>
<td>2029</td>
<td>70</td>
<td>120</td>
</tr>
<tr>
<td>Upgrade Saulsville 132/11kV substation</td>
<td>2024</td>
<td>2026</td>
<td>70</td>
<td>120</td>
</tr>
<tr>
<td>Upgrade and Refurbish Boom 132/11kV substation</td>
<td>2028</td>
<td>2030</td>
<td>110</td>
<td>120</td>
</tr>
<tr>
<td>Upgrade Capital Park 132/11kV substation</td>
<td>2030</td>
<td>2032</td>
<td>70</td>
<td>120</td>
</tr>
<tr>
<td>Upgrade Villieria 132/11kV substation</td>
<td>2032</td>
<td>2034</td>
<td>35</td>
<td>80</td>
</tr>
<tr>
<td>New Camel 132/11kV substation</td>
<td>2033</td>
<td>2035</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>New Lotus 132/11kV substation</td>
<td>2030</td>
<td>2032</td>
<td>0</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 2: Region 3 Planned Projects
Source: City of Tshwane energy and electricity long term (20 years) Master plan 2018

The 2055 vision for Region 3 includes the following projects:

1. Modernization of the Inner City
   - Mandela development Corridor
   - Tshwane House (completed)
2. Hatfield node development
3. Government offices at Salvokop precinct

For the Hatfield node development, the planned new Hatfield 132/11kV substation shall cater for this planned development. The refurbishment of River 132/11kV substation shall also assist in supplying this planned development including the planned new 132kV cable from Skinner 132/11kV substation.

- REGION 4

The Region borders on the area of jurisdiction of the City of Johannesburg Metropolitan Municipality, Ekurhuleni Metropolitan Municipality as well as Mogale City to the west. The regions served by both north-south and east west first order roads (highways), links it to the rest of Gauteng and the broader region. The region consists of an urban area to the east and a rural area to the west both of which are currently under pressure for development. The current dominant sectors in Region 4 are finance and business services, general
Government services, manufacturing, and trade. The region also forms part of an area of economic expansion to the north of Johannesburg where this sub-node is dominated by smart industries and business tourism. The region falls within the economic core identified for Gauteng Province with the legs of the triangular core the N1 Highway on the western side and the R21 Highway with its linkage to the Oliver Tambo International airport on the eastern side. The region includes a few prominent land uses of strategic significance to the City of Tshwane. These include:

- Zwartkop and Waterkloof Military Airports
- Thaba Tshwane/ Voortrekker Hoogte military Base
- Centurion Metropolitan Core, Centurion Gautrain Station
- Super Sport Park, Highveld Technopark
- Highway Business Park
- Route 21 Corporate Park
- Sunderland Ridge Industrial Area
- N1 Corridor
- Samrand Commercial Area Gateway development
- Olievenhoutbosch Absa Housing development
- Centurion Aviation Village.

A higher percentage of higher income earners reside in Region 4 with the result that many offices and retail functions have relocated to the region during the past few years. The region is generally well provided with service infrastructure. With development rapidly moving closer to the development edge and demarcated urban edge to the west of the region, development pressure in this area challenges the rate at which bulk infrastructure can be provided to accommodate expansion. Region 4 bulk electricity network consists of 1 infeed station, 15 132/11kV substations, 1 switching station and 27 satellite substations.

![Figure 2: Region 1 Load Growth](image)

Source: City of Tshwane energy and electricity long term (20 years) Master plan 2018

The 2055 vision for Region 4 includes the following planned projects:
- Centurion Aerospace Village: Centurion Aerospace Village is situated around Waterkloof Air force base to the north eastern side of Region 4. It is a high-tech advanced manufacturing aero-mechanical and defence cluster aimed at integrating sub-tier suppliers of the local industry into the global supply chain. This development falls in the electrical supply region of Waterkloof and Cornwall Hill 132/11kV substation. The planned upgrading of these substations in 2026 and 2029 respectively shall provide sufficient capacity for this high-tech advanced cluster development.

- Tshwane International Convention Centre (African Gateway): It is around the Centurion Gautrain Station. The Convention Centre shall allow The City of Tshwane to host international conventions. The development falls inside the electrical supply area of Kentron and De Hoewes 132/11kV substation. The planned upgrade of the Kentron 132/11kV substation in 2018 and the existing capacity of the De Hoewes 132/11kV substation shall provide sufficient capacity for these 2 developments.

- Legacy Project; The Legacy Project is situated in the southern corner of N1 and the K105 (Botha Ave). This development shall comprise of multi-national corporations; educational institutions and residential development. The development falls within the planned Hennops 132/11kV substation electrical supply area. The planned construction of the new Hennops 132/11kV substation is 2023 and shall provide sufficient capacity for this development.

- **REGION 5**

  Region 5, bordered by the N1 to the west and the N4 freeway to the south, has rather weak spatial structure characterized by heavy through traffic, vast open spaces, small economic centers and enormous development pressure from residential areas from Tshwane pushing further and further eastward. Region 5 is a rural area characterized by nature conservation (including the Dinokeng Blue IQ project of Gauteng), tourism and mixed agricultural land uses. Mining, especially in Cullinan provides work opportunities for communities in the area. The region includes a few prominent land uses of strategic significance to the City. These include:

  ✓ Cullinan Mine
  ✓ Dinokeng Nature Reserve and
  ✓ Cullinan Town Centre
Region 5 bulk electricity network contains of 2 132/11kV substations and 1 satellite substation. Region 5 planned load growth for the next 20 years are as follows:

Based on the load growth the following projects were identified with the planned completion dates:

<table>
<thead>
<tr>
<th>Project name</th>
<th>Start date</th>
<th>Completion date</th>
<th>Existing Capacity (MVA)</th>
<th>Planned capacity (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Gem Valley 132/11kV substation</td>
<td>2021</td>
<td>2023</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>New 132kV line from Mamelodi 2 to Gem Valley substation</td>
<td>2021</td>
<td>2023</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>New Roodeplaat 132/11kV substation</td>
<td>2026</td>
<td>2029</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>New 132kV line from Gem Valley substation to Roodeplaat substation</td>
<td>2027</td>
<td>2029</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>New Cullinan/Refilwe 132/11kV substation</td>
<td>2028</td>
<td>2031</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>New 132kV line from Gem Valley substation to Cullinan/Refilwe substation</td>
<td>2029</td>
<td>2031</td>
<td>0</td>
<td>300</td>
</tr>
</tbody>
</table>

Table 3: Region 5 Planned Projects
Source: City of Tshwane energy and electricity long term (20 years) Master plan 2018

The City of Tshwane 2055 vision for Region 5 centers around the revitalization and development of this region will be anchored around the three areas:

- Cullinan
- Refilwe and
- Rayton

As part of this revival, the City of Tshwane will lead the infill high density and mixed use development in and around the Rayton CBD as well and invest in the upgrade of infrastructure to support future economic activities. The building of the new Cullinan/Refilwe substation shall cater to supply the above needs.
REGION 6

Region 6, bordered by the N1 freeway to the west and Ekurhuleni Local Municipality to the South has 24 wards. It is the region with the greatest development pressure. Almost all the developable land within the southern section of the region has been developed and the uncontrolled development in the old Kungwini area places a burden on the existing saturated road infrastructure. The south-eastern section of this region has the highest income per capita, but there is also a huge concentration of people in the north-east quadrant with no to low income.

The north-eastern section of the region accommodates mostly low-income communities and industrial land uses. The middle and south-western section of the region accommodates medium to high-income areas with large institutional uses. Although population densities in the south-eastern section of the region are relatively low, this part of the region has the highest percentage of group housing developments compared to any other region. Much development has taken place further to the east in the last decade and the road network development has not kept up with land development resulting in severe congestion during the peak hours. The region contains a number of strategic land uses including the CSIR, South African National Intelligence Service, Silverton, Waltloo, Koedoespoort industrial areas and the Menlyn Park Retail Node which has a metropolitan function in terms of facilities. The economic base for Region 6 is balanced between the retail, office sector in the southern and western sections, with commercial, warehousing, wholesale or industrial activities in the north of the region. Region 6 bulk electricity network contains of 1 infeed station, 9 x 132/11kV substations, 1 switching station and 14 satellite substations. There is an urgent need to invest in new infeed stations.

Region 6 planned load growth for the next 20 years are as follows:

![Region 6 Load Growth](image)

*Figure 4: Region 6 Load Growth*

*Source: City of Tshwane energy and electricity long term (20 years) Master plan 2018*

Based on the load growth the following projects were identified with the planned completion dates:

-
Table 4: Region 6 Planned Projects
Source: City of Tshwane energy and electricity long term (20 years) Master plan 2018

<table>
<thead>
<tr>
<th>Project name</th>
<th>Start date</th>
<th>Completion date</th>
<th>Existing Capacity (MVA)</th>
<th>Planned Capacity (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Wildebees 400/132kV Infeed station</td>
<td>2022</td>
<td>2024</td>
<td>0</td>
<td>315</td>
</tr>
<tr>
<td>New 132kV line from Wildebees to Eland substation</td>
<td>2018</td>
<td>2020</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>New 132kV line from Wildebees to Hatherley substation</td>
<td>2017</td>
<td>2020</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>New Denneboom 132kV switchyard</td>
<td>2021</td>
<td>2023</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>New Mooiplaats 132/11kV substation</td>
<td>2020</td>
<td>2022</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>New 132kV line from Wildebees to Mooiplaats substation</td>
<td>2021</td>
<td>2022</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>Upgrade Mamelodi I 132/11kV substation</td>
<td>2023</td>
<td>2025</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Upgrade Mamelodi II 132/11kV substation</td>
<td>2022</td>
<td>2024</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>New Atterbury 132/11kV substation</td>
<td>2028</td>
<td>2031</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>New 132kV cable from Willows substation to Atterbury substation</td>
<td>2029</td>
<td>2031</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

The planned refurbishment projects for region 6 are refurbishment of Watloo substation 132/11kV substation, project to commence in 2024, finish 2026. The 2055 vision for Region 6 include the following projects:

- ✓ Menlyn Main node development (completed): - Menlyn Maine is envisioned to be the first “Green Living Precinct” in South Africa. The Menlyn Maine precinct is the densification of an existing low-density residential suburb with an approximate size of ± 135 000 m². Land Usage has been divided into the following uses: 140 00 m² of office space, 35 000 m² of retail and dining space, 85 000 m² residential and 15 000 m² luxury hotel space - all of which are overlooking 5 700 m² of scenic parks that run through the centre of the entire precinct. The whole Menlyn Maine development is supplied by the recently upgraded Highlands 132/11kV substation. If the development grows beyond the supply on the Highlands substation a part of the development will be supplied by the planned new Atterbury 132/11kV substation.

