CEDERBERG MUNICIPALITY

WATER MASTER PLAN

Volume 1

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LIST OF ABBREVIATIONS & ACRONYMS

ADD	-	Average daily demand (a seasonal or monthly average)
AADD	-	Annual average daily demand
AC	-	Fibre-reinforced cement
ACB	-	Assumed Consumption Billing
ADDWF	-	Average daily dry weather flow
AGRIC	-	Agriculture/Rural
ArcView	-	GIS program (software)
BPT	-	Break pressure Tank
BWL	-	Bottom Water Level (in m a.s.l.)
CAD	-	Computer Aided Draughting
CC	-	City Council
Ces	-	Community Engineering Services consulting engineers
CMIP	-	Consolidated Municipal Infrastructure Fund
d	-	day
DTM	-	Digital terrain model
DWAF	-	Department of Water Affairs and Forestry
EGL	-	Energy Grade Line (in m a.s.l.)
FCV	-	Flow Control Valve
GIS	-	Geographic Information System
GLS	-	Geustyn Loubser Streicher Inc. consulting engineers
GOV	-	Government (Land Use)
h	-	hour
ha	-	hectare
ID	-	Identification Number
IDP	-	Integrated Development Plan
IMQS	-	Infrastructure Management Query Station (software package)
IPDWF	-	Instantaneous peak dry weather flow
IPWWF	-	Instantaneous peak wet weather flow
IT	-	Information technology
kℓ	-	kilolitre
kℓ/d	-	Kilolitre/day
km	-	Kilometre
kW	-	kilowatt
kWh	-	kilowatt-hour

ℓ	-	litre
ℓ/day/UE	-	Litre/day/unit erf
ℓ/h/connection	-	Litre/hour/connection
ℓ/min	-	Litre/minute
ℓ/min/m pipe/m Ø	-	Litre/minute/meter pipe length/meter pipe diameter
ℓ/min/UE	-	Litre/minute/unit erf
ℓ/s	-	Litre/second
LDO	-	Land Development Objective
m	-	metre
m a.s.l.	-	Metres above mean sea level
m/s	-	Metres per second
ME	-	Mechanical and electrical
MIS	-	Management Information System
Mℓ	-	Megalitre
MLC	-	Metropolitan Local Council
mm	-	Millimetre
MNF	-	Minimum night flow
P&G	-	Preliminary and general
PDDWF	-	Peak daily dry weather flow
PDF	-	Peak day factors
PHF	-	Peak hour factors
PPP	-	Public Private partnership
PRV	-	Pressure Reducing Valve
PS	-	Pumping Station
PSV	-	Pressure Sustaining Valve
PWF	-	Peak week factors
RDP	-	Reconstruction and Development Program
RSC	-	Regional Services Council
s	-	second
SCB	-	Shared Consumption Billing
SDA	-	Strategic Development Area
SEWSAN	-	Sewer System Analysis program (software)
SG	-	Surveyor General
Swift	-	Sewer Water Interface For Treasury systems (software)
SWOT	-	Strengths, Weaknesses, Opportunities & Threats
TC	-	Town Council
TWD	-	Total annual water demand
TWL	-	Top Water Level (in m a.s.l.)

UAW	-	Unaccounted-for-water
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)
WWTP	-	Wastewater Treatment Plant / Facility (sewage)
WSDP	-	Water Services Development Plan
WTP	-	Water Treatment Plant (potable water)

1. INTRODUCTION

1.1 BRIEF

CEs was appointed to implement a master plan of the water distribution system for Cederberg Municipality. The project was partly funded by the Department of Local Government as part of the CMIP Capacity Building Project.

The project entails the establishment of computer models for the water distribution systems in Cederberg, the linking of these models to the stand and water meter databases of the treasury's financial system, evaluation and master planning of the water distribution system, and the posting of all information to IMQS.

This master plan report lists the analyses and findings of the study on the Cederberg water distribution system.

1.2 STUDY AREA

The location of Cederberg within the Western Cape is shown on Figure CEW1.1 The towns within the boundary of the Cederberg Municipality, and the 1:10 000 orthophoto numbers for each, are:

- Citrusdal (3219 CA6, 11)
- Clanwilliam (3218 BB18, 19)
- Elandsbaai (3218 AD7, 8)
- Graafwater (3218 BA 12, 13, 17, 18)
- Lambertsbaai (3218 AB7, 12)
- Leipoldtville (3218 AB 25)
- Wuppertal (not addressed in this report).

Each of the towns' cadastral layout with the suburbs are shown on Figure CEW1.2, with a separate figure for each town, or water district, as follows:

- (a) Citrusdal
- (b) Clanwilliam
- (c) Elandsbaai
- (d) Graafwater
- (e) Lambertsbaai
- (f) Leipoldtville

This notation to distinguish between towns is used throughout the report for all figures where appropriate.

1.3 PREVIOUS MASTER PLANNING

No overall master planning had been conducted for the Cederberg Municipality prior to this investigation, but various Engineering Consultants had been performing evaluation and planning of portions of the distribution systems in the area over the years. The most notable in this respect include studies and designs performed by Kwezi V3 (for most of the towns), Tlou and Matji (for Clanwilliam), ICE (Citrusdal) and Arcus-Gibb (for Leipoldtville). No information is available for Wuppertal. The updated Water Services Development Plan (WSDP) for Cederberg Municipality is currently being compiled by Tlou and Matji, but it was not available at the time of compiling this report and is not required for its completion.

The relevant information was included and the firms consulted as part of this investigation.

1.4 DEFINITIONS

1.4.1 Water distribution system

In this report the term *water distribution system* is used to describe any system of pipes, valves, pumps and meters or other associated equipment, including all mains, connecting pipes and water installations that are used or are intended to be used in connection with the supply of potable water.

