LANGEBERG MUNICIPALITY

WATER MASTER PLAN

March 2012

gls consulting

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LIST OF ABBREVIATIONS & ACRONYMS

AADD	-	Annual average daily demand
BWL	-	Bottom Water Level (in m a.s.l.)
CEs	-	Community Engineering Services consulting engineers
CoCT	-	City of Cape Town
d	-	Day
ECE	-	Element consulting engineers
EGL	-	Energy Grade Line (in m a.s.l.)
FCV	-	Flow Control Valve
GIS	-	Geographic Information System
GLS	-	GLS consulting engineers
h	-	Hour
ha	-	Hectare
IMQS	-	Infrastructure Management Query Station (software package)
kℓ	-	Kilolitre
kℓ/d	-	Kilolitre/day
km	-	Kilometre
KV3	-	Kwezi V3 consulting engineers
m	-	Metre
m a.s.l.	-	Metres above mean sea level
m/s	-	Metres per second
MIS	-	Management Information System
Mℓ	-	Megalitre
mm	-	Millimetre
NRW	-	Non-revenue water
P&G	-	Preliminary and general
PDF	-	Peak day factors
PHF	-	Peak hour factors
PRV	-	Pressure Reducing Valve
PS	-	Pumping Station
PSV	-	Pressure Sustaining Valve
PWF	-	Peak week factors
RES	-	Residential

s	-	Second
SG	-	Surveyor General
SWIFT	-	Sewer Water Interface For Treasury systems (software)
TWD	-	Total annual water demand
TWL	-	Top Water Level (in m a.s.l.)
UE	-	Unit erf
uPVC	-	Unplasticised polyvinylchloride
UWD	-	Unit Water Demand (e.g. ℓ/stand/d, or kℓ/ha/d)
VAT	-	Value Added Tax
WADISO	-	Water Distribution System Optimization program (software)
WTP	-	Water Treatment Plant (potable water)

1. INTRODUCTION

1.1 BRIEF

GLS consulting engineers (GLS) was appointed to update the master plan of the water distribution system for Langeberg Municipality. The project was funded by the Winelands District Municipality.

The project entails the establishment or updating of computer models for the water systems in Langeberg Municipality, the linking of these models to the stand and water meter databases of the treasury's financial system, evaluation and master planning of the networks, and the posting of all information to an engineering graphical information system (GIS).

This master plan report lists the analyses and findings of the study on the water distribution systems of all the towns within the Langeberg Municipality.

1.2 STUDY AREA

The location of Langeberg within the Western Cape is shown on Figure LBW1.1. The towns within the boundary of the Langeberg Municipality are:

- Ashton
- Bonnievale
- McGregor
- Montagu
- Robertson

Figures LBW1.2a - e show the suburbs with suburb names entered during this investigation for all records in the GIS database.

1.3 PREVIOUS MASTER PLANNING

Community Engineering Services (Pty) Ltd (CEs) conducted a water master plan for Langeberg Municipality for the town of Bonnievale in June 2004 and for the town of Robertson in January 2006, Element consulting engineers (ECE) conducted a water master plan for the town of Montagu in July 2005 and Kwezi V3 consulting engineers (KV3) for the town of McGregor in August 2006.

GLS conducted a water master plan for all the towns in the Langeberg Municipality in August 2009. No master planning had been conducted for the town of Ashton in Langeberg Municipality prior to the 2009 investigation (no report was available), but various Engineering Consultants have been performing evaluation and planning of portions of the distribution systems in Ashton and the other towns in the area over the years. The most notable in this respect include studies and designs performed by KV3 and ECE.

This study entails the updating of the August 2009 master plan performed by GLS.

1.4 DEFINITIONS

1.4.1 Water supply system

In this report the term *water supply system* is used to describe the reticulation system downstream of the clean water reservoir and upstream of individual consumer meters; it is also often termed the internal water reticulation system. Capital expenditure relating to this system is the responsibility of the Municipality.

In order to further distinguish between capital expenditure by the Municipality and by other role-players the following terms are defined:

- *Bulk water supply system* is used to describe the system upstream of the clean water reservoir, yet belonging to the Municipality, while the term,
- *External bulk water supply system* – is used to describe those parts of the water supply system that are owned by third parties.

1.4.2 Water management zones

Management zones are often termed bulk zones, distribution zones, or water pressure zones. Following the notation of the Water Demand Cookbook (McKenzie et al, Nov 2003) the following terms are used in this report. *A water management zone* can be either a district, a sub-district or a zone, where:

- a *district* is a unique area with individual bulk supply and boundaries usually fixed by topographical constraints. This would include various consumer categories (typically about 30 000 connections).
- a *sub-district* is a subdivision of a district and is identified by a reservoir, tower, pump, or PRV zone (typically 2000 to 10 000 connections). This would include various consumer categories.
- a *zone* is a subdivision of a district, identified by areas of similar characteristics (typically not larger than 2000 connections).

The set-up (identifying and installing, where necessary, zone valves) and maintenance of zones (training maintenance staff to understand why these zone valves should not be opened) is a particular challenge to many towns in South Africa.

1.4.3 Non-revenue water (NRW)

Generally speaking NRW is the difference between the volume of water purchased by a water service provider (or bulk supply to the town) and the volume of water sold to consumers (recorded by consumer meters and billed to consumers). However, the definition of NRW and the topic is much more involved – NRW is best described by a table and detailed report such as the one by McKenzie et al (2002), where a detailed table is provided to illustrate the different components of NRW.

In this report the term NRW is used to describe all water use that is not recorded in the treasury system of the Municipality and is considered to be "unaccounted-for", whether it is metered or not. Unless metered unbilled water use is specifically pointed out it is not included in the analysis in this investigation.

1.4.4 Stand

In this report *stand* is used to denote a piece of ground identified in the database of the Surveyor General (SG) as a unique property. A stand could have one or more (or no) metered connections to the water supply system. The words property, site, erf (or erven), and lot are also sometimes used elsewhere to describe a stand.

1.4.5 Treasury record

A *treasury record* is a consumer's account that is recorded in the treasury database of the Municipality. Each treasury record normally represents a water meter forming a consumer's connection to the water supply system. Some treasury records might not pertain to a water connection (or customer meter).

