
# Mpolweni Water Supply Scheme

## Preliminary Design Report

Appointment Ref.: 16/7/1/1

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**Revision 0**

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REPORT DETAILS

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*Approved for PSP by:*

| | |
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## Acronyms and Abbreviations

| | |
|---|---|
| AADD | Annual Average Daily Demand |
| CA | Competent Authority |
| BWL | Bottom Water Level |
| uMDM | UMgungundlovu District Municipality |
| DTM | Digital Terrain Model |
| DWS | Department of Water and Sanitation |
| EIA | Environmental Impact Assessment |
| EIR | Environmental Impact Assessment Report |
| EMPr | Environmental Management Programme |
| ESCBPH | Escongweni BPH Engineers |
| HSE | Health Safety & Environment |
| HDPe | High Density Polyethylene |
| O&M | Operation and Maintenance |
| QA | Quality Assurance |
| QC | Quality Control |
| PQP | Project Quality Plan |
| PPP | Public-Private Partnership |
| RACI | Responsible, Accountable, Consulted and Informed |
| RFI | Request for Information |
| RFP | Request for Proposals |
| RoD | Record of Decision |
| SLA | Service Level Agreement |
| SAC | Sector Appraisal Committee |
| TA | Transaction Advisor |
| TWL | Top Water Level |
| UW | Umgeni Water |
| VIP | Ventilated Improved Pit |
| uPVC | Unplasticized Polyvinyl Chloride |
| BWL | Bottom Water Level |
| WULA | Water Use Licence Application |

# 1 INTRODUCTION

uMgungundlovu District Municipality (uMDM) appointed Escongweni BPH Engineers (ESCBPH) to provide professional services required for the design and implementation of the Mpolweni, Thokozani and Claridge Water Supply Scheme.

This report covers the preliminary investigation, route selection, planning and costing for the level of design appropriate to make all decisions on feasibility and the selection of the most desirable project option for the implementation of the Mpolweni Thokozani Water Supply Schemes.

All designs are based on “Guidelines for Human Settlement Planning and Design”, (Red Book) and uMDM's Design guidelines.

# 2 BACKGROUND

The project area is located in uMshwathi Local Municipality within the uMgungundlovu District Municipality in KwaZulu Natal. The project area can be accessed by travelling along the R33 main road between Pietermaritzburg and Greytown. After turning into the R614 provincial road, the project area is located approximately 5.5km further ahead.

## 2.1 PROJECT LOCATION

The project area comprises of three communities; Mpolweni, Thokozani and Claridge.
The project area is located in uMshwathi Local Municipality within the uMgungundlovu District Municipality in KwaZulu Natal. The project area can be accessed by travelling along the R33 main road between Pietermaritzburg and Greytown. After turning into the R614 provincial road, the project area is located approximately 5.5km further ahead. Please find attached in Annexure A the project location boundary and existing infrastructure.

*Table 1: Project Location*

| Sub-Project No. | Project Area | Latitude* | Longitude* | District Municipality | Local Municipality |
|---|---|---|---|---|---|
| 1 | Mpolweni Community | 29°25’15.71’’S | 30°28’49.99’’E | uMgungundlovu (DC22) | uMshwathi |
| 2 | Thokozani Community | 29°25’44.75’’S | 30°26’19.44’’E | uMgungundlovu (DC22) | uMshwathi |
| 3 | Claridge Community | 29°31’25.51’’S | 30°23’3.52’’E | uMgungundlovu (DC22) | uMshwathi |

The coordinates for the project area are listed in table 1 above. These coordinates indicate the estimated centre of the communities. Figure 1 illustrates the overall project area.


*Figure 1: Locality Plan*

The Mpolweni community has existing reticulation obtained through asbuilt drawings from UMDM. The existing reticulation pipelines was constructed by Umgeni Water in 1997 and will be considered in the new design where possible. Thokozani has no record of any existing reticulation from UMDM or Umgeni Water however, from site inspections it was identified that 40% of the area is currently reticulated.

# 3 PROJECT OBJECTIVES

The primary objectives for the project are summarised as follows:

- To provide access to a portable water supply to the various communities in the project
- To reduce the water services backlog and uplift the standards of living of the communities in question
- To provide the community with a uniform level of service of a house connection.
- To construct new infrastructure that will serve to satisfy the increasing water demand within the project area.
- To provide an economically efficient solution to the water supply problem.
- To provide a level of service that will ultimately allow for a waterborne sanitation system in future.
- To provide employment for local labour.
- To provide and encourage skills development through intensive programmes directly involved in the planning, construction and commissioning of the scheme.

# 4 *Overview* of Regional Planning Studies

The following pieces of information were received from the uMDM and its service providers:

- Draft feasibility study for the Mpolweni as submitted to DWA; *prepared in 2012 and provided by uMDM*
- The uMshwathi Bulk Water Scheme – Mpolweni Secondary Bulk Water Pipeline & Reservoir design report (7,5km X 315-250mm Ø UPVC Pipe & 4.0ML Concrete Reservoir); prepared *in 2014 and provided by uMDM*
- *Mpolweni, Thokozani and Claridge Business plan; prepared in 2019 based on the need of all three communities*

# 5 SCOPE OF WORK

The technical scope of works is the reticulation of the water network for Mpolweni which includes all pipelines, valves, hydrants, meters and ancillary components. The scope of work includes the refurbishment of the existing bulk storage infrastructure, the complete upgrade of the reticulation complete reticulation network within the project boundary with house connections. The upgraded associated infrastructure will have a design life of 20 years from construction completion.

# 6 WATER SOURCE

Raw water is collected at Midmar Dam which is the source water to the Upper Mgeni System. The raw water is treated at DV Harris Wastewater Treatment Works which can distribute 120Ml/day as confirmed by the managing water board Umgeni Water. The on-site distribution reservoir at the DV Harris WWTW has a Top Water Level (TWL) of 979.000msl. A 1000mm diameter steel bulk pipeline delivers water to the command reservoirs in Claridge.

There are two command reservoirs situated alongside each other which consist of a 23Ml/day Belfort reservoir that supplies the Msunduzi area and a 50Ml/day Claridge reservoir supplies water to the uMshwathi area via the Wartburg sub-system. The Wartburg sub-system includes water supply to the project areas of Mpolweni, Thokozani and Claridge. The existing Claridge reservoir has a capacity of 50 Mℓ/d with a TWL of 940.297m.

Umgeni Water prepared the figure 2 below which illustrates the sales trends for the DV Harris WTW. The red line is the annual average sales/ usage while the green line illustrates the forecasted demand requirements for the Wartburg sub-system. The flow projections did start from July 2018 with the assumption that the new 850mm diameter pipeline, as highlighted in the following section 7 below, would become active. The forecasted demand requirements have a continuously increasing grade for the next three years (2020 to 2023) since Umgeni Water have included the projected water demand requirements for the project areas Mpolweni and Thokozani based on the findings of this preliminary design report.

