WATER DEMAND FORECASTS FOR INFRASTRUCTURE DEVELOPMENT AND WATER CONSERVATION AT LOCAL MUNICIPALITY LEVEL

Report to the
WATER RESEARCH COMMISSION

by

CONNINGARTH ECONOMISTS

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1 INTRODUCTION

Due to the fact that water resources in South Africa are scarce, decisions regarding the development of water supply infrastructure and the allocation of water between the various water-use sectors, including households, will, at times, have to be made. Obviously, such decisions will result in trade-offs that will impact on the economy and the welfare of society in general. Assessing the consequences of alternative courses of action and their trade-offs is of crucial importance, especially in the wake of limited resources.

There will always be a trade-off between the commercial use of water, an adequate supply of potable water to households, and minimum water flows to preserve the environment. Furthermore, the dire need to optimise scarce water resources in terms of its contribution to the welfare of society and the economy is accentuated by the fact that developing new water resources entails enormous capital outlays, where capital is a scarce resource in a developing country like South Africa. Hence, the need exists to optimise water usage across the various economic sectors and households. This optimisation of water usage can only be effectively implemented when it is possible to make well-informed decisions regarding the re-allocation of existing water resources and the allocation of new water resources.

Within this context, the Department of Water Affairs (DWA) has undertaken work to calculate the water balance of certain specific Water Management Areas (WMAs), Metropoles and Local Municipalities. However, no attempt has been made to determine the demand for water by the various economic sectors, including households, for the economy as a whole that recognises that the national water demand/supply situation represents an integrated system with widespread linkage effects. Conningarth Economists has been commissioned by the Water Research Commission (WRC) to fill this gap in information regarding the overall national water demand/supply situation; and to determine the role of water as a vital economic input.

1.1 Project Objectives

The objectives of this project include:

- Producing short-, medium- and long-term water demand forecasts at a local municipality that can subsequently be aggregated into larger water usage areas such as Provinces, Metropoles, District Municipalities, Water Management Areas, Catchment Management Areas, and
- Producing Water Balances for the various water usage areas that compare the water demand forecasts with current water supply capabilities with the intention of highlighting areas where additional water supply capacity will be required in future

Within the context of these objectives, it is important to recognise that the demand for water is an outcome of future economic activity. Therefore, the first aspect in water demand forecasting is to develop a long-term forecast for the South African economy. The second aspect is to derive the water needs to support the forecasted economic growth and development. To be able to achieve this, it is necessary to estimate the current water needs of the various sectors and to determine the change in the intensity of water-use by the various water demand components. The third aspect is to estimate water demand at a Local Municipality level; and to project water sales by individual Local Municipalities.

1.2 Broad Methodology

Conningarth Economists has expanded the water demand component of its Long-Term Forecasting Modelling system (LTFM). This proprietary modelling system incorporates a macroeconomic element that forecasts economic activity for the various economic sectors, including households. The outputs of these macroeconomic forecasts are then used to create a supply and demand database that incorporates 31-year forecasts of local production, exports, local demand, and imports for 114 commodities at a Magisterial District level. By making use of water satellite account data, to establish water demand Nationally and for the major sectors, water use coefficients are employed to convert Rand value production forecasts into water demand volumes – this process is described in more detail in a later section. Finally, water demand forecasts are converted into Municipality water sales forecasts for Domestic and Non-Domestic users.

1.3 Project Deliverables

The project commenced upon signing of an agreement between Conningarth Economists and the WRC on 28th February 2017. The duration of the project is in accordance with the table below that reflects project phases, key deliverables, and deadlines.

Table 1.1: Project Phases & Milestones

	Project Phase	Deliverable	Timing
1	**Inception and Project Plan**	Project Conceptualization and team Mobilization	20/06/2017
2	**Water Demand Forecasting**	Forecasting the South African Economy and expansion of Macroeconomic Forecasting Model to include Water-use Coefficients	30/09/2017
3	**Report on Findings and Presentation to Target Groups**	Report and Presentation of the Macroeconomic Forecasting Model and its functional operation to the Client and Target Group	30/01/2018
4	**Water Balance and Expanded MFM Testing**	Testing the Long Term Water Demand Forecasting Model by estimating the Water Balance of selected Case Study Areas	31/05/2018
5	**Review Findings Where Necessary and Compile Database and User Manual**	Review findings following the testing of Long-Term Water Demand Forecasting Model and compiling a User-Manual	30/09/2018
6	**Seminar To Disseminate Information**	Organise a Seminar to enable information transfer	30/11/2018
7	**Compile Final Report and Handover of Model**	Compile Final Report and handover of Long-Term Water Demand Forecasting Model and presentation to Client	25/01/2019

1.4 Report Structure

This report relates to the seventh phase of the project that involves finalising the Water Demand element of the Long-Term Forecasting Model (WD LTFM) and handover of the model. The handover consists of the Excel-based model on a USB Flash Disk and User Guide.

Following on from this Introduction, this report includes the following sections:

- **Section 2: Water Demand Forecasts** – this section describes the methodology used to produce a 31-year long-term forecast of the demand for water in South Africa, as well as the integrated workings of the proprietary Conningarth Long-Term Forecasting Model, and
- **Section 3: Instruction Manual for the Water Demand Forecasting Model** – this section provides a step-by-step guide to using the WD LTFM in supporting decision-making processes regarding the allocation of water resources to the various economic sectors; and in the development of new water supply infrastructure

2 WATER DEMAND FORECAST

2.1 Macroeconomic Growth Model for South Africa

This section of the report provides an overview of the approach used in developing a long-term forecast model of the South African economy by Conningarth. Readers wishing to know more about this macroeconomic forecasting approach and the model are referred to the report produced during the second phase of the project, i.e. Deliverable 2: Water Demand Forecasting, 29 September, 2017.

As indicated above, the demand for water is an outcome of future economic activity. Therefore, the first step in forecasting long-term water demand is to develop a forecast for the South African economy that takes into account significant factors such as:

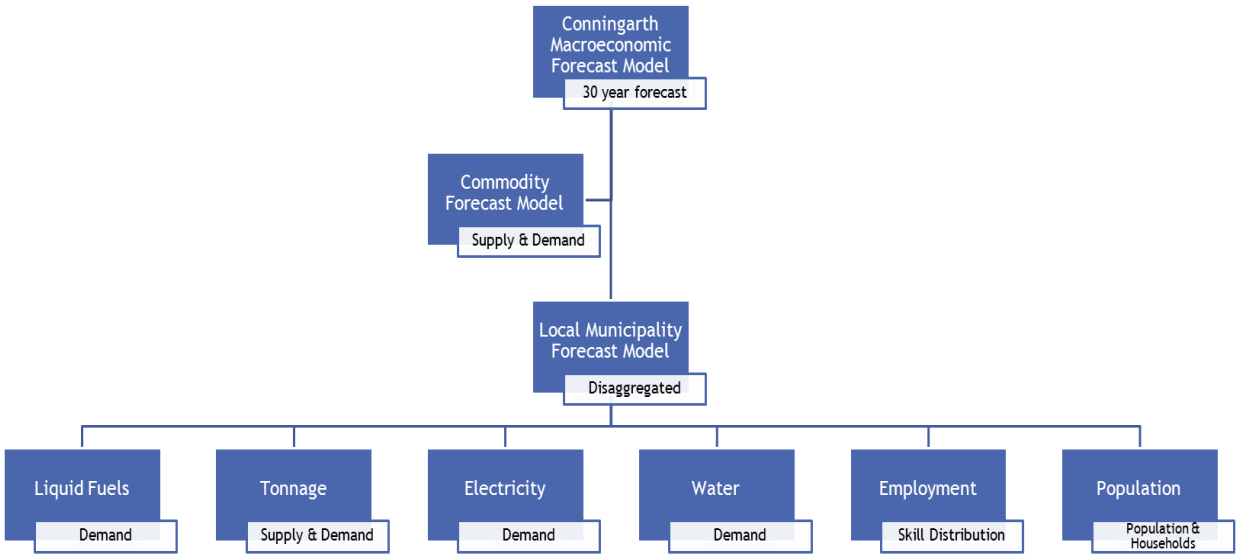
- Global economic growth prospects
- sub-Saharan African country economic growth prospects
- Global commodity price cycles
- South African fixed investment trends
- Global and South African trade trends
- Global, African, and South African population growth trends
- Urbanisation in South Africa
- Shifts in economic sector contribution to South African national output, and
- South African socio-economic challenges

Conningarth has developed a proprietary Long-Term Forecasting Model (LTFM) that has three core elements:

- A macroeconomic forecasting element for the National economy
- A commodity-level supply and demand forecasting element, and
- A municipal-level forecasting element

The figure below illustrates the interrelationship of these three elements of the modelling system. The figure also illustrates how the commodity-level supply and demand forecasts are disaggregated to a Local Municipality level; and how these Local Municipality forecasts are used to derive forecasts of the demand for key economic resources such as liquid fuels, electricity, water, and labour.

Figure 2.1: Structure of the Conningarth Long-Term Forecasting Model



Key features of the LTFM include:

- Forecasts are made taking into account long-term global economic trends and RSA business cycles
- Forecasts are initially made using a top-down, macroeconomic trend approach; and then adjusted for bottom-up, global/RSA industry-specific structural and policy changes
- Forecasts of supply are equal to demand, implying a balanced economy
- Forecasts are initially made in Rand value figures, using constant base year prices; and are then converted into other values using multipliers for the base year
- Forecasts of supply and demand are disaggregated to South African provincial and local municipality levels
- Forecasts are made for 3 scenarios:
  - Most likely supply and demand volumes – assuming that historical and current trends will continue throughout the forecast period
  - High supply and demand volumes – assuming that identified global and local industry-level positive 'trigger factors' will stimulate supply and demand volumes, and
  - Low supply and demand volumes – assuming that identified global and local industry-level negative trigger factors will suppress supply and demand volumes
- Forecast assumptions and final commodity volume and value forecasts are available as a series of MS Excel worksheets

2.1.1 Philosophy and Assumptions

South Africa is an open economy, and its imports and exports are directly linked to what is happening in the rest of the world. As such, the macroeconomic forecast model incorporates assumptions regarding global economic developments; and, in making forecasts of the South African economy, Conningarth makes use of reports and data produced by the IMF, the World Bank, and other international financial institutions such as the African Development Bank, the Asian Development Bank and the Organization for Economic Co-operation and Development (OECD).

In addition, Conningarth also belongs to the international INFORUM Group, which is supported by a sub-division of the International Input-Output Association. Countries involved in the INFORUM Group include the USA, China, Russia, Germany, Italy, Japan, and Spain. These countries are using the INFORUM model for forecasting and macroeconomic impact studies. This group exchanges information on world economic developments on a regular basis.

At a local South African level, macroeconomic forecasts are guided by the National Development Plan (NDP), the New Growth Path (NGP), the National Infrastructure Plan (NIP), and the Industrial Policy Action Plan 2 (IPAP). Forecasts fully reflect the official National Accounting Framework of South Africa since the macroeconomic model is based on these same data sets. The forecast consists of three growth scenarios, namely a Likely, High, and Low Growth scenario. The South African economy is projected on an annual basis for 31 years into the future. The main emphasis is on the medium- to long-term; however, given the fact that forecasts are updated on a rolling annual basis, they can also be used for short term budgeting purposes.

Macroeconomic forecasts are made from a top down as well as a bottom up approach; and are verified with industry specialists. The outcome of the economic sector forecasts holds major advantages in the sense that such aggregates can be employed for forecasting demands for inputs such as electricity, water and labour due to the fact that each sector has its own resource use intensity.

The macroeconomic forecasting element of the LTFM provides forecasts of overall production, GDP and final demand components at a national and provincial level. Detailed supply and demand equations are produced on a sectoral level that comprise of production, intermediate demand, final consumption expenditure, gross capital formation, exports and imports. Although Conningarth has applied a modelling approach to producing forecasts, every effort is made to ensure that the base year data from which forecasts are projected is, as far possible, derived from actual national and sectoral figures.