1.5 STRUCTURE AND SCOPE OF REPORT

This report addresses the distribution of potable water within the Langeberg Municipal area. Water quality aspects and the analysis of the bulk water (raw water) pipelines upstream of the WTP's and reservoirs are beyond the scope of this report.

Investigation of, and comments on the sufficiency of the existing water sources are beyond the scope of this study.

The contents of each chapter is arranged so that all of the text is grouped together, followed by the tables and then the figures if applicable to the chapter.

1.6 DISCLAIMER

The investigation has been performed and this report has been compiled based on the information made available to GLS. All efforts, within budget constraints, have been made during the gathering of information to ensure the highest degree of data integrity. The information supplied to GLS by the Langeberg Municipality and other consultants at the outset of this master planning process is assumed to be the most accurate representation of the existing system up to date hereof.

Subsequent to the completion of the data capturing, the layout plans including the relevant attributes, were handed back to the Municipality so that the information could be verified by the Client. GLS can therefore under no circumstances be held accountable by any party for any direct, indirect, special or consequential damages as a result of inaccurate information received pertaining to the components of the existing system.

The information in this report is intended for use by the Langeberg Municipality only.

2. EXISTING SYSTEM

2.1 WATER SOURCES

2.1.1 Ashton

Ashton receives its water from four sources, i.e. the Breede River irrigation canal, the Cogmanskloof Irrigation Board, two small streams in the Langeberg mountain catchment area and water abstracted from the Breede River. The water is purified at the Ashton Water Treatment Plant (WTP).

2.1.2 Bonnievale

Bonnievale receives its water from the Breede River. Water is extracted from the river at two points, viz. a pumping station directly from the river and via an irrigation canal which runs through the town. The main extraction point to the WTP is the canal. Extraction directly from the river is only done as a supplementary source and in emergency conditions.

2.1.3 McGregor

McGregor is supplied with water from the Houtsbaai River which is treated at the McGregor WTP.

2.1.4 Montagu

Montagu receives its water from four sources, i.e. Kruiskloof, Keurkloof, Rietvlei and the CBR pipeline scheme. This supply is also supplemented with water from aquifers in Badskloof situated in Montagu West. The water is purified at the Montagu WTP.

2.1.5 Robertson

Robertson receives its water from two sources. The first source is water from the Langeberg mountain catchment area north of Robertson. The second source is water extracted from the Breede river irrigation canal. The water is purified at the Robertson WTP.

Note: Investigation of, and comments on the sufficiency of the existing water sources are beyond the scope of this study.

2.2 BULK SUPPLY SYSTEM

The analysis of the bulk supply system, viz. the system upstream of the storage reservoirs or WTP’s is beyond the scope of this study.

2.3 RETICULATION SYSTEM LAYOUT AND OPERATION

2.3.1 General Description

The existing Langeberg water supply system is discussed in this section.

The water distribution system layouts are shown on Figures LW2.1, with a separate Figure for each area as follows:

- a – Ashton
- b – Bonnievale
- c – McGregor
- d – Montagu
- e - Robertson

This notation to distinguish between areas is used throughout this report for all tables and figures where appropriate.

The water distribution zones are shown in Figures LW2.2.

Table LBW2.1 provides a summary of the pipes, reservoirs, pumps and control valves in the existing system.

Table LBW2.2 provides a summary of the existing water demand (AADD) of each zone in the system.

2.3.2 Ashton

The system is operated in 4 zones. There are 3 sets of reservoirs and 1 PRV zone.

The Cogmanskloof zone is the largest of the zones and supplies 67% of the total water demand. Langeberg and Ashton Foods (Pty) Ltd (which is the largest water user in Ashton with two canning factories) is located in the Cogmanskloof zone and contributes to over 90% of the water demand in this zone during peak season (from October to March). The zone is supplied with water from the Cogmanskloof reservoir and the WTP to Langeberg pump station located at the Ashton WTP, which pumps directly to the Langeberg and Ashton Foods (Pty) Ltd factories and into the system. During peak season conditions water is also augmented from the Conradiedorp PRV zone to the Cogmanskloof zone through a non-return valve between the zones.

The Cogmanskloof reservoir is supplied with water through a dedicated rising main and pump station from the Ashton WTP as well as with water through the network from the WTP to Langeberg pump station. From the Cogmanskloof reservoir water is pumped to the Conradiedorp reservoir which supplies the Conradiedorp and Conradiedorp PRV zones.

The Zolani reservoir is supplied with water during peak season conditions through a dedicated rising main and booster pump station supplied with water from the Conradie PRV zone. The Zolani reservoir supplies the Zolani zone.

During off-peak season conditions the Zolani reservoir is supplied with water through the Cogmanskloof zone.

2.3.3 Bonnievale

The system is operated in 2 zones supplied from 2 sets of reservoirs.

From the WTP water is pumped to the Old reservoirs which supply the Old reservoir zone. Water is also pumped from the WTP through to the New reservoir which supplies the New reservoir zone.

The Old reservoir zone is the largest of the zones and supplies 69% of the total water demand.

2.3.4 McGregor

McGregor is operated in 1 zone supplied from 2 sets of reservoirs.

2.3.5 Montagu

The system is operated in 8 zones. There are 6 sets of reservoirs, 3 balancing tanks and 1 booster zone for a higher lying area.

From the Montagu WTP water is pumped through dedicated rising mains to the Montagu South, George Brink and Ashbury Upper reservoirs.

The Montagu South zone is supplied from the Montagu South reservoir, the George Brink zone from the George Brink reservoirs and the Ashbury Lower reservoir from the Ashbury Upper reservoir.

From the George Brink reservoirs water is supplied through a dedicated gravity main to the Mill Street pump station from where it is pumped through the Montagu West zone to the Montagu West balancing tank, which supplies the Montagu West zone.

The Kanonkop and Kanonkop booster zones are supplied from the Kanonkop balancing tank, which is supplied with water through a dedicated rising main and pump station from the George Brink reservoir.

The Ashbury Lower zone is supplied with water from the Ashbury Lower reservoir. The Badshoogte zone is supplied from the Badshoogte balancing tank, which is supplied with water through a dedicated rising main and pump station from the Ashbury Lower reservoir.