The estimated water demand requirements for Claridge was also included by Umgeni Water however, further investigations and information is still required to finalise the preliminary design.

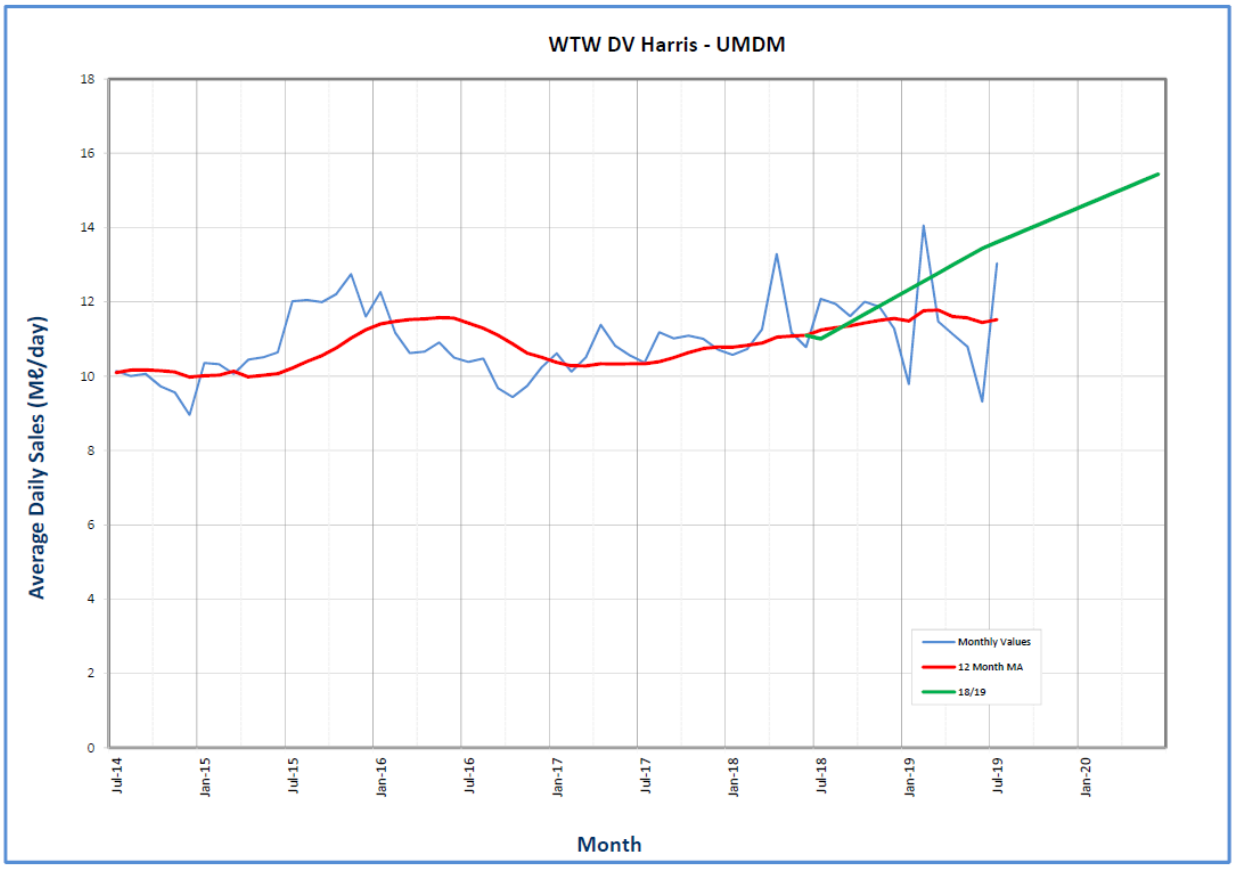



Figure 2: DVH UMDM Sales Trends

Umgeni Water have included the bulk water demand requirements as per the calculations within this report (Annexure B) thus acknowledging their commitment to UMDM for the bulk water supply to Mpolweni, Thokozani and Claridge for the next 20 years. Furthermore, an approval/ confirmation letter has been requested from Umgeni Water.

# 7 EXISTING INFRASTRUCTURE

The existing infrastructure consists of bulk water supply infrastructure including a water treatment works, bulk pipelines and storage reservoirs. Raw water is collected at Midmar Dam and treated at the DV Harris water treatment works which has an on-site distribution reservoir with a Top Water Level (TWL) of 979.000 msl. The existing Claridge reservoir has a capacity of 50 Mℓ/d with the TWL of 940.297msl.

The Mpolweni area was supplied via a 160mm diameter secondary bulk pipeline to two existing reservoirs of 400 Kℓ/d each with TWL of 795.000msl and 717.000msl respectively and thereafter distributed to the existing reticulation network. The reticulation network does not service all the residents within the project boundary hence UMDM initiated a project that augmented the bulk supply to Mpolweni.

A new 300mm/ 250mm diameter secondary bulk pipeline and a 4Ml reinforced concrete reservoir was constructed with sufficient capacity to supply the current population of Mpolweni and considering future growth and planned developments within the area. As part of this project, the water from the outlet of the 4Ml reservoir will distributed to every household and flow requirements allowed for expansion.

During multiple site investigations, it was noted that the meters are clustered, with five or more meters at one location without any indication as to which meter connects to which house thus UMDM water revenue department is unable to bill the relevant consumer.
The existing reticulation network within Mpolweni is insufficient for the current households, thus resulting in some houses not having any access to water. The length of existing reticulation is approximately 45 740m of pipe ranging from 40mm to 160mm in diameter. The Umgeni Water asbuilt details are dated 1997 (22 years ago), thus the design life has lapsed.

Over the years UMDM Operations and Maintenance Department has replaced many pipes within the existing network hence existing reticulation will be considered for future use during the design stage, on condition that the current quality of the pipelines are acceptable and the existing pipe diameters and class align with the required diameters based on the design model. The new command reservoir of 4 Mℓ/d at Mpolweni currently utilises approximately 2Ml.

The Thokozani area is estimated to have 40% reticulated with water pipelines based on visual inspections however, it has been noted by UMDM that the pipes are very old and with multiple leaks and bursts. For this reason, the undertaking is that a completely new reticulation network will be designed and constructed. Similar to Mpolweni, UMDM have provided new a new secondary bulk system with a 2Ml reservoir which will be sufficient to serve the population of Thokozani with estimated future growth over the next 20 years.

The existing bulk pipelines are split into various sections below;

- DV Harris WTW to Claridge Reservoir – A 1000mm diameter steel pipeline gravitates to the command reservoir
- Claridge Reservoir to Wartburg – A new 850mm diameter steel pipeline gravitates to the Wartburg reservoir and other distribution areas
- Claridge Reservoir to Wartburg – An older 300mm diameter steel pipeline gravitates towards the 2Ml Wartburg reservoirs
- Wartburg pump station to 4Ml Mpolweni Reservoir – A 315mm uPVC which connects to a 300mm steel pipe, which ultimately connects to a 250mm uPVC feeds the reservoir
- Claridge Reservoir to Thokozani Distribution reservoir – A 200mm diameter steel pipelines branch off the 300mm diameter steel pipeline which feeds Wartburg
- Wartburg Pump station to 400kl Mpolweni reservoirs – A 160mm diameter steel pipeline off-take from the 300mm steel to Wartburg feeds these reservoirs. It is planned that this line will be decommissioned once system is fully functionally.