2.1.2 Local Municipality Element

The commodity-level supply and demand forecasts that are made at a national and provincial level are disaggregated to a local municipality level. This exercise incorporates 9 provinces, 8 Metropoles, 44 District Municipalities, and 226 Local Municipalities. The database also allows for aggregation of Local Municipalities into the 19 Water Management Areas (WMA's), Catchment Management Areas, and any other level of geographical aggregation required.

Disaggregation to a local municipality level is achieved by identifying localised geographical sources of supply (i.e. municipality-level locations for domestic production and sea and air ports and border posts through which imports enter South Africa), as well as points of demand (i.e. municipality-level locations for household and government consumption and sea and air ports and border posts through which exports leave South Africa). Appendix 2 to this report contains a complete list of the metropoles and district and local municipalities incorporated into this element of the overall modelling system.

2.2 Water Demand Projections

The Conningarth Long Term Forecasting Model can be extended to produce forecasting models for various resources, including water. As part of this project, Conningarth has compiled a Water Demand Long-Term Forecasting Model (WD LTFM) to assist potential users that are responsible for the provision of water supply infrastructure and the development of water management strategies with their work. The WD LTFM provides 31-year forecasts of the demand for water at a Local and District Municipality and Metropolitan Council level.

Water demand projections consist of two elements:

- Commodity water-use coefficients, and
- A water balance for South Africa

2.2.1 Commodity Water-Use Coefficients

Water demand is derived from commodity-level production forecasts and from forecasted household water demand using so-called water-use coefficients that reflect the intensity with which each commodities' production process and household uses water. Water-use intensity differs substantially across commodities; for instance, to produce R1 million worth of vegetables under irrigation uses far more water than does the production of R1 million worth of textile products. The same argument holds for high income households that use much more water than low income households.

In determining commodity-level production water-use coefficients, use has been made of the Natural Resource Accounts compiled in the Updated Water Accounts for South Africa published by StatsSA; the Water Resource Strategy produced by the DWA, 2013; and the Supply and Use Matrix produced by StatsSA that provides detailed sectoral usage of water. Water usage by households has been derived from the South African Social Accounting Matrix (SAM) compiled by Conningarth. In addition to these sources, use has also been made of a study undertaken by Conningarth for the WRC where water coefficients were calculated, namely, "*Econometric Model to predict the effect that various Water Resource Management Scenarios would have on South Africa's Economic Development: K5/1570", 2008*.

It is important to recognise that water-use coefficients change over time as a result of technology changes that effect commodity-level production processes and consumer behaviour. In the case of irrigation agriculture, which uses approximately 65% of all water used in South Africa, specific attention has been given to determining the impact that technological changes will have on water use over time (i.e. the use of more efficient irrigation methods such as pivots and drip irrigation vs older, more water intensive flood irrigation and standard drag-line sprinkler methods). In this study, use has been made of regression analysis applied to historical water-use data obtained from Water Boards and Local Municipalities to determine water-use coefficient changes over time.

2.2.2 Water Balance for South Africa

In order to determine total water usage in South Africa for the 2017 base year, water balance figures for South Africa have been derived from the Strategic Overview of the Water Sector in South Africa 2017 report published by DWS. This report indicates that South Africa has a reliable yield (at 98% assurance of supply) of only about 15 billion m^3/annum, comprising 68% surface water, 13% groundwater, 13% return flows and 6% from other sources, such as desalination of brackish or seawater.

South Africa's mean annual runoff (MAR) is about 49 billion m^3/annum. Ground water usage is about 2.78 billion m^3/annum, although this may be an underestimation. Recent estimates indicate that the potential, reliable groundwater yield could be over 5 billion m^3/annum. It is estimated that return flows from irrigation, urban domestic uses and bulk industrial and mining effluents could offer re-use opportunities of up to 1.9 billion m^3/annum. This could also be an underestimation, when taking into account Acid Mine Drainage treatment. Current surface water usage is estimated to be 17.1 billion m^3/annum, roughly split between agriculture (55%), industry (18%), municipal (17%), mining (5%) and afforestation (5%). Total surface and groundwater usage is 19.88 billion m^3/annum.

South Africa has a reliable yield, at 98% assurance of supply, of only about 15 billion m^3/annum, comprising 68% surface water, 13% groundwater, 13% return flows, and 6% from other sources, such as desalination.

This study uses the estimate of 19.9 billion m^3/annum as compared to the 15 billion m^3/annum at a 98% assurance of supply reflected in the DWS 2017 report. The 19.9 billion m^3/annum figure is roughly split between agriculture and forestry (65.8%), power stations (4.3%), mining (3.3%), manufacturing (3.2%), trade and services (6.7%), and urban domestic (13.9%), and rural domestic (2.8%).

2.2.3 Detailed Algorithm Projecting Water Demand Forecasts per Commodity per Municipal Area

Water demand forecasts per Municipal area are derived using the following steps:

BASE YEAR ESTIMATION

1. Natural Resource Accounts 2000 – Water Accounts – updated with figures derived from the Strategic Overview of the Water Sector in South Africa reports for 2013, 2015, and 2017 published by DWS – have been used to determine total water usage for the major water-use sectors, i.e.:
    a. Agriculture (irrigation, dryland, livestock and forestry)
    b. Power Stations
    c. Mining (gold and other mining)
    d. Manufacturing (food processing and other manufacturing activities)
    e. Trade and Services (construction, transport, government and other trade and services)
    f. Domestic (urban and rural consumption)
2. Using a key distribution system for each major sector (i.e. manufacturing), water usage is divided among the various commodities for the base year. The three keys used are:
    a. **Commodity Production** (Rand million) – with the underlying principle being that the more that is produced, the greater will water use be – values for this key are obtained from Conningarth's latest I-O Table, which is based on StatsSA's most recent Supply and Use Tables
    b. **Water Purchases per Commodity** (Rand million) – input is derived from the most recent StatsSA Supply and Use Tables to estimate water purchases per commodity
    c. **Water-Use Coefficients per Commodity** (million cubic meters per million Rand of production) – these coefficients are multiplied with the commodity production figures (see a). This exercise is similar to the exercise described in (b), but approaches the issue from a slightly different angle. These coefficients are obtained from previous work undertaken by Conningarth
3. A weighted average of the output obtained from applying the three keys described above is used to obtain water use per commodity figures for the base year.

FORECASTING WATER DEMAND PER COMMODITY

Future water demand per commodity consists of 2 elements:

1. Historic water usage volumes are analysed using regression techniques to determine trends in water usage, specifically changes in propensity to consume. The change in the real price of water is negatively correlated to water usage (i.e. the higher the real price, the lower is usage). These propensity coefficients are then applied to the forecasted future trends in water usage to determine unique coefficients per year based on changing propensities of consumption of water, and
2. These unique multipliers/coefficients are applied to the production values of commodities to obtain water usage per commodity

FORECASTING WATER DEMAND PER MUNICIPAL AREA

Finally, these unique multipliers/coefficients are applied to commodity production values within each municipality to obtain water usage per commodity per local municipality

2.2.4 Testing Municipal Water Demand Base Year Estimates with Actual Water Usage Figures

The only water-use component of the WD LTFM that can be compared with actual water usage is the water that is bought by a municipality and sold to its customers, which include registered manufacturing and commercial businesses and urban households that are located within municipal boundaries – it is important to recognise that local municipalities do not generally supply/sell water to agricultural, forestry, mining, electricity generation and bulk industrial concerns. Rather, the large-scale users of water acquire water directly from 'wholesale' suppliers such as water boards, etc.

This study has identified two sources that publish actual local municipality water usage figures:

- The DW&S Benchmarking of Water Loss, Water-Use Efficiency and Non-Revenue Water in South Africa Municipalities (2004/05 to 2015/16) report (PEP: WP11084(WP11047-PEP4); and
- The DW&S No Drop website (http://www.dwa.gov.za/dir_ws/ndrp/Default.aspx).

After having examined the data available from these two sources, it was decided that the DW&S Benchmarking of Water Loss, Water-use Efficiency and Non-Revenue Water in South Africa Municipalities (2004/05 to 2015/16) report (hereafter, referred to as the DW&S Benchmarking Report) would be used as the source for actual local municipality water usage figures in this study. The reason for this is that this report compiles a detailed water balance for each local municipality that includes the following key statistics that are relevant to this study:

- **System Input Volume (SIV)** figures that represent 'the potable volume input to the water supply system from the water utility's own sources, as measured at the water treatment works outlet, allowing for all known errors (i.e. errors on bulk water meters); as well as any water imported from other sources, also corrected for known bulk metering errors'
- **Authorised Consumption** figures that reflect 'the volume of metered and/or unmetered water-used by registered customers, the water utility and others who are implicitly or explicitly authorised to do so by the water utility, for residential, commercial, and industrial purposes'
- **Water Loss** figures that incorporate
  - **Commercial or Apparent Losses** that are 'made up from the and authorised consumption (theft or illegal use), plus all technical and administrative inaccuracies associated with customer metering', and

- **Real Losses**, which are 'the physical water losses from the pressurised system, up to the point of measurement of customer use'
- **Nonrevenue Water (NRW)**, which is 'the volume of water supplied by the water utility but for which it receives no income'

Two case study areas were used to compare water demand forecasts produced by the WD LTFM with water usage figures presented in the DW&S Benchmarking Report, namely:

- The **Umgeni Water Board**, which is situated within the Mvoti to Umzimkulu Water Management Area (WMA) in the KZN province, and
- The **Inkomati-Usuthu Catchment Management Agency**, which is situated within the Inkomati-Usuthu WMA in the Mpumalanga province

In undertaking the benchmarking exercise for the local municipalities included in these two case study areas, forecasted water demand figures for 2016 for the manufacturing and commercial activities, and households for these municipalities produced by the WD LTFM have been compared with the Authorised Consumption figures for these same municipalities derived from the DW&S Benchmarking Report. An appendix to this report includes detailed information regarding SIV, Authorised Consumption, Water Losses, and NRW derived from the DW&S Benchmarking Report for all local municipalities in South Africa. This section presents the results of this comparison exercise[1].

It is important to note that comparisons of water supply and water demand can only be sensibly made at a Water Catchment Area (WCA) level, where water demand by the manufacturing and commercial sectors and urban households that are located within the boundaries of the local municipality; as well as the water requirements of all other sectors within the boundaries of the WCA (i.e. agriculture, forestry, mining, electricity generation, and rural households) can be taken into account.

The comparison exercise undertaken in this Deliverable 4 element of the overall study indicates that there are significant differences between the water demand forecasts calculated in the CLTFM, and the actual water usage provided in the DW&S Benchmarking Report. Given the fact that the 2016 local municipality water usage figures provided in the DW&S Benchmarking Report are considered to be sufficiently reliable enough to be used as base year figures from which long-term water demand growth rates can be determined, the consultants recommend that the SIV and Authorised Consumption water usage figures provided in the DW&S Benchmarking Report for 2016 be used as the base year water demand figures for the manufacturing and commercial activities and households situated within the boundaries of the local municipalities modelled in the CLTFM.

2.3 Forecasting Municipal Water Sales

It is important to note that there is a major difference between total water usage in a specific municipal area and the water supplied by the municipality to its registered users. In many municipalities, more than one supplier is responsible for supplying water within the municipal area, i.e. the municipality itself, that supplies water to registered domestic and non-domestic users; as well as Water Boards that supply water to power generation facilities, mines, and large industrial concerns such as iron and steel

[1] Readers wishing to obtain a more detailed understanding of the methodology used are referred to the report produced during the fourth phase of this project, i.e. Deliverable 4: Water Balance and Expanded MFM Testing. This Deliverable 4 report addresses two aspects of the overall study, namely: a comparison of Conningarth's water demand forecasts with actual water usage data for all of the local municipalities in South Africa; and a demonstration of how Conningarth's water demand forecasts can be used to produce 30-year projections of water balances for 2 case study WMAs out of the 19 WMAs in South Africa.

producers; and, in the case of water for irrigation agriculture, water is extracted directly from rivers, dams, and boreholes. This water supplied by boards and extracted from rivers, dams and boreholes does not flow through the municipal water reticulation system.