The Qui Sana zone is supplied with water from the Qui Sana reservoir, which is supplied with water from the Badshoogte zone through a rising main and booster pump station.

2.3.6 Robertson

The system is operated in 5 zones supplied from 4 sets of reservoirs. The Reservoir 1 zone is the largest of the zones and supplies 64% of the total water demand.

At the WTP water gravitates into Reservoir 1 from where water is pumped into the distribution zone. The Reservoir 1 PRV zone is supplied with water through the Reservoir 1 zone.

There is a further booster pump station within this Reservoir 1 zone, which boosts the supply to Reservoir 4 situated in the southern part of town at Nkqubela.

Water is also pumped from the pumping station at Reservoir 1 to a higher lying Reservoir 2 zone. From Reservoir 2 water is pumped up to a next higher lying Reservoir 3 zone.

2.4 EXISTING OPERATIONAL PROBLEMS

The operational staff indicated the following operational problems:

- Low residual water pressures in Ashton during peak season conditions.
- Regular pipe breaks in Happy Valley area in Bonnievale.
- Pipe breaks in Bonnievale Town if pressure is not relieved into the lower zone.
- Low residual water pressures in McGregor.
- Low residual water pressures in Montagu in the Kanonkop, Badshoogte and Ashbury Lower zones.
- There are approximately 12 pipe breaks per month in Robertson.

2.5 SPECIAL CONSIDERATIONS

2.5.1 General

Detailed drawings of the system are included in the plan book. The plan book should be used to indicate (by physical markings on the drawings) any additional information, or amendments, that would improve the quality of the final product.

2.5.2 Information to be clarified

Detail information regarding pump duty points, reservoir capacities and top water levels of reservoirs in Ashton (pump information), Bonnievale (pump information), McGregor (reservoir information), Montagu (pump and reservoir information) and Robertson (pump and reservoir information) should be clarified.

2.5.3 Data integrity

If this report is noted to have any discrepancies compared to alternative information, GLS should be contacted in this regard to ensure that the relevant sections of the system are verified in an attempt to continuously improve the data integrity.

3. PRESENT LAND USE AND WATER DEMAND

3.1 METHODOLOGY

The SWIFT program is a link between treasury billing data, and water/sewer network models. (The name is derived from "***S**ewer **W**ater **I**nterface **F**or **T**reasury systems*"). The program was used to analyse the present land use and water demand situation in Langeberg, as well as the projected potential water demand for a fully occupied existing system.

3.2 SWIFT ANALYSIS

A SWIFT analysis was conducted as part of this investigation. The Langeberg Municipality has an R-Data treasury system, with a single treasury system for all the towns in the Municipal area. A data extraction routine for SWIFT was compiled as part of this investigation and will remain a standard part of the R-Data software suite in future.

The treasury records for the period February 2010 to January 2011 were used as the base information for the analysis.

3.3 LAND USE

With cognizance of the limited land use and zoning codes maintained in the treasury system being operated by the Langeberg Municipality, the following land use categories were identified for this study:

- Residential stands
- Farms/Agricultural holdings
- Flats
- Cluster
- Business and commercial
- Educational
- Government/Institutional/Municipal
- Industrial
- Other/Unknown
- Parks

In order to account for the effect of stand size on residential water demand, the RES category is further subdivided into five sub-categories, based on stand size, as follows:

- RES 500 - smaller than 500 m^2
- RES 1 000 - 500 m^2 to 1 000 m^2
- RES 1 500 - 1 000 m^2 to 1 500 m^2
- RES 2 000 - 1 500 m^2 to 2 000 m^2
- RES > 2 000 - larger than 2 000 m^2

The LARGE category is required to remove these special water consumers from their regular land use category, so as to prevent them from skewing the statistics for the specific category and to detach them from any theoretical UWD's that might not be applicable to them. The large water users are discussed later in this Chapter.

3.4 DISTRIBUTION ZONES AND ZONAL METER READINGS

3.4.1 General Description

Distribution zones are defined in Section 1.4 of this report.

No zonal meter readings are available for Langeberg Municipality. Table LBW3.1 lists the total bulk water meter readings as obtained from the Municipality which represents the water supplied to the entire Langeberg Municipality.

3.5 INFORMAL SETTLEMENTS

The treasury data does not contain any information on informal settlements in the study area.

The following information on informal settlements with basic services, as required by DWA, was gathered by WorleyParsons in May 2011:

- 279 households in Bonnievale.
- 115 households in McGregor.
- 40 households in Ashbury in Montagu.
- 512 households in Nkqubela in Robertson.

These readings are not included in the treasury data and therefore the settlements contribute to the NRW figure.

3.6 SWIFT RESULTS AND RESULTING WATER DEMANDS

3.6.1 Suburb-by-suburb land use and water use statistics

All available treasury data in Langeberg was analysed with the SWIFT program, in order to determine (for each stand/meter record) the suburb, the land use, whether it is occupied or vacant, its AADD and TWD for the base year. This information was then totalised and summarised by SWIFT per suburb, and broken down into the various land use categories. Average unit water demands (ℓ/stand/d) were also determined for each land use category in each suburb. The results are summarised in Table LBW3.2.

Figure LBW3.1 shows all the stands coloured in accordance with their land use according to the SWIFT analysis.

3.6.2 Distribution zone land use and water use statistics

Each stand/record was linked or associated via GIS to its specific distribution zone(s) and the same totals and summaries as above were produced per distribution zone and were also broken down into the various land use categories. In this way the total water demand (TWD) per distribution zone was determined. The results are summarised in Table LBW3.2.

3.6.3 Non-revenue water

The total water inputs for each area were compared with the total water sales, which resulted in NRW figures of 29% in Ashton, 31% in Bonnievale, 21% in McGregor, 10% in Montagu and 24% in Robertson. The results are summarised in Table LBW3.3.

3.6.4 Rationalized ("theoretical") unit water demands

The UWD's per land use in each suburb were rationalised into rounded-up "theoretical" values. These values were calibrated by applying them to the total number of occupied stands in each land use category of each suburb, and comparing the resultant "theoretical" total water demand (excluding NRW) for each suburb with the actual water demand (excluding NRW) for the suburb. The results are summarised in Table LBW3.4.