Capital expenditure relating to the water distribution system is the responsibility of the Municipality. In order to further distinguish between capital expenditure by the Municipality and by others the following terms are defined:

- *bulk water distribution system* – is used to describe the system upstream of the clean water reservoir, yet belonging to the Municipality, while the term
- *external bulk water distribution system* – is used to describe components of the water distribution system relevant to the analysis, but are owned by third parties.

1.4.2 Water management zones

Following the notation of SABS0306:1999 the following terms are used in this report. Various types of *water management zones* should be present in each water distribution system:

- a *district* is a unique area identifiable by discrete boundary points. It has no upper limit to the number of connections and it comprises any number of subdistricts and zones containing various categories of consumers. It usually has an individual bulk supply and boundaries usually fixed by topographical constraints (typically about 30 000 connections). A district is served with water that passes through a permanent dedicated district water meter.

- a *subdistrict* is a subdivision of a district and is a separately isolatable section of a district that comprises one or more zones (typically 2 000 to 10 000 connections) in which water entering or leaving can be measured. This would include various consumer categories.
- a *pressure zone* is any area in a water distribution system that is supplied from a single pressure-control device or reservoir, the boundaries of which are normally incorporated within, coincide with, or encompass, but never cross, the district, subdistrict, or zone boundaries.
- A *zone* is a separately isolatable section of a subdistrict, usually not exceeding 2000 connections, in which quantities of water entering and leaving can be measured. Ideally a zone should be fed from only one source.

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 Unaccounted-for water (UAW) and water balance

The acronyms UAW and UFW are used in literature for the term *unaccounted-for-water*. In this report UAW is used as per SABS0306:1999. UAW 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 UAW.

SABS0306:1999 provides the following definitions:

- Unaccounted-for water (volume). UAW is the difference between the measured volume of water put into the water distribution system and the total volume of water measured to authorized consumers whose fixed property address appears on the official list of the water services authority. Accounting-for in this sense pertains to being responsible for the account (e.g. an address is required to which the account for the water consumption is sent).
- The water balance is the difference between the measured volume of potable water put into a water distribution system and the total volume of potable water measured at any intermediate point in the water distribution system. This is a statement setting out the amount of water flowing in and flowing out on an area-by-area basis.

In this report the term UAW is used to describe UAW as per the SABS definition above, limited only to potable water.

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 distribution 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 consumer water meter forming a consumer's connection to the water distribution system. Some treasury records might not pertain to a water connection (or customer meter).

SABS0306:1999 provides the following definitions:

- A consumer meter is a device that measures the volume of water leaving a water distribution system and entering a consumer's installation for the purpose of billing and accounting for water.
- Billing volume is the total volume of water actually recorded as having passed through a consumer meter during a specified time interval, for a given area, district, town or selection of stands, for which payment would normally be made.

1.5 DISCLAIMER

The information in this report is intended for use by the Municipality. All efforts were made during this master planning process to ensure the highest data integrity. The information supplied to CEs by the Municipality and other Consultants at the outset of this master planning process is assumed to be the most accurate representation of the system at the time and is considered to be "as-built" for the purpose of this investigation.

In those cases where verification was found to be critical and was subsequently performed specific mention is made in this report of the method of verification and the section verified. Alternatively a master plan item is included in this report, with cost estimate, to allow the Municipality to budget accordingly in order to address the verification of the system data intergrity at the soonest convenience.

If this report is noted to have any discrepancies compared to alternative information CEs should be contacted in this regard to ensure that the relevant sections of the system are verified as part of a future ongoing bureau service aimed at improving the data intergrity over time.

2. EXISTING SYSTEM

2.1 SYSTEM LAYOUT AND OPERATION

2.1.1 General Description

The existing Cederberg water distribution system is discussed in this section. None of the towns in Cederberg share a water distribution system with another town, i.e. water is supplied via independent water distribution systems to each town.

The water districts are shown in Figure CEW2.1. In the case of Cederberg each water district is also a town. The pressure zones are also indicated on Figure CEW2.2. A schematic diagram of the system is presented in Figure CEW2.3.

The following tables provide summaries for each of the different types of elements in the system:

- Table CEW 2.1 – pipes
- Table CEW 2.2 – reservoirs, tanks and water towers
- Table CEW 2.3 – pumps
- Table CEW 2.4 – control valves.

2.1.2 Citrusdal

The three pressure zones in Citrusdal are fed by two reservoir systems (a high and low reservoir) and two pressure reducing valves (PRV's) feeding from the high reservoir zone.

2.1.3 Clanwilliam

The water distribution system is operated in four pressure zones. The pressure zones are fed by three different reservoir systems (Sederville, Platdammetjies and the new 3Ml reservoir) and the fourth, Crystal Waters, is fed via a booster pump connected to the 3Ml reservoir pressure zone.

2.1.4 Elandsbaai

The water distribution system is relatively basic and is operated as a single pressure zone supplied from the main reservoir. There is a PRV in the main pipeline leading from the reservoir, but its location and setting are not clear. The system is modelled in this investigation as if no PRV is in place. The PRV should be added to the model if it is still in use.

2.1.5 Graafwater

The water distribution system is relatively basic and is operated as a single pressure zone supplied from the main reservoir. No knowledge exists of any pressure control devices in the system.

2.1.6 Lambertsbaai

The water distribution system is operated as a single pressure zone supplied indirectly from the main reservoir, via a booster pump and water tower.

The Lambertsbaai reservoir site is relatively low compared to the altitude of stands in the town. The water pressure is increased in two ways before it is supplied to town: (a) it is pumped from the low-level reservoir to an adjacent 21m high water tower and (b) is supplied from the low-level reservoirs directly to the network via a booster pump located at the reservoir site.