This section describes how water supplied by Municipalities to registered users is determined and forecasted. Three aspects are of importance:

- Calculation of municipal water usage for the base year
- Determining water usage for Domestic and Non-Domestic water users located within a municipal area, and
- Forecasting future municipal water usage by Domestic and Non-Domestic users

2.3.1 Calculating Base Year Water Usage per Municipality

As indicated above, the SIV and Authorised Consumption water usage figures provided in the DW&S Benchmarking Report for 2016 are used to determine the base year water usage figures for each municipality[2]. The key objectives of the study that underpins this report were as follows:

- Report on SIV, NRW, water loss and efficiency trends, based on 2004/05 to 2015/16 municipal financial year data
- Calculate a 2015/16 water balance for each municipality where no better information exists, and
- Disseminate NRW/water loss benchmarking information in municipalities, government organisations, and consumers throughout South Africa to create awareness

WRP Pty Ltd, who are responsible for compiling the DW&S Benchmarking Report, make use of a modified International Water Association (IWA) water balance that includes free basic water as the standard reporting format for NRW and water losses in South Africa. The datasets provided in this report were sourced through the DWS regional offices and very few municipalities were contacted directly. The submission of data was especially poor in the Eastern Cape, Free State, North West, Limpopo, and Mpumalanga. Most municipalities in Gauteng, KwaZulu-Natal, and the Western Cape, and about 50% to 70% in the Northern Cape are submitting data on a regular basis.

A two-page water balance sheet is produced for each local municipality. In considering this water balance sheet, cognizance should be taken of the following:

- All information contained in these water balance sheets is provided to WRP by the respective municipalities or Water Services Authority on an annual basis
- The municipality is required to provide only 15 values per annum to complete the sheet. These values are split between basic information such as the population served, and the water balance information
- All volumes are in kl/annum (where kl = m^3 = 1 000 litres) and are based on the municipal financial year (July to June)
- The municipalities listed are in accordance with the boundary reform at the time of the municipal election of 3 August, 2016

In calculating water balances for each municipality, the DW&S Benchmarking Report makes provision for municipalities to provide a breakdown of the billed metered water they supply into Domestic and Non-Domestic categories. However, very few municipalities supply this level of detailed input. As such,

[2] Benchmarking of Water Loss, Water Use Efficiency and Non-Revenue Water in South African Municipalities (2004/05 to 2015/16). PEP: WP11084(WP11047 – PEP4. Prepared by: Business Intelligence Support Team; Department: Water and Sanitation. July 2017.

Conningarth has developed a customised methodology for breaking down the municipality Authorised Consumption figures derived from the DW&S Benchmarking Report into Residential Users and Manufacturing and Commercial Users.

In instances where the DW&S Benchmarking Report does reflect Domestic and Non-domestic figures for specific municipalities, the figures reflected in this report were calculated by the customised methodology described above. In most instances, there was a remarkable correspondence between the figures supplied by the few municipalities and the figures calculated by Conningarth. As such, it was decided that, where actual municipality-level data is available, the figures reflected in the DW&S Benchmarking Report would be used, whilst the Conningarth estimates would be used for all other municipalities. In these instances, the estimated figures were adjusted to bring them more in line with averages for similar municipalities.

2.3.2 Projecting Domestic and Non-Domestic Water Sales per Municipality

In the case of residential household water users, the base year Domestic Water Use figure for each municipality derived from the DW&S Benchmarking Report is multiplied by a household water consumption growth index calculated by Conningarth to calculate residential water use in volume terms for each year of the 30-year forecast period from 2018 to 2048.

In the case of Non-Domestic water use, the base year non-domestic water Use figure for each municipality derived from the DW&S Benchmarking Report is multiplied by an indexed growth rate calculated by Conningarth for each of the manufacturing and services commodities that make up the non-domestic water users that are located within municipal boundaries.

The following section provides instructions on how to use the WD LTFM in support of decision making processes regarding the allocation of water to different sectors; and in investing in new water supply infrastructure.

3 INSTRUCTION MANUAL FOR THE WATER DEMAND FORECASTING MODEL

3.1 Introduction

Conningarth has compiled the Water Demand Long-Term Forecasting Model (WD LTFM) to assist potential users that are responsible for the provision of water supply infrastructure and the development of water management strategies with their work. The WD LTFM provides 31-year forecasts of the demand for water at a Local and District Municipality and Metropolitan Council level. These entities are aggregated to provide Provincial and National water demand forecasts.

The WD LTFM has been compiled using Microsoft Excel. The WD LTFM workbook (entitled 'Water Quantities.xlsx') includes 33 worksheets. The first worksheet, entitled 'Data Extraction', ***is the only worksheet that users of this model will work with***. The remaining 32 worksheets contain water demand forecast data for the base year (worksheet '0') and the 31 years of the forecast period (worksheets '1' to '31').

3.2 Water Demand Data Extraction

The WD LTFM enables users of this forecast model to extract water demand data for the following criteria:

1. **Geographical Area:**
   - Province, and
   - District and Local Municipality
2. **Economic Sector:**
   - Agriculture
   - Mining
   - Manufacturing, and
   - Services
3. **Commodity (114 commodities)**
4. **A Final Demand Component:**
   - Households, and
   - Total Economy
5. **Local Municipalities**

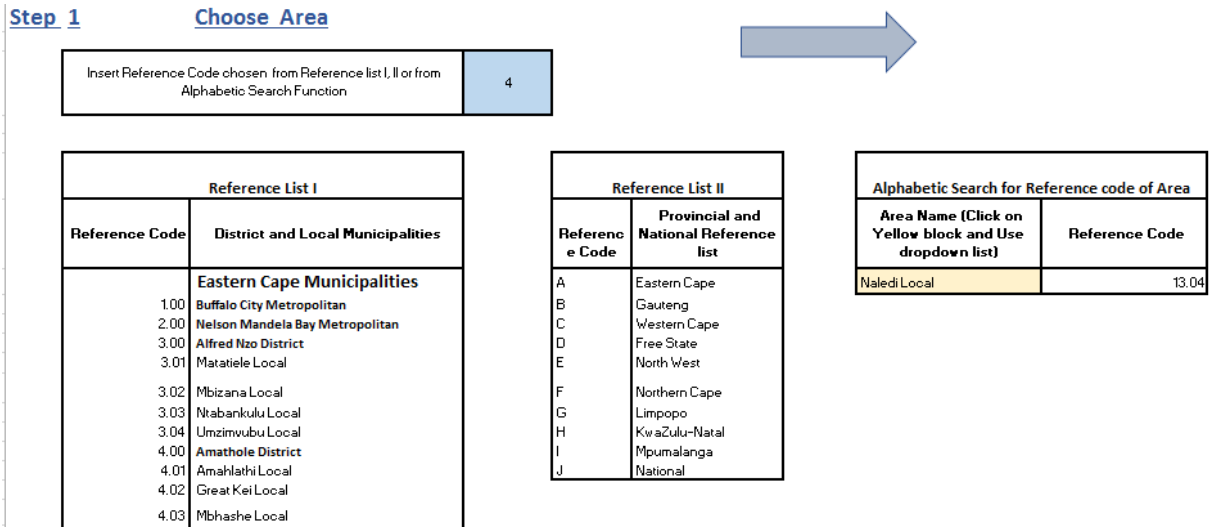
The results of extracting data for any of the criteria listed above are presented in the following formats:

- **Water Demand Forecasts**, expressed in million cubic metres, for the base year and each of the 30 years of the forecast period for the Likely, Low, and High forecast scenarios
- **Water Demand Growth Rates**, expressed in percentages
- **Water Demand Growth Indices**, with the base year = to 100, and
- **A Water Demand Graphic** reflecting a line-graph based on million cubic metres of water demand for each year of the forecast period

The sections below describe the procedure for inserting reference codes for each of the extraction criteria described above into the Data Extraction worksheet in the WD LTFM Water Quantities excel workbook.

3.3 Step 1: Selecting Geographic Areas

The first step in the data extraction process involves inserting a Reference Code for the Province, District Municipality, or Local Municipality of interest to the model user. The graphic below reflects an image of this element that can be found in the top left-hand corner of the Data Extraction worksheet. Note that this graphic reflects the fact that the numeric code for the Amathole District Municipality (4.00) has been inserted into the blue-coloured data capture cell.



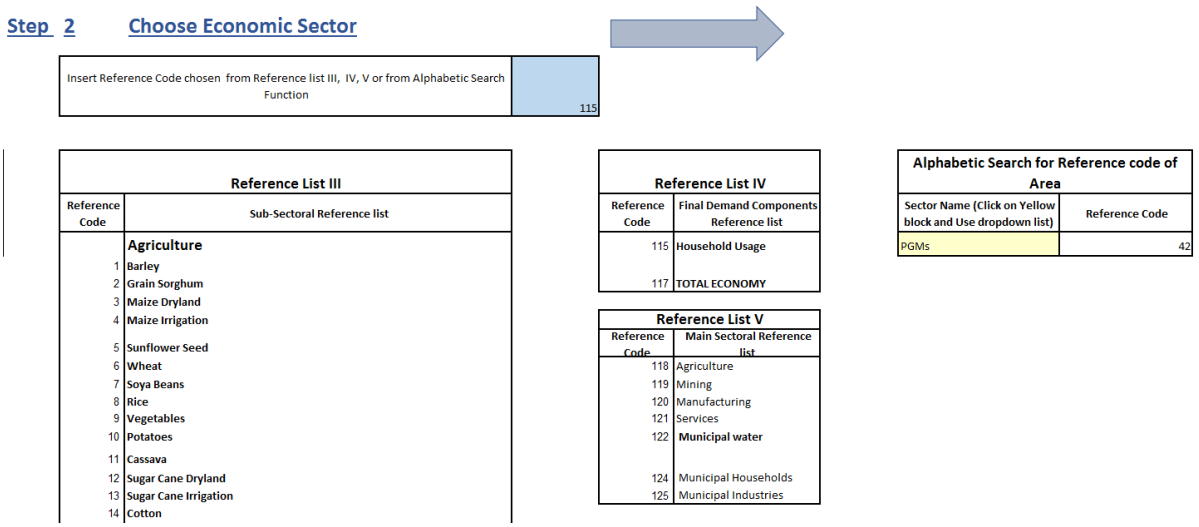
The above graphic reflects the following elements:

- The '**Insert Reference Code chosen from Reference List I, II, or from Alphabetic Search Function**' box with its associated blue-coloured worksheet cell into which the reference code for the geographic area of interest is manually inserted
- **Reference List I**, which contains numeric reference codes for each of the 52 District Municipalities and 226 Local Municipalities included in the WD LTFM
- **Reference List II**, which contains alphabetic reference codes for each of the 9 Provinces and National included in the WD LTFM , and
- The **Alphabetic Search for Reference Code of Area** element that allows the user to insert the alphabetic name of the District or Local Municipality for which they want water demand data. This procedure then automatically generates the numeric reference code for the local, district, or Metropolitan area sought

The only action that the user needs to perform is to manually insert the appropriate reference code for the geographic area for which they are wanting water demand data into the blue-coloured cell. The WD LTFM is programmed to automatically select water demand data for the geographic area associated with the reference code inserted into the blue-coloured cell. An appendix to this instruction manual contains a complete list of the reference codes associated with the geographic areas included in the WD LTFM.

3.4 Step 2: Choosing Economic Sector

The second step in the data extraction process is to select the economic sector or specific commodity for which the user wants water demand data. The graphic below reflects an image of this element that can be found in the Data Extraction worksheet. Note that this graphic reflects the fact that the numeric code for the Final Demand Household Component (115) has been inserted into the blue-coloured data capture cell.