3.6.5 Rationalized ("theoretical") NRW

For planning and evaluation purposes, the NRW figures were also rationalised on a regional (wider-area) basis, as allowed by the sensibility of the results. A NRW figure of 17% for Ashton, 32% for Bonnievale, 20% for McGregor, 6% for Montagu and 18% for Robertson were applied for modelling purposes of the existing system.

A NRW figure of 15% for Ashton, 20% for Bonnievale, 15% for McGregor, 10% for Montagu and 15% for Robertson were applied for modelling of the future systems in the Langeberg Municipality.

3.6.6 Theoretical present water demand

The rationalised UWD's and NRW's were applied to all the stands in each land use category of each suburb, as a "theoretical" model of the present water demand situation. For calibration, the resultant "theoretical" total water demand (inc. NRW) for each suburb was compared with the actual water demand (inc. NRW) for the suburb. The results for the formal areas are summarised in Table LBW3.4.

3.6.7 Potential land use and AADD of existing developments

The SWIFT program determines the total number of vacant stands in each land use category for each suburb and each distribution zone. These vacant stands do not contribute to the present water demand calculations (actual or theoretical) as described above. However, the SWIFT program also determines from treasury data what the land use or zoning rights of vacant stands might be. The rationalised theoretical UWD's and NRW's can therefore also be applied to these vacant stands in order to determine their potential water demand, should they become developed/occupied.

The theoretical present water demand model was therefore extended in SWIFT to include all vacant stands and a potential fully occupied present water demand (inc. NRW) for each suburb and distribution zone in Ashton was determined. The results are summarised per suburb in Table LBW4.2.

3.7 LARGE WATER USERS

Table LBW3.5 is a list of the stands defined as large users in SWIFT for Langeberg Municipality. The table shows the large water users (> 20 kℓ/d) sorted per demand. The tabulated information for each user (e.g. owner, consumer, address) is unchanged as recorded in the treasury system.

The water demand for each of the large users recorded in the treasury database is interrogated by SWIFT. The AADD calculated by SWIFT for each large user is used to calculate the peak flow for the relevant consumer. The location of each large user is identified uniquely in view of its demand in the water system model.

3.8 WATER DEMAND USED FOR SYSTEM MODELLING

The SWIFT results presented in Section 3.6 were further analysed before populating the water models. The Swift results, however, provide valuable insight into the monthly water use patterns of each individual consumer – information that could be used to accurately estimate the unit water demand for the (fully occupied) existing system water model.

The reasons for further analysing the SWIFT results to obtain input parameters for the water models (instead of using SWIFT directly) include:

- All treasury records are not linked to the cadastral data (GIS) and neither have the existing links been verified, implying that a portion of the water demand calculated by Swift would be lost if populating the water models directly with the SWIFT result. These records, and especially the large users, were then linked by hand according to their addresses obtained from the treasury data.

4. FUTURE LAND USE AND WATER DEMAND

4.1 FULL OCCUPATION OF EXISTING DEVELOPMENTS

For the future land use and water demand scenario the potential future developments for the area were taken into account.

These areas are information gathered from the Spatial Development Framework for Langeberg Municipality supplied by the Planning Directorate of Langeberg Municipality.

It was thus not only assumed that all existing but vacant stands in the treasury data would become "occupied", i.e. start using water (as for the existing system), but also that these potential future developments would materialise and start using water.

4.2 POTENTIAL FUTURE LAND DEVELOPMENTS AND WATER DEMAND

The potential areas for future developments were identified in consultation with the Municipality's town planning consultants. Each potential area was assigned an anticipated predominant land use, and will be phased in over a 20-year period.

The potential future land developments are shown on Figure LBW4.1, coloured according to the land use.

Typical UWD's (per ha or per stand/unit) were estimated for the potential future areas based on previous experience and statistics obtained from the SWIFT analysis of the present water demands.

4.3 FUTURE WATER DEMAND

The future AADD of the Langeberg system is summarised in Table LBW4.2. The future AADD (modelled as the future system) represents an increase of ± 80% over the actual present AADD, and an increase of ± 25% over the potential fully occupied present AADD.

5. EVALUATION AND PLANNING CRITERIA

5.1 WATER DEMANDS AND PEAK FACTORS

5.1.1 Planning

The major objectives pursued in the evaluation and planning of the water supply system as presented in this report can be summarised as follows:

- Establishing a model of the water network that accurately reflects the existing system.
- Detailed water demand analysis based on data in the treasury system.
- Conformity with operational requirements and criteria adopted for this study.
- Optimal use of existing facilities with excess capacity.
- Optimisation of the system with regards to capital -, maintenance - and operational cost.

The future system planning was done so as to satisfy the future water demands. The future AADD of the study area is anticipated to be 33 374 kℓ/d. This AADD will be realised in the year ± 2031 if the demand increases at a compound growth rate of ± 3,0 % per year.

5.1.2 Present and future AADD's

Existing systems were evaluated on the basis of the existing AADD as documented, including NRW.

For planning of future systems it was accepted that all existing vacant stands are occupied and are using water in accordance with the assumed UWD's, and AADD's of all potential future developments were added.

5.1.3 Peak factors

The peak factors used for this study are dependent on type of land use in the area under consideration, and the magnitude of water demand in the area, and are summarised in Table LBW5.1.

These peak factors are based on factors measured and obtained from other previous studies in South Africa.

5.2 OPERATIONAL CRITERIA

5.2.1 Maximum and minimum pressures

The pressure criteria used for the evaluation and planning of the reticulation networks are listed in Table LBW5.2.

5.2.2 Fire fighting flows

Fire fighting flow and pressure criteria are listed in Table LBW5.2. The requirements are more or less in conformity with those prescribed by the so-called "Red Book" (Guidelines for Human Settlement Planning and Design - Dept. of Housing, August 2003).

5.2.3 Flow velocities

Flow velocities must be limited in order to protect pipeline coatings and reduce the effects of water hammer. The preferred maximum allowed is 1,8 m/s, but an absolute maximum of 2,2 m/s is acceptable where only intermittent peak flows occur.

5.2.4 Pump stations

Pump stations should always have one standby pump available. An electrically driven standby pump should suffice except in the case of high-risk areas, where the standby pump should be diesel-driven.