- ✓ Mamelodi CBD and surrounding townships

- REGION 7

The City of Tshwane will continue to invest in the further development of light industries in the areas of Ekandustria and Bronkhorstspruit in order to support the manufacturing sector and small businesses. It is also regarded as the main agricultural focal point in the region for developing an agro-processing hub and value-add products for the export market. The 2055 vision for region 7 includes the light industries development in Ekandustria and Bronkhorstspruit.
The upgrading of Cathie and Ekandustria 132/11kV substations will supply these planned developments.

**6.6.2 Electrification**

The Department of Energy is responsible for formulation of policies and regulations for the energy sector. Through the Integrated National Electrification Program, the DOE is responsible for assisting municipalities with funding for implementation of electrification projects; this is in order to reach universal access to electricity by 2025.

The DoE occasionally provides capacity building support to municipalities struggling to implement the electrification program. Electrification is a key to economic development and growth, the building block of a sustainable community. Electrification project planned to be implemented in the City of Tshwane Municipality during Financial Year 2019/20.

These planned projects will have an impact on the electricity loadings of the Tshwane networks, especially on both the morning and the evening peak loads in line with the residential load profiles.
<table>
<thead>
<tr>
<th>Project Name</th>
<th>Region</th>
<th>Ward</th>
<th>No. of Connections</th>
<th>Cost Per Connection</th>
<th>Total Project Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garankuwa Zone 14</td>
<td>1</td>
<td>32</td>
<td>500</td>
<td>R 28,050.00</td>
<td>R 14,025,000.00</td>
</tr>
<tr>
<td>Soshanguve Block GG (Stand 241)</td>
<td>1</td>
<td>94</td>
<td>79</td>
<td>R 28,050.00</td>
<td>R 2,215,950.00</td>
</tr>
<tr>
<td>Soshanguve South X19</td>
<td>1</td>
<td>37</td>
<td>600</td>
<td>R 28,050.00</td>
<td>R 16,830,000.00</td>
</tr>
<tr>
<td><strong>Total Regional 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R 33,070,950.00</td>
</tr>
<tr>
<td>Soshanguve Block MM</td>
<td>2</td>
<td>96</td>
<td>80</td>
<td>R 28,050.00</td>
<td>R 2,244,000.00</td>
</tr>
<tr>
<td><strong>Total Regional 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R 2,244,000.00</td>
</tr>
<tr>
<td>Booyens Ext 4</td>
<td>3</td>
<td>55</td>
<td>402</td>
<td>R 28,050.00</td>
<td>R 11,276,100.00</td>
</tr>
<tr>
<td>Booyens Ext 4 Feeder Cables</td>
<td>3</td>
<td>55</td>
<td>0</td>
<td>R 20,000,000.00</td>
<td>R 20,000,000.00</td>
</tr>
<tr>
<td>Fourt West Ext 4 / 5</td>
<td>3</td>
<td>7</td>
<td>400</td>
<td>R 28,050.00</td>
<td>R 11,220,000.00</td>
</tr>
<tr>
<td><strong>Total Regional 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R 42,496,100.00</td>
</tr>
<tr>
<td>Olievenhoutbosch</td>
<td>4</td>
<td></td>
<td>500</td>
<td>R 28,050.00</td>
<td>R 15,000,000.00</td>
</tr>
<tr>
<td><strong>Total Regional 4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R 15,000,000.00</td>
</tr>
<tr>
<td>Pienaarsport Ext 22</td>
<td>5</td>
<td>100</td>
<td>1000</td>
<td>R 28,050.00</td>
<td>R 28,050,000.00</td>
</tr>
<tr>
<td>Pienaarsport Ext 23</td>
<td>5</td>
<td>100</td>
<td>1500</td>
<td>R 28,050.00</td>
<td>R 42,075,000.00</td>
</tr>
<tr>
<td><strong>Total Regional 5</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R 70,125,000.00</td>
</tr>
<tr>
<td>Mamelodi Erf 34041 Electrification (Phomolong)</td>
<td>6</td>
<td>40</td>
<td>1052</td>
<td>R 28,050.00</td>
<td>R 29,508,600.00</td>
</tr>
<tr>
<td>Mamelodi X11</td>
<td>6</td>
<td>10.97</td>
<td>1100</td>
<td>R 28,050.00</td>
<td>R 30,855,000.00</td>
</tr>
<tr>
<td>Nellmapius Ext 22</td>
<td>6</td>
<td>104</td>
<td>773</td>
<td>R 28,050.00</td>
<td>R 21,682,650.00</td>
</tr>
<tr>
<td><strong>Total Regional 6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R 82,046,250.00</td>
</tr>
</tbody>
</table>

Table 6: Tshwane Electrification projects
6.6.3 Electricity challenges

The following are challenges experienced in the City in so far as provision and or maintenance of electricity is concerned.

- **Burnt substations**
  
  Capacity at the burnt substations Mooikloof, Wapadrand, Phumlani and Brakfontein can only supply existing consumers, no capacity to cater for new consumers. Insurance claims to fix burnt substations takes roughly 3-4 years.

- **More power from infeed power needed**
  
  Overwhelming demand from development create backlog for electricity supply. The City is in the dire need for more power to support the increase in population.

- **Cable / Copper theft**
  
  Cable theft, vandalism of the electricity infrastructure equipment, illegal connections and power loss is a continuous problem and very costly. Brakfontein substation burnt due to cable theft and lightning.

- **Climate change**
  
  CO₂ is projected to experience drastic increases in the number of very hot days and high fire-days under, which will plausibly lead to increases in veld fires damaging power transmission lines. The projected increases in temperature and the annual number of very hot days imply changes in the household and industrial energy demand that is required to achieve human comfort within buildings.

  More particularly, the demand for cooling may be expected to increase in the spring, summer and autumn seasons, whilst the winter demand for heating is likely to decrease (a benefit from climate change).

- **Ageing infrastructure**
  
  Ageing infrastructure and need for replacement and maintenance is a continuous challenge.

- **Electrification challenges**
  
  Project stoppages by the community; Community Business Forum, Invasion of RDP houses.

- **Land use change**
  
  Placement of sub stations and extension of services subject to new development and land use changes that is not known beforehand.

- **Load shedding**
  
  Power shortages and power cuts due to load shedding by ESKOM is a continuous problem. Since the load shedding earlier this year, Eskom has made much progress in implementing its Nine-Point Plan, ensuring
better maintenance of its generation fleet, reducing costs and ensuring adequate reserves of coal.

- Safety of personnel

Attacks of electricians attending to electricity faults, outages and related matters is rife in the City. This results to service interruptions and make it difficult or for officials to respond to service delivery interruptions.

- Electricity network

There are serious concerns that the city’s electricity network is not able to meet the requirement of NERSA License condition with regards to Standards and Quality of electricity supply: -

- Frequency of outages (SAIFI)
- Durations of Outages affecting the standards of services (SAIDI)
- A total of 52 Secondary Substation are vandalized making it difficult for the City to provide redundancy in the network or to back feed customers when outages happen.
- The most affected regions are Region 1, 3, 4 and 7.

Figure 15: Regional Analysis: Low capacity Areas
Source: City of Tshwane GIS
6.7. WATER

6.7.1 Current status

Water scarcity is an economic and social issue. Without access to clean drinking water and lack of access to adequate sanitation facilities, disproportionately affects some of the poorest regions in the world. The current potable water demand for the Municipality is 987 Ml/d and projected to grow to 2591 Ml/d by 2058 (Tshwane Water Services Development Plan (September 2017)).

All the regions in COT contribute to the water supply of the city with major dams and extensive river courses supplying water. However, a projected hotter and drier CO\text{T} in the future is a cause of concern, especially given the anticipated growth in the agricultural industry and the economic hubs. This sector is also affected by flooding, droughts and extreme events.

The regions affected will include the high population density Regions 1 and 2, parts of Regions 3 and 4 and other pockets across the city region City of Tshwane Vulnerability Assessment to Climate Change (8:2015). Achieving a sustainable balance between supply and demand and making sure there’s enough water of the right quality for the purpose for which it is needed is key to achieving water security. City of Tshwane get water from the following sources:

- **Rand Water**
  The main source of bulk water to the CoT is Rand water, which accounts for 78% of the total bulk input to the network. The existing system has 49 connections to the Rand Water system, which imports water from the Vaal River system. These connections mostly supply under pressure into COT reservoirs and water towers, but in some cases the pressure is utilized to supply directly into reticulation networks.

- **City of Tshwane Water Treatment Plants (WTP)**
  Water treatment plants receive water extracted from local watercourses and impoundments, provide a total of 16% of the bulk water used by the network. These WTPs include Rietvlei, Roodeplaat, Temba, Bronkhorstspruit and a number of smaller package plants located around Bronkhorstspruit dam.

  - **Rietvlei Water Treatment Plant**
    Rietvlei Water Treatment Plant is situated south-east of Pretoria City Centre in the Rietvlei Nature Reserve approximately 20 kilometers from the CBD. It was built by the Town Council of Pretoria in 1934 to supplement Pretoria’s drinking water. It is owned and operated by the CoT. Originally designed as a 15 MI/d water treatment plant and build
in the time of the Great Depression in 1932-1934, the water treatment plant provided for settling, sand filtration and chlorination.

In 1988, the treatment plant was upgraded to a 40 Ml/d plant again in 1999 it was further upgraded with the addition of Granular Activated Carbon (GAC) to treat the musty taste and odors so commonly produced by algae in eutrophic impoundments. The Rietvlei WTW is designed for 40 000 m³/d (40 Ml/d), and is capable of producing its design flow rate. The water produced at this Water Treatment Work is on average approximately 37 Ml/d.

- Roodeplaat Water Treatment Works

Roodeplaat WTW was built in September 2005 and is owned and operated by COT. Roodeplaat WTW was operated and maintained by Magalies Water until September 2012 when CoT took control of the operation and maintenance of the works. Roodeplaat WTW has recently been upgraded by the addition of two ozonation points. These include dosage of ozone at the raw water inlet (called pre-ozonation) to oxidize iron and manganese in the raw water as well as a dosing point before the GAC filtration step (called pre-GAC–ozonation) to assist with color removal, pathogen removal and taste and odor removal.

Roodeplaat Dam drains a catchment area of 684 km² and impounds a volume of 43.5 million m³ at full supply level. The dam has a surface area of 403 ha and was completed in 1959. The intake arrangement is fairly new, as it was redesigned and installed at the time of the construction of the Roodeplaat WTW. The intake is sized with surplus capacity to allow for future extension. The Roodeplaat WTW is designed to produce 60 Ml/d. Average water production for the period was 43 Ml/d. The Roodeplaat WTW is designed to produce 60 Ml/d and pumps to the following areas: Sinoville, Wonderboom and Montana. There are plans in place to upgrade the works to a capacity of 120 Ml/d.