At first glance the system appears to be operated as two separate pressure zones, as is also indicated on the drawings of the system (dated pre-1990) provided during this investigation. However, for the past +- 10 years the two valves on the corners of Leipoldt street and Sybil street and Leipoldt street and Hoogstraat have remained open and the system is now operated as a single pressure zone.

Water is supplied from the reservoir site to town via 3 pipes. Two of the pipes are connected to the booster pump. These are a 150mm pipe feeding directly to Malkopbaai and a 225mm pipe following from the reservoir along Van Zyl street and then along St Mark street towards the centre and north of town. The third pipe feeds from the water tower. It is a 200mm pipe running parallel to the 225mm pipe mentioned above, but it follows along Van Zyl street instead and is connected to the reticulation of the RDP development directly.

A check valve is located on the 200mm pipe just beyond the reservoir site in order to prevent water feeding back from the booster pump, via the system, to the tower when the demand in town is low.

2.1.7 Leipoldtville

The Leipoldtville water distribution system is operated as a single pressure zone supplied from the main reservoir. No knowledge exists of any pressure control devices in the system.

2.2 BULK SUPPLY SYSTEM

2.2.1 General Description

The bulk water distribution system of Cederberg is not analysed in this investigation. However, the following provides a brief summary of the water supply sources to each town:

- Citrusdal – water is abstracted from the Olifants River and is delivered to the WTP via pumps and a rising main at a rate of about 40 l/s. Water is also abstracted from two boreholes and supplied to a raw water reservoir, and then to the WTP.
- Clanwilliam – water is abstracted from the Clanwilliam dam in the Olifants River and supplied to the high pressure zone via pumps and a rising main. Water is also fed to the low level reservoir from a tributory of the Olifants River and is abstracted at the Jan Dissels balancing reservoir.
- Elandsbaai – groundwater is abstracted via 7 boreholes located on the north-eastern side of the town.
- Graafwater – groundwater is abstracted via a borehole.
- Lambertsbaai – a limited allocation of groundwater is abstracted via boreholes in the Wadrif state controlled underground water resource. In 1996 it was reported that the actual abstraction regularly exceeded the allocation. No additional information was obtained during this investigation. Currently another potential underground water resource is being investigated as well.

2.3 EXISTING OPERATION PROBLEMS

2.3.1 General

The operation problems mentioned by Municipal operations staff during this investigation are highlighted in this section.

2.3.2 Citrusdal

No operation problems pertaining to the water distribution system were identified.

2.3.3 Clanwilliam

The industrial area is known to have low pressures. Alternative infrastructure upgrades to improve the pressure in the industrial area have been investigated in the past.

2.3.4 Elandsbaai

No operation problems were identified.

2.3.5 Graafwater

No operation problems were identified.

2.3.6 Lambertsbaai

The pressure in the north-eastern part of town is often low during holiday periods, particularly along Otterdam street. Also, during peak demand periods both pumps are required to supply the water to town – there is no standby capacity. Even though this has not to date caused specific problems standby pumping capacity is required to increase the reliability of the system.

2.3.7 Leipoldtville

No operation problems were identified.

2.4 SPECIAL CONSIDERATIONS

2.4.1 General

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

2.4.2 Information to be clarified

There are various discrepancies between different sources of information pertaining to:

- Citrusdal pump station and rising main capacity (included as master plan item).
- the size of the two Platdammetjie reservoirs in Clanwilliam provided by the Municipality and other work. The latest information provided by the Municipality gives the capacity of the two reservoirs as 640 kl each, but other information lists the size as 450kl each. The capacity should be verified.
- the size and water levels of the Cederville reservoir in Clanwilliam. Some sources indicate a size of 1 000 kl while others list 1 500 kl. One source lists the TWL as 154,0m and another lists 162,7m (the latter TWL is exactly the same as the TWL provided for Platdammetjies reservoirs).
- Zoning and zone valves in the Clanwilliam system, although clarification of this matter is not critical – the zones have to be changed to allow sufficient residual pressure for the new RDP developments.
- Elandsbaai main pipe system connectivity and pipe diameter, as well as PRV location and setting (included as master plan item).
- Lambertsbaai pump and rising main capacity (master plan item included).
- The Leipoldtville reservoir size is unknown.

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 Cederberg, 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 Cederberg Municipality has an ICL Abakus 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 ICL Abakus software suite in future.

The treasury records for the period January 2003 to December 2003 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 Cederberg Municipality, the following land use categories were identified for this study:

- 01 - Residential stands
- 02 - Business and commercial
- 03 - Industrial
- 04 - Government/Institutional/Municipal
- [no entry] - assumed to be residential

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

- RES[0] - smaller than 500 m^2
- RES[1] - 500 m^2 to 1 000 m^2
- RES[2] - 1 000 m^2 to 1 500 m^2
- RES[3] - 1 500 m^2 to 2 000 m^2
- RES[4] - 2 000 m^2 to 2 500 m^2
- RES[5] - larger than 2 500 m^2

The LARGE category is required to remove relatively large 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 MANAGEMENT ZONES AND ZONAL METER READINGS

3.4.1 General Description

Management zones are defined in Section 1.4 of this report.

Monthly zonal water meter data is available for Clanwilliam, Lamberts Bay and Graafwater. Very limited data is available for Citrusdal. No information is available for the other towns.

Table CEW3.1 lists the zonal water meter readings in the Cederberg water distribution system and the meter details. Sufficient data for use during modelling could only be obtained for the estimating the UAW for following districts: Clanwilliam, Graafwater and Lambertsbaai.

3.4.2 Citrusdal

Zonal meter readings are available since September 2003, although only the first four months' data was supplied in electronic format at the time of gathering information for this investigation. The limited meter readings are not used as part of this investigation.