5.2.5 Redundancy

Within distribution networks to end-users, branched systems should be avoided as far as possible, i.e. there must be at least two directions of flow to a consumer. For bulk supply systems branched portions may be acceptable, due to the role of reservoirs, and redundancy refers more to the level of integration in the system.

5.3 RESERVOIR SUPPLY RATES AND STORAGE CAPACITIES

Reservoirs in the system serve two main functions:

- Emergency storage, including that required for fire fighting, to provide sufficient water when a supply failure occurs.
- Balancing storage, required to balance out peaks in the demand.

For initial assessment of reservoir size these two functions are viewed integrally. The criteria for total reservoir volume used in this study for evaluation and planning is 48 hours of the AADD (of the reservoir supply zone) for all the towns in the Langeberg Municipality for gravity and pumped supply to the reservoir. It is noted that this could represent as little as 24 to 30 hours' storage of the peak day demand for high-peak consumers.

The volume required for the balancing function is dependent on the supply rate to the reservoir and is therefore closely related to the capacity of the feeder main to the reservoir.

In some cases where capacity appears to be a problem the relationship between balancing storage in a reservoir and the supply to the reservoir is dealt with as follows in order to optimise the system by means of time simulation:

- For new reservoirs, the optimum combination of supply rate and balancing volume was determined.
- For existing reservoirs, any excess capacity was utilised as balancing storage, in order to minimise the required supply rate and thus also the load on the system supplying the reservoir.
- For existing reservoirs with limited capacity for balancing, an economic analysis was done in order to determine whether to increase the supply rate to the reservoir so that the balancing load is minimised, or whether to increase the storage capacity.

Balancing storage is an analytical exercise based on time simulation, but in contrast the emergency storage is a matter of perception and subjective assessment of the risk of non-supply of water. It is often not necessary to provide more than 18 h x AADD emergency storage in a reservoir (in addition to balancing storage), unless there are specific conditions or risks to justify a larger storage.

These criteria are summarized in Table LBW 5.3.

Taken into consideration that the risk of interruption of bulk water supply to Ashton, Bonnievale, Montagu and Robertson is relatively high due to the fact that all water is pumped and that these towns would therefore be reliant on continuous power supply, it was assumed that 30 h x AADD would be provided as emergency storage in the reservoirs.

5.4 WATER TOWER SUPPLY RATES AND STORAGE CAPACITIES

No water towers are present in the existing system of Langeberg. The criteria is nevertheless included for the sake of completeness.

Water towers serve merely to sustain pressure in a network, and should not be regarded as facilities for balancing peaks and for emergency supply. Because of their relatively small volumes, the supply rates to towers must be such that they can be kept full at all times. On the other hand, volumes must be large enough to allow room for operation of pumps filling the tower (where applicable) such that the number of pump cycles per day is limited. The following guidelines as summarised in Table LBW5.3 were used for evaluation and planning of water towers:

- Supply rate into tower - 1,0 to 1,1 x PHF x AADD
- Tower storage - 2 h to 6h x AADD

In Montagu there is however 3 balancing tanks present and the same criteria used for water towers were applied to the balancing tanks.

5.5 OPTIMAL USE OF EXCESS CAPACITIES IN EXISTING FACILITIES

Many existing facilities may have excess capacity when measured in terms of the operational criteria described above. In the planning done for this study it was strived to utilise the excess capacities in existing facilities to its economically viable maximum.

5.6 ECONOMIC OPTIMISATION AND COST FUNCTIONS

All the strategic and technical alternatives studied were compared on mainly economic grounds, with a view to establishing a "master plan" which will result in the lowest present value of capital works, operations and maintenance.

The cost functions for cost estimates, cost comparisons and economic optimisation in general, are presented in Table LBW5.4.

It should be noted that the proposed pipeline routes are indicated schematically on the Master Plan and that no detail topographical or geotechnical surveys have been conducted to verify these routes. The detail assessment of the routes are thus beyond the scope of this report and should be performed in the preliminary design stage during implementation. A variance of the cost estimates could therefore be experience typically due to the presence of hard rock in the substrata along the pipeline route, existing services of which the crossings appear to be problematic or for which ever reason the pipeline route has to be lengthened.

6. EVALUATION AND MASTER PLAN

6.1 EXISTING SYSTEM

6.1.1 Overview

The results of the existing system analysis are presented in the following figures:

- Figure LBW6.1 shows the static pressures in each system, thus the maximum pressure that could be expected in the system at any time.
- Figure LBW6.2 shows the residual pressures in each system under peak hour demand conditions.
- Figure LBW6.3 shows the flow velocity in each system under peak hour demand conditions.

6.1.2 Discussion

Ashton

The static analysis indicates no areas in the network where pressures are below 24m or above 90m.

The residual pressures in the existing system under peak hour demand conditions are in the 24m to 90m range.

There are a few pipes which have a velocity under peak hour demand conditions which exceeds 1,5 m/s. The most significant of these are 2 x 200 mm Ø supply pipes from Ashton WTP to Langeberg and Ashton Foods (Pty) Ltd when both pumps run simultaneously, the 150 mm Ø supply pipe that augments water from the PRV zone to the Cogmanskloof zone and the 200 mm Ø supply pipe between the 2 factories of Langeberg and Ashton Foods (Pty) Ltd.

Bonnievale

The residual pressures in the Old reservoir (lower) zone under peak hour demand conditions are in the 24m to 90m range, which is within the design criteria. Large areas in the New reservoir (higher) zone are below 24m and even below 15m. These areas are mainly in Happy Valley and are experienced generally due to the lack of conveyance in the system.

There are a number of pipes which have a velocity under peak demand conditions which exceed 1,5 m/s. These pipes, apart from the pipe in Myrtle Rigg Street near Town Central, are all in Happy Valley suburb. This is once again due to the lack of conveyance in this part of the network.

McGregor

The static analysis indicates no areas where pressures exceed 90m. The higher lying areas, to the south of McGregor, experience pressures below 24m. This is due to the topology of the town and the relatively low lying nature of the existing reservoirs.

The residual pressures in large areas in McGregor are below 24 m and even below 15 m. The low pressures are experienced mainly due to the topology of the town and the relatively low lying nature of the existing reservoirs.