- Temba Water Treatment Works

Temba WTW was upgraded as part of the work done by the Roodeplaat / Temba Water Services Trust. Temba WTW is provided with water from the Leeukraal dam which is fed by the Apies River. The effluent from the Rooiwal WWTW is fed into this system. Temba WTW was operated and maintained by Magalies Water until September 2012, when COT took full responsibility for all operational issues. The water from the Temba WTW is distributed to Temba and Moretele.

The following items were of concern and require urgent attention:

- The raw water quality is concerning as the ammonia levels are regularly 6mg/L and this makes disinfection exceptionally
difficult and also forms disinfection by-products such as trihalo-methane’s.

✓ Spillage of water into the road reserve from the sludge lagoons needs to be investigated.
✓ Sludge lagoons are very full and there is no schedule available for emptying the lagoons.
✓ Ultraviolet radiation dosing is in place at the final water produced before chlorination but has been discontinued.
✓ The endocrine disrupting potential of the raw water supplied to the Temba WTW needs to be studied in more detail and on a regular basis to ensure that the GAC and ozonation technology which is to be installed during the coming upgrade, will be sufficient to remove all the organic pollutants within the raw water supply to protect the health of the consumer.
✓ Maintenance is neglected and a maintenance plan should be compiled and provision made for timeous replacement or repair of broken equipment.

Bronkhorstspruit WTW is situated near the town of Bronkhorstspruit and lies adjacent to the Zithobeni informal settlement. This municipal area formerly known as Kungwini, was absorbed by CoT and supplies the town of Bronkhorstspruit as well as adjoining townships and villages with drinking water. Some of this water is also distributed to Thembisile Hani Local Municipality through a 26km 500mm Ø and a 37km 1000mm Ø bulk pipeline. It is part of the Western Highveld Scheme (South). Raw water is abstracted from the Bronkhorstspruit Dam which impounds a volume of 57.9 million m³ at full supply level. The dam has a surface area of 861 ha and was completed in 1950. Water is supplied through a 700mmØ cast iron pipeline. The raw water pump station was designed with 3 pumps installed - as two duties and one standby but at the time of our visit only one pump was available.

Bronkhorstspruit dam is used for the supply of water to the Bronkhorstspruit WTW as well as Bronkhorstbaai and Summerplace WTWs which are situated on the banks of the Bronkhorstspruit dam, approximately 10km from the town of Bronkhorstspruit. The dam is also the source of water for several small water treatment plants on the banks of the dam which are privately owned and managed. Bronkhorstspruit WTW has a capacity of 54 Ml/d. The average production of the WTW for the period January 2010 to November 2012 was 55.3 Ml/d, this is in excess of the current water use license.

Temba WTW expansion possibilities’ using the return flows from Rooiwal must be investigated in a preliminary engineering design study.

- Bronkhorstspruit Water Treatment Plant
Several periods of no water production are noted (Dec 2011), due to a major breakdown in the transformer feeding the WTW, causing a complete shutdown for a few days. Bronkhorstspruit WTW provides water to the town of Bronkhorstspruit via the Ekangala and Zithobeni Reservoirs. Rand Water also supplements the water supply via the Ekangala Reservoir which is also used to provide water further north to Tembisile.

Bronkhorstspruit WTW potential for expansion has been studied in detail but due to the water shortage in this area, no additional capacity is available at this present time. Tembisile in the north takes more water than it should and therefore water demand management should be implemented in this area. Due to high reported losses within the network, it is difficult to reduce water demand in this area.

Although there is sufficient space available on site to increase the capacity of the Bronkhorstspruit WTW there is no planned expansion due to the lack of supply from the Bronkhorstspruit dam. However, there is sufficient space for upgrading of the sand filtration system.

Immediate Interventions required:

- Raw water pumps were out of order and this has been a problem for a significant period of time. One of the pumps has been replaced, a preventative maintenance plan is required to ensure that breakdowns are attended to timeously.

- A Class V Supervisor/ Plant Manager should be available on-site to manage this WTW as well as sufficient number of qualified staff to man Bronkhorstspruit as well as Bronkhorstbaai and Summerplace WTW.

- The transformer on site has no back up facility and the current transformer is on loan from another location. Should this transformer fail, the water supply to the town of Bronkhorstspruit will fail.

- Sand filtration system does not backwash efficiently and there is no facility for air scour. The sand was replaced only approximately four years ago – however due to the poor backwashing regime there are significant signs of filtration failure in terms of cracked beds, mud balls and plant growth on the filter media. This is a significant critical control point which should be upgraded to ensure good quality water from this WTW.

- Distribution system leaks – it is alleged that there are areas within the network where significant water leakage within the distribution network occurs. Due to the significant shortage of
water in this area, water leakage detection and repair should be prioritized.

✓ Recovered water from the backwash is not chemically dosed before being added to the process train again which may concentrate unwanted protozoan parasites and other pathogenic organisms in the treatment process.

✓ The cause of the poor air distribution at the DAF units should be investigated as this does not allow for good separation of the flocculated materials and puts undue pressure on the sand filtration system.

✓ A good maintenance plan and team should be available to ensure that maintenance and repairs are carried out timeously. Due to the previous municipality’s poor financial status, many pumps and motors are in need of repairs, although COT is currently working on the backlog.

- Bronkhorstbaai Water Treatment Plant

The Bronkhorstbaai WTW also known as the Waltbaai WTW is a package plant situated on the banks of the Bronkhorstspruit dam to provide water to the Bronkhorstbaai community. There are also several privately owned package plants which also provide water to the various gated communities which surround the Bronkhorstspruit Dam. The water provided to the community is pumped up to two small reservoirs on the surrounding hills which provide water to the area by gravity feed.

The source of the water to the Bronkhorstbaai WTW is the Bronkhorstspruit Dam. The water is pumped to the Bronkhorstbaai WTW by means of a raw water pump situated on a float approximately 200m away from the plant with a flexible hose. There is only one raw water pump available without a standby pump for raw water supply. The capacity stated on site is 0.55 Ml/d or 23 m3/h. Currently the WTW is under pressure to produce sufficient water to all the residents in the area and additional water is required. However, no data on the amount of water produced at the Bronkhorstbaai WTW was available at the time of report writing and therefore no comment can be made on the production of the WTW.

Treatment Plant Performance

The Bronkhorstbaai WTW was part of the Kungwini Local Municipality and was taken over by the COT in May/June 2011. However, some monitoring of the WTW was started in 2010 and 2011 in parallel with Rand Waters’ operational and monitoring work in order to ensure that there was continuity in the process during the transition from Kungwini to CoT as well as knowledge sharing. As with Bronkhorstspruit and Summerplace increased monitoring of more parameters during the
2011/12 period exposed new risks. These risks included chronic health risks which were not previously measured and included total organic carbon, total trihalomethanes and chloroform, which is a part of the THM group of compounds. These risks are similar to those noted in Summerplace WTW.

Water Distribution

Bronkhorstbaai WTW provides water to the settlement known as Bronkhorstbaai which surrounds the Bronkhorstspruit Dam. The water is pumped from the final water clear water tank to two reservoirs situated on the hills around the dam from which it is gravity fed to the consumer. Several other WTW including Aqua Vista and Kungwini Estates are privately owned and provide water to their own gated communities. Bronkhorstbaai is a Class D works and it is operated by COT although the maintenance duties are currently still on contract with Rand Water. The plant manager is in charge of both this WTW as well as Summerplace WTW.

Although the Bronkhorstbaai WTW is subject to the same raw water shortage as the Bronkhorstspruit WTW, it is anticipated that the Department of Water Affairs may be accepting of an expansion of this small plant as the cost of alternatives may be exorbitant and also because the plant will be used as a “regional” facility into which the surrounding smaller plants can be consolidated. There is sufficient space on the existing site to accommodate the expansions as indicated above.

The following items need to be addressed:

- Raw water pump and methodology of extraction needs to be reviewed to allow for sustainable raw water supply despite floods or droughts. Only one raw water pump is available and should this fail, it will cause a major water supply disruption.
- The dosing protocol, pumps and storage facilities for dosing the flocculent needs to be replaced with duty and standby pumps, new storage facilities for flocculent as well as jar testing apparatus.
- Laboratory space at the WTW is not available and makes testing difficult.
- No internet access is available, making communication cumbersome and impeding rapid response when required.
- The disposal of sludge and wash water into the dam can impact on the quality of the incoming raw water and it is recommended that an alternative method be investigated for disposal of the wash water and sludge.
- Replacement of the final water tank with two new tanks should be considered as the current tank is rusting through and no
alternative water storage is in place. Failure of this tank will cause a severe water disruption.

✓ A maintenance plan and contracts need to be implemented in order to prevent poor service delivery.

✓ Staffing is insufficient and additional staff needs to be employed with sufficient skills and knowledge to enable them to operate and maintain the WTW.

✓ Investigation into the regionalization of the Bronkhorstbaai WTW should be investigated in a preliminary engineering design study.

- Summerplace Water Treatment Plant

The Summerplace WTW is a package plant which has been placed to supply water to the Summerplace gated community situated next to Bronkhorstspruit Dam. Currently the WTW is supplying about 50 houses. The abstraction point for Summerplace WTW is in a vlei area which is situated several hundred meters away from the Bronkhorstspruit dam. The abstraction point is not a sustainable source and during drought conditions there is a strong likelihood that this vlei area can dry up.

The WTW has an abstraction allocation from the Bronkhorstspruit dam which it is not currently utilizing. The reason for this is unknown but it may be a source of metals and turbidity in the raw water. The capacity of the WTW was stated on site to be 0.70 Ml/d or 29 m3/h. No information on the flow rates through the WTW was available. The plant can treat 0.7 Ml/d at present but demand on the plant is less than 0.1 Ml/d. This plant will very likely be decommissioned. Currently the WTW is only operated every second or third day to supply the houses in the Summerplace Estate. The final water quality is problematic in terms of the operational performance of the WTW where the turbidity of the final water is below the limits required. For 2011 and 2012, the aesthetic risks included color, iron and manganese. During 2012, CoT increased their monitoring program and trihalomethanes, Total Organic Carbon and Microcyclic toxins were found to be below the limits required.