3.4.3 Clanwilliam

Zonal meter readings are available since January 2000. The monthly data for the period up to October 2003 was provided in electronic format at the time of gathering information for this investigation, but this period of record is insufficient to be used in the calculation of the annual UAW.

3.4.4 Elandsbaai

No data could be obtained at the time of this investigation.

3.4.5 Graafwater

Zonal meter readings are available since December 1999. The monthly data for the period up to June 2003 was provided in electronic format at the time of gathering information for this investigation.

3.4.6 Lambertsbaai

Zonal meter readings are available since January 1998. The monthly data for the period up to November 2003 was provided in electronic format at the time of gathering information for this investigation.

3.4.7 Leipoldtville

No data could be obtained at the time of this investigation.

3.5 INFORMAL SETTLEMENTS

The treasury data does not contain any information on informal settlements for any of the towns in the Municipal area. The results are summarised in Table CEW3.2.

The backlog for RDP housing in some towns in the Municipal area is also caused by farm workers requiring permanent dwellings (even though they are not currently living in informal settlements, but on the farms).

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 Cederberg was analysed with Swift in order to determine (for each stand/meter record) the suburb, the land use, whether a stand 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 CEW3.3.

Figure CEW3.1 shows all the stands coloured in accordance with their land use according to the Swift analysis. It is clear from the Figure that the land use description recorded in the treasury system is not comprehensive.

Figure CEW3.2 shows the stands coloured in accordance with their AADD according to the Swift analysis.

3.6.2 Zone land use and water use statistics

Each stand/record was linked or associated via GIS to specific water zone(s) and the same totals and summaries as above were produced per zone and were also broken down into the various land use categories. In this way the total water demand (TWD) per zone was determined. The results are summarised in Table CEW3.4.

In this Cederberg master plan the zone boundaries coincide with the district boundaries and the results are thus provided for each district, or per town, instead of per water pressure zone.

3.6.3 Unaccounted-for-water

The total water inputs for each zone (where available) were compared with the total water sales for each corresponding zone (inclusive of the estimated water use by informal settlements where applicable), in order to estimate the UAW. The results are summarised in Table CEW3.5.

The periods of measurement do not correspond. UAW estimates are based on the Swift extraction period (Jan 2003 – Dec 2003) and the corresponding average for data available from the bulk meters corresponding to this period. The results could only be calculated for:

- Clanwilliam where 10 months' data was available from bulk meters from Jan 2003 to Oct 2003.
- Graafwater, where 6 months' data was available from bulk meters from Jan 2003 to Jun 2003.
- Lambertsbaai, where 11 months' data was available from bulk meters from Jan 2003 to Nov 2003.

Ideally, zonal water meter readings should be improved and extended to include all towns in the study area and to reflect water pressure zones instead of districts.

3.6.4 Rationalised ("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 UAW) for each suburb with the actual water demand (excluding UAW) for the suburb.

Swift 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 UAW'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 (including UAW) for each suburb and distribution zone in Cederberg was determined.

The results are summarised in Table CEW3.6.

3.6.5 Rationalised (“theoretical”) UAW

For planning and evaluation purposes, the UAW values were also rationalised on a zone-by-zone basis, or regional (wider-area) basis, as allowed by the sensibility of the results. Despite the fact that UAW values could be calculated for some zones an UAW value of 25% was instead applied to all users in Cederberg for modelling purposes, as this approach is more conservative and the value used is relatively similar to that obtained when based on the zonal meter data and actual UAW for the three available towns.

3.6.6 Theoretical present water demand

The rationalised UWD’s and UAW’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. UAW) for each suburb was compared with the actual water demand (inc. UAW) for the suburb. This exercise has been completed for all towns in Cederberg.

However, after evaluating the hydraulic models based on these water demands it was considered necessary to further analyse the theoretical unit water demands before applying these theoretical water demands directly to populate the water models.

Also, some of the towns experience a large holiday influx and the AADD-based demands cannot be adopted directly from Swift without further analysis, as these are based on the annual average. Instead, the data has to be further scrutinized in order to estimate water demands for each town and suburb, as discussed in Section 3.8.

3.7 LARGE WATER USERS

Table CEW3.7 is a list of all the stands defined as large users in Swift for Cederberg Municipality. The table shows the large users sorted per town and also includes the Wadiso node number to which the demand has been allocated. The tabulated information for each user (e.g. owner, consumer, address) is unchanged as recorded in the treasury system.

The definition of a large user is relative to the town size and is influenced by the layout of each water distribution system. The definition for large users as per this investigation is:

- Citrusdal - AADD > 20 kℓ/d;

- Clanwilliam - AADD > 20 kℓ/d;
- Elandsbaai - AADD > 3 kℓ/d;
- Graafwater - AADD > 3 kℓ/d;
- Lambertsbaai - AADD > 20 kℓ/d;
- Leipoldtville - no water demand data in SWIFT for Leipoldtville, thus no large users could be identified.

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 relevent consumer. The location of each large user is identified uniquely in view of its demand in the hydraulic model of the water distribution system.

3.7.1 General

The information shows that most of the large users are located in Clanwilliam, but the largest user is located in Lambertsbaai. Some of the large users in the treasury system could not be linked to a GIS Code (SG data) and subsequently it is not possible to identify the correct location for such users in the models. Such users can be identified by a lack of data in the GIS_CODE column as well as the NODE columns of Table CEW3.7.

It is critical that the location of these “unidentified” users be inspected on a one-to-one basis for addition in each water model. The location assigned to each of the other large users, for which GIS-codes and node numbers were assigned during this investigation, should also be inspected and verified on a one-to-one basis (e.g. in IMQS) by the Municipality.

The position currently adopted (as per the link between the treasury code and the GIS code) for each large user is shown in Figure CEW3.3 for each town.

Note: In order to identify the town it is necessary to inspect the first three digits of the column “Suburb” in the table.