The 100 mm Ø portion of the main 150 mm Ø supply pipe from the McGregor 1 & 2 reservoirs to the McGregor 3 reservoir, the 100 mm Ø supply pipe from McGregor 1 & 2 reservoirs to town and the 100 mm Ø supply pipe from McGregor 3 reservoir have flow velocities exceeding 1,5 m/s in the system.

Montagu

The static analysis indicates no areas where pressures exceed 90m. The higher lying areas in the George Brink, Kanonkop, Kanonkop booster, Ashbury Lower and Badskop zones experience pressures below 24m. This is due to the topology of the town and the relatively low lying nature of the existing reservoirs.

The residual pressures in the existing system under peak hour demand conditions in the Montagu West and Kanonkop zones are below 15m. This is due to the lack of conveyance in the system in these zones. Residual pressures in the Badshoogte, Ashbury Lower and George Brink zones of below 15 m are experienced.

There are a few pipes with velocities exceeding 1,5 m/s in the system. The most significant of these are the 150 mm Ø dedicated rising main from George Brink reservoir to Kanonkop balancing tank, the 100 mm Ø supply pipe from Kanonkop reservoir to the Kanonkop zone, the 75 mm Ø dedicated rising main from Ashbury Lower reservoir to Badshoogte balancing tank and the 75 mm Ø supply pipe from Badshoogte balancing tank to Montagu Springs. A 50 mm Ø supply pipe in the Kanonkop booster zone also experiences velocities above 1,5 m/s.

Robertson

The static analysis indicates two areas where pressures are below 24 m. This is at the high-lying eastern side of Reservoir 2 zone and the higher lying areas in Nkqubela when the booster pump is not operational.

The residual pressures in the upper Reservoir 3 zone under peak demand conditions are in the 24m to 90m range, which is within the range of the design criteria. Large areas in the Reservoir 1 and 2 zones are below 24 m and even below 15 m. The low pressures are experienced mainly due to the lack of conveyance in the system and insufficient zone boundaries.

There are a few pipes with a velocity that exceeds 1,5 m/s under peak hour demand conditions. This is once again due to the lack of conveyance in these parts of the network.

6.1.3 Replacement value

Table LBW6.1 gives an estimate of the replacement value of the existing Langeberg system, based on the cost functions shown on Table LBW5.4.

6.2 EXISTING BULK SUPPLY SYSTEM

Table LBW6.2 is a summary of the reservoir and feeder evaluation of the existing system. For each reservoir it shows:

- The potential present AADD of the zone(s) served by the reservoir, which might include a PRV or booster zone.
- The volume of the reservoir, in relation to the AADD served by the reservoir (expressed as h x AADD). The available balancing volume is the total volume minus the required 30 h x AADD emergency volume. If this is more than 18 h x AADD, the surplus is regarded as "spare" capacity.
- The feeder mains to the reservoir, and their capacities expressed as a ratio of the AADD served by the reservoir. Feeder main capacities have been estimated based on a maximum flow velocity of 1,8 m/s, and not on the actual hydraulic capacity. The required flow of feeder mains is also listed, based on the amount of balancing storage available, and the peak factors and pattern of demand in the reservoir zone. Where the feeder capacity exceeds the required flow, a "spare" capacity is indicated. Feeder mains with a negative "spare" capacity are deficient.

6.2.1 Reservoirs

Evaluated on a town-for-town basis, Ashton, Bonnievale, Montagu and Robertson have insufficient reservoir storage in some of its zones and require additional storage. Montagu and Robertson are the only towns where the overall storage for the town is sufficient.

In Ashton the only zone with insufficient storage is the Cogmanskloof zone. This is due to the high water demand of Langeberg & Ashton Foods which is located in this zone. If the water demand of Langeberg & Ashton Foods is excluded from the calculations, there is sufficient capacity in all the zones in Ashton.

In Bonnievale the new upper reservoir has sufficient capacity and the lower old reservoirs have a deficit. The spare in the higher lying reservoir could be utilised in emergency conditions for the lower lying zone.

McGregor has sufficient balancing capacity in its zone, but requires additional storage for emergency purposes.

In Montagu the Montagu West, Kanonkop, Kanonkop booster and Badshoogte zones are supplied from balancing tanks and their reservoir storage are located in the George Brink and Ashbury Lower reservoirs. The Ashbury Lower reservoir is the only reservoir in Montagu with insufficient reservoir capacity, but it should however be kept in mind that the reservoir capacity of the Ashbury Upper reservoir can be utilised for the Ashbury Lower reservoir. The Ashbury Upper reservoir currently does not have a zone of its own and only supplies the Ashbury Lower reservoir with water.

In Robertson, Reservoir 1 & 4 reservoirs have insufficient reservoir capacity, but it is only marginally and the spare in the higher lying Reservoir no. 3 could be utilised in emergency conditions for the lower lying zones.

6.2.2 Feeder mains

In Ashton the 2 x 200 mm Ø feeder mains from the Ashton WTP to Langeberg and Ashton Foods requires upgrading.

In Montagu the 75 mm Ø rising main from Ashbury Lower reservoir to Badshoogte balancing tank requires upgrading.

In Robertson the 75 mm Ø feeder main between the Reservoir no. 1 network and the Nkqubela pumping station requires upgrading.

The existing feeder mains in Bonnievale and McGregor all have sufficient capacity to supply the existing water demands.

6.2.3 Pumping stations

During peak season conditions the WTP to Langeberg and WTP to Cogmanskloof pumps are running continuously without any standby pumps and upgrading of these 2 pump stations is required.

In Montagu the Mill Street, WTP to Ashbury and Ashbury to Badshoogte pump stations are presently at capacity and requires upgrading shortly.

In Robertson the Reservoir 1 to town pump station is at capacity and requires upgrading.

In Bonnievale the capacities of all the pumping stations are sufficient for the existing water demands.

The duty points of Cogmanskloof and Zolani pumping stations in Ashton, Pumps 1 - 4 in Bonnievale, all the pump stations except the WTP to Ashbury Upper in Montagu and the reservoir no. 2 -3 pump station in Robertson must be verified.