These compounds are chronic health risks and their presence may be, in part, due to the raw water source currently used by the Summerplace WTW. Although Summerplace has a Water Use license for abstraction from Bronkhorstspruit Dam, for unknown reasons the water for Summerplace is being abstracted from a wetland which in all likelihood is the source of the high organic content of the water. Of more concern however is the low microbiological quality and disinfectant residuals which indicate that the current disinfectant dosing protocol is not maintaining sufficient disinfectant to ensure good quality water.
The water from the WTW is distributed to the Summerplace gated community which is currently about 50 houses and is planned to be approximately 300. Summerplace is operated and managed by the Process Controller in charge of the Bronkhorstbaai WTW, which is a few kilometers away. The current Class 0 Process Controller has extensive experience at both Summerplace and Bronkhorstbaai WTW. Current planning is for water supply to be centralized at Bronkhorstbaai with Summerplace being decommissioned. There is sufficient space on site to expand the works if this was required.

The following interventions are required at Summerplace:

- Replacement of the current chlorination facility with a chlorine gas facility as the sodium hypochlorite dosing apparatus is old and unreliable.
- Should the plant not be decommissioned in the near future, the raw water abstraction point should be moved from the vlei area to the Bronkhorstspruit dam to improve the raw water quality and treatment of the water to drinking water standard.

- **Boreholes**

The remaining 5% of the bulk water requirement is made up by boreholes and springs. The two fountains within the Groenkloof Nature Reserve, namely the Lower Fountains located south of the pump house and the Upper Fountains which feed into the Apies River, had historically supplied the whole of Pretoria with drinking water. The proclamation of the Groenkloof Nature Reserve was primary to protect these water sources.

The Upper and Lower Fountains springs currently feed into the Findlay Reservoir, which supplies approximately 5000 people as well as the business activities within the Pretoria CBD with potable water. Sterkfontein Spring which delivers ±4 ML/d. Rietvlei springs also provide ±7 ML/d, however this is blended with the supply at Rietvlei WTP. The 16 boreholes in the network are widely distributed and generally supply water to rural and peripheral areas, however a number of larger boreholes in the south of the network each contribute in excess of 1ML/d to the bulk system.

The Water and Sanitation Division completed a ground water vulnerability study to identify the capture zones and pollution potential of its valuable ground water sources wherein it was confirmed that the 100 day and 1-year capture zones of the Fountains springs generally lie...
within land under the control of the Groenkloof Nature Reserve. The 5-year capture zone encompasses part of Waterkloof airport, Kloofsig and Lyttleton Manor.

- Magalies Water

A further 1% is provided by Local WTP’s that are owned and operated by Magalies Water, which include Klipdrift, Wallmannsthal and Cullinan WTP. The current Water Master Plan (September 2017) assumes that the majority of water supply will continue to be provided by Rand Water from the Vaal River system.

Significant capacity upgrades will also be required at almost all of the CoT and Magalies Water WTP’s, as well as the bulk distribution and storage infrastructure required to convey this to the current and future supply zones across the network. Certain portions of the Moretele Local Municipality water systems are linked to or supplied from the Tshwane bulk system. The same applies to the Madibeng Locality Municipality. A small rural portion of Midrand in City of Johannesburg is supplied from the Tshwane bulk water system. Certain portions of the Midrand area sewer systems discharge into the Tshwane sewer system. In the Bronkhorstspruit area, two large diameter pipes that are jointly supplied from RW and COT feed into Thembisile. Rand Water has capped supply to the City due to the water shortages and this has resulted in limited supply of water during certain periods as a result alternatives sources may need to be considered for the future, especially with regards to Climate Responsiveness.
## Table 11: Sources of energy, targets and uses table

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<th>Water Resource</th>
<th>Present supply</th>
<th>Future supply</th>
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Source: September 2017 Master Plan Source: Cot WSDP (September 2017)
6.7.2 Current and future demand

On the basis of bulk water meter information from all the City of Tshwane’s (CoT’s) water sources, the year 2016 Annual Average Daily Demand (AADD) was 920 ML/d, which include external supplies to Johannesburg (Midrand), Moretele, Madibeng and Thembisile. With some adjustments for rationalization of Unit Water Demands (UWD’s), meter inaccuracies and water losses the current theoretical AADD for the CoT water system is estimated at 924 ML/d.

CoT has approximately 720 000 formal water customers on 580 000 stands in the billing systems. In addition, CoT monitors water supply to 200 000 informal settlements units. External supplies to Madibeng, Moretele, Thembisile and Johannesburg (Midrand) are also monitored and billed. The current CoT water loss figure of 27% is the difference between the bulk water inputs from all the water sources, and the billed or monitored (metered) supply to customers and informal areas. For purposes of evaluating and planning the CoT water and sanitation systems, it has been assumed that the long term water loss figure can be brought down to 20% through Water Conservation and Demand Management (WCWDM). Future demands for CoT are determined on the following basis:

- Infilling of vacant stands
  There are many developed unoccupied vacant stands in CoT. Such stands have been identified from the billing systems. If a theoretical UWD is applied to these stands they can contribute a further 164 ML/d (including losses) to the present AADD. This will result in a total potential fully occupied AADD of 1 088 ML/d based on the extent of the current network.

- Spatial Development Framework and Future Water Requirements
  The future development areas (FDA) are based on the SDF, which are anticipated to develop over a horizon of 45 years. The FDA’s will add a net contribution of 1 478 ML/d to the future AADD. With an additional growth in the water supply to external areas, the potential future AADD is estimated to increase from the existing 924 ML/d to 2 565 ML/d over the next 45y to 50y. This includes an AADD of 42 ML/d which will be generated in the Johannesburg water system, but needs to be accounted for in that it will end up in the CoT sewerage system.

The water master plan for the CoT was therefore compiled for a future “ultimate” AADD of 2,591 ML/d, to be realized in 45 – 50 years from now. This development plan, however, focuses on the requirements of the first 5 years. Some problems are more specific to communities, for example, water in Hammanskraal, and white elephants in Refilwe, Zithobeni and Mamelodi where intervention is needed urgently.

![City of Tshwane Present Water Sources](image1)

![City of Tshwane Future Water Sources](image2)

Figure 16: City of Tshwane Present and Future reliance on Water Sources
Source: Cot WSDP (September 2017)
6.7.3 Challenges

The City is faced with major challenges in so far as bulk / maintenance water supply is concerned.

- Finance

An analysis of the water networks within the City has indicated that 14.6% of the pipes would have reached the end of their economical lifespan within the next 5 years. The total replacement cost is estimated at R6.2 billion. Region 1 is most affected with suburbs around Pretoria North, Wolmer and Flourana.

- Development outside the urban edge

Pressure for development in Region 4 has resulted in developments taking place outside the urban edge. This type of development decentralizes municipal services and increases expenses in constructing and maintaining the necessary infrastructure.

- Infrastructural Problems

Most of the northern suburbs in Region 1 and 2, Pretoria North, Wolmer, and Annlin area is characterized by infrastructural problems. The pipes are old and must be replaced with bigger ones to accommodate population growth and the proposed density in the area. The land use applications are not being considered for approval in certain areas within the above mentioned areas.

- Tribal areas

Providing proper infrastructure in areas under tribal authority like Marokolong in Temba is a challenge because the area is not formalized.

- Rand water

Rand water cap applicable for the next 10 years restrict further water supply for new growth and development in the City. There are currently water dependent agricultural projects being identified with no plan as to how water will be provided. Due to maintenance of Rand Water on their water pipelines which supplies water to the City of Tshwane, operation will be at 84% capacity. Due to the duration of the shutdown, some areas may experience a shortage of water or low water pressure.

- Boreholes

Conservatively, the future reliance on springs and boreholes has been reduced due to the risk associated with possible contamination.

6.7.4 Water loss and WCWDM

The COT has actively been engaged in Water Loss and Water Conservation and Water Demand Management (WCWDM) activities for a number of years. The non-revenue water (NRW) component of the city is at 27.5% as at 31 January 2017. Non-revenue water (NRW) is water that has been produced and is "lost" before it reaches the customer. Losses can be real losses (through leaks, sometimes also referred to as physical losses) or apparent losses (for example through theft or metering inaccuracies). The Figure below depicts the fluctuations in the city's NRW since January 2007:
6.7.5 Portable water quality

COT purchases more than 70% of all potable water from Rand Water and is thus not responsible for the input quality of this water. COT does however have to ensure the quality of water from its own surface water sources (WTP’s) and ground water sources (fountains and boreholes). In addition, COT has to ensure that input water quality is maintained in the distribution system. To this end there is an extensive monitoring system in place that is being managed from a laboratory at Rietvlei WTP. The results of this monitoring system are uploaded to the DWS Blue Drop website, where it contributes amongst other factors to the overall Blue Drop status of the COT systems. The table below summarizes the historical COT Blue Drop performance:

**Table 12: City of Tshwane historical Blue Drop status**

Source: Cot WSDP (September 2017)
6.8 SANITATION

COT is responsible for own waste water treatment and a large portion of the future required Capex is for the provision of additional capacity. COT discharges all its treated effluent into the Crocodile and Olifants River catchments. The layout of the complete COT sewer system comprises of 8 different main drainage areas, below is a summary of the elements that make up the COT system. The existing sewer system serving COT consists of:

- 19 own Waste Water Treatment Works
- 15 private or institutionally owned WWTW’s
- 8,987km of Gravity mains (of which 539 km is external or privately owned)
- 86km of rising main (18km of which is external or privately owned)
- 124 Pump structures (45 of which are external or privately owned)

<table>
<thead>
<tr>
<th>WWTW Name</th>
<th>Current Capacity (ML/d)</th>
<th>Future Capacity (ML/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Babelegi WWTW</td>
<td>2,300</td>
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<td>Bavianaaspoort WWTW</td>
<td>60,000</td>
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<tr>
<td>Daspoort (West)WWTW</td>
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<tr>
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<table>
<thead>
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<td>Sandspruit WWTW</td>
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</tr>
<tr>
<td>Schurveberg WWTW</td>
<td>-</td>
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<td>Summerplace WWTW</td>
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<tr>
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</tr>
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<td>Temba WWTW</td>
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</tr>
<tr>
<td>Zeekoegat WWTW</td>
<td>30,000</td>
<td>160,000</td>
</tr>
</tbody>
</table>

Table 1: COT existing and future WWTW’s and capacities
Source: Cot WSDP (September 2017)

The effluent quality is monitored by an extensive system that is managed by the laboratory at Daspoort Waste Water Treatment Works. The City is also faced with a huge challenge as far as sanitation is concerned:

- Rooiwal, Klipgat, Bavianaaspoort and Sunderland Ridge waste water treatment plants have malfunctioned since 2010. This poses a risk of people getting sick to the extent that they lose their lives.
Bronkhorstspruit WTP, Roodeplaat WTP, Rietvlei WTP, and Temba WTP are 64% under-staffed in terms of legislated requirements and will have serious negative impact over time.