# 8 ESTIMATED CURRENT AND FUTURE WATER DEMANDS

The demand for the project area will be calculated based on the Annual Average Daily Demand (AADD) which will not only incorporate households, but also special institutions located with the project area such as schools, clinics, business parks and so forth.

The water demand is calculated based on standard guidelines. In summary, demands shall be analysed as follows:

- **Present demand** – to be obtained from physical site counts based on cadastral layout and recent uMgungundlovu aerial photography.
- **Future demand** – Town planning schemes to be used to allocate site demands based on planned land use zoning as well as population growth estimates based on Census statistics

## 8.1 DESIGN PHILOSOPHY

This chapter describes the design parameters that are proposed to be used for the design of the replacement pipelines for this project. These criteria have been compiled using the Human Settlement Planning Design Guidelines (Red Book), Standards of the uMDM and accepted national design practice.

### 8.1.1 Design Criteria

The design criteria are summarised as follows below, see annexure B for the calculation sheet;

Table 2:Design criteria

| Item | | Description | Design Parameter |
|---|---|---|---|
| 1.0 | | Design horizon | 20 years |
| 2.0 | | Population | • Census 2011<br>• StatsSa<br>• Google Earth Desktop Study<br>• IEC (2019)<br>• House Counts |
| 3.0 | | House Occupancy | 5 people per household |
| 4.0 | | Growth Rate | 1.5% / 2.5% per annum |
| 5.0 | | Design Water Usage | 85 l/c/d |
| 6.0 | | Conveyance Losses | 15% |
| 7.0 | | Summer Peak Factor | 1.5 |
| 8.0 | | Instantaneous Peak | 4 |

## 8.2 Mpolweni

Current household counts and typical population statistics based on house counts from aerial imagery are shown in the table below. Population estimates were based on an occupancy rate of 1:5 for each household meaning that there is an average of five people living in each household.

Initial indications based on design standards allowed for 8 people per household however, with recent visits to the area and from latest imagery it can be noted that the norm is for a single dwelling unit per plot which resides between 4 to 6 people per unit per plot.

Information received from StatsSA indicated a population growth of 1.37% between Census 2001 and Census 2011. IEC results from the latest 2019 presidential elections was inconclusive since only half the population in the area voted.

The area demographics report done in 2012 recorded a total number of 2858 of existing households and 1113 potential households as part of a future housing development noted by uMshwathi Local Municipality. A further 3500 sites in KameelHoek has also been targeted for housing development.

A desktop study was conducted in 2019 using the latest Google earth imagery which resulted in an existing house count of 2524. This is 334 houses less than the count done in 2012. Since 2012, the planned housing developments did not get implemented however, it is likely that it did not occur due to lack of services within the area.

Although a negative growth can be seen in the past 7 years, future housing developments are reliant on the availability of services. Housing developments have already been planned for the area which will attract additional residents and will result in more housing developments for the area.

Current household counts and typical population statistics based on house counts from aerial imagery are shown in the table below. The number of households to be served by this project is 6 024 houses for Mpolweni and 2 030 houses for Thokozani.

The area within the project boundary has potential of growing based on the land availability hence a growth factor of 2.5% was used as a conservative measure.

Table 3: Mpolweni house counts

| Sub-Area | Household Counts | Estimated Population |
|---|---|---|
| Emvundlweni | 319 | 1,595 |
| Mpolweni | 743 | 3,715 |
| Newtown | 317 | 1,585 |
| Emseni | 466 | 2,330 |
| Ekukhuleni | 203 | 1,015 |
| Vundla road | 111 | 555 |
| Ematshali Ext 1 | 240 | 1,200 |
| Kogcwabaza | 162 | 810 |
| New (Recently completed) | 40 | 200 |
| Planned (KameelHoek) | 3,500 | 17,500 |
| **Total** | **6,101** | **30,505** |

The following base data and design criteria were used to estimate the current and future demand for the Mpolweni community:

**Households**

| | |
|---|---|
| House Occupancy: | 5 people per household |
| Design Period: | 20 years |
| Population Growth: | 2.5% per annum |
| Losses: | 15% |
| Consumption: | 85 l/c/d |

Therefore, the Gross Annual Average Daily Demand (GAADD) can be calculated as follows:
GAADD= [(6,101 households x 5 ppl/household x 85 l/c/d) + 15% losses] = 2,981,863 l/day **say 3.0 Ml/day.**

The future GAADD is: 2.981 + 2.5% growth per year for a period of 20 years = 4.767 Ml/day **say 4.8 Ml/day**

Based on the above flow requirements, the current reservoir infrastructure (4Ml, Res A- 400kl, Res B- 400kl) has sufficient capacity for 24hour storage which is in accordance to the UMDM design report for the 4Ml reservoir.

## 8.3 Thokozani

A house count of the Thokozani area was conducted using aerial images as shown below while also reflecting on The Department of Human Settlements future plans for the area. With the already clustered layout of houses in the area and the limited space for additional growth a growth factor of 1.5% has been used as a conservative factor.

Table 4: Thokozani house counts

| Settlement Name | Estimated No. of Households | Population Estimate |
|---|---|---|
| Thokozani | 1171 | 5,855 |
| Planned | 859 | 4,295 |
| **Total** | **2,030** | **10,150** |

The following base data and design criteria were used to estimate the current and future demand for the Thokozani community:

**Households**

| | |
|---|---|
| House Occupancy: | 5 people per household |
| Design Period: | 20 years |
| Population Growth: | 1.5% per annum |
| Losses: | 15% |
| Consumption: | 85 l/c/d |

Therefore, the Gross Annual Average Daily Demand (GAADD) can be calculated as follows:

GAADD= [(2,030 households x 5 ppl/household x 85 l/c/d) + 15% losses] = 992,162 l/day **say 1 Ml/day.**

The future GAADD is: 0.992 + 1.5% growth per year for a period of 20 years = 1.317 Ml/day **say 1.32 Ml/day**

Thokozani has an existing reservoir with the capacity of 2Ml/day. This means that Thokozani has sufficient capacity for the next 20 years.
The future projection for the two communities is as tabulated below:

Table 5: Future population projection

| Area Description | Current | | 20-year horizon | |
|---|---|---|---|---|
| | No. of Households | Estimate Population | No. of Households | Estimate Population |
| Mpolweni | 6,101 | 30,505 | 9,440 | 47,200 |
| Thokozani | 2,030 | 10,150 | 2,886 | 14,430 |

## 8.4 Peak demand and Peak Factors

The peak demand which will be used to determine the capacity of the various scheme elements are as follows:

Reticulation: Instantaneous Peak Factor = 4
Summer Peak Factor = 1.5

Bulk and Secondary Bulks: Peak Factor = 1.5

Residual Pressure at consumer connections: Between 18m and 80m
(refer to annexure E for civil designer outputs)

# 9 PROPOSED INFRASTRUCTURE

## 9.1 Zoning

The assessments conducted in the Mpolweni project area proved that the houses surrounding the 4Ml reservoir are at the same level as the 4Ml reservoir. Thus, those houses cannot be serviced by the 4Ml reservoir due to insufficient pressure at each household. Furthermore, investigations and pressure management highlighted that a portion of houses near the Wartburg pump station cannot be served by the 4Ml reservoir as the pressures would be insufficient. This resulted in both those areas requiring an elevated tank each to ensure each house/ metering point has a minimum pressure of 1.8bar.