All pumping stations in Bonnievale and Robertson have standby pumps available, but the pump stations in Ashton and Montagu require standby pumps.

6.3 MASTER PLAN – ASHTON

6.3.1 Proposed distribution zones

The proposed distribution zones are indicated on Figure LBW6.4a.

The changes to the existing distribution zones are the following:

- The Conradiedorp PRV zone is included in the Cogmanskloof zone.
- The Cogmanskloof reservoir zone is increased to include future development areas A01 – A05 & A09.
- The Conradiedorp reservoir zone is increased to include future development areas A06 & A08.
- The boundaries of the existing Zolani zone are increased to accommodate future development areas A07, A10 & A11.

6.3.2 Proposed future system and required works

The existing Ashton water distribution system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

The proposed master plan items are presented in Figure LBW6.5a.

A few distribution pipelines are required to reinforce water supply within the Ashton distribution network. The most significant is the upgrading of the supply pipelines between Ashton WTP and Cogmanskloof reservoir to Langeberg & Ashton Foods through the Cogmanskloof zone network.

Upgrading of the supply pipelines between the Conradiedorp reservoir and future development area A06 and the supply pipeline between the Zolani reservoir and future development area A07 are also required.

6.3.3 Bulk System

The existing bulk water supply system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

Table LBW6.5 is a summary of the reservoir and feeder evaluation of the future system for the future water demand.

Reservoirs

A new 10,5 Mℓ reservoir is proposed at the existing Cogmanskloof reservoir site to augment reservoir storage for Langeberg & Ashton Foods.

When additional storage capacity is required for Zolani, a new 2,0 Mℓ reservoir should be constructed at the existing Zolani reservoir site.

When additional storage capacity is required for Conradiedorp, a new 1,0 Mℓ reservoir should be constructed at the existing Conradiedorp reservoir site.

Feeder mains

One of the 200 mm Ø feeding mains from the WTP to the Langeberg factory needs to be upgraded to a 315 mm Ø main.

Pumping stations

The following pump stations require upgrading in future:

- Upgrading of the Ashton WTP to Cogmanskloof reservoir pump station.
- Downsize the Cogmanskloof to Conradiedorp pump station.
- Add a 3rd pumpset for standby at Ashton WTP to Langeberg factory pump station.
- New Conradiedorp booster pump station.

6.3.4 Cost estimates of future works

The cost estimates for the proposed future reinforcements to the Ashton system are summarised in Table LBW6.4

6.4 MASTER PLAN – BONNIEVALE

6.4.1 Proposed distribution zones

The proposed distribution zones are indicated on Figure LBW6.4b.

The changes to the existing distribution zones are the following:

- The zone boundaries in Happy Valley are changed slightly so that the new reservoir zone is enlarged while the old reservoir zone is reduced. This is done to ensure that the spare storage capacity in the new reservoir is utilised while the deficit in storage in the old reservoir could be reduced.
- The boundaries of the New reservoir zone are increased to include future development areas B03 & B06 – B09.
- It is further proposed that a PRV is installed on the main supply pipeline from the new reservoir feeding the Town area to reduce the pressure by 20 m. A high occurrence of pipe breaks has been experienced in this area if the pressure is not relieved via a "choked" valve to the Town Central network.

6.4.2 Proposed future system and required works

The existing Bonnievale water distribution system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

The proposed master plan items are presented in Figure LBW6.5b.

The distribution system items can be summarized as follows:

- A number of inter-connections are required to improve the network conveyance in Happy Valley.
- Reinforcing pipelines are required to improve network conveyance in the Old reservoirs zone.
- A new main supply pipeline is required in the New reservoir zone to supply future development areas B03 & B06 – B09.

6.4.3 Bulk System

The existing bulk water supply system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

Table LBW6.5 is a summary of the reservoir and feeder evaluation of the future system for the future water demand.

Reservoirs

A new 5,5 Mℓ reservoir is proposed to supply additional storage at the Old reservoirs site.

When additional storage capacity is required in the New reservoir zone when future development areas B06 – B09 develop, a new 4,0 Mℓ reservoir should be constructed at the existing New reservoir site.

Feeder mains

The following new feeder mains will be required in future:

- Utilize the existing 200 mm Ø rising main between to the new reservoir as an additional supply to the old reservoir when existing supply to the old reservoir nears capacity.
- New 315 mm Ø dedicated rising main between Old and New reservoirs.

Pumping stations

The following existing pump stations require upgrading in future:

- The duty point of the existing pumps 1 - 4 should be verified.

A new pumping station at the Old reservoirs site to supply water from the Old reservoirs to the New reservoir is proposed.

6.4.4 Water Demand Management

It is proposed that Bonnievale implements a Water Demand Management Programme. As part of this programme it is proposed that bulk water meters are installed downstream of all reservoirs. A telemetry system should also be installed whereby the reservoirs, pumping stations and bulk water meters can be monitored from a central control station both for ease of management of the system and to gather essential future master planning information.

6.4.5 Cost estimates of future works

The cost estimates for the proposed future reinforcements to the Bonnievale system are summarised in Table LBW6.4

6.5 MASTER PLAN – MCGREGOR

6.5.1 Proposed distribution zones

The proposed distribution zones are indicated on Figure LBW6.4c.

The changes to the existing distribution zones are the following:

- The McGregor reservoir zone is increased to include future development areas Mc01 – Mc05.

- The zone boundaries of the McGregor reservoir zone are changed to include the new booster zone.

A new booster zone is proposed for the existing higher lying erven of McGregor that currently experiences low static pressures.

6.5.2 Proposed future system and required works

The existing McGregor water distribution system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

The proposed master plan items are presented in Figure LBW6.5c.

A few distribution pipelines are required to reinforce water supply within the McGregor distribution network. Inter-connection pipes and zone valves are also required to re-zone the existing network to incorporate the new booster zone.

6.5.3 Bulk System

The existing bulk water supply system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

Table LBW6.5 is a summary of the reservoir and feeder evaluation of the existing system for the future water demand.

<u>Reservoirs</u>

A new 2,0 Mℓ reservoir at the existing McGregor reservoir 1 site is proposed.

Note: At the time the previous master plan was conducted (August 2009), KV3 was appointed by Langeberg Municipality for the design and implementation of this proposed 2,0 Mℓ reservoir.