3.7.2 Citrusdal

All but one of the large users in Citrusdal could be linked to a GIS code (a school at stand number 1752 remains to be linked).

The largest three water users are are “Citrusdal Koop wynkelders”, “Goede Hoop Sitrus” and “Citrusdal sentrale sport”.

3.7.3 Clanwilliam

The location of most large users are known. The largest are “Plet Houses”, “Clanwilliam Sekondere skool” and “Rooibos BPK”, all using more than 100 kl/d.

One of the large users for which a location could not be identified represents the irrigation of parks in Clanwilliam as a combined account, which could not be linked to a precise location in the water model (one of the account numbers is 009999061). In future each meter (for each park) should be given a separate account in the treasury system in order to distinguish between the water use at each of these locations.

3.7.4 Elandsbaai

The Municipal sports ground (23 kl/d) is the only significant large water user in Elandsbaai, although some others are also listed in the table. Only the smallest of these could not be located.

3.7.5 Graafwater

There are not many large water users in Graafwater. Boland AGRI (10 kl/d) is the most significant.

3.7.6 Lambertsbaai

The largest water user in Cederberg is located in Lambersbaai. It is recorded as “LBFC GROENTEAANLEG” in the treasury database. The acronym represents Lamberts Bay Fishing Company. This same company appears to have four different accounts in the treasury system, all including “LBFC” in the “Stand_Owner” field of the database.

The demand for “LBFC groente-aanleg” is 535 kl/d. However, the total for all the “LBFC” accounts is 637,0 kl/day, representing 22% of the total AADD for the town. This user alone represents more than 25% of all the water use by large water users in Cederberg Municipal area.

These water uses do not link to the same GIS stand, implying that they are geographically unique (the water is abstracted from different nodes in the hydraulic model). The exact extraction points for each of these four records has to be verified in order to ensure that the model is an accurate representation of the existing system.

Potential might exist to modify the water use (or use pattern) of one or more of these demand nodes in order to relieve the stress on the system during peak periods.

3.7.7 Leipoldtville

There is no information regarding water use in the treasury system for stands in Leipoldtville. Thus, no large users were identified.

3.8 WATER DEMAND USED FOR SYSTEM MODELLING

3.8.1 Motivation for further analysis of demand

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:

- Swift calculates the AADD per stand, but some towns' water distribution systems are stressed severely during periods of holiday influx or weather conditions (e.g. hot dry summers corresponding to high demand periods). These high-demand periods are not reflected by the AADD, which is an annual average. It is thus necessary to evaluate the water demand for each town individually by means of inspection and detailed analysis.
- The suburb, land-use and zoning codes maintained in the Municipality's treasury database are not considered reliable enough to allow demand calculations to be based solely on these codes. Mainly residential land uses could be allocated by means of the land use codes (and residential land use was also allocated to all records with no codes). However, the theoretical unit water demand calculated by Swift is strongly linked to the suburb category and land use of each stand, thus providing a result that is less accurate than if the suburb, land use and zoning descriptions in the treasury database were accurate.
- 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.
- Some of the towns are relatively small, with relatively small water distribution systems. It is important to evaluate each system uniquely and in more detail to ensure accurate results.

3.8.2 Water Demand

In order to estimate water demand per stand each town is subjectively divided into water-use-regions with similar unit water demands as shown in Figure CEW3.4. The results are shown in Table CEW3.8.

The Swift analysis provides valuable insight during selection of these water-use-regions and the unit water demand of stands in each area.

The theoretical water demand chosen as input parameter for the water model is presented as the last column in Table CEW3.8, for each water-use-region. The table also includes the unit water demand for stands based on one of three calculation methods to aid comparison:

- direct Swift results for all acupied stands in a suburb per stand size category (this information could be presented only if the water-use-region is identified as a suburb in the treasury system by means of a unique suburb code)
- where a particular water-use-region is not identified as a suburb in the treasury data it is possible to join the Swift results to the GIS data in order to investigate the water demand of ocupied stands in specific chosen water-use-regions.
- guideline estimates for unit water demand are included in order to compare the actual water demand reported by the treasurer (by one of the above means) to rigid results that would be used if no treasury data were available.

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 each town were taken into account (as presented by the Municipality's town planners). 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 additional 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 a development priority, as follows:

- Priority 1: In progress, imminent within the next few years
- Priority 2: Not foreseen in the near future

The potential future land developments in each town in Cederberg are shown on Figure CEW4.1. The land developments are coloured according to the land use and the perceived development priority is indicated as well.

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. For future RDP development the UWD of the existing RDP stands was projected to the future land use as well.

Where the UWD is based on area a water demand of 12 kl/day/ha is used for residential developments and 20 kl/day/ha for business/commercial/industrial developments. A summary of the potential future developments are listed in Table CEW4.1.

The backlog in RDP houses lead to the most notable future developments in most towns in Cederberg. The latest figures indicate a shortage of 850 RDP units for Clanwilliam, 450 for Lambertsbaai, and 2900 for Citrusdal. These numbers to not necessarily aggree with those presented by the Municipality's Town Planning Consultant. After consultation with the latter consultant, Municipal staff and some of the Municipality's Engineering Consultants the following number of RDP units were used in this investigation as an ultimate future scenario:

- Citrusdal, 1840, of which 640 are scheduled for construction in the near future.
- Clanwilliam, 1200, of which 300 are scheduled for construction in the near future.

- Elandsbaai, 300, of which 120 are scheduled for construction in the near future
- Graafwater, 600, of which 300 are scheduled for construction in the near future.
- Lambertsbaai, 1400, of which 450 are scheduled for construction in the near future.
- Leipoldtville, 10, not required immediately.