The 4Ml zone is the largest zone within the project. The zones where therefore identified by means of available storage and pressure. Refer to annexure C for the three zones within Mpolweni.

The Thokozani investigations showed that the one reservoir of 2Ml that is servicing the area has sufficient pressure for all houses/ metering points within Thokozani. The project area has no rivers or drastic valleys that would entail the project area to be split into zones.

## 9.2 Pressure management

Pressures in Mpolweni will be managed by splitting the water scheme into three hydraulic pressure zones. Two zones will be commanded by two elevated tanks of 150kl. The reservoirs have been sized based on 24-hour storage which is greater than the 4hours recommended in the Guidelines for Human Settlement, Planning and Design (The Red Book). The need for the elevated tanks is to ensure that the households within the high lying areas have at least a minimum of 1.8bar pressure at their meter connection. The remaining zone will be commanded by the 4Ml reservoir. The two existing 400kl reservoirs is proposed to be refurbished based on the capacity requirements noted in section 8.2 above.

The first 400Kl reservoir (Res A) is located next to the 4Ml reservoir and will be used as additional storage to the 4Ml. The second 400Kl reservoir (Res B) is located approximately centrally of the project area. This reservoir will serve as both additional storage to the 4Ml and act as a break pressure tank (BPT) to the low-lying areas within the 4Ml reservoir pressure zone. Res B (Proposed BPT) will have its own designated sub-zone with main reticulation pipeline from the 4Ml. The existing secondary bulks will be used; which includes a 300mm diameter steel pipeline, a 315mm diameter uPVC pipeline, and a 250mm diameter uPVC pipeline.

Thokozani has one zone supplied from the existing 2Ml reservoir. The existing bulk pipeline that feeds the 2Ml reservoir will be maintained; which includes a 200mm diameter steel pipeline that branches from the existing 300mm bulk steel pipeline. The new pipe network will start from the outlet of the 2Ml reservoir.

In the case of reticulation mains, pressures will be managed by the construction of pressure reducing valves in order regulate pressures.

| Area | No. of Pressure Reducing Valves |
|---|---|
| Mpolweni | 57 |
| Thokozani | 0 |

## 9.3 Reticulation layout

The reticulation will consist of mains varying in diameter from 25mm to 250mm. The layout was chosen to follow the alignment of the access roads as far as possible, to mitigate the environmental impact. (refer to Annexure D). The Mpolweni reticulation totals at 203,770m and the Thokozani reticulation is 48,260m.

The water connection for each household will consist of a 25mm diameter HDPe service pipe with a water meter. Households without water connections will have to apply for these connections through the ISD consultant under this contract for them to be registered under uMDM's consumer database. Water meters are necessary for billing purposes and for water balancing in the event of leak detection.

Table 6 below shows the proposed pipe lengths for the project's reticulation.

Table 6: Proposed Reticulation Lengths

| Area | Hydraulic Zone | Reticulation pipe length (m) | Total Length (m) |
|---|---|---|---|
| Mpolweni | Zone 1 | 16,650 | 203,770 |
| | Zone 2 | 163,340 | |
| | Zone 2a | 12300 | |
| | Zone 3 | 11,030 | |
| Thokozani | | 48,260 | 48,260 |
| **Total** | | | **252,030** |

Refer to layout plan drawing Annexure D.

## 9.4 Metering

### 9.4.1 Customer Meters

All existing customer meters will be analysed in order to determine if it's possible to refurbish and reuse or if there's a need for the meters to be replaced. The meters will be installed above ground in plastic housings. The meters will be installed 1m from the property boundary and 1m from the road reserve.
Each customer will apply to uMgungundlovu District Municipality for a billable water connection and the responsibility of the connection from the meter to the house with be the customers responsibility.

### 9.4.2 Metering Zones and Intelligent Meter Reading

#### *9.4.2.1 General*

Provision is made for the installation of new meters with manually read registers, however "intelligence" devices can be added to the new meters that will monitor water consumption and allow the meters to be read electronically by a short-range radio transmitter-receiver device.

A bulk meter chamber has been constructed at the main off-take from the Mpolweni Pump station. The reservoirs to the respective zones will also be metered. Where zone footprints are relatively large, the zone will be sub-divided with a meter, thus allowing a completely monitored flow network.

#### *9.4.2.1 Metering Zones*

Mpolweni has been divided into five metering zones and zone boundaries have been defined so that customers in the database can be allocated to a metering zone. This will enable relatively accurate water balances to be carried out for the system as a whole and within the metering zones. Table 7 below shows the current Gross Annual Average Daily Demand for the Mpolweni metering zones.

Thokozani has been divided into two metering zones and zone boundaries have been defined so that customers in the database can be allocated to a metering zone. This will enable relatively accurate water balances to be carried out for the system as a whole and within the metering zones. Table 8 below shows the current Gross Annual Average Daily Demand for the Thokozani metering zones.