Step 2 **Choose Economic Sector**

Insert Reference Code chosen from Reference list III, IV, V or from Alphabetic Search Function	115

Reference List III

Reference Code	Sub-Sectoral Reference list
	Agriculture
1	Barley
2	Grain Sorghum
3	Maize Dryland
4	Maize Irrigation
5	Sunflower Seed
6	Wheat
7	Soya Beans
8	Rice
9	Vegetables
10	Potatoes
11	Cassava
12	Sugar Cane Dryland
13	Sugar Cane Irrigation
14	Cotton

Reference List IV

Reference Code	Final Demand Components Reference list
115	Household Usage
117	TOTAL ECONOMY

Reference List V

Reference Code	Main Sectoral Reference list
118	Agriculture
119	Mining
120	Manufacturing
121	Services
122	Municipal water
124	Municipal Households
125	Municipal Industries

Alphabetic Search for Reference code of Area

Sector Name (Click on Yellow block and Use dropdown list)	Reference Code
PGMs	42

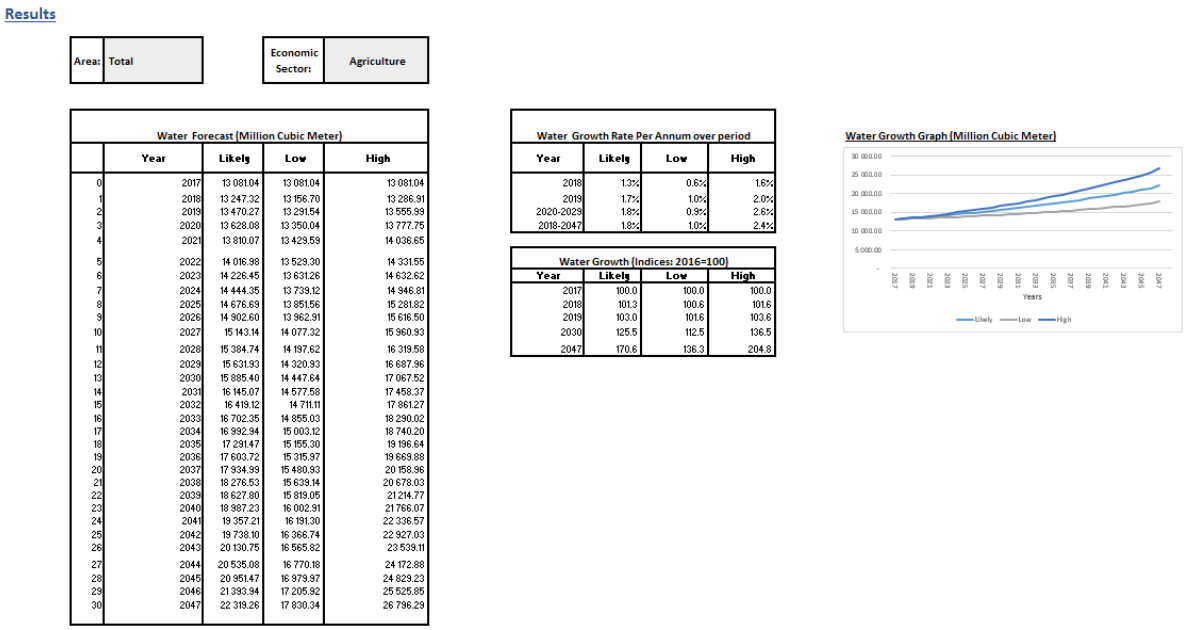
The graphic above illustrates the following elements:

- The '**Insert Reference Code Chosen from Reference List III, IV, V, or from Alphabetic Search Function**' box with its associated blue-coloured worksheet cell into which the reference code for the economic sector or commodity of interest is manually inserted
- **Reference List III**, which contains numeric reference codes for each of the 114 commodities included in the WD LTFM
- **Reference List IV**, which contains numeric reference codes for the two Final Demand Components included in the WD LTFM
- **Reference List V**, which contains numeric reference codes for the four Main Economic Sectors included in the WD LTFM, and
- The **Alphabetic Search for Reference Code of Area** element that allows the user to insert the alphabetic name of the final demand component, economic sector, or commodity for which they want water demand data. This procedure then automatically generates the numeric reference code for the economic sector or commodity sought

The only action that the user needs to perform is to manually insert the appropriate reference code for the economic sector or commodity for which they are wanting water demand data into the blue-coloured cell. The WD LTFM is programmed to automatically select water demand data for the economic sector or commodity associated with the reference code inserted into the blue-coloured cell. An appendix to this instruction manual contains a complete list of the reference codes associated with the commodities included in the WD LTFM.

3.5 Results

The WT LTFM is programmed to automatically produce results that reflect the water demand for the geographic area selected in Step 1, and the economic sector/final demand component/commodity chosen in Step 2. As such, users are **not required to take any further actions in order to generate results**. The graphic below illustrates the results of inserting the reference code for the Amathole District Municipality (4.00) and the Final Demand Household Component (115).



Results

Area:	Total

Economic Sector:	Agriculture

Water Forecast (Million Cubic Meter)

	Year	Likely	Low	High
0	2017	13 081.04	13 081.04	13 081.04
1	2018	13 247.32	13 156.70	13 286.91
2	2019	13 470.27	13 291.54	13 555.99
3	2020	13 628.08	13 350.04	13 777.75
4	2021	13 810.07	13 429.59	14 036.65
5	2022	14 016.98	13 529.30	14 331.55
6	2023	14 226.45	13 631.26	14 632.62
7	2024	14 444.35	13 739.12	14 946.81
8	2025	14 676.69	13 851.56	15 281.82
9	2026	14 902.60	13 962.91	15 616.50
10	2027	15 143.14	14 077.32	15 960.93
11	2028	15 384.74	14 197.62	16 319.58
12	2029	15 631.93	14 320.93	16 687.96
13	2030	15 885.40	14 447.64	17 067.52
14	2031	16 145.07	14 577.58	17 458.37
15	2032	16 419.12	14 711.11	17 861.27
16	2033	16 702.35	14 855.03	18 290.02
17	2034	16 992.94	15 003.12	18 740.20
18	2035	17 291.47	15 155.30	19 196.64
19	2036	17 603.72	15 315.97	19 669.88
20	2037	17 934.99	15 480.93	20 158.96
21	2038	18 276.53	15 639.14	20 678.03
22	2039	18 627.80	15 819.05	21 214.77
23	2040	18 987.23	16 002.91	21 766.07
24	2041	19 357.21	16 191.30	22 336.57
25	2042	19 738.10	16 366.74	22 927.03
26	2043	20 130.75	16 565.82	23 539.11
27	2044	20 535.08	16 770.18	24 172.88
28	2045	20 951.47	16 979.97	24 829.23
29	2046	21 393.94	17 205.92	25 525.85
30	2047	22 319.26	17 830.34	26 796.29

Water Growth Rate Per Annum over period

Year	Likely	Low	High
2018	1.3%	0.6%	1.6%
2019	1.7%	1.0%	2.0%
2020-2029	1.8%	0.9%	2.6%
2018-2047	1.8%	1.0%	2.4%

Water Growth (Indices: 2016=100)

Year	Likely	Low	High
2017	100.0	100.0	100.0
2018	101.3	100.6	101.6
2019	103.0	101.6	103.6
2030	125.5	112.5	136.5
2047	170.6	136.3	204.8

Water Growth Graph (Million Cubic Meter)

The graphic above illustrates the following elements:

- **Water Forecast (million cubic metres)**, which reflects the results for total water demand in the Agriculture sector for the Likely, Low, and High water demand scenarios for the base year (2017) and the 30 years of the forecast period (2018 to 2047)
- **Water Growth Rate Per Annum over Period**, which reflects annual growth rates in water demand in the Agriculture sector for the 2018 and 2019 years for the Likely, Low, and High water demand scenarios; as well as the compound annual growth rates for these same scenarios for the 2020-2029 and 2018-2047 periods
- **Water Growth (Indices: 2016 = 100)**, which reflect the indexed growths for water demand in the Agriculture sector for the Likely, Low, and High water demand scenarios for the 2017, 2018, 2019, 2030, and 2047 years, and
- A **Water Growth Graph (million cubic metres)**, which reflects line graphs for the Likely, Low, and High Agricultural water demand scenarios

These are the standard results produced by the WD LTFM. It is important to note that the water demand figures reflected in the Water Forecast (million cubic metres) element of the WD LTFM can be 'copied' and 'pasted' into a separate excel workbook for further analysis. An appendix contains a case study that illustrates how the WD LTFM can be applied in answering a specific question, in this case: Which geographic regions and economic sectors account for the greatest demand for water?

4 APPENDIX 1: CASE STUDY EXAMPLE OF APPLYING THE WATER DEMAND LONG-TERM FORECASTING MODEL

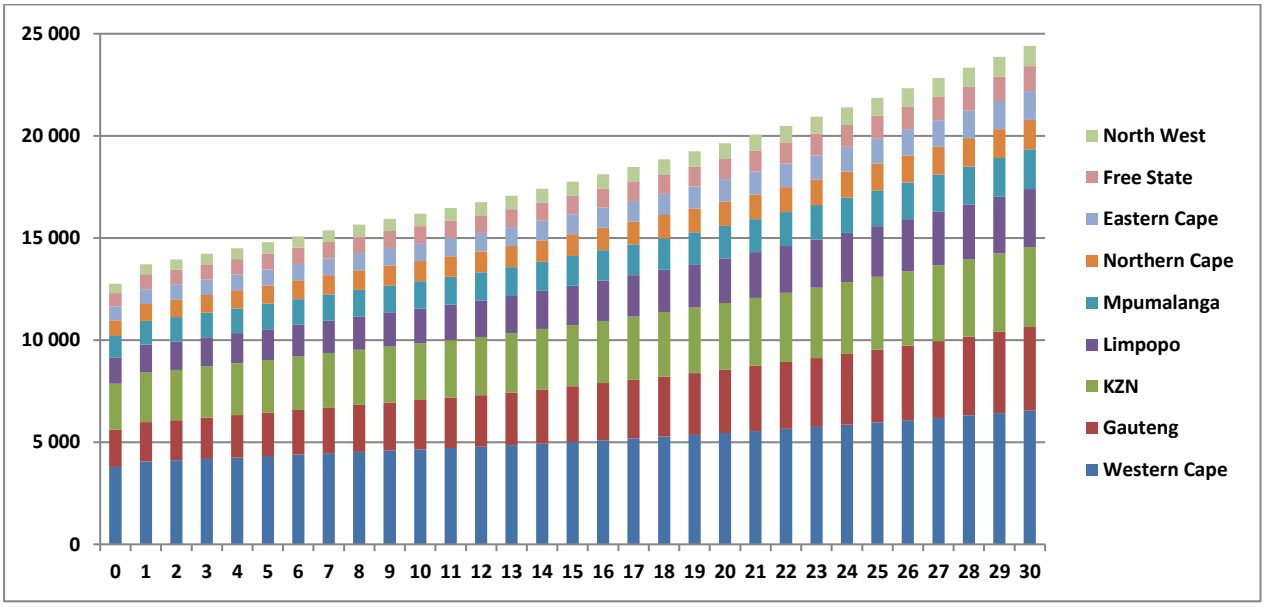
This case study illustrates the use of the Water Demand Long-Term Forecasting Model (WD LTFM) in answering the question:

Which geographic regions and economic sectors account for the greatest demand for water?

In order to answer this question, it is initially necessary to analyse water demand by geographic region, starting with the 9 provinces. The alphabetic reference codes for the nine provinces were inserted into **Choose Area** blue-coloured cell in the WD LTFM as described in Step 1 above. In addition, the numeric reference code for the Total Economy (117) was inserted into the **Choose Economic Sector** blue-coloured cell as described in Step 2 above.