4.3 UPGRADING/RELOCATION OF INFORMAL AREAS

In each town the most significant potential future development is clearly extention to the RDP housing. In some instances this is to accomodate farm workers who require housing after moving to town from the rural areas.

4.4 FUTURE WATER DEMAND

The future AADD of the Cederberg system is summarised in Table CEW4.2.

The future AADD (modelled as the future system) represents an increase of between 1,1% and 2,6% per year over 20 years for towns in Cederberg when compared to the potential fully occupied present AADD (modelled as the existing system).

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 bulk water distribution 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 major objectives pursued in the evaluation and planning of the bulk water supply horizon for planning purposes – a scenario that would correspond to a time frame of about 25 years into the future.

5.1.2 Present and future AADD's

Existing systems were evaluated on the basis of their maximum potential present AADD, i.e. as though all presently developed stands are occupied and are using water in accordance with the assumed UWD's.

For planning of future systems, AADD's of all potential future developments and upgraded informal areas 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 CEW5.1.

5.1.4 24 h Water demand patterns

Actual measurements from previous work were used to establish typical 24-hour demand patterns for different land use types, and different system sizes. These are shown on Figure CEW5.1.

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 CEW5.2.

5.2.2 Fire fighting flows

Fire fighting flow and pressure criteria are listed in Table CEW5.2. The requirements are more or less in conformity with those prescribed by the so-called "Red Book" (Guidelines for Engineering Services and Amenities - Dept. of Housing, 1995).

Note that fire flow criteria were not used to evaluate the systems as part of this first round investigation.

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 1,5 m/s, but velocities of up to 2,0 m/s may be acceptable if 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 36 hours or 48 hours of the AADD (of the reservoir supply zone) for gravity and pumped supply to the reservoir respectively. It is noted that this could represent as little as 7 to 8 hours' storage of the peak day demand for high-peak consumers such as small coastal holiday towns.

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 CEW 5.3.

5.4 WATER TOWER SUPPLY RATES AND STORAGE CAPACITIES

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 CEW5.3 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

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 whatever way it has come about, 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 CEW5.4.

6. EVALUATION AND MASTER PLAN

6.1 EXISTING SYSTEM (FULLY OCCUPIED)

6.1.1 Overview and replacement value

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

- Figure CEW6.1 shows the static pressures in each system, thus the maximum pressure that could be expected in the system at any time.
- Figure CEW6.2 shows the residual pressures in each system under peak hour demand conditions.
- Figure CEW6.3 shows the flow velocity in the each system under peak hour demand conditions.

Table CEW6.1 gives an estimate of the replacement value of the existing Cederberg system, based on the cost functions shown on Table CEW5.4.

6.1.2 Citrusdal

The static analysis shows no areas where pressures exceed 90m.

Residual pressures in the existing system under peak hour demand conditions are mainly in the 24m to 60m range, which is within the range of the design criteria. Areas where pressures are the lowest are the high regions of the zone supplied by the low level reservoir (about 20m residual pressure), but this is not a concern.

There are no pipes with velocities exceeding 1.5m/s in the system.

6.1.3 Clanwilliam

The static analysis shows that pressures exceed 90m in parts on Crystal Waters based on the pump capacity used for the hydraulic model (refer to Table CEW2.3). Some pipes in the upper part of the Cederville reservoir zone have a static head that is lower than the design criteria (24m), but for most of the area the static pressure is more than 15m.

Residual pressures in the existing system under peak hour demand conditions are below the design criteria of 24m. Areas where pressures are below 15m include the higher parts of the industrial area currently supplied by the Platdammetjies reservoirs, some sections of the RDP area supplied by Cederville reservoir and the suction side of the 150mm diameter Crystal Waters pump station supply line. The latter problem is not yet experienced, because Crystal Waters is only partially occupied currently.

Areas where velocities exceed 1.5m/s include:

- the main 225mm diameter pipe from Platdammetjies reservoir to town (velocity about 1,7 m/s) and the section where it reduces to 150mm diameter (velocity 2,3m/s). The latter velocity is very high, but it is only in a short pipe section and the high velocity might be due to incorrect modelling of the pipe diameter for the 150mm section. The planbook could be used to verify whether the reduction from 225 to 150mm is at the right location.
- a schematic 75mm diameter pipe section leading to part of the RDP region. The latter is not a concern, since the actual layout is likely to include more than one pipe instead of only one, but the layout has not yet been captured (included) in the hydraulic model.

6.1.4 Elandsbaai

The static analysis shows no areas where pressures exceed 90m. It is not clear whether a PRV is present in the system and no PRVs were included in the model due to the lack of information regarding such pressure control devices.

Residual pressures in the existing system under peak hour demand conditions are mainly in the 24m to 60m range, which is within the range of the design criteria. There are no serviced areas in the model where pressures are below 24m.

The is one section where the velocity is equal to 1,5m/s – in the main 100mm diameter pipeline leading to the RDP housing (immediately after the reduction from 150mm on the northern side of the river). This is not critical.

6.1.5 Graafwater

The static analysis shows no areas where pressures exceed 90m, but one section on the northeastern side of town where the static pressure is below 24m.

Residual pressures in the services part of the system under peak hour demand conditions are in the 24m to 40m range, which is within the range of the design criteria.

The are no areas where the velocity exceeds 1.5m/s.

6.1.6 Lambertsbaai

The static analysis shows no areas where pressures exceed 90m and no low pressure areas (<24m).

Residual pressures in the existing system under peak hour demand conditions are below the criteria for most of the town due to the small altitude difference between the reservoir site and the stands in town (and the relatively small booster pump size). The greatest part of town has residual pressures below 24m, which are below the design criteria. Areas where pressures are below 15m include the entire north-eastern part of town. The low pressures in particularly Otterdam street region have been confirmed by operations staff as well.