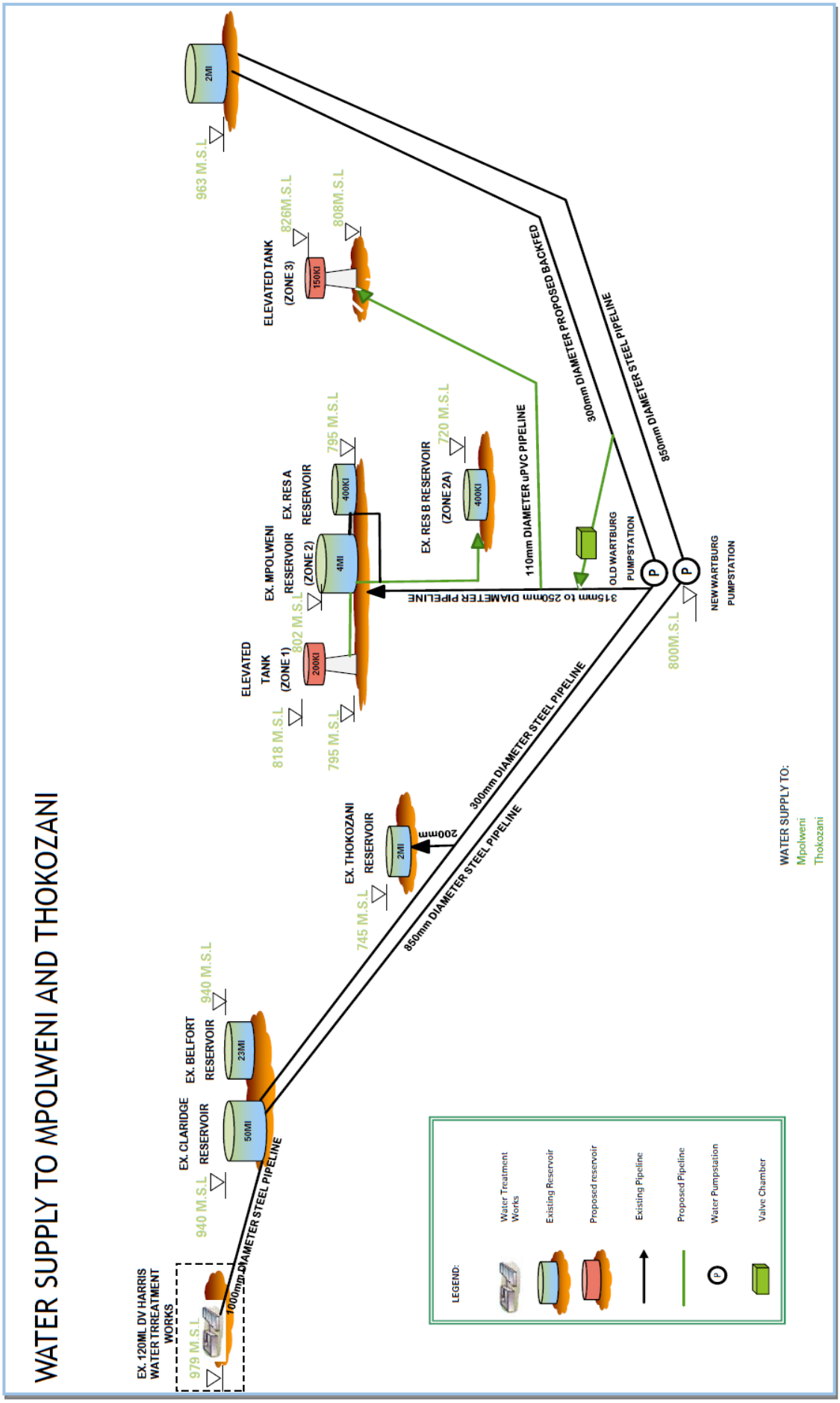
Table 7 : Demands for Metering Zones for Mpolweni

| Hydraulic Zone | House Count | Demand (l/capita/day) | AADD (kl/day) | Losses @ 15% | GAADD (kl/day) |
|---|---|---|---|---|---|
| Zone 1 | 216 | 85 | 82 | 14 | 106 |
| Zone 2 | 5605 | 85 | 2382 | 357 | 2739 |
| Zone 2a | 118 | 85 | 50 | 8 | 58 |
| Zone 3 | 162 | 85 | 69 | 10 | 79 |
| Total | 6101 | | 2593 | 389 | 2982 |

Refer to drawing Annexure C for zones.

Table 8: Demands for Metering Zones for Thokozani

| Hydraulic Zone | House Count | Demand (l/capita/day) | AADD (kl/day) | Losses @ 15% | GAADD (kl/day) |
|---|---|---|---|---|---|
| Thokozani | 2030 | 85 | 863 | 129 | 992 |


WATER SUPPLY TO MPOLWENI AND THOKOZANI
EX. 120ML DV HARRIS WATER TRREATMENT WORKS
979 M.S.L
1000mm DIAMETER STEEL PIPELINE
EX. CLARIDGE RESERVOIR
50Ml
940 M.S.L
EX. BELFORT RESERVOIR
23Ml
940 M.S.L
850mm DIAMETER STEEL PIPELINE
300mm DIAMETER STEEL PIPELINE
EX. THOKOZANI RESERVOIR
2Ml
745 M.S.L
200mm
ELEVATED TANK (ZONE 1)
200Kl
802 M.S.L
818 M.S.L
EX. MPOLWENI RESERVOIR (ZONE 2)
4Ml
795 M.S.L
EX. RES A RESERVOIR
400Kl
795 M.S.L
EX. RES B RESERVOIR (ZONE 2A)
400Kl
720 M.S.L
315mm to 250mm DIAMETER PIPELINE
110mm DIAMETER uPVC PIPELINE
OLD WARTBURG PUMPSTATION
P
NEW WARTBURG PUMPSTATION
800M.S.L
ELEVATED TANK (ZONE 3)
150Kl
826M.S.L
808M.S.L
963 M.S.L
2Ml
300mm DIAMETER PROPOSED BACKFED
850mm DIAMETER STEEL PIPELINE
WATER SUPPLY TO:
Mpolweni
Thokozani
LEGEND:
Water Treatment Works
Existing Reservoir
Proposed reservoir
Existing Pipeline
Proposed Pipeline
Water Pumpstation
Valve Chamber

# 10 PROPOSED PIPELINE DETAILS

## 10.1 Material Type Selection

The pipe material will be selected based on the pressure levels obtained in the design (refer to annexure E for civil designer outputs).

For pipes 50mm and below, with pressures of PN16 or below, HDPE pipe is used.
HDPe was selected for the following reasons:

- A very tough, durable pipe material ideal for handling, transporting and laying and ideal for traversing the various streams and erosion dongas
- Due to the toughness of the pipe material, the specifications for Selected Granular and Selected Fill materials for pipe bedding can be relaxed by allowing a slightly higher PI. This also enables higher quantities of excavated materials from trenches and other excavations to be used for bedding material with or without the need for screening. There are time and cost benefits associated with this as there appears to be a shortage of suitable bedding materials in the area
- The advantage of being able to curve the pipes around, over or under obstacles without the need for expensive bends and fittings.

For the bulk mains and reticulation pipes greater than 50mm, with pressures less than 16 bar, uPVC Class 16 and 12 is used.
uPVC was selected for the following reasons:

- The light weight of the pipe is ideal for handling – suited to labour intensive projects
- It is easy to install
- Durability and toughness – resistance to installation damage
- It has low frictional resistance and enhanced hydraulic performance

During the preliminary design, it was evident that there will be no reticulation pipelines exceeding 12 bar pressures. Thus, only uPVC and HDPe pipes will be used in the reticulation. However, where there are stream crossings and above ground pipelines, steel pipes will be used.

Where steel pipes are required, light duty TOSA wrapped klambon pipes were initial proposed as used only on previous UMDM water supply projects however, it has recently been discovered that the main supplier of these pipes has liquidated their business and can no longer supply klambon pipe (see Annexure F for Robor Liquidation letter and Certificate). GMS pipe rolled grooved and jointed using couplings and wrapped with Denso tape (see Annexure G) are proposed as an alternative because;

- pipes are similar to Klambon however, the type of wrapping differs (TOSA wrap for Klambon and Denso wrap for other groove ended pipes)
- It must also be noted that TOSA wrapped pipes when damaged are repaired with Denso tape which makes the difference in wrapping minimal.