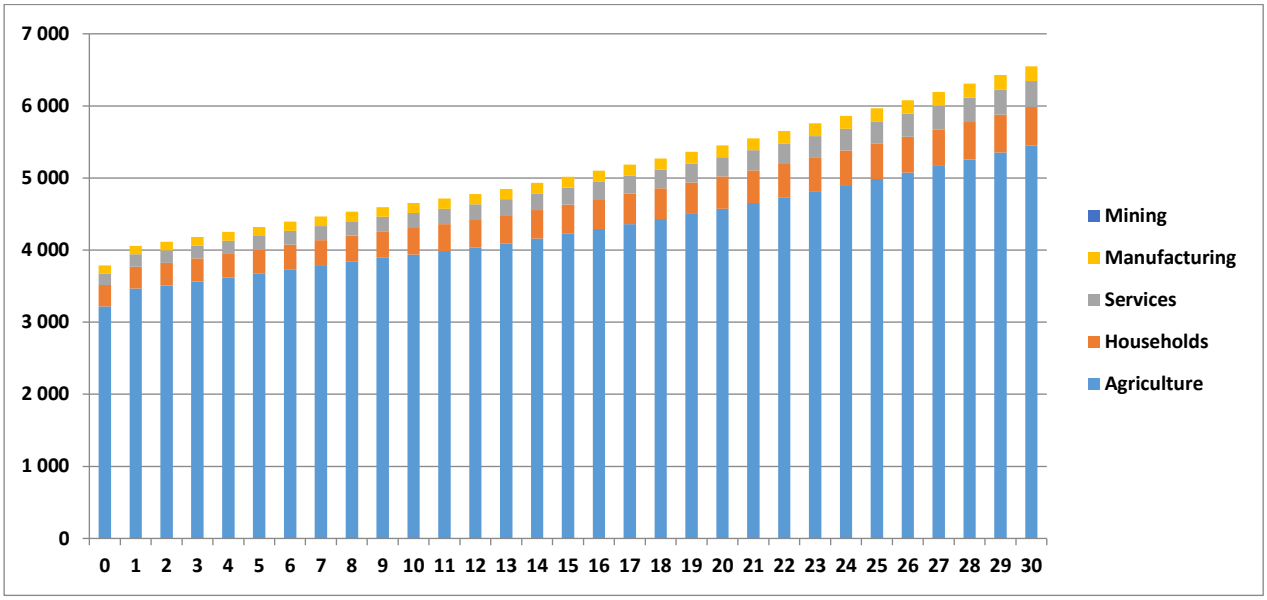
The resulting water demand figures for the Likely Scenario were copied from the **Water Forecast (million cubic metres)** element in the **Results** section of the WD LTFM and pasted into a separate Excel workbook (users should note that, when pasting water demand result figures from the WD LTFM into a new Excel workbook, either the 'Paste Options 123' icon or the 'Paste Special, Paste, Values' based instruction should be used in order not to link the new workbook to the WD LTFM).

The water demand figures copied out of the WD LTFM were then charted to produce the graphics reflected below. The first graphic indicates that the greatest demand for water occurs in the Western Cape Province, which accounts for 29.7% of national water demand at the beginning of the forecast period, declining slightly to 26.8% at the end of the period.

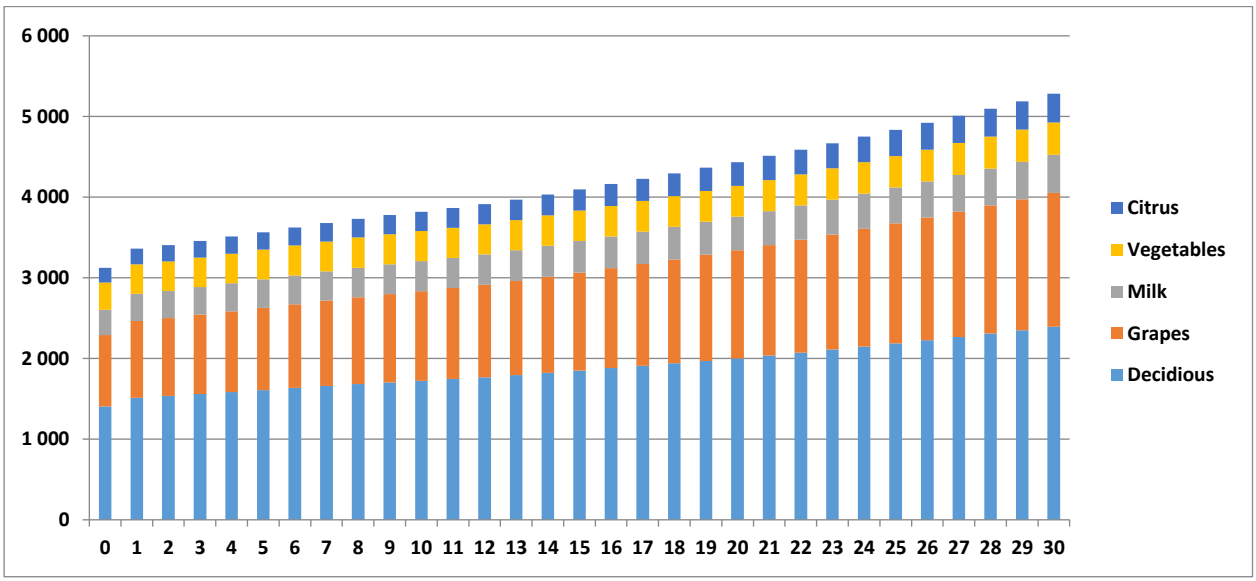


Given that demand for water is greatest in the Western Cape, this case study focuses on further analysing water demand in this province. This process starts with analysing water demand in the Western Cape Province by economic sector, including the Households final demand component. This involves inserting the numeric code for the Western Cape Province (C) as described in Step 1 above, and the numeric codes for the major economic activities and Households as described in Step 2 above. The results of this exercise were then copied into the separate Excel workbook and the graphic below was chartered from these figures.

The graphic below indicates that water demand is greatest in the Agriculture sector, which accounts for approximately 85% of water demand throughout the forecast period.

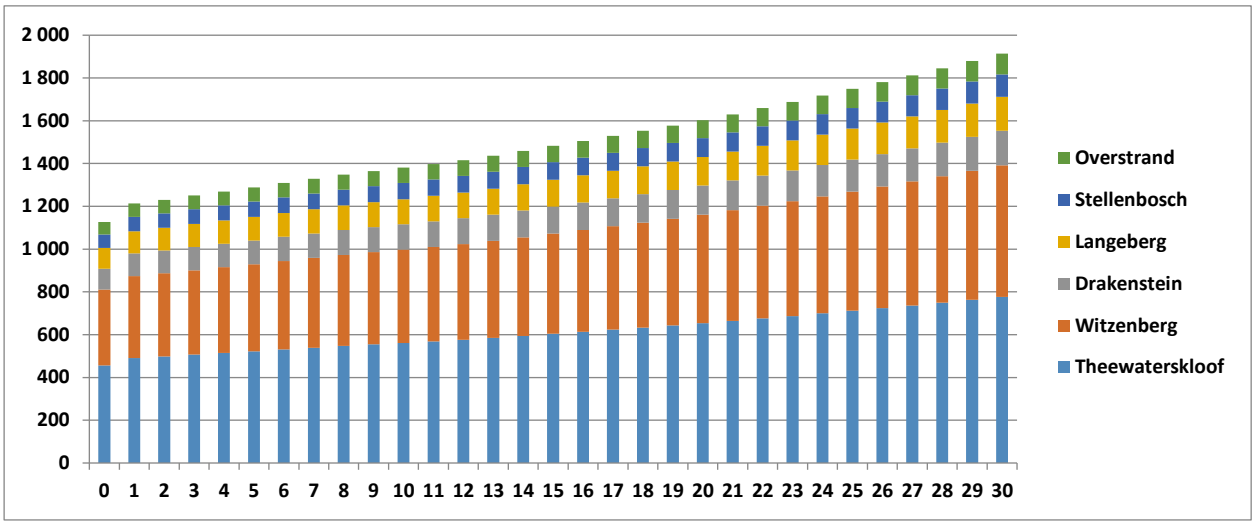


The next step involves determining which agricultural commodities consume the greatest volumes of water. This involves inserting the numeric codes for the agricultural commodities into the Choose Economic Sector Blue Coloured cell. The graphic below reflects water demand for the 5 agricultural commodities that account for more than 95% of water demand in the agricultural sector in the Western Cape Province throughout the forecast period. Of these 5 commodities, Deciduous Fruit and Grapes are the commodities that have the greatest demand for water.

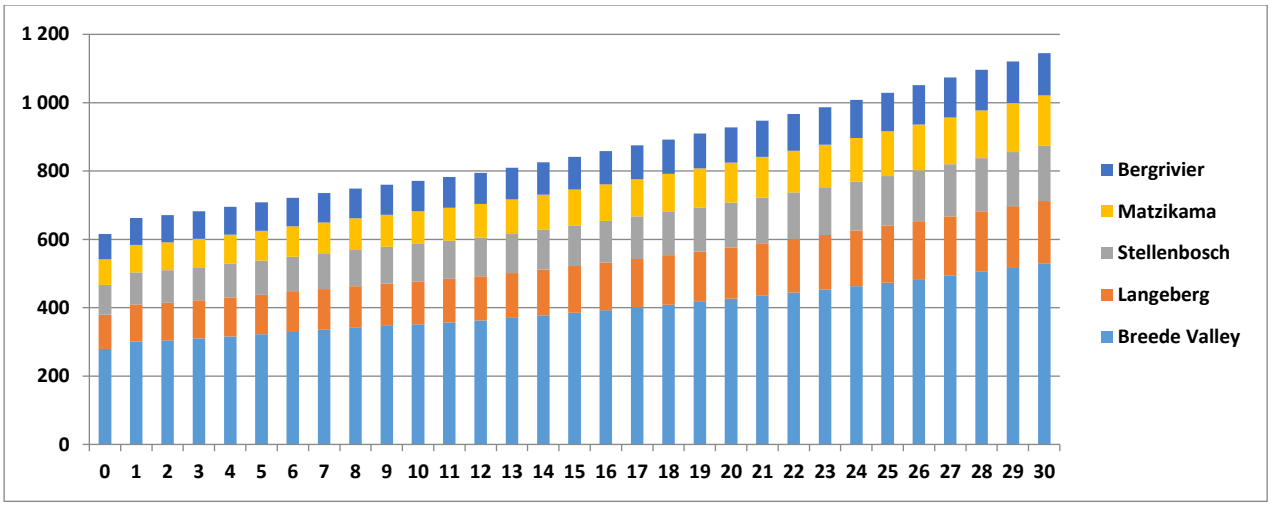


The final step in this analysis of water demand in the agricultural sector within the Western Cape Province involves determining the local municipalities where Deciduous Fruit and Grapes are grown that will need to supply the bulk of the water that will be required to grow these crops. This involves inserting the numeric codes for Deciduous Fruit and Grapes into the Choose Economic Sector blue-coloured cell as described in Step 2 above and the numeric codes for the top six Local Municipalities where these fruits are grown into the Choose Area blue-coloured cell as described in Step 1 above.

The graphic below reflects this information for Deciduous Fruit. This graphic indicates that the Theewaterskloof and Witzenberg local municipalities will be required to supply just over 70% of the water required to grow deciduous fruit in the Western Cape Province throughout the forecast period.



The graphic below reflects a similar exercise for Grapes. In the case of this commodity, the greatest demand for water occurs in the Breede Valley local municipality. It is interesting to note that Deciduous Fruit and Grapes are both grown in the Stellenbosch and Langeberg local municipalities, whereas the other local municipalities are only required to supply one of these 2 crops with water.



This water demand case study illustrates how the WD LTFM can assist various institutions at a national, provincial, and local government level in establishing where they need to focus their attention to ensure that adequate water supply infrastructure is available to ensure that long-term water demand requirements are met.