There are a few critical pipes where velocities exceed 1.5m/s, of which the most sgnificant is the main 225mm diameter pipeline feeding to the north-eastern part of town where the velocity is between 1,6 m/s and 1,8 m/s.

6.1.7 Leipoldtville

The static analysis shows no areas where pressures exceed 90m.

Residual pressures in the existing system under peak hour demand conditions are mainly in the 24m to 60m range, which is within the range of the design criteria.

The are no areas where the velocity exceeds 1.5m/s.

6.2 BULK SUPPLY

The bulk system was not modelled as part of this investigation.

6.3 MASTER PLAN - CITRUSDAL

6.3.1 Discussion

The Citrusdal water distribution system has sufficient capacity to cater for the existing (fully occupied) scenario, and even has spare capacity, particularly in the zone supplied by the 3Ml high level reservoir.

The potential future developments address mainly the RDP housing backlog. With the location of the RDP houses as per this master plan these developments would link to the high level reservoir, which is advantageous due to the spare capacity in this part of the system. The pipes leading from the high level reservoir have sufficient capacity to cater for the future scenario, but the reservoir capacity would have to be extended. Verification of the existing pump and rising main capacity is an important first step to ensure that the existing capacity has been modelled accurately.

Also, the combined reservoir capacity of the low level reservoirs is slightly inadequate when compared to the criteria and the existing capacity should be verified. The reservoir capacity versus required capacity is summarised in Table CEW6.2.

6.3.2 Proposed future system

Static pressure in the proposed future system is shown in Figure CEW6.5(a), the residual pressure under peak demand in Figure CEW6.6(a) and peak flow velocity in Figure CEW6.7(a).

Proposed future water management zones remain unchanged and are presented in Figure CEW6.8(a).

The first 640 houses, as well as the next phase comprising 600 houses, could be supplied directly from the 150mm pipe leading from the reservoir to PRV1, with the future offtake just upstream of PRV1. However, the flow velocity in the 150mm pipe would then become high (>2 m/s) during peak periods. It would be more advantageous to provide a ringfeed as indicated on the master plan drawing to link the future system to more than one pipe in the existing distribution system. The ringfeed would be connected to the system where the two 100mm diameter pipes intersect one another near stand 3354, along Long str. The next phases would link to the ringfeed.

6.3.3 Required works and cost estimate

The cost estimates for the proposed future extensions are summarized, together with all other master plan items for Cederberg Municipality, in Table CEW6.3. The proposed future changes to the system are presented in Figure CEW6.4(a).

6.4 MASTER PLAN - CLANWILLIAM

6.4.1 Discussion

The existing (fully occupied) model of the Clanwilliam water distribution system shows that the system has to be modified in order to meet the residual pressure criteria during peak flow.

The potential future developments address mainly the RDP housing backlog, but extensions to the industrial area and residential area are also foreseen. The master plan includes additional pipes, re-zoning of the system, and additional reservoir capacity, as summarised in Table CEW6.2.

6.4.2 Proposed future system

Static pressure in the proposed future system is shown in Figure CEW6.5(b), the residual pressure under peak demand in Figure CEW6.6(b) and peak flow velocity in Figure CEW6.7(b).

Proposed zonal water meter locations and management zones are presented in Figure CEW6.8(b). Zone 1 would be fed from Platdammetjies (as is presently the case), Zone 2 from Cederville, and Zone 3 from the 3Ml reservoir.

A few aspects are noteworthy:

- The master plan items listed do not meet the criteria presented in Chapter 5. The unit water demands as per this investigation appear to be relatively high and could perhaps be reduced by effective water demand management instead of further infrastructure upgrades.

- The water demand at Crystal Waters is high according to the Swift analysis (refer to Chapter 3). If this high demand is sustained with the area fully occupied, infrastructure upgrades would be required in order to supply this demand. Such upgrades would include an additional parallel pipe to the pump suction side and upgrade of the pump. This could probably be avoided if the water demand of the consumers in this area could be curtailed by means of an efficient WDM programme.
- Also, the water demand for RDP stands in Clanwilliam are significantly higher than in other towns in Cederberg (0,800kl/stand/day compared to unit water demands of between 0,400 and 0,600 kl/stand/day in the other Cederberg towns), implying that a future WDM programme should also include the RDP area, which could lead to an improved residual pressure in the RDP development as well as the rest of town.

6.4.3 Required works and cost estimate

The cost estimates for the proposed future extensions are summarized, together with all other master plan items for Cederberg Municipality, in Table CEW6.3. The proposed future changes to the system are presented in Figure CEW6.4(b).

6.5 MASTER PLAN - ELANDSBAAI

6.5.1 Discussion

The Elandsbaai water distribution system has sufficient capacity to cater for the existing (fully occupied) scenario and has spare capacity. However, there are two aspects regarding the existing system that need to be verified (location and setting of the PRV on the main pipeline from the reservoir and the connectivity and diameter of the pipe/s leading from the reservoir). The latter was included as master plan item CEW.18.

The potential future developments address mainly the RDP housing backlog, but some low density residential stands in the western part of town are also foreseen.

The reservoir capacity has to be increased to allow for these future developments, as shown in Table CEW6.2.

6.5.2 Proposed future system

Static pressure in the proposed future system is shown in Figure CEW6.5(c), the residual pressure under peak demand in Figure CEW6.6(c) and peak flow velocity in Figure CEW6.7(c).

The system analysis in view of the future upgrades has not been completed pending the outcome of item CEW.18. The pressures indicated for the future system are below the design criteria and show that additional infrastructure upgrades, listed as the null-item CEW.22 in Table CEW6.3, would be required. The future developments, particularly in the western part of town, are likely to induce some infrastructure upgrades to the system. These could be accurately evaluated and included in this master plan as soon as item CEW.18 has been resolved.