- Withstands high pressures
- May be used above ground
- Can be easily jointed using couplings
- Requires cathodic protection

## 10.2 Pipe Trenching and Bedding

Trench excavations will be carried out in accordance with SABS 1200, DB Earthworks (Pipe trenches) and pipe bedding in accordance with SABS 1200, LB Bedding (Pipes).

The trench width will be the outside diameter of the pipe plus 150mm either side. The minimum trench width will be 450mm. The minimum trench width and depth will be reduced for smaller diameter pipes i.e. house connections. This will be in line with the EPWP programme and its implementation will be clearly defined in the Schedule of Quantities. Dual trenches to have smaller reticulation pipe 300mm higher than the larger parallel pipe within the same trench.

The trench depths, as per the Red Book will be as follows:

- Road Crossings: Pipe diameter + Bedding + 0.8m
- Otherwise: Pipe diameter + Bedding + 0.6m

The pipe bedding will consist of selected granular bedding material of thickness at least 100mm beneath and on top of the pipe, with a 200mm layer of selected fill material on top of the granular material, beneath the trench backfill material, in accordance with Drawing LB – 2 in SABS 1200, LB.

The trench will be excavated by hand to grade out all local high and low points to minimize the need for air and scour valves.

## 10.3 Erosion Control Measures

The topsoil will be removed along the proposed pipeline route to suit trench width, at a depth of 150mm and stockpiled separately from the other excavated material.

After pipe laying and the backfilling and compacting of the trench material, the topsoil will be reinstated and lightly compacted.
On downhill slopes the trench will also be backfilled so that the backfill material forms cut-off berms at regular intervals, at least 150mm higher than the ground either side of the trench to prevent surface water from running along the trench and eroding the backfilled material.

An environmental consultant will be appointment to address all environmental requirements and ensure compliance on the overall project.

### 10.4 Pipe handling, laying, jointing and trench installation

Particular Specifications will be included in the procurement stage. All construction contracts to cover the handling, laying, jointing, installation and testing of the pipes will be as per SANS 1200 and the Client's specification.

A provision of not more than 500m of pipeline sections will be laid tested before excavations for other sections can commence.

## 11 VALVE AND OTHER CHAMBERS

Isolating valves will be installed at 2000m intervals for bulk mains and at major offtakes/ branches for the reticulation mains.

Air valves will be installed at all local high points and at 600m maximum spacing along flat pipe runs in bulk mains.

Scour valves will be installed at all local low points along bulk and reticulation mains. The type of scour valve to be used under this contract will be the flanged cast steel wedge gate valve to SABS 664, minimum class 16 with non-rising spindle and clockwise closing when viewed from above.

Pressure Reducing Valves (PRV's) will be situated where the pressure in the reticulation mains exceeds 7.5 bar. There are 30No. PRVs proposed under this project (refer to annexure E for civil designer outputs).

## 12 STREAM CROSSINGS

There are two watercourses which will need to be crossed along the proposed pipeline route. A geotechnical investigation will be done during the design stage to determine whether a stream crossing below ground would be viable versus a bridge strapping for both crossings.
The first crossing is required for a 100mm diameter pipes located between Ematshali Ext. 1 and Vundla as seen in figure 2 below. The proposed route is parallel to the existing 250mm diameter steel pipe crossing.


Figure 2: Stream crossing No. 1

The second crossing is of a 250mm diameter pipe is located at the entrance of Kameelhoek as seen in figure 3 below.


Figure 3: Stream Crossing No. 2

Stream crossings will be along the roads and on visible tracks. Where a pipeline crosses a watercourse above ground, HDPe / uPVC pipes will change to a steel pipes before crossing and change back after crossing the watercourse.

Where practically possible, pipelines will be buried below ground at watercourse crossing to avoid the obstruction of the natural stream flow.

# 13 PIPELINE AND JOINT TESTING

*Hydraulic Pressure Testing:* The pipeline will be pressure tested in sections up to 1.25 times the pressure (PN) rating of the pipe section under test. The pressure test process will be as per Clause 7.3 of SABS 1200L.
After attaining the full test pressure, the pressure decrease rate is recorded and compared with the allowable decrease rate and relevant actions taken depending on the result. The pressure in the pipe is then decreased in steps and the pipe pressure recorded.

Due to the nature of the HDPe material, the pressure test process will not be as per Clause 7.3 of SABS 1200L but will be as per the process described in the Particular Specifications in the tender document. This will involve the stepped increase in test pressure over a stated time period allowing for the HDPe pipe to deform visco-elastically. After each pressure increase the pipe is given sufficient time to deform (expand) which is indicated by a pressure drop due to this expansion, before the test pressure is then increased again.
After attaining the full test pressure, the pressure decrease rate is recorded and compared with the allowable decrease rate and relevant actions taken depending on the result. The pressure in the pipe is then decreased in steps and the pipe pressure recorded.

*Destructive testing***:** Random samples of butt-welds are cut out of the pipe and subjected to destructive tensile tests (and bending tests if ordered) either by an approved in-field testing process (preferred to save time), or by the Southern African Plastic Pipe Manufacturers Association (SAPPMA) or any other approved testing authority.

# 14 ROAD CROSSINGS

Surfaced (bitumen) road crossings and gravel road crossings will need to be done. It is the requirement of the Department of Transport DoT that all road crossings be carried out by pipe boring whilst it is proposed that gravel road crossings be carried out by open cut trenching with the necessary provision for traffic deviations and control. This proposal will be confirmed with DoT prior to construction whilst allowance is made for pipe boring for all road crossings.

# 15 AS-BUILT INFORMATION

Within Mpolweni, there is currently information of the existing bulk pipelines from the pump station to the 4Ml reservoir that was constructed in 2017. The pipelines range from 160mm diameter pipe to a 315mm diameter pipe. The pipe materials include uPVC and Klambon. The existing reticulation network within Mpolweni has the length of approximately 45 740m of pipe ranging from 40mm to 160mm in diameter. The asbuilt is dated 22 years ago, thus the design life of the reticulation pipelines has lapsed. The 4Ml was constructed in 2017. It is currently using 2Ml. The two 400Kl reservoirs have no asbuilts. Thokozani has no available asbuilt information.

Based on the new design and once constructed, Escongweni BPH Engineers will provide complete as-built drawings according the survey of the pipelines constructed. GIS shapefiles will also be provided with the associated attributes together with the close-out report.

# 16 RESERVOIRS

All primary reservoirs (Claridge reservoir) should be sized to carry 48hrs storage of the supply area's Average Annual Daily Demand (AADD), in line with the Red book and DWS guidelines for water supply into communities. Elevated tanks will solely be used for boosting of pressure for reticulation purposes and as such, are sized to carry 24-hour storage of the area's AADD. This also is in line with the DWS's guidelines. With 48hr storage having been allocated to a supply area, command and service reservoirs within the communities will be sized to share the 48hr storage required per area.