As done with the water network, future sewer flows for CoT are determined on the basis that current unoccupied stands will become occupied and that the future expansion of networks and existing development densifications will occur in accordance with the Spatial Development Framework (SDF).

(a) Infilling of vacant stands

If a typical UH is applied to each of the currently vacant stands within developed areas in COT, they can contribute another 71ML/d to the present PDDWF, for a total potential fully occupied present PDDWF of 628ML/d.

(b) Spatial Development Framework and Future Sewer Flows

The 2400 future development areas (FDA’s) based on the approved Spatial Development Framework (SDF) are anticipated to develop over a horizon of 45 years. Each of these FDA’s has been assigned an anticipated land use, density, UH, additional sewer pipe length (for calculation of groundwater infiltration) and implementation year.

Many of the FDA’s are existing informal areas, which currently have no flush sanitation, but are earmarked to be in-situ upgraded to full service level. The FDA’s will add a net contribution of 1192ML/d PDDWF, together with the 71ML/d PDDWF due to occupation of existing vacant stands. This includes future developments in Johannesburg within the Midrand region, which can generate a further 30 ML/d. The potential future PDDWF is therefore estimated to increase from existing 557ML/d to 1820 ML/d over the next 45y to 50y.

Discharge Water Quality

COT discharges all its treated effluent into the Crocodile and Olifants River catchments. The effluent quality is monitored by an extensive system that is managed by the laboratory at Daspoort WWTW. The results of this monitoring system are uploaded to the DWS Green Drop website, where it contributes amongst other factors to the overall Green Drop status of the COT systems.

Table below shows the improvements in achieving Green Drop status over the last 10 years as well as the targets set for the immediate future.
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
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<td>2</td>
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<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
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<td>Green Drop</td>
</tr>
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<td>2 Baviaanspoort</td>
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<td>No GD</td>
<td>No GD</td>
<td>Green Drop</td>
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<tr>
<td>3 Daspoopt</td>
<td>3</td>
<td>Green Drop</td>
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<td>No GD</td>
<td>No GD</td>
<td>Green Drop</td>
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<td>4 Ekangala</td>
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<td>No GD</td>
<td>No GD</td>
<td>Green Drop</td>
<td>Green Drop</td>
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<tr>
<td>5 Godrich</td>
<td>7</td>
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<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
<td>Green Drop</td>
</tr>
<tr>
<td>6 Klipgat</td>
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<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
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<tr>
<td>7 Rayton</td>
<td>7</td>
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<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
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<td>Green Drop</td>
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<tr>
<td>8 Refilwe</td>
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<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
<td>Green Drop</td>
</tr>
<tr>
<td>9 Rethabiseng</td>
<td>7</td>
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<td>No GD</td>
<td>No GD</td>
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<td>Decommissioned</td>
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<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
<td>Green Drop</td>
</tr>
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<td>No GD</td>
<td>Green Drop</td>
</tr>
<tr>
<td>13 Sandspuit</td>
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<td>No GD</td>
<td>No GD</td>
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<td>Green Drop</td>
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<td>Green Drop</td>
<td>Green Drop</td>
</tr>
<tr>
<td>15 Sunderland Ridge</td>
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<td>No GD</td>
<td>No GD</td>
<td>Green Drop</td>
<td>Green Drop</td>
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<td>No GD</td>
<td>No GD</td>
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<td>Green Drop</td>
</tr>
<tr>
<td>17 Zeekoegat</td>
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<td>Green Drop</td>
<td>No GD</td>
<td>No GD</td>
<td>No GD</td>
<td>Green Drop</td>
<td>Green Drop</td>
</tr>
<tr>
<td>Hennopssriver (New)</td>
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<td></td>
<td></td>
<td>Green Drop</td>
<td>Green Drop</td>
</tr>
<tr>
<td>Cullinan/Refilwe (New)</td>
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<td></td>
<td></td>
<td></td>
<td>Green Drop</td>
<td>Green Drop</td>
</tr>
</tbody>
</table>

Table 14: Green Drop history and targets

Source: Cot WSDP (September 2017)
6.8.1 Water Resource Master Plan

In 2014, a study was completed concerning the possible upgrading or extension of City of Tshwane’s (COT) own water resources, with a view to reduce the dependence on imports from the Vaal River basin (via Rand Water). It also concerned the Crocodile River basin and the Olifant’s River basin, which both receive significant sewer return flows from Ekurhuleni, Johannesburg and COT that influence the yields of the local water resources and water allocations to downstream users.

The local water resource yields of the Crocodile River and Olifant’s River tributaries, which are the sources for the main COT and Magalies Water WTP’s, are all very much dependents on the above sewer return flows (with Bronkhorstspruit WTP and Cullinan WTP being notable exceptions). Developing or extending COT’s own water resources will reduce the load on the Vaal River system (via Rand Water), but as a result reduce the return flows into the Crocodile and Olifant’s River basins. A particular constraint in this regard is the assurance of sufficient yield to enable water supply to the proposed Eskom coal fired power plants in Lephalale via the Mokolo Crocodile Water Augmentation Project (MCWAP).

In the Olifants River basin, all Department of Water Affairs (DWA) allocated licenses for water abstraction are already being exceeded and water is imported from the Vaal River via a 30 ML/d pumping scheme that delivers water into the Ekandustria reservoirs, for on-supply to Thembisile. The purpose of the water resource analysis was thus to establish the current and projected future yields of local water resources, while incorporating the effect of current and future WWTW return flow. This will confirm the possible upgrading or extension of COT’s own water resources, while maintaining the assurance of supply to the system downstream users.

Future water demand and sewer flows

In accordance with the CoT current water and sewer master plans, which are based on the approved SDF, the CoT AADD is set to increase over the next 45y – 50y to 2591ML/d, with concomitant increase in ADDWF to 1593 ML/d. Note that these values assume a reduction of losses from the current 27% to an anticipated 20%, on the basis of improved Water Conservation practices.

Current bulk water master plan and its requirement for future water resources

The current bulk water Master Plan for COT was compiled without any prior knowledge of the limitations on and expansion possibilities of the water resources supplying COT’s and MW’s WTP’s. In this context, most of the future requirement for water was assumed to be from Rand Water, but the following Water Treatment Plants matters were included in the Master Plan:

- Rietvlei WTP – to remain at 40 ML/d since there was no knowledge of additional resource.
- Roodeplaat WTP – to increase from 60 ML/d to 120 ML/d being the ultimate demand driven requirement.
- Temba WTP – to increase from 60 ML/d to 180 ML/d as required for projected future summer peak demands.
- MW Klipdrift WTP – to remain at 18 ML/d (of which 8 ML/d is supplied to COT), with the slack taken up by extensions to the Temba WTP.
• MW Wallmannsthal WTP – to increase from 12 ML/d to 24 ML/d, with the slack taken up by augmentation from the RW system.
• MW Cullinan WTP - to increase from 16 ML/d to 48 ML/d as required for projected future summer peak demands.
• MW Bronkhorstspruit WTP - to increase from 54 ML/d to 174 ML/d as required for projected future summer peak demands (in addition to existing 30 ML/d RW augmentation scheme already in place).

6.8.2 Current sewer reticulation and WWTW Master Plan

The following extensions to the main WWTWs are foreseen in the sewer reticulation MP:

Crocodile River basin:

• Sunderland Ridge WWTW (95 ML/d to be extended to 217 ML/d).
• Schurveberg WWTW (proposed WWTW with 46 ML/d capacity).
• Baviaanspoort WWTW (60 ML/d to be extended to 312 ML/d).
• Zeekoegat WWTW (30 ML/d to be extended to 160 ML/d).
• Daspoort WWTW (60 ML/d).
• Rooiwal WWTW (245 ML/d to be extended to 548 ML/d).
• Temba WWTW (12 ML/d to be extended to 89 ML/d).
• Rietgat WWTW (27 ML/d to be extended to 115 ML/d).
• Sandspruit WWTW (20 ML/d to be extended to 62 ML/d).
• Klipgat WWTW (55 ML/d to be extended to 95 ML/d).
• ERWAT Olfantsfontein WWTW (105 ML/d to be extended to 157 ML/d).
• ERWAT Hartbeesfontein WWTW (45 ML/d).

Olifants River basin:

• Lewzene WWTW (proposed with 7 ML/d capacity, replacing Cullinan and Refilwe WWTWs).
• Rayton WWTW (1 ML/d to be extended to 11 ML/d).
• Godrich WWTW (5 ML/d to be extended to 40 ML/d).
• Ekangala WWTW (proposed with 20 ML/d capacity, replacing existing maturation ponds).
6.9 IMPLEMENTATION

Based on the status of engineering infrastructural services, it is imperative to take note that immediate intervention is needed in order to address capacity issues, maintenance, water shortages and innovative alternative ways to generate and save electricity in the City. The following are interventions and planned projects:

6.9.1 Electricity: Eskom

The City is faced with challenge in so far as capacity is concerned mainly in Region 6 as it is growing the fastest. Shortage of electricity capacity in the Pretoria east area (Region 6) means no new bulk consumers or upgrade could be accommodated in the City until 2021/22. The north (Region 1) is also flagged (electricity shortage) with some progress coming (new substation). Eskom’s projects entails establishing two new transmission substations in Tshwane, one to the north (near Soshanguve) and the other east of Tshwane (near Mamelodi).

- Diphororo Phase 1 400/132Kv

Diphororo needs to be upgraded to supply the growing demand in the northern side of the Municipality (Region 1). The planned substation transformer capacity is 400/132 KVA. Diphororo would provide support to the Kwagga supply area once load is shifted from Kwagga to Diphororo. This Infeed is to be situated to the North western part of the COT Area. Expected year 2021.

- Wildebees 400/132Kv

Wildebees was originally planned to be commissioned in 2014 but the project has not yet started to date due to the numerous delays. This infeed station would help by alleviating the load on the Kwagga and the Njala supply areas. This Infeed is to be situated in the North Eastern part of the CoT area (Region 6). The system consists of 9 substations with one switching station. The future Wildebees system will comprises of (Koedoespoort, Mamelodi I, Mamelodi II, Mamelodi III, Pumulani, Pyramid, Villieria, Watloo and Willows).