5 APPENDIX 2: GEOGRAPHIC AREA REFERENCE CODES

5.1 Provincial and National Reference Codes

Reference Code	Province
A	Eastern Cape
B	Gauteng
C	Western Cape
D	Free State
E	North West
F	Northern Cape
G	Limpopo
H	KwaZulu-Natal
I	Mpumalanga
J	National

5.2 District and Local Municipality Reference Codes

Reference Code	Province, District and Local Municipalities
EASTERN CAPE MUNICIPALITIES	
1.00	**Buffalo City Metropolitan**
2.00	**Nelson Mandela Bay Metropolitan**
3.00	**Alfred Nzo District**
3.01	Matatiele Local
3.02	Mbizana Local
3.03	Ntabankulu Local
3.04	Umzimvubu Local
4.00	**Amathole District**
4.01	Amahlathi Local
4.02	Great Kei Local
4.03	Mbhashe Local
4.04	Mnquma Local
4.05	Ngqushwa Local
4.06	Nkonkobe Local (Raymond Mhlaba)
5.00	**Chris Hani District**
5.01	Emalahleni Local
5.02	Engcobo Local
5.03	Inkwanca Local
5.04	Intsika Yethu Local
5.05	Inxuba Yethemba Local
5.07	Sakhisizwe Local
6.00	**Joe Gqabi District**
6.01	Elundini Local
6.02	Gariep Local
6.03	Maletswai Local (Walter Sisulu)
6.04	Senqu Local
7.00	**OR Tambo District**
7.01	Ingquza Hill Local
7.02	King Sabata Dalindyebo Local
7.03	Mhlontlo Local
7.04	Nyandeni Local
7.05	Port St Johns Local
8.00	**Sarah Baartman District**
8.01	Dr Beyers Naude (Baviaans Local)
8.02	Blue Crane Route Local

8.05	Kou-Kamma Local
8.06	Kouga Local
8.07	Makana Local
8.08	Ndlambe Local
8.09	Sundays River Valley Local
FREE STATE MUNICIPALITIES	
9.00	**Mangaung Metropolitan**
10.00	**Fezile Dabi District**
10.01	Mafube Local
10.02	Metsimaholo Local
10.03	Moqhaka Local
10.04	Ngwathe Local
11.00	**Lejweleputswa District**
11.01	Masilonyana Local
11.02	Matjhabeng Local
11.03	Nala Local
11.04	Tokologo Local
11.05	Tswelopele Local
12.00	**Thabo Mofutsanyana District**
12.01	Dihlabeng Local
12.02	Maluti-A-Phofung Local
12.03	Mantsopa Local
12.04	Nketoana Local
12.05	Phumelela Local
12.06	Setsoto Local
13.00	**Xhariep District**
13.01	Kopanong Local
13.02	Letsemeng Local
13.03	Mohokare Local
13.04	Naledi Local
GAUTENG MUNICIPALITIES	
14.00	**City of Johannesburg Metropolitan**
15.00	**City of Tshwane Metropolitan**
16.00	**Ekurhuleni Metropolitan**
17.00	**Sedibeng District**
17.01	Emfuleni Local
17.02	Lesedi Local
17.03	Midvaal Local
18.00	**West Rand District**
18.01	Merafong City Local
18.02	Mogale City Local
18.03	Randfontein Local
14.00	**City of Johannesburg Metropolitan**
KWAZULU-NATAL MUNICIPALITIES	
19.00	**eThekwini Metropolitan**
20.00	**Amajuba District**
20.01	Dannhauser Local
20.02	eMadlangeni Local
20.03	Newcastle Local
21.00	**Harry Gwala District**
21.01	Greater Kokstad Local
21.02	Ingwe Local
21.04	Ubuhlebezwe Local
21.05	uMzimkhulu Local
22.00	**iLembe District**
22.01	KwaDukuza Local
22.02	Mandeni Local
22.03	Maphumulo Local
22.04	Ndwedwe Local
23.00	**Ugu District**
23.01	Ezinqoleni Local

23.03	Umdoni Local
23.04	Umuziwabantu Local
23.05	Umzumbe Local
24.00	**uMgungundlovu District**
24.01	Impendle Local
24.02	Mkhambathini Local
24.03	Mpofana Local
24.04	Msunduzi Local
24.05	Richmond Local
24.06	uMngeni Local
24.07	uMshwathi Local
25.00	**uMkhanyakude District**
25.02	Jozini Local
25.03	Mtubatuba Local
25.04	The Big 5 False Bay Local
25.05	uMhlabuyalingana Local
26.00	**uMzinyathi District**
26.01	Endumeni Local
26.02	Msinga Local
26.03	Nquthu Local
26.04	Umvoti Local
27.00	**uThukela District**
27.01	Alfred Duma
27.03	Indaka Local
27.04	Okhahlamba Local
28.00	**uThungulu District**
28.01	City of uMhlathuze Local
28.04	Nkandla Local
28.05	Ntambanana Local
28.06	uMlalazi Local
29.00	**Zululand District**
29.01	AbaQulusi Local
29.02	eDumbe Local
29.03	Nongoma Local
29.04	Ulundi Local
29.05	uPhongolo Local

LIMPOPO MUNICIPALITIES	
30.00	**Capricorn District**
30.01	Aganang Local
30.02	Blouberg Local
30.03	Lepelle-Nkumpi Local
30.04	Molemole Local
30.05	Polokwane Local
31.00	**Mopani District**
31.01	Ba-Phalaborwa Local
31.02	Greater Giyani Local
31.03	Greater Letaba Local
31.04	Greater Tzaneen Local
31.05	Maruleng Local
32.00	**Sekhukhune District**
32.01	Elias Motsoaledi Local
32.02	Ephraim Mogale Local
32.03	Fetakgomo Local
32.04	Greater Tubatse Local
32.05	Makhuduthamaga Local

33.00	**Vhembe District**
33.01	Makhado Local
33.02	Musina Local
33.03	Mutale Local
33.04	Thulamela Local
34.00	**Waterberg District**
34.01	Bela-Bela Local
34.02	Lephalale Local
34.03	Modimolle Local
34.04	Mogalakwena Local
34.06	Thabazimbi Local
MPUMALANGA MUNICIPALITIES	
35.00	**Ehlanzeni District**
35.01	Bushbuckridge Local
35.02	Mbombela Local
35.03	Nkomazi Local
35.04	Thaba Chweu Local
36.00	**Gert Sibande District**
36.01	Chief Albert Luthuli Local
36.02	Dipaleseng Local
36.03	Dr Pixley Ka Isaka Seme Local
36.04	Govan Mbeki Local
36.05	Lekwa Local
36.06	Mkhondo Local
36.07	Msukaligwa Local
37.00	**Nkangala District**
37.01	Dr JS Moroka Local
37.02	Emakhazeni Local
37.03	Emalahleni Local
37.04	Steve Tshwete Local
37.05	Thembisile Hani Local
37.06	Victor Khanye Local

NORTHERN CAPE MUNICIPALITIES	
38.00	**Frances Baard District**
38.01	Dikgatlong Local
38.02	Magareng Local
38.03	Phokwane Local
38.04	Sol Plaatje Local
39.00	**John Taolo Gaetsewe District**
39.01	Ga-Segonyana Local
39.02	Gamagara Local
39.03	Joe Morolong Local
40.00	**Namakwa District**
40.01	Hantam Local
40.02	Kamiesberg Local
40.03	Karoo Hoogland Local
40.04	Khai-Ma Local
40.05	Nama Khoi Local
40.06	Richtersveld Local
41.00	**Pixley Ka Seme District**
41.01	Emthanjeni Local
41.02	Kareeberg Local
41.03	Renosterberg Local
41.04	Siyancuma Local
41.05	Siyathemba Local
41.06	Thembelihle Local
41.07	Ubuntu Local

41.08	Umsobomvu Local
42.00	**ZF Mgcawu District**
42.01	!Kheis Local
42.02	//Khara Hais Local
42.03	Kai !Garib Local
42.04	Kgatelopele Local
42.05	Mier Local
42.06	Tsantsabane Local
NORTH WEST MUNICIPALITIES	
43.00	**Bojanala Platinum District**
43.01	Kgetlengrivier Local
43.02	Madibeng Local
43.03	Moretele Local
43.04	Moses Kotane Local
43.05	Rustenburg Local
44.00	**Dr Kenneth Kaunda District**
44.01	City of Matlosana Local
44.02	Maquassi Hills Local
44.03	Tlokwe City Council Local
45.00	**Dr Ruth Segomotsi Mompati District**
45.01	Greater Taung Local
45.02	Kagisano-Molopo Local
45.03	Lekwa-Teemane Local
45.04	Mamusa Local
45.05	Naledi Local
46.00	**Ngaka Modiri Molema District**
46.01	Ditsobotla Local
46.02	Mahikeng Local
46.03	Ramotshere Moiloa Local
46.04	Ratlou Local
46.05	Tswaing Local
WESTERN CAPE MUNICIPALITIES	
47.00	**City of Cape Town Metropolitan**
48.00	**Cape Winelands District**
48.01	Breede Valley Local
48.02	Drakenstein Local
48.03	Langeberg Local
48.04	Stellenbosch Local
48.05	Witzenberg Local
49.00	**Central Karoo District**
49.01	Beaufort West Local
49.02	Laingsburg Local
49.03	Prince Albert Local
50.00	**Eden District**
50.01	Bitou Local
50.02	George Local
50.03	Hessequa Local
50.04	Kannaland Local
50.05	Knysna Local
50.06	Mossel Bay Local
50.07	Oudtshoorn Local
51.00	**Overberg District**
51.01	Cape Agulhas Local
51.02	Overstrand Local
51.03	Swellendam Local
51.04	Theewaterskloof Local
52.00	**West Coast District**
52.01	Bergrivier Local
52.02	Cederberg Local
52.03	Matzikama Local
52.04	Saldanha Bay Local
52.05	Swartland Local

6 APPENDIX 3: COMMODITY REFERENCE CODES

Reference Code	Sub-Sectoral Reference list
AGRICULTURE	
1	Barley
2	Grain Sorghum
3	Maize Dryland
4	Maize Irrigation
5	Sunflower Seed
6	Wheat
7	Soya Beans
8	Rice
9	Vegetables
10	Potatoes
11	Cassava
12	Sugar Cane Dryland
13	Sugar Cane Irrigation
14	Cotton
15	Grapes
16	Subtropical fruit
17	Citrus
18	Deciduous fruits (excl. table grapes)
19	Milk (bulk)
20	Wool and Mohair
21	Eggs
22	Livestock (Red Meat)
23	Poultry (White Meat excl. Eggs)
24	Other agriculture
25	Forestry
26	Fishing (incl. seafood)
MINING	
27	Coal Mining Exports
28	Coal Mining Domestic
29	Coal Mining Powerstation
30	Coal Mining Sasol
31	Coal Mining Fly Ash
32	Crude oil
33	Natural gas (Moss Gas)
34	Iron Ore Exports
35	Iron Ore Domestic
36	Precious metal ore
37	Other precious metals and minerals (incl. diamonds)
38	Gold
39	Magnetite
40	Chrome
41	Copper
42	PGMs
43	Manganese Exports
44	Manganese Domestic
45	Titanium slag
46	Rutile
47	Ilmenite (Titanium ore)
48	Zinc
49	Other Non-Ferrous Metal Mining
50	Alumina
51	Gypsum
52	Zircon
53	Stone
54	Granite
55	Limestone
56	Rock Phosphate
57	Sulphur
58	Fluorspar
59	Salt
60	Other non-metallic minerals
61	Precious and semi-precious stones (excl. diamonds)
62	Other mining

MANUFACTURING	
63	Processed food
64	Soya bean products
65	Slaughtered animal meat (incl. broilers)
66	Animal feed
67	Beverages (incl. malt)
68	Tobacco products
69	Textile products (incl. Leather)
70	Wood timber and products
71	Wood chips
72	Paper
73	Pulp of wood and paper
74	Recycled paper
75	Printing
76	Petrol
77	Diesel
78	LNG and methane rich gas (Piped Gas Transnet)
79	Jet fuel
80	Other petroleum products
81	Chemicals
82	Fertilizer
83	Other chemicals
84	Pharmaceutical products
85	Rubber products (incl. Plastics)
86	Non-metallic mineral products
87	Bricks
88	Cement
89	Iron & steel
90	Ferrochrome
91	Ferromanganese
92	Scrap metals (incl. Recycling)
93	Non-ferrous metal products
94	Metal products (excl. machinery)
95	Electrical machinery
96	Machinery and equipment
97	Motor vehicles
98	Motor vehicle parts & accessories
99	Transport Equipment
100	Furniture
101	Other manufacturing industries
SERVICES	
102	Electricity Generation
103	Electricity Distribution
104	Water Generation
105	Water Distribution
106	Building construction
107	Civil engineering and other construction
108	Wholesale and retail trade
109	Catering and accommodation services
110	Transport and storage
111	Communication
112	Finance and insurance
113	Business services
114	Community, social and personal services (incl. Government)

7 APPENDIX 4: SELECTED IWA WATER BALANCE INFORMATION

The table below reflects selected IWA water balance information regarding System Input Volume, Authorised Consumption, Non-Revenue Water, and Water Losses that has been derived from the DW&S Benchmarking of Water Loss, Water-use Efficiency and Non-Revenue Water in South Africa Municipalities (2004/05 to 2015/16) report. The water loss percentage figure reflected in this table has been calculated as the percentage that water losses represent of SIV.