Where there is a command reservoir, service reservoirs (4Ml and 2Ml) will be sized to carry 24Hrs of AADD. The 4Ml and 2Ml reservoirs where designed and constructed previously based on 24hour storage. Although Umgeni Waters Claridge Reservoir can accommodate 48hour storage it does raise a concern that if there is a leak on the existing 300mm bulk line (19.2km long) to Mpolweni and Thokozani, the repair has to be done within a day to ensure these areas have an uninterrupted supply of water.

The Mpolweni project area has three existing reservoirs. The 4Ml reservoir was constructed in 2017, thus it is still in good condition. The two 400Kl reservoirs will require refurbishment. A structural analysis will be conducted to determine the viability of the reservoirs. The existing 400kl (Res A) next to the 4Ml reservoir will only be used as additional storage. The other existing 400kl reservoir will serve a dual purpose of additional storage to the 4Ml and act as a BPT to the low-lying areas within the 4Ml zone.

The Thokozani project area has two existing reservoirs. The 250Kl reservoir will be decommissioned. The new 2Ml reservoir will be used for the project area. As noted above, this 2Ml reservoir has been sized for 24hour storage which poses a risk of interrupted supply if there is a leak on the lengthy 300mm diameter bulk supply pipeline.

Based on the above, the 300mm diameter, 19.2km long, bulk supply pipeline will become a high risk pipeline since there is insufficient storage within Mpolweni and Thokozani for a 48hour period. In the event that there is a problem on the pipe route, the only storage available in Mpolweni and Thokozani is for 24hours. It is preferred that 48hour storage within the service reservoirs is available. The operations and maintenance team will need to monitor this pipeline especially due to its age to ensure there are no leaks or potential leaks that could hinder the Mpolweni and Thokozani water supply network.

The existing 300mm diameter steel rising main from the Mpolweni old pumpstation that was feeding Wartburg may be used as a gravity line to backfeed into Mpolweni from Wartburg. This would require a chamber to be constructed to connect the backfeed to the Mpolweni bulk pipeline resulting in available storage should the existing 24hour storage in Mpolweni be depleted. UMDM to advise if this chamber should be included as part of this contract.
Note that the above only solves the storage problem for Mpolweni. Thokozani will still have a storage issue under repairs or maintenance unless another reservoir next to the 2Ml Thokozani reservoir is constructed.

## Mpolweni Top Structure Sizing:

**FOR 200KL ELEVATED TANK (Zone 1)**

GAADD= [(216 households x 5 ppl/household x 85 l/c/d) + 15% losses] = 105,570 l/day **say 106 Kl/day**

The future GAADD is: 106 + 2.5% growth per year for a period of 20 years = 169.770 kl/day **say 200Kl/day**

**FOR 4ML and 400Kl RESERVOIR (Zone 2)**

GAADD= [(5,606 households x 5 ppl/household x 85 l/c/d) + 15% losses] = 2,739,933 l/day **say 2.740 Ml/day**

The future GAADD is: 2.740 + 2.5% growth per year for a period of 20 years = 4,381 kl/day **say 4,4 Ml/day**
With the existing 4Ml and 400kl reservoirs next to each other totalling 4.4Ml/day storage capacity, the current infrastructure is sufficient for the capacity requirements over the next 20 years. This is subject to the existing 400kl reservoir being refurbished where necessary.

**FOR 400KL RESERVOIR (Proposed BPT) (Zone 2a)**

GAADD= [(117 households x 5 ppl/household x 85 l/c/d) + 15% losses] = 57,184 l/day **say 58 Kl/day**

The future GAADD is: 58 + 2.5% growth per year for a period of 20 years = 91,417 kl/day **say 100 Kl/day**

Additional storage of 300kl/day is available for future use if necessary, subject to the refurbishment of this existing reservoir.

**FOR 150KL ELEVATED TANK (Zone 3)**

GAADD= [(162 households x 5 ppl/household x 85 l/c/d) + 15% losses] = 79,178 l/day **say 80 Kl/day**

The future GAADD is: 680 + 2.5% growth per year for a period of 20 years = 126.577 kl/day **say 150Kl/day**

## Thokozani Top Structure Sizing

**FOR 2ML RESERVOIR:**

GAADD= [(2,030 households x 5 ppl/household x 85 l/c/d) + 15% losses] = 992,163 l/day **say 0.993 Ml/day**

The future GAADD is: 0.993 + 1.5% growth per year for a period of 20 years = 1.317 Ml/day **say 1.3 Ml/day**

All primary reservoirs (Claridge reservoir) will be sized to carry 48hrs storage of the supply area's Average Annual Daily Demand (AADD), in line with the Red book and DWS guidelines for water supply into communities. With 48hr storage having been allocated to a supply area, command and service reservoirs within the communities will be sized to share the 48hr storage required per area.

In general, where there is a command reservoir, service reservoirs will be sized to carry 24Hrs of AADD.
(see Annexure B for calculation sheet)

# 17 APPROVALS / AUTHORISATIONS

Consultation with authorities and other service providers whose services could be affected during construction will be requested to provide details of their existing services and any requirements they may have for protecting or moving services where necessary.

## 17.1 Environmental Management

On the 28th of June 2013 the Department of Economic Development, Tourism and Environmental Affairs (EDTEA) issued an Environmental Authorisation for this project. Refer to Annexure H**.** An EMPr and ROD will still be necessary. An Environmental consultant will be appointment under the detail design stage.

## 17.2 Compliance with OHS Act

As the employer's agent, Escongweni BPH Engineers will appoint a Health and Safety Agent to review all designs at design stage, review all documents and drawings for tender and provide a risk assessment and health and safety specification, audit the contractors compliance and close-out.

## 17.3 Department of Water Affairs

At a meeting held on 12 august 2019 with DWS, uMDM and Escongweni BPH Engineers (EscBph) presented the draft Business Plan for the project. Amendments were made and the final submission to DWS was on 20th September 2019.

Table 9 below lists the authorities that will be considered to provide comments on the proposed water scheme.

Table 9: Authorities having Rights/Powers of Sanction

| No. | Authority | Comments |
|---|---|---|
| 1 | Transnet | No rail servitude encroachments occur in the project area |
| 2 | KZN DoT | Trenching not allowed in road crossings and pipes exceeding 100mm diameter to be laid 2m outside road reserve. Road reserves currently being determined. Approvals are still to be obtained. |
| 3 | Telkom | No underground infrastructure. Overhead infrastructure will be visible on site. Approvals are still to be obtained. |
| 4 | SANRAL | There are no SANRAL road reserve encroachments in the project area |
| 5 | Eskom | No underground infrastructure. Overhead infrastructure will be visible on site. Approvals are still to be obtained. |
| 6 | DWA | Water Use License Application will be submitted for water use authorization |
| 7 | DAEA | Basic Assessment Report will be submitted to the Environmental Authorization during the design stage |

## 18 SUB-CONSULTANTS

Sub-consultants will be acquired during the design stage for further investigations, such as:

- Geotech
- Survey
- Environmental
- ISD

## 19 CURRENT PROJECT STATUS

Preliminary designs are 100% complete for the project. The Business plan was submitted September 20th, 2019.