Wildebees substation will provide much needed relief to Njala substation and support further development in the PTA East area and the outskirts thereof. The project is at the planning stage. Wildebees needs to be built by 2024. The construct the new Wildebees 400/132kV station which will provide an additional capacity of 250MVA with the ultimate design of 945MVA. Below is a map indicating existing substations, planned projects by Eskom and areas with capacity problems in the City.
6.9.2 Alternative Energy

If universal access to electricity is to be reached by 2025, the following is needed:

(i) Solar power: Of all of the renewable energies in South Africa, solar power holds the most potential. Because of the country’s geographic location, it receives large amounts of radiative energy which is useful in the solar electricity sector. Solar energy is a low-cost source of energy compared to traditional non-renewable energy resources in South Africa. The use of solar energy in South Africa is driving the use of other renewable energy sources including: wind, hydroelectric, and biomass.

(ii) Wind energy: Wind power is a renewable, widely distributed and clean form of energy. The production of wind energy does not produce greenhouse gases and is an alternative to burning fossil fuels. There are currently 19 wind energy developments in South Africa with more than 600 wind turbines. On the international scale, South Africa ranks as having fair to reasonable wind resources. Due to the high wind velocity on the coast of the country, Cape Town has implemented multiple wind farms which are successful in generating significant amounts of electricity for residents.

(iii) Biomass: Biomass is currently the largest renewable energy contributor in South Africa with 9-14% of the total energy mix.

(iv) Hydropower: Hydropower, or hydroelectric power, is energy that is captured from flowing water and turned into electricity. The most common forms of hydropower use hydroelectric dams to create a reservoir for storing water. When the water is released from the reservoir, it flows through a turbine which generates electricity. South Africa currently has 7 hydroelectric power stations, dispersed across the country, all owned by Eskom.

(v) Adequate funding for capital projects, management of INEP program, skills transfer/Training

(vi) Implementation in line with the Master Plan, need to solve the serious challenges in the EDI - difficult to run an electrification program where networks requires serious upgrading.

(vii) Good co-operation between National Government and other spheres of government

(viii) Resources with municipalities to be improved, political intervention, long procurement processes, lack of responsibility and accountability, lack of reporting

(ix) Explore the option of getting the City to source electricity from independent power producers (IPPs).

(x) Green roofs improve air and water quality while reducing energy cost. The plants and soil provide more green space and insulation on roofs.
6.9.3 City of Tshwane’s Energy Strategy

South Africa is the world’s 14th largest emitter of greenhouse gases (GHGs), principally due to a heavy reliance on coal (The Carbon Brief Profile, 1:2015). South Africa is experiencing a rise in a number of consumers wanting to contribute positively to the environment. It must also be noted that though being environmentally cautious and wanting to reduce the energy bill, consumers find relief through being energy efficient and being able to use energy resources optimally. This rise is mostly experienced in the high-income, commercial and industrial consumer categories. The use of natural gas, liquid petroleum gas is slowly gaining awareness for usage. The Energy Mix Strategy (EMS) document seeks to outline the following objectives that would support the green economy in the City of Tshwane with a specific focus to the Energy and Electricity business. The goals are:

- a. To improve the security of electricity supply in the City and reduce technical and non-technical losses;
- b. To encourage the use of alternative energy resources by the city and its consumers.
- c. To reduce the greenhouse gas emissions through the introduction of greening and promotion of energy efficiency;
- d. To positioning the City as a strategic partner in the drive to support green economic activities in the city and its consumers;
- e. To increase access and affordability to all sources of energy options in a way that helps to address inequality and poverty in the COT;
- f. To develop an affordable energy supply strategy that considers a variety of sources and integrate them their application to support a sustainable spatial planning.

Aspirations

- a. Increased opportunities and investment in energy efficiency and energy management to reduce COT’s existing energy demand and carbon footprint;
- b. Renewable energy options are developed and promoted in the City and they contribute effectively to a greener and more sustainable energy supply mix; and
- c. Energy accessibility and affordability for all COT residents is enhanced in a way that makes cleaner renewable fuels available for cooking, heating, transportation and lighting.

The realization of the energy mix measures and initiatives largely depends on the full support by Political leadership and executive management. The crucial success factor to meet the needs and expectation of top management are the following:
1. Money related factors: profitability, productivity, cost effectiveness, etc.
2. Customer focused factors: customer loyalty, image (including environment), etc.
3. Factors affecting the core business: product innovation and quality, procurement, process reliability, outsourcing, etc.
4. Management related factors: risk/quality management, human resources (health, security), policy and strategy, information / data management, etc.

The energy mix strategy, to achieve the above-mentioned indicators, will in future have to look at different initiatives to encourage renewable energy uptake without impacting on the overall sustainability (revenue impact) of the City.

The implementation across the COT of Energy sector will be aimed at realizing the following objectives, namely:

- Ensuring the reduction in energy utilization by 10-15% per annum as outlined in the revised Energy Efficiency Strategy of the Department of Energy and keep the losses at 10%
- Ensuring uptake of electricity supply from renewable energy as prescribed in the renewable energy targets with the immediate goal of 8% by 2020.

The following four interventions have been identified as key avenues to assist in operationalizing this strategy and achieving its targets.

a. Improving energy management and governance through knowledge-based energy information.
   i. This will be done through regular reports to executive managements, quarterly performance review reports and annual report to Mayoral committee highlighting actual performance against the set targets.
   ii. Intra-web publication and reporting system to track the uptake.
   iii. Formal re-engineering of the metering system to enable uptake and wheeling path in the network.
   iv. Procurement of power from embedded generation.

b. Managing energy related environmental and health impacts
   i. By converting the User’s energy use to CO2 emission and
evaluate the contribution of EDD to COT Carbon footprint.

c. Influencing budgeting process of EED
   i. By providing energy profile and forecast to enable EED to budget for energy use and demand in line with the energy mix strategic targets
   ii. Provide a leading role on any additional power required and link it to the energy forecast of the respective User.
   iii. Provide for penalty regime through block tariff scheme to encourage users to be energy efficient.

d. Ensuring Security of Energy Supply
   i. Investigate on alternatives source of energy for COT in the long term to reduce dependency on Eskom.
   ii. Implementation of Tariff Structures that takes into account growth and energy needs of the COT.

The City of Tshwane’s Future Energy Mix and Renewable Targets

In plotting out the path for the city’s future energy mix there are benchmarks from which to work from the different spheres of government. The Department of Energy’s Vision 2025: aims to improve the country’s energy mix by having 30% clean energy. The Gauteng Provincial target is set for 10% of renewable energy resources by 2021. A long-term energy strategy requires the appropriate mix of conventional and renewable sources. Through the past years the growth in this demand is being slow due to the energy efficiency, high electricity tariffs and the use of alternative energy resources. However, the energy economy in the country and in the city is changing, renewable energy technologies are becoming cheaper, the city must confront how it will actively diversify its current energy mix and allow for less dependency on non-renewable energy resources.

A State of Energy Study from March 2016 commissioned by the City of Tshwane suggests the following targets for the city to strive to achieve in the long term.

<table>
<thead>
<tr>
<th>Renewable/cleaner energy as portion of electricity supply</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
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<tbody>
<tr>
<td></td>
<td>8%</td>
<td>16%</td>
<td>21%</td>
<td>29%</td>
</tr>
</tbody>
</table>

Table 15: City of Tshwane Targets  
Source: CoT Energy Mix Strategy 2018 (Draft)

This is based on an assessment of the city’s current renewable energy resources and the future prospects in the sector. Considering the information in the State of Energy Study the following are recommended as the guiding targets for the future.
City of Tshwane Renewable Energy Targets

<table>
<thead>
<tr>
<th>Energy resource</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2035</th>
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<tr>
<td>Renewable/cleaner energy as portion of electricity supply</td>
<td>8%</td>
<td>12%</td>
<td>16%</td>
<td>20%</td>
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*Table 16: City of Tshwane Renewal Energy Targets*

*Source: CoT Energy Mix Strategy 2018 (Draft)*

The table reflects the immediate targets for 2020. These targets will then be adjusted by a factor of 1.5 for 2025, 2030 and 2035

Table 2

<table>
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<tr>
<th>Energy resource</th>
<th>Consideration</th>
<th>Targeted penetration by 2020 (%)</th>
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<th>Driver</th>
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<tr>
<td>Photovoltaic technology</td>
<td>Renewable (green)</td>
<td>7% of maximum demand</td>
<td>Electricity generation for self-consumption and resale.</td>
<td>City and Private Consumers. All consumer categories</td>
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<tr>
<td>Solar Water Heaters(^2) (SWH)</td>
<td>Renewable (green)</td>
<td>Less than 1% contribution based on the maximum demand</td>
<td>Thermal energy (water heating)</td>
<td>Private consumers Mostly domestic and commercial consumers</td>
</tr>
<tr>
<td>LP Gas</td>
<td>Alternative (less emissions) [greening]</td>
<td>Less than 1% contribution based on the maximum demand</td>
<td>Cooking in households</td>
<td>Private consumer</td>
</tr>
</tbody>
</table>

*Table 17: Sources of energy, targets and uses table*

*Source: CoT Energy Mix Strategy 2018 (Draft)*
Natural Gas | Alternative (less emissions) [greening] | Less than 1% contribution based on the maximum demand | Steam and heat production | Alternative for diesel in the transport sector | Electricity generations (not very common) | - City¹ and Private consumers
---|---|---|---|---|---|---
Biofuels (from different types of waste) | Renewable (greening) | Less than 2% contribution based on the maximum demand | - Electricity generation | - Steam or heat production | - City¹ and Private consumers

Table 18: Sources of energy, targets and uses
Source: CoT Energy Mix Strategy 2018 (Draft)

Participation of the Tshwane Electricity and Energy Department in the national Department of Energy managed Energy Efficiency Demand Side Management (EEDSM) Programme. This has included:

i. Replacing 125W Mercury Vapour lamps with 70W High Pressure Sodium lamps in 30,338 street lights,
ii. Replacing 54W incandescent lamps with 9W LED lamps at 296 traffic light intersections,
iii. Replacing 56W T8 fluorescent lamps with 36W T5 fluorescent lamps in 98 municipal buildings.
iv. Purchasing electric vehicles for municipal fleet.

Renewable energy developments in and around the City

i. Exploration of landfill methane gas–to-power is underway
ii. Small hydro reservoir pilot exists
iii. Facilitation of wheeling of electricity and the Use of System agreement for private developers.
iv. Large solar PV plant feasibility is under consideration.