Table 7.1: Selected IWA Water Balance Information for local municipalities in South Africa. Million kilolitres, 2016

Local Municipality	SIV	Authorised Consumption	Non-Revenue Water	Water Losses (SIV-Auth Cons)	Water Loss % (Losses/SIV)
EASTERN CAPE MUNICIPALITIES					
Buffalo City Metropolitan	66 792 119	42 269 532	31 061 907	24 522 587	36.7%
Nelson Mandela Bay Metropolitan	115 476 923	64 336 821	53 337 617	51 140 102	44.3%
Alfred Nzo District					
Matatiele Local	7 398 078	2 960 474	4 437 604	4 437 604	60.0%
Mbizana Local	4 090 117	2 773 672	1 316 445	1 316 445	32.2%
Ntabankulu Local	2 011 738	1 405 843	605 895	605 895	30.1%
Umzimvubu Local	4 464 384	2 634 559	1 829 825	1 829 825	41.0%
Amathole District					
Amahlathi Local	4 202 605	1 831 253	2 371 352	2 371 352	56.4%
Great Kei Local	1 647 483	683 677	783 805	963 806	58.5%
Mbhashe Local	5 763 209	3 436 506	2 326 703	2 326 703	40.4%
Mnquma Local	6 240 431	3 841 930	2 398 501	2 398 501	38.4%
Ngqushwa Local	2 365 454	1 268 962	1 096 492	1 096 492	46.4%
Raymond Mhlaba	7 409 556	3 286 956	4 122 600	4 122 600	55.6%
Chris Hani District					
Emalahleni Local	3 562 651	1 855 105	1 671 546	1 707 546	47.9%
Engcobo Local	2 885 829	2 163 162	722 667	722 667	25.0%
Enoch Mgijimi Local	13 969 403	6 142 821	7 826 581	7 826 582	56.0%
Intsika Yethu Local	3 460 774	2 373 298	1 087 476	1 087 476	31.4%
Inxuba Yethemba Local	3 621 769	1 762 221	1 859 548	1 859 548	51.3%
Sakhisizwe Local	2 265 452	1 106 973	1 158 480	1 158 479	51.1%
Joe Gqabi District					
Elundini Local	3 585 316	2 253 646	1 331 570	1 331 670	37.1%
Gariep Local	1 942 682	905 995	1 036 688	1 036 687	53.4%
Maletswai Local	4 023 244	2 068 599	1 954 645	1 954 645	48.6%
Senqu Local	4 099 651	2 194 343	1 905 308	1 905 308	46.5%
OR Tambo District					
Ingquza Hill Local	4 182 280	3 205 527	976 753	976 753	23.4%
King Sabata Dalindyebo Local	20 356 399	5 465 308	14 891 091	14 891 091	73.2%
Mhlontlo Local	4 119 662	2 450 598	1 669 064	1 669 064	40.5%
Nyandeni Local	4 830 077	3 621 524	1 208 553	1 208 553	25.0%
Port St Johns Local	2 407 943	1 893 379	514 564	514 564	21.4%
Sarah Baartman District					
Dr Beyers Naude	5 379 351	3 277 169	2 407 941	2 102 182	39.1%
Blue Crane Route Local	1 895 314	836 099	836 099	1 059 215	55.9%
Kou-Kamma Local	1 683 477	907 773	775 704	775 704	46.1%
Kouga Local	6 836 408	3 255 917	3 580 491	3 580 491	52.4%
Makana Local	4 365 752	2 078 262	2 287 490	2 287 490	52.4%
Ndlambe Local	3 882 673	1 591 061	2 291 612	2 291 612	59.0%
Sundays River Valley Local	3 091 953	1 313 835	1 778 118	1 778 118	57.5%

Local Municipality	SIV	Authorised Consumption	Non-Revenue Water	Water Losses (SIV-Auth Cons)	Water Loss % (Losses/SIV)
FREE STATE MUNICIPALITIES					
Mangaung Metropolitan	72 306 705	52 698 581	29 606 739	19 608 124	27.1%
Fezile Dabi District					
Mafube Local	2 782 816	1 176 159	1 606 657	1 606 657	57.7%
Metsimaholo Local	14 642 297	6 005 947	8 636 351	8 636 350	59.0%
Moqhaka Local	10 639 112	4 665 805	5 973 307	5 973 307	56.1%
Ngwathe Local	8 041 323	2 796 768	5 244 556	5 244 555	65.2%
Lejweleputswa District					
Masilonyana Local	3 332 912	1 339 062	1 993 850	1 993 850	59.8%
Matjhabeng Local	36 627 059	18 835 239	17 791 821	17 791 820	48.6%
Nala Local	3 529 626	1 542 755	1 986 872	1 986 871	56.3%
Tokologo Local	1 459 416	617 312	842 114	842 104	57.7%
Tswelopele Local	2 018 624	873 847	1 144 777	1 144 777	56.7%
Thabo Mofutsanyana District					
Dihlabeng Local	9 158 469	4 168 771	4 989 698	4 989 698	54.5%
Maluti-A-Phofung Local	20 460 368	7 104 828	13 355 540	13 355 540	65.3%
Mantsopa Local	2 525 974	1 071 283	1 454 692	1 454 691	57.6%
Nketoana Local	2 937 736	1 274 456	1 663 280	1 663 280	56.6%
Phumelela Local	2 131 173	921 443	1 209 730	1 209 730	56.8%
Setsoto Local	7 368 690	2 621 563	4 747 127	4 747 127	64.4%
Xhariep District					
Kopanong Local	2 735 293	1 091 078	1 644 215	1 644 215	60.1%
Letsemeng Local	2 081 252	828 879	1 252 373	1 252 373	60.2%
Mohokare Local	1 842 834	775 392	1 067 442	1 067 442	57.9%
Naledi Local	1 214 122	516 688	697 434	697 434	57.4%
GAUTENG MUNICIPALITIES					
City of Johannesburg Metropolitan	578 391 853	429 772 861	221 839 414	148 618 992	25.7%
City of Tshwane Metropolitan	351 883 407	263 854 887	91 687 735	88 028 520	25.0%
Ekurhuleni Metropolitan	363 964 110	252 605 565	125 859 904	111 358 545	30.6%
Sedibeng District					
Emfuleni Local	98 140 532	64 085 453	58 988 859	34 055 079	34.7%
Lesedi Local	6 808 711	5 429 982	1 808 053	1 378 729	20.2%
Midvaal Local	13 842 674	10 019 383	4 238 612	3 823 291	27.6%
West Rand District					
Merafong City Local	13 476 658	7 747 714	5 728 944	5 728 944	42.5%
Mogale City Local	30 915 430	24 623 093	13 719 247	6 292 337	20.4%
Randfontein Local	15 677 325	10 895 333	4 968 772	4 781 992	30.5%
Westonaria Local					
KWAZULU-NATAL MUNICIPALITIES					
eThekwini Metropolitan	325 289 460	206 856 500	132 146 790	118 432 960	36.4%
Amajuba District					
Dannhauser Local	1 941 205	1 151 143	790 062	790 062	40.7%
eMadlangeni Local	2 940 445	1 997 724	2 325 121	942 721	32.1%
Newcastle Local	32 666 876	18 776 068	15 842 498	13 890 808	42.5%
Harry Gwala District					
Greater Kokstad Local	4 746 191	2 224 650	2 521 541	2 521 541	53.1%
Dr Nkosazana Dlamini Zuma Local	2 775 271	1 497 170	1 278 102	1 278 101	46.1%
Ubuhlebezwe Local	2 345 204	1 306 964	1 038 240	1 038 240	44.3%
uMzimkhulu Local	4 519 155	2 529 144	1 990 011	1 990 011	44.0%
iLembe District					
KwaDukuza Local	6 065 185	1 395 537	4 972 179	4 669 648	77.0%
Mandeni Local	7 134 921	4 964 111	2 550 278	2 170 810	30.4%
Maphumulo Local	1 899 242	1 551 864	716 296	347 378	18.3%
Ndwedwe Local	2 374 886	1 780 608	1 023 261	594 278	25.0%
Ugu District					
Ray Nkonyeni Local	25 453 515	11 366 987	14 086 528	14 086 528	55.3%
Umuziwabantu Local	4 519 082	1 421 548	3 097 534	3 097 534	68.5%
Umzumbe Local	3 627 936	1 938 100	1 689 836	1 689 836	46.6%
uMgungundlovu District					
Impendle Local	1 138 695	480 471	658 224	658 224	57.8%
Mkhambathini Local	2 979 603	1 487 762	1 491 840	1 491 841	50.1%
Mpofana Local	1 973 514	833 751	11 397 963	1 139 763	57.8%