<u>Feeder mains</u>

No feeder mains require upgrading in future.

<u>Pumping stations</u>

A new booster pump station is proposed for the higher lying areas in McGregor.

Note: At the time the previous master plan was conducted (August 2009), KV3 was appointed by Langeberg Municipality for the design and implementation of the proposed booster pump station and new booster zone.

6.5.4 Cost estimates of future works

The cost estimates for the proposed future reinforcements to the McGregor system are summarised in Table LBW6.4.

6.6 MASTER PLAN – MONTAGU

6.6.1 Proposed distribution zones

The proposed distribution zones are indicated on Figure LBW6.4d.

The changes to the existing distribution zones are the following:

- A new Ashbury Upper zone is proposed for the higher lying areas in the existing Ashbury Lower zone and to accommodate future development areas M07 – M09, M12, M13 & M16. It is proposed that this zone is supplied from the existing Ashbury Upper reservoir.
- The boundaries of the existing Montagu South, George Brink and Ashbury Lower zone are increased to accommodate future development areas M01 – M06, M14, M15 & M18.

6.6.2 Proposed future system and required works

The existing Montagu water distribution system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

The proposed master plan items are presented in Figure LBW6.5d.

A number of distribution pipelines are required to reinforce water supply within the Montagu distribution network as well as new supply pipelines for the new future development areas.

A few inter-connection pipes and zone valves are also required to re-zone the existing Ashbury Lower network in order to incorporate the proposed Ashbury Upper zone.

6.6.3 Bulk System

The existing bulk water supply system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

Table LBW6.5 is a summary of the reservoir and feeder evaluation of the existing system for the future water demand.

Reservoirs

A new 2,0 Mℓ reservoir is proposed at the existing Badshoogte balancing tank site. A new 3,5 Mℓ reservoir is also proposed at the Ashbury Upper reservoir site for emergency storage purposes in the lower lying George Brink & Ashbury Lower zones.

Feeder mains

The following new feeder mains and upgrading of existing feeder mains will be required in future:

- Upgrade of the existing 200 mm Ø rising main from Montagu WTP to Ashbury Upper reservoir.
- New 160 mm Ø feeder main to proposed Badshoogte reservoir.

Pumping stations

The following new pump stations and upgrading of existing pump stations are proposed for the future:

- New Ashbury Upper to Badshoogte pump station at the Ashbury Upper reservoir.
- Upgrading of the Mill Street, Kanonkop booster and WTP to Ashbury pump stations.
- Add a 2rd pumpset for standby at WTP to South pump station.
- Add a 3rd pumpset for standby at WTP to George Brink pump station.
- Verify the duty points of the existing pump stations in Montagu.

6.6.4 Cost estimates of future works

The cost estimates for the proposed future reinforcements to the Montagu system are summarised in Table LBW6.4.

6.7 MASTER PLAN – ROBERTSON

6.7.1 Proposed distribution zones

The proposed distribution zones are indicated on Figure LBW6.4e.

The changes to the existing distribution zones are the following:

- The Reservoir 2 and 3 zone boundaries are changed so that the new zones are enlarged. This is done to ensure that the storage capacity in the upper zones are optimised for the future demands and to improve pressures in the zones.
- A future booster pump zone for the higher lying areas of the Reservoir 4 zone is proposed.
- The rest of the zones remain the same apart from the fact that they are enlarged to accommodate future development areas.

6.7.2 Proposed future system and required works

The existing Robertson water distribution system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

The proposed master plan items are presented in Figure LBW6.5e.

The distribution system items can be summarized as follows:

- A number of inter-connections and zone valves are required to re-zone the distribution system.
- Reinforcing pipelines are required to improve supply and ring network conveyance in the Reservoir 1 zone.
- A new main supply pipeline is required to the Nkqubela area.

6.7.3 Bulk System

The existing bulk water supply system has insufficient capacity to supply the future water demands for the fully occupied scenario and the additional future development areas.

Table LBW6.2 is a summary of the reservoir and feeder evaluation of the existing system for the future water demand.

Reservoirs

A new 5,0 Mℓ (Reservoir 5) reservoir is proposed to supply additional storage to the Reservoir 1 zone. This reservoir is proposed on the hillside to the west of the existing town. This reservoir will act as a balancing reservoir which will feed the larger reservoir zone under peak demands.

When additional storage capacity is required in the Reservoir 2 and 3 zones, a new 3,0 Mℓ reservoir should be constructed at the existing Reservoir 3 site.

When additional storage capacity is required in the Reservoir 4 zone, a new 2,5 Mℓ reservoir should be constructed at the existing Reservoir 4 site.

Feeder mains

The following new feeder mains will be required in future:

- Upgrade of one of two 250 mm Ø feeders from Reservoir 1 supplying to the central town area.
- Upgrade of the existing 75 mm Ø feeder main from the Reservoir 1 network to the Nkqubela booster pump station.

Pumping stations

The following new pump stations and upgrading of existing pump stations are proposed for the future:

- Upgrading of both the existing pump sets at Reservoir 1 pumping stations is proposed. These pumping stations require upgrading on the mechanical and electrical items.
- Upgrading of the Reservoir 1 - 2 and Reservoir 2 - 3 pump stations.
- New reservoir 4 booster pump station.

6.7.4 Cost estimates of future works

The cost estimates for the proposed future reinforcements to the Robertson system are summarised in Table LBW6.4.

6.7.5 Water Demand Management

It is proposed that Robertson implements a Water Demand Management Programme. As part of this programme it is proposed that bulk water meters are installed downstream of all reservoirs. A telemetry system should also be installed whereby the reservoirs, pumping stations and bulk water meters can be monitored from a central control station both for ease of management of the system and to gather essential future master planning information.

7. MASTER PLAN COST SUMMARY

7.1 PROJECTED CAPITAL EXPENDITURE

Table LBW7.1 is a summary of the costs associated with the proposed master plan.

7.2 MASTER PLAN UNIT COST

The master plan implementation at cost of R 120,5 million will increase the Langeberg system capacity from its present AADD of 18 542 kℓ/d to the future AADD of 33 374 kℓ/d. This amounts to an implementation unit cost of R 8 124 R/kℓ/d.