Overall the City of Tshwane has made progress in gradually introducing energy efficient measures into its operations, preparing for future energy demands and gradually moving towards a space where provision is going to be made for more renewable energy to support power supply in the city. The Energy and Electricity Division (EED) is being repositioned to focus on encouraging energy security through diversification of the city’s energy sources, with an emphasis on encouraging investment into renewable sources and energy efficiency. The plans to advance this sector includes; encouraging and coordinating the implementation of the projects in line with vision 2030, financial support to implement the energy mix strategy, promotion of innovative and clean technologies, the use of energy efficiency technologies, migration towards Smart-grid technologies and control, sustained energy supply from both fossil fuels and renewable sources and institutional support.
Further, the EED is on continuous basis developing policy that will guide the successful integration of alternative energy resources for application in the City. One of which is the Embedded Generation policy. Upon approval of this policy, the process to adapt the electricity by-law to incorporate other energy resources will begin. The policy and the bylaw will assist in the implementation of the energy mix strategy.

The City energy business continues to evolve from being the buyer of energy from Eskom to also becoming a trader with businesses and residents. The new revolution, means anyone can produce and sell to the aggregator (City) and paid back based on approved Tariffs. This is a win-win solution for both the city and Customers as the revenue of the city remains neutral whilst supporting new business ventures. If this is not considered, it will lead to death spiral to City’s energy business.

Revenue Protection and Future Potential Revenue

In order to mitigate against these risks careful consideration will need to be given to Revenue Protection. There are various options to mitigate revenue losses from renewable energy (RE) and energy efficiency (EE) adoption by electricity customers. Given already above-inflation Eskom price increases, municipal tariffs cannot simply be increased in an attempt to bring in the necessary revenue due to the price elasticity of demand and potential impact on the poor. High electricity prices make the financial case for RE and EE more attractive. Therefore, other measures need to be explored: -

a) Decoupled tariff: In the residential sector, the most sensible option is to protect revenue using a decoupled tariff which is composed of a fixed charge and energy charge. This is the most transparent tariff as it shows the cost of the service - i.e. having access to the grid – separate to the actual cost of electricity. It can be applied across the board, or just to grid-connected PV customers (not as a penalty). In this way the municipality protects its ability to operate as a distributor no matter how much or little electricity is sold.

b) The NETFIT1 business case proposed by Eskom and CSIR describes a mechanism to compensate municipalities for monetary losses as a result of PV adoption. This proposal is gathering support and could be implemented at a national level in future. However, this model does not intend to address revenue loss from EE interventions, which would remain significant.
c) Non-technical losses constitute the most significant electricity revenue loss for the municipality currently. NERSA’s acceptable technical loss figure for a network like the City of Tshwane is estimated to be 7%. However, the reality of the situation is that non-technical losses in the city are still well above 20%. Nevertheless, any improvements in this figure will have a significant benefit to the municipality, and as such should be continuously pursued.

Non-payment losses are also significant and should be co Green electricity tariffs: Although the price of electricity is starting to become the driver of consumer adopting alternative sources, some of these Organizations have a strategic objective of procuring and producing their product using green energy. The City can introduce the resale of green energy to assist these corporates to meet their objective. In this model, the City must have off take agreements with the IPP or have developed its own RE plants that is adequate to meet the consumer expectations.

d) Charging stations: In the next 10 to 20 years, there is a strong believe that the automotive sector will be moving towards electric driven cars. This is another opportunity for revenue generation by the municipality. A pre-paid card model or a bank credit card model can be used to sell electricity units for charging cars at the municipal offices. The private sector can invest in such for roll-out in the malls around the City.

Monitoring and Evaluation

The successful implementation of this strategy will have to be broken down into yearly deliverables which are then captured within the business plan of the Utility Services Department. Thereafter this strategy will need to be reviewed every five years in order to determine if the targets that have been adopted require revision or updating.

The use of smart-grid technology will enable performance monitoring especially when reverse feed is approved for a specific consumer. Real time monitoring of the large EG generators will become possible. Billing will be automated eliminating human error and reducing under-billing indirectly addressing non-revenue electricity problem of the City.

Proposals for the upgrading of the Rooiwal power station and the conversion of waste to energy in the Pretoria West power station.

6.9.4 Overview of key water projects

A full list of Projects that are scheduled to begin within the next 5 years is provided. It is beyond the scope of this report to discuss each of these individually, however the following major (macro) projects warrant further discussion: -
- Themba WTP expansion due to water shortage (IDP-710878T).
- Reservoirs at Mamelodi R5, Parkmore HL (Menlyn), Grootfontein, Mooikloof, Sunderland Ridge, Highveld, Sekampaneng, La-Montagne (Nelmapius), Pretoriusrand (Olievenhoutsbosch) (IDP-712534)
- Extension of the Rietvlei WTP and Roodeplaat for purposes of water security.
- Pumping system from Roodeplaat WTP to Doornpoort East/West reservoirs & Roodeplaat-Doornpoort bulk pipe line (IDP-711335DP).
- Upgrade Wallmannsthal WTP and pumps (BLK-WT-159) – Magalies Water.
- Southerly reinforcement (phase 2) and easterly reinforcement of Bronberg (Kungwini) bulk system (BLK-KW-081) and Extension of Bronberg (Kungwini) bulk from Goedemoed junction to Mooiwater reservoir + new reservoir (phase 1) (BLK-KW-083).
- Replacement and upgrading of deficient bulk pipelines (IDP-711335D).
- Upgrade of bulk water supply pipeline from Mamelodi to Bronkhorstspruit (Ekangala) – Rand Water

The listed projects have to be implemented by CoT but can be partly financed from bulk services contributions by developers. There are also a number of projects included in the MP that pertain to external Water Service Providers (viz. Magalies Water and Rand Water) but are critical to the operation of the COT system.

The VRS is under pressure and the Department of Water Affairs (DWA) is actively working towards reducing the load on the River. Given the cost of water supply from Rand Water and also the pressure from the DWA to reduce the load on the Vaal River, the CoT has to review its current water supply practices in order to secure its future sources in a sustainable and optimal way. An overall review of the plants concluded that:

- Groundwater source quality is not as pristine as one would like which reinforces the need for diligent operation of disinfection processes. The organic quality of the water is excellent. Some concerns exist regarding the sporadic spiking of lead and selenium levels. This may however be a result of systematic errors in sampling, analysis and reporting and this needs to be investigated.
- The surface water sources generally demonstrate poor microbiological qualities as would be expected of these sources. Temba however shows much worse water qualities in this regard than other sources and this is reason for concern. Temba also shows the poorest chemical raw water quality followed by Roodeplaat. All sources show high levels of organic carbon which suggest special advanced processes need to be considered for its treatment.
- A process review indicated that that the main phase separation processes of the treatment trains, in all cases, should be DAF followed by sand filtration. This is indeed the cases at Rietvlei,
Roodeplaat and Bronkhorstspruit, as well as for the latest two treatment trains at Temba. The old treatment trains at Temba, and the two small plants at Bronkhorstbaai and Summerplace rely on settling ahead of filtration – a less than optimal option.

Iron and manganese are problematic in most surface water sources. Iron is most serious at Temba and Summerplace – there are no dedicated aeration or oxidation processes ahead of filtration. Manganese is more troublesome – not only must it be oxidised before phase separation, but it also requires a stronger oxidant than air, such as chlorine, permanganate, chlorine dioxide or ozone. Such measures are indicated at Rietvlei, Roodeplaat and Temba, but may not necessary at the other three treatment plants. Rietvlei is about to get ozone, Roodeplaat had ozone added recently, while Temba used chlorine dioxide successfully a year or two ago, which has since been discontinued.

As the source waters will for surface water treatment plants will naturally increase its proportion of treated municipal wastewaters, the occurrence and concentration of endocrine disrupting chemicals will become more of a concern. Previous studies have shown that these chemicals are present in South African surface waters at levels which dictate careful consideration. Particularly if these sources are to make up a larger portion of the potable water supply. Therefore, these chemicals as well as the others which have already been identified as a risk for COT such as Lindane and DDT should be the focus of further research and study and should be monitored on a regular basis as part of risk management within the municipality. The municipality is encouraged to research these compounds in conjunction with academic institutions especially in the light of the re-use of effluents proposed here.

### 6.9.5 Water resource analysis

Water Resources Planning Model (WRPM) analyses were conducted to establish the maximum surplus yield that could potentially be utilized without affecting the assurance of supply of any users through an iterative process.

The results of the analysis indicated that, after meeting MCWAP requirements, a surplus yield was available in Hartebeespoort Dam, Roodeplaat Dam, Rietvlei Dam and the Apies River system. The analysis results concluded that the total surplus yields (as of 2014) available from Rietvlei Dam, Roodeplaat Dam and Oliefontein WWTW (Hartebeespoort Dam) are 4.7 Mm$^3$/a, 9.2 Mm$^3$/a and 27.6 m$^3$/a respectively and are projected to increase to 33.0 Mm$^3$/a, 63.6 Mm$^3$/a and 44.5 Mm$^3$/a respectively by 2057 (mainly due to increased sewer return flows).
Rietvlei WTP and Roodeplaat WTP are at present the most appropriate points for access to the additional water resources available in the Crocodile River catchments. The reasons for this are, that the sites house substantial established WTPs, which draw water from the two largest impoundments in the city, providing appropriate buffers and reservoirs for raw water storage. The only portion of the Hartbeespoort surplus yield that would be feasible for the COT to utilize is the return flows from the ERWAT Olifantsfontein WWTW, which contribute to the Hartbeespoort Dam yield. The surplus yields in the Crocodile River basin are sufficient to allow the following: -

- Stepwise increase of the Rietvlei WTP capacity from 40 ML/d to 140 ML/d.
- Further increase of the Rietvlei WTP capacity to 240 ML/d if water is transferred from the ERWAT Olifantsfontein WWTW to the Rietvlei Dam.
- Stepwise increase of the Roodeplaat WTP capacity from 60 ML/d to 240 ML/d.
- Increasing the Temba WTP from 60 ML/d to 180 ML/d in step with the peak summer requirements.

Additional capacity created at Rietvlei WTP (with or without Olifantsfontein WWTW transfer) can be efficiently absorbed into the bulk water distribution system. In order to efficiently utilize the additional Roodeplaat WTP capacity, it will be required to increase the supply into the Wallmannsthal system, thereby eliminating the need for any further Wallmannsthal WTP expansions. The results of the WRPM analysis, with the CoT projection, showed that the users cannot be supplied according to their required assurance criteria.

The following interventions will be required to ensure sufficient water resource availability: -

- Total surplus yield from Rust de Winter Dam required as support.
- The successful implementation of WCDM initiatives to achieve total savings of 12.8 Mm$^3$/a.
- Additional augmentation of approximately 14 Mm$^3$/a.

There is no further yield available for the required increases in capacity at the Cullinan and Bronkhorstspruit WTPs. The only option for augmenting this shortage is additional supply from RW into these two systems.