Msunduzi Local	71 398 543	45 842 363	33 833 690	25 556 180	35.8%
Local Municipality	**SIV**	**Authorised Consumption**	**Non-Revenue Water**	**Water Losses (SIV-Auth Cons)**	**Water Loss % (Losses/SIV)**
Richmond Local	2 953 516	1 081 253	1 512 263	1 872 263	63.4%
uMngeni Local	7 370 100	4 030 307	3 339 793	3 339 793	45.3%
uMshwathi Local	3 686 481	1 508 359	2 178 122	2 178 122	59.1%
uMkhanyakude District					
Hlabisa Local					
Jozini Local	3 955 478	2 130 295	1 825 183	1 825 183	46.1%
Mtubatuba Local	5 975 388	2 226 383	3 749 005	3 749 005	62.7%
The Big 5 False Bay Local	2 194 065	1 092 506	1 101 559	1 101 559	50.2%
uMhlabuyalingana Local	3 353 106	2 067 970	1 285 137	1 285 136	38.3%
uMzinyathi District					
Endumeni Local	2 286 738	823 739	1 462 998	1 462 999	64.0%
Msinga Local	2 875 043	2 235 991	639 052	639 052	22.2%
Nquthu Local	3 040 897	1 746 633	1 294 264	1 294 264	42.6%
Umvoti Local	3 185 371	1 561 999	1 623 371	1 623 372	51.0%
uThukela District					
Alfred Duma Local	31 426 232	11 791 590	19 634 642	19 634 642	62.5%
Indaka Local	12 754 920	3 802 117	8 952 804	8 952 803	70.2%
Okhahlamba Local	7 534 648	1 571 341	5 963 306	5 963 307	79.1%
uThungulu District					
City of uMhlathuze Local	46 642 034	28 963 634	18 520 689	17 678 400	37.9%
Nkandla Local	1 874 289	1 142 846	731 443	731 443	39.0%
uMlalazi Local	3 956 947	2 401 735	1 555 212	1 555 212	39.3%
Zululand District					
AbaQulusi Local	11 589 879	5 067 402	6 522 477	6 522 477	56.3%
eDumbe Local	3 718 614	1 217 459	2 501 154	2 501 155	67.3%
Nongoma Local	5 655 172	1 732 998	3 922 174	3 922 174	69.4%
Ulundi Local	6 738 216	1 872 113	4 866 103	4 866 103	72.2%
uPhongolo Local	6 630 735	1 818 819	4 811 917	4 811 916	72.6%
LIMPOPO MUNICIPALITIES					
Capricorn District					
Aganang Local	4 550 020	1 983 134	2 566 886	2 566 886	56.4%
Blouberg Local	5 914 140	2 520 763	2 673 377	3 393 377	57.4%
Lepelle-Nkumpi Local	8 060 213	3 500 606	4 559 607	4 559 607	56.6%
Molemole Local	4 110 380	1 775 554	2 334 827	2 334 826	56.8%
Polokwane Local	42 527 444	20 396 202	22 131 242	22 131 242	52.0%
Mopani District					
Ba-Phalaborwa Local	27 750 657	11 509 848	16 240 809	16 240 809	58.5%
Greater Giyani Local	19 136 393	8 705 447	10 430 946	10 430 946	54.5%
Greater Letaba Local	15 080 273	6 673 967	8 406 306	8 406 306	55.7%
Greater Tzaneen Local	43 271 809	17 394 722	25 877 087	25 877 087	59.8%
Maruleng Local	4 601 971	1 980 863	2 621 108	2 621 108	57.0%
Sekhukhune District					
Elias Motsoaledi Local	7 725 678	3 498 883	4 226 795	4 226 795	54.7%
Ephraim Mogale Local	3 746 364	1 924 527	1 821 837	1 821 837	48.6%
Fetakgomo Local	11 050 254	4 725 581	6 324 673	6 324 673	57.2%
Greater Tubatse Local	2 630 262	1 239 273	1 390 989	1 390 989	52.9%
Makhuduthamaga Local	7 415 530	3 759 588	3 655 942	3 655 942	49.3%
Vhembe District					
Makhado Local	17 971 181	8 129 955	9 841 226	9 841 226	54.8%
Musina Local	4 751 127	1 866 004	2 885 123	2 885 123	60.7%
Mutale Local	2 994 628	1 467 855	1 526 773	1 526 773	51.0%
Thulamela Local	21 179 692	9 603 339	11 576 352	11 576 353	54.7%
Waterberg District					

Local Municipality	SIV	Authorised Consumption	Non-Revenue Water	Water Losses (SIV-Auth Cons)	Water Loss % (Losses/SIV)
Bela-Bela Local	3 948 162	2 359 652	1 588 510	1 588 510	40.2%
Lephalale Local	6 101 025	2 470 110	3 630 915	3 630 915	59.5%
Modimolle Local	4 253 614	1 885 882	2 367 732	2 367 732	55.7%
Mogalakwena Local	10 685 805	4 986 744	5 699 061	5 699 061	53.3%
Mookgophong Local					
Thabazimbi Local	5 129 545	3 100 000	2 029 545	2 029 545	39.6%
MPUMALANGA MUNICIPALITIES					
Ehlanzeni District					
Bushbuckridge Local	17 172 109	8 142 693	9 029 416	9 029 416	52.6%
Mbombela Local	52 684 434	22 608 848	30 635 933	30 075 586	57.1%
Nkomazi Local	12 981 792	5 813 325	7 168 468	7 168 467	55.2%
Thaba Chweu Local	5 895 516	2 862 873	3 032 643	3 032 643	51.4%
Gert Sibande District					
Chief Albert Luthuli Local	4 720 855	2 688 224	2 032 631	2 032 631	43.1%
Dipaleseng Local	2 185 091	910 052	1 275 039	1 275 039	58.4%
Dr Pixley Ka Isaka Seme Local	3 281 627	1 451 126	1 830 500	1 830 501	55.8%
Govan Mbeki Local	32 775 056	23 043 060	9 731 996	9 731 996	29.7%
Lekwa Local	7 304 469	2 648 163	4 656 305	4 656 306	63.7%
Mkhondo Local	8 488 516	3 233 921	5 254 596	5 254 595	61.9%
Msukaligwa Local	9 718 075	4 564 401	5 153 674	5 153 674	53.0%
Nkangala District					
Dr JS Moroka Local	23 098 275	23 187 674	9 593 023	-89 399	-0.4%
Emakhazeni Local	2 658 868	1 242 994	1 415 874	1 415 874	53.3%
Emalahleni Local	48 017 663	20 678 228	27 339 435	27 339 435	56.9%
Steve Tshwete Local	19 027 776	15 134 078	4 643 863	3 893 698	20.5%
Thembisile Hani Local	17 594 778	11 728 638	5 866 140	5 866 140	33.3%
Victor Khanye Local	3 385 814	2 192 860	1 192 954	1 192 954	35.2%
NORTHERN CAPE MUNICIPALITIES					
Frances Baard District					
Dikgatlong Local	1 901 030	1 075 943	825 086	825 087	43.4%
Magareng Local	1 022 331	550 068	472 263	472 263	46.2%
Phokwane Local	4 283 503	1 840 576	2 442 927	2 442 927	57.0%
Sol Plaatje Local	33 418 358	17 987 096	17 945 633	15 431 262	46.2%
John Taolo Gaetsewe District					
Ga-Segonyana Local	4 687 422	2 383 197	2 304 225	2 304 225	49.2%
Gamagara Local	3 872 628	1 976 106	1 896 522	1 896 522	49.0%
Joe Morolong Local	4 523 015	1 778 600	2 744 416	2 744 415	60.7%
Namakwa District					
Hantam Local	843 740	747 014	96 725	96 726	11.5%
Kamiesberg Local	421 490	225 356	196 133	196 134	46.5%
Karoo Hoogland Local	602 420	320 772	281 648	281 648	46.8%
Khai-Ma Local	801 524	493 810	307 715	307 714	38.4%
Nama Khoi Local	2 411 427	1 694 232	770 080	717 195	29.7%
Richtersveld Local	538 937	292 337	246 600	246 600	45.8%
Pixley Ka Seme District					
Emthanjeni Local	3 437 583	2 600 757	836 826	836 826	24.3%
Kareeberg Local	474 172	326 811	147 361	147 361	31.1%
Renosterberg Local	704 791	411 764	293 027	293 027	41.6%
Siyancuma Local	2 325 121	1 332 597	992 524	992 524	42.7%
Siyathemba Local	2 570 377	1 299 106	1 271 271	1 271 271	49.5%
Thembelihle Local	1 645 871	673 098	972 773	972 773	59.1%
Ubuntu Local	782 477	445 511	337 965	336 966	43.1%
Umsobomvu Local	2 375 009	1 019 045	1 355 964	1 355 964	57.1%
ZF Mgcawu District					
!Kheis Local	909 539	566 467	343 073	343 072	37.7%
//Khara Hais Local					
Kai !Garib Local	3 798 367	2 108 977	1 689 390	1 689 390	44.5%
Kgatelopele Local	925 846	508 535	417 311	417 311	45.1%

Local Municipality	SIV	Authorised Consumption	Non-Revenue Water	Water Losses (SIV-Auth Cons)	Water Loss % (Losses/SIV)
Mier Local	13 190 139	8 587 519	4 602 620	4 602 620	34.9%
Tsantsabane Local	1 737 186	945 245	791 941	791 941	45.6%
NORTH WEST MUNICIPALITIES					
Bojanala Platinum District					
Kgetlengrivier Local	3 430 098	1 250 223	2 179 875	2 179 875	63.6%
Madibeng Local	23 940 378	13 200 000	10 740 378	10 740 378	44.9%
Moretele Local	5 124 871	2 899 819	2 225 052	2 225 052	43.4%
Moses Kotane Local	11 148 266	7 080 767	4 067 500	4 067 499	36.5%
Rustenburg Local	52 471 859	27 855 037	24 616 822	24 616 822	46.9%
Dr Kenneth Kaunda District					
City of Matlosana Local	33 337 396	13 954 134	19 383 261	19 383 262	58.1%
Maquassi Hills Local	3 517 073	1 576 408	1 940 665	1 940 665	55.2%
Tlokwe City Council Local	15 047 839	6 134 584	8 913 255	8 913 255	59.2%
Dr Ruth Segomotsi Mompati District					
Greater Taung Local	5 245 017	2 926 183	2 318 834	2 318 834	44.2%
Kagisano-Molopo Local	3 394 765	1 722 331	1 672 434	1 672 434	49.3%
Lekwa-Teemane Local	2 452 596	1 079 825	1 372 770	1 372 771	56.0%
Mamusa Local	1 882 941	769 252	1 113 689	1 113 689	59.1%
Naledi Local	2 868 051	1 308 309	1 559 742	1 559 742	54.4%
Ngaka Modiri Molema District					
Ditsobotla Local	9 126 474	3 508 782	5 617 692	5 617 692	61.6%
Mahikeng Local	17 465 023	8 527 833	8 937 190	8 937 190	51.2%
Ramotshere Moiloa Local	8 255 864	3 263 285	4 992 578	4 992 579	60.5%
Ratlou Local	2 502 880	1 646 099	856 781	856 781	34.2%
Tswaing Local	5 285 436	2 216 057	3 069 380	3 069 379	58.1%
WESTERN CAPE MUNICIPALITIES					
City of Cape Town Metropolitan	329 003 716	278 188 342	73 031 874	50 815 374	15.4%
Cape Winelands District					
Breede Valley Local	15 297 201	12 750 366	2 577 429	2 546 835	16.6%
Drakenstein Local	18 614 555	16 252 203	2 399 581	2 362 352	12.7%
Langeberg Local	7 762 738	6 816 539	961 724	946 199	12.2%
Stellenbosch Local	13 484 831	10 883 687	2 975 500	2 601 144	19.3%
Witzenberg Local	6 824 382	5 857 831	1 344 944	966 551	14.2%
Central Karoo District					
Beaufort West Local	2 766 435	1 276 981	1 494 987	1 489 454	53.8%
Laingsburg Local	677 084	321 691	356 747	355 393	52.5%
Prince Albert Local	716 850	415 737	302 549	301 113	42.0%
Eden District					
Bitou Local	3 180 226	2 541 042	727 598	639 184	20.1%
George Local	12 390 930	9 323 144	3 092 568	3 067 786	24.8%
Hessequa Local	3 135 400	2 535 557	606 114	599 843	19.1%
Kannaland Local	2 012 602	1 393 631	622 996	618 971	30.8%
Knysna Local	5 565 849	4 558 768	1 018 213	1 007 081	18.1%
Mossel Bay Local	7 532 573	6 264 583	1 283 055	1 267 990	16.8%
Oudtshoorn Local	7 613 160	6 146 111	1 482 275	1 467 049	19.3%
Overberg District					
Cape Agulhas Local	2 391 392	1 973 758	422 417	417 634	17.5%
Overstrand Local	7 338 496	5 921 777	1 431 396	1 416 719	19.3%
Swellendam Local	1 886 129	1 243 057	646 844	643 072	34.1%
Theewaterskloof Local	4 879 228	3 573 221	1 399 390	1 306 007	26.8%
West Coast District					
Bergrivier Local	2 624 992	2 355 213	275 029	269 779	10.3%
Cederberg Local	2 879 870	2 194 527	691 103	685 343	23.8%
Matzikama Local	4 925 476	3 593 567	1 444 972	1 331 909	27.0%
Saldanha Bay Local	13 868 661	12 825 141	1 136 657	1 043 520	7.5%
Swartland Local	5 322 635	4 339 005	994 275	983 630	18.5%
NATIONAL TOTALS	**4 039 406 878**	**2 590 947 484**	**1 665 791 824**	**1 448 459 394**	**35.9%**