Proposed zonal water meter locations and management zones are presented in Figure CEW6.8(c).

The modelled residual pressure in the western part of town drops to about 13m when the future developments are included, but no infrastructure upgrades are included in this mater plan to increase this pressure. The reason for this exclusion is the fact that the PRV in the system is not accurately modelled at this stage.

6.5.3 Required works and cost estimate

The cost estimates for the proposed future extensions are summarized, together with all other master plan items for Cederberg Municipality, in Table CEW6.3. The proposed future changes to the system are presented in Figure CEW6.4(c). Note that master plan item CEW.22 has a zero value (refer also to paragraph 6.5.2).

6.6 MASTER PLAN - GRAAFWATER

6.6.1 Discussion

The Graafwater water distribution system has sufficient capacity to cater for the existing (fully occupied) scenario and has spare capacity in view of future developments. The reservoir capacity requires upgrading, as summarised in Table CEW6.2, and the new developments require pipework to link to the existing water mains. However, no upgrades in the existing distribution system are required in view of these future developments.

6.6.2 Proposed future system

Static pressure in the proposed future system is shown in Figure CEW6.5(d), the residual pressure under peak demand in Figure CEW6.6(d) and peak flow velocity in Figure CEW6.7(d).

Proposed zonal water meter locations and management zones are presented in Figure CEW6.8(d).

6.6.3 Required works and cost estimate

The cost estimates for the proposed future extensions are summarized, together with all other master plan items for Cederberg Municipality, in Table CEW6.3. The proposed future changes to the system are presented in Figure CEW6.4(d).

6.7 MASTER PLAN - LAMBERTSBAAI

6.7.1 Discussion

The Lambertsbaai water distribution system has insufficient capacity to cater for the fully occupied existing load on the system. In other words, when all the existing serviced stands are occupied, and a simultaneous peak would occur, as is likely during periods of holiday influx, the system can not provide sufficient residual pressure to all stands as per the design criteria.

As shown in Table CEW6.2 the reservoir capacity is also insufficient and infrastructure upgrades are required to meet the existing fully occupied demand scenario. Additional upgrades are required in view of the existing system at the booster pumps.

The poor residual pressure in the system is mainly due to the low altitude of the reservoir in relation to that of the town, caused in turn by the relatively flat topology of the surrounding area. Also, the size of the booster pumps (as per the information available for the hydraulic model), are relatively small compared to what is actually required to meet the fully occupied demand scenario.

Required standby pump capacity is required to ensure redundancy in the system during these high influx holiday periods, but at present it is not in place. In conducting the master plan it was assumed that the first priority would be to at least ensure a residual pressure of 15m in the north-eastern part of town (around Otterdam street) instead of the 24m criteria. This would however not meet the design criteria normally used for housing in South Africa.

Significant upgrades would be required in future to cater for the foreseen future developments.

6.7.2 Proposed future system

Static pressure in the proposed future system is shown in Figure CEW6.5(e), the residual pressure under peak demand in Figure CEW6.6(e) and peak flow velocity in Figure CEW6.7(e).

It is clear that the proposed future system does not meet the design criteria in the section around Otterdam street. Additional infrastructure upgrades would be required to further improve the pressure if this is required by the Cederberg Municipality.

Proposed zonal water meter locations and management zones are presented in Figure CEW6.8(e).

6.7.3 Required works and cost estimate

The cost estimates for the proposed future extensions are summarized, together with all other master plan items for Cederberg Municipality, in Table CEW6.3. The proposed future changes to the system are presented in Figure CEW6.4(e).

6.8 MASTER PLAN - LEIPOLDTVILLE

6.8.1 Discussion

The Leiplodtville water distribution system is almost insignificant when compard to the other towns in Cederberg. The system has sufficient capacity to cater for the fully occupied existing load on the system and for the foreseen future developments.

6.8.2 Proposed future system

Static pressure in the proposed future system is shown in Figure CEW6.5(f), the residual pressure under peak demand in Figure CEW6.6(f) and peak flow velocity in Figure CEW6.7(f).

No changes are proposed to the system at this stage, but the reservoir capacity has to be verified.

Proposed zonal water meter locations and management zones are presented in Figure CEW6.8(f), but remain unchanged.

6.8.3 Required works and cost estimate

The cost estimates for the proposed future extensions are summarized, together with all other master plan items for Cederberg Municipality, in Table CEW6.3. The proposed future changes to the system are presented in Figure CEW6.4(f).

6.9 CONCLUSION

Most of the towns in Cederberg have spare capacity in the water distribution system to cater for full occupation of the existing town's stands, as well as for some future developments. In general the reservoir capacity is the main concern and almost all towns require upgrading of the reservoir capacity.

The most significant and -urgent changes are expected in:

- Clanwilliam (immediate re-zoning of the system with some additional pipes and valves required to cater for RDP developement) and
- Lambertsbaai (upgrade of pump station and provision of standby pumps).

In both cases the upgrades are required merely to satisfy the existing fully occupied demand scenario. Thus, prior to catering for additional RDP developments, work is required to improve the system reliability to meet the design criteria.

There is potential for WDM in Cederberg, with particular reference to Clanwilliam where the unit water demand is higher than in the other towns.

7. MASTER PLAN COST SUMMARY

7.1 PROJECTED CAPITAL EXPENDITURE

Table CEW7.1 is a summary of the costs associated with the proposed master plan.

Figure CEW7.1 shows the projected required capital expenditure to implement the master plan over time.

7.2 MASTER PLAN UNIT COST

The master plan implementation at cost of R16,425 million will increase the Cederberg system capacity from its present AADD of 9 577 kℓ/d to the future AADD of 13 372 kℓ/d. This amounts to a unit cost of R 4 328 /kℓ/d. The latter value is comparable to the implementation cost in other areas in the Western Cape.