If a transfer scheme from Olifantsfontein were to be implemented, this would involve:

- A receiving works on the site of the Olifantsfontein WWTW.
- A pumping station.
13 km of pipeline to transfer the raw water across the catchment. Receiving works at the Marais Dam just upstream of Rietvlei Dam. Based on the yield analyses, a transfer capacity of 80 ML/d could be supplied by 2020, and a further 40 ML/d by 2045. The expansion of the Rietvlei WTP can then be executed according to the following timeframes.

- Current capacity = 40 ML/d.
- 2020: 100 ML/d expansion.
- 2035: 50 ML/d expansion.
- 2045: 50 ML/d expansion.
- WTP capacity at 2055 = 240 ML/d.

It is proposed that the expansions be implemented on open land to the north of the Rietvlei Dam wall, which will require pumping of the raw water to this higher elevated site. The following additional infrastructure will need to be provided:

- A new abstraction facility as the current unit has reached its capacity.
- A raw water pumping station to deliver water to the new site.
- A new sludge handling facility.

The existing 40 ML/d capacity of Rietvlei WTP is pumped into the Klapperkop and Garsfontein “receiving” reservoirs, from where it is on-sold to many other reservoirs and distribution zones. The same can be done with the extended capacities of the Rietvlei WTP, almost allowing 100% utilization of the expanded capacities. A new pumping system is required with required items in sync with the WTP extensions and the future demands.

The following capacity expansions are proposed in the light of available resources:

- Current capacity = 60 ML/d.
- 2015 Expansion: 30 ML/d (still in planning stage).
- 2025 Expansion: 50 ML/d.
- 2035 Expansion: 50 ML/d.
- 2045 Expansion: 50 ML/d.
- Total WTP capacity by 2055: 240 ML/d.

The following additional infrastructure will need to be provided in order to establish the WTP along this proposal:

- A new abstraction facility.
- A raw water pump station and pumping mains to deliver water to the WTP site.

All the additional water from the proposed 4 phases of the extended Roodeplaat WTP will have to be pumped. There are two existing
pumping schemes in place, namely 60 ML/d to Montana reservoir, and 10 ML/d to Wallmannsthal reservoir. Additional pumping systems are required to optimally accommodate the Roodeplaat WTP in the bulk water system, with phasing in synch with the WTP extensions and the future demands.

There is no additional water resource available from natural flow and/or sewer return flows to increase the capacity of the Cullinan WTP or the Bronkhorstspruit WTP from their existing 16 ML/d and 54 ML/d capacities. The only option is to augment the water supply from the RW system, parallel to the already existing 30 ML/d augmentation scheme via RW Bronberg Reservoir.

The long term required additional augmentation to Cullinan amounts to 32 ML/d on a peak summer day, and similarly 112 ML/d to the Bronkhorstspruit system (via the Ekandustria reservoirs). Due to the dire situation in the Olifants River catchment, and to allow for expansion of the small Bronkhorstspruit WTP, these values have been rounded up to 40 ML/d and 120 ML/d respectively for planning purposes. The required infrastructure could be considered extensions of the RW (Bronberg) system, although would require resolution with RW and MW regarding existing and future operational boundaries.

Conclusion from WRMP

The following conclusions were drawn from the WRMP analysis:

- There is sufficient surplus yield available in the Crocodile River basin for CoT to increase the capacities and supply areas of Rietvlei and Roodeplaat WTP’s, and despite significant capex it can be achieved at a unit cost for water which is lower than the RW tariff.
- There is sufficient yield available in the Crocodile River basin to expand the Temba WTP in step with the increase in demand.
- There is no additional resource available in the Olifants River basin for expansion of the Cullinan, Bronkhorstspruit and Bronkhorstbaai WTPs. The only solution is an augmentation scheme from RW to Cullinan and Bronkhorstspruit. Such a scheme should include buffer capacity, which will allow underutilization of the Olifants resource for Cullinan and Bronkhorstspruit, essentially freeing up the limited resource required to expand the Bronkhorstbaai WTP.
- PPP’s may be considered for the implementation of the WRMP, on the basis that such course of action will be off the CoT balance sheet and should result in bulk water supply to COT at a rate lower than the current RW tariff.

Implementation of the WRMP in its entirety should be considered in order to reduce the dependency on RW and the Vaal River system, but also to ensure the possibility of a resource trade-off that will allow RW/Vaal augmentation into the Olifant basin, in order to supply the Cullinan, Bronkhorstbaai, Bronkhorstspruit, Zithobeni, Rethabiseng, Ekangala, Ekandustria, and Thembisile areas.

In this context, the implementation of the following components of the WRMP should be considered in the 5 Year plan:
✓ Transfer scheme from Olifantsfontein WWTW to Rietvlei dam.
✓ Expansion of 100 ML/d at Rietvlei WTP.
✓ Bulk water supply pumping scheme to distribute 100 ML/d from Rietvlei WTP into Klapperkop and Garsfontein reservoirs.
✓ Concomitant augmentation scheme from RW Bronberg reservoir to Cullinan and Ekandustria (a RW project).
✓ Expansion of 30 ML/d at Roodeplaat WTP.
✓ Bulk water supply pumping schemes to distribute additional capacity from Roodeplaat WTP into Wallmannsthal and proposed Doornpoort reservoirs.

There is potential to implement all of the above from the CoT balance sheet, if an external implementation mechanism (e.g. private or public-public partnership PPP) can be considered which will sell the bulk water to CoT at a tariff below that currently charged by Rand Water. Region 5 has large water and sanitation services backlogs. This ranges from a need to upgrade the current infrastructure and creating new infrastructure in the different municipal wards. The need is mainly reflected in the informal settlements that are spread out within the various wards. Informal settlements, though small and relatively contained, are spread throughout the area, forming low-income residential enclaves.

The townships of Rayton, Cullinan and Refilwe are currently the only areas that are serviced with sewer borne sanitation. The entire Kameeldrift area (Kameeldrift, Derdepoort, Roodeplaat, and surrounding areas) do not have sewer borne sanitation. The rural areas use groundwater and on-site sanitation of which septic tanks with soak ways and self-constructed pit toilets are the most common.

6.9.6 Water Management

Water is a key resource that the world cannot survive without. It has been confirmed that people in Southern Africa are living in a water-scarce country and need practical solutions to the problem of water shortages.

(a) Rainwater harvesting

Rainwater harvesting is not a new concept; it is an ancient practice. It is a technique that collects and stores rainwater for irrigation, laundry, toilet flushing, pool top-up, wash bays and as an off-grid/alternative supply of water. In some areas it is still the only supply of water. Rainwater can be collected from various hard surfaces such as rooftops and/or other man made above ground hard surfaces. Rainwater harvesting is growing in popularity due to an overall interest in reducing the consumption of potable water and the inherent qualities of rainwater. Unfortunately, urban living, population increase, climate change, failing infrastructure, pollution, our lifestyles (to name a few)
are all contributing to a worldwide water crisis. It is actually really very simple; our demand exceeds our supply and to sink another borehole isn’t the answer; we are busy depleting our groundwater supply. To secure a future with enough water we have to save water; we have to harvest rainwater, because:

- It is a natural resource and reduces flooding, storm water runoff, erosion and contamination of surface water.
- It reduces the need for purchasing bottled water.
- It is an excellent source of water for irrigation
- It is relatively simple to install, depending on the application.
- It reduces your water bill.
- It supplies water during water outages.
- It promotes water and energy conservation.

Harvested rainwater can be used for many applications.

(b) Grey water recycling (truck & car washes)

Grey water is made up of bath, shower, bathroom sink and washing machine water which makes up a large portion of household water wastage. Grey water is recycled for introduction back into the facility or used for other purposes like irrigation. Plants that use vast amounts of water such as wash bays, for example, benefit hugely by installing a water recycling system as they can save up to 90% of their water costs.

It’s also environmentally responsible to reuse water instead of sending it down the sewer.

(c) Sewer treatment plants

Packaged sewer treatment plants in the form of tanks that can be moved from site to site as well as permanent non-packaged plants. The sewage treatment plants are designed to meet local discharge standards.

(d) Effluent harvesting

Effluent harvesting includes recycling and reusing water from paint and chemical plants or any manufacturing or mining operation that produces effluent water. Water harvesting in a residential context is also becoming increasingly popular as homeowners are looking to save money and become less reliant on municipal water.

(e) Bio-mite Septic Tank Systems

Water is recycled within the Septic Tank, which goes through a special process before being used to water the lawn or non-food gardens via underground pipe systems.
Septic Tanks treat effluent, which allows you to re-use/recycle the treated water for outdoor irrigation. Effluent is the wastewater that comes from toilets, dishwashers and waste disposal. It makes up 15-30% of domestic wastewater. Filtered effluent is not only beneficial for the home garden and lawn, but it is also good for the environment. Benefits include:

- Less stress on septic systems
- Conserves energy
- Water conservation
- Habitat protection
- Plant growth

(f) Buffer tanks

Backup or buffer tanks offer water security during water shortages or cuts. The system consists of a buffer tank where the water flows through and is always kept full in case there is a water shortage/cut and the booster pump connected to the system continues to pressurise the premises using this water stored in the buffer tank.

Advantages include:

- Water security

- Silent Pump
- Ideal when water supply pressure is low.

6.8.5 Waste Water Treatment

COT is responsible for own waste water treatment and a large portion of the future required Capex is for the provision of additional capacity. A full list of projects scheduled to begin within the next 5 years are provided, however the following major (macro) projects warrant further discussion:

- Extension of the existing 150 ML/day Rooiwal North WWTW sludge facility, with an additional 80ML/day Biochemical Nutrient Removal Module (IDP-710411D).
- Extension of the existing 60 ML/day Baviaanspoort WWTW sludge facility, with an additional 40ML/day Biochemical Nutrient Removal Module (IDP-710411F1).
- Extension of the existing 30 ML/day Zeekoegat WWTW sludge facility, with an additional 50ML/day Biochemical Nutrient Removal Module (IDP-710411B).
- Backlog eradication projects in greater Temba and Ekangala (IDP-710878)
- The listed projects all have to be implemented by CoT, but can be partly financed from bulk services contributions by developers.
6.10 CONCLUSION

The chapter gave an overview of the current infrastructure of Tshwane’s electricity, water and sanitation. Based on the discussions it is clear that the Municipality needs to invest more in renewable sustainable technologies in order to provide electricity, water and sanitation to its residents and large customers, whilst still aligning and complying with various applicable legislations. Challenges that comes with urbanization pertaining to the management of resources, particularly water and energy cannot be ignored. To achieve a better Tshwane 2055, it remains the responsibility of all role players to ensure the dream is achieved.

6.11 REFERENCES