## 20 IMPLEMENTATION PROGRAMME

The proposed programme is as follows:

Table 10: Programme of works

| Milestone End dates | | |
|---|---|---|
| | Mpolweni | Thokozani |
| Submission of business plan | 20 September 2019 | 20 September 2019 |
| Approval of business plan | 14 October 2019 | 14 October 2019 |
| Preliminary design complete | 30 September 2019 | 30 September 2019 |
| Detailed design Complete | 22 November 2019 | 22 November 2019 |
| Tender advertising | March 2020 | March 2020 |
| Procurement | April 2020 | April 2020 |
| Tender appointment | May 2020 | May 2020 |
| Commencement of Contract | June 2020 | June 2020 |
| Commencement of Works | July 2020 | July 2020 |
| Duration | 18months | 12months |
| Completion Works | Dec 2021 | July 2021 |

# 21 COST ESTIMATES

## 21.1 Mpolweni

The construction costs for the Mpolweni project are set out in Table 11 based on the pipe details as per annexure E. The construction value includes Preliminary and General costs:

Table 11 : Cost estimate for the Mpolweni Project Area

| High level Estimate | | | | Preliminary design Estimate | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Description** | **Estimated Qty** | **Rate** | **Amount** | **Zone 1 - Pipe QTY** | **Zone 2 - Pipe QTY** | **Zone 2a - Pipe QTY** | **Zone 3 - Pipe QTY** | **TOTAL DESIGNED QUANTITY** | **Rate** | **Amount** |
| Water Reticulation - including earthworks, bedding, pipelaying, jointing, backfilling, testing | | | | | | | | | | |
| 200Ø steel | 2000 | R 1 600,00 | R 3 200 000,00 | | | | | 100 | R 1 600,00 | R 160 000,00 |
| 100Ø steel | 5000 | R 1 300,00 | R 6 500 000,00 | | | | | 350 | R 1 300,00 | R 455 000,00 |
| 250Ø uPVC Class 16 | | | | | 760 | | | 760 | R 850,00 | R 646 000,00 |
| 250Ø uPVC | | | | | 4850 | | | 4850 | R 800,00 | R 3 880 000,00 |
| 200Ø uPVC | | | | | | | | 0 | R 650,00 | R 0,00 |
| 160Ø uPVC | 18000 | R 400,00 | R 7 200 000,00 | | 1050 | | | 1050 | R 400,00 | R 420 000,00 |
| 110Ø uPVC Class 16 | | | | | 260 | | | 260 | R 350,00 | R 91 000,00 |
| 110Ø uPVC | 20000 | R 300,00 | R 6 000 000,00 | 950 | 4000 | | 160 | 5110 | R 300,00 | R 1 533 000,00 |
| 75Ø uPVC Class 16 | | | | | 800 | | | 800 | R 250,00 | R 200 000,00 |
| 75Ø uPVC | 25000 | R 200,00 | R 5 000 000,00 | 500 | 9500 | 3800 | 1020 | 14820 | R 200,00 | R 2 964 000,00 |
| 50Ø HDPE | 48000 | R 120,00 | R 5 760 000,00 | 7000 | 58000 | 3300 | 4200 | 72500 | R 120,00 | R 8 700 000,00 |
| 25Ø HDPE | 68472 | R 100,00 | R 6 847 200,00 | 8200 | 84120 | 5200 | 5650 | 103170 | R 100,00 | R 10 317 000,00 |
| SUB-TOTAL Secondary and retic | 186472 | | R 40 507 200,00 | 16650 | 163340 | 12300 | 11030 | 203770 | | R 29 366 000,00 |
| Bends and fittings | | | R 200 000,00 | | | | | 2 | R 300 000,00 | R 600 000,00 |
| Chambers | | | R 1 500 000,00 | | | | | 2 | R 1 500 000,00 | R 3 000 000,00 |
| PRVs | 50 | R 75 000,00 | R 3 750 000,00 | | | | | 57 | R 90 000,00 | R 5 130 000,00 |
| Refurbishment of 2No. 400kl reservoirs | | | R 750 000,00 | | | | | | | R 750 000,00 |
| household meters | 2600 | R 3 500,00 | R 9 100 000,00 | | | | | 2601 | R 5 000,00 | R 13 005 000,00 |
| 50kl elevated | | | R 2 000 000,00 | Zone 1 Elevated tank - 200kl | | | | 1 | R 2 000 000,00 | R 2 000 000,00 |
| 100kl elevated | | | R 3 000 000,00 | Zone 3 Elevated tank - 150kl | | | | 1 | R 1 500 000,00 | R 1 500 000,00 |
| Sub- total | | | R 60 807 200,00 | | | | | | | R 55 351 000,00 |
| P&G's and miscillaneous | 30% | R 60 807 200,00 | R 18 242 160,00 | | | | | | R 55 351 000,00 | R 16 605 300,00 |
| **TOTAL CONSTRUCTION COST** | | | **R 79 049 360,00** | | | | | | | **R 71 956 300,00** |

## 21.2 Thokozani

The construction costs for Thokozani are set out in Table 12 based on the pipe details as per annexure E.

The construction value includes Preliminary and General costs:

Table 12: Cost estimate for the Thokozani Project Area

| High level Estimate | | | | Preliminary design Estimate | | |
|---|---|---|---|---|---|---|
| **Description** | **Qty** | **Rate** | **Amount** | **TOTAL DESIGNED QUANTITY** | **Rate** | **Amount** |
| Water Reticulation - including earthworks, bedding, pipelaying, jointing, backfilling, testing | | | | | | |
| 200Ø steel | | | R 0,00 | | R 1 600,00 | R 0,00 |
| 100Ø steel | | | R 0,00 | | R 1 300,00 | R 0,00 |
| 250Ø uPVC Class 16 | | | R 0,00 | | R 850,00 | R 0,00 |
| 250Ø uPVC | | | R 0,00 | | R 800,00 | R 0,00 |
| 200Ø uPVC | | | R 0,00 | 750 | R 650,00 | R 487 500,00 |
| 160Ø uPVC | 5000 | R 400,00 | R 2 000 000,00 | 700 | R 400,00 | R 280 000,00 |
| 110Ø uPVC Class 16 | | | R 0,00 | | R 350,00 | R 0,00 |
| 110Ø uPVC | 6000 | R 300,00 | R 1 800 000,00 | 2210 | R 300,00 | R 663 000,00 |
| 75Ø uPVC Class 16 | | | R 0,00 | | R 250,00 | R 0,00 |
| 75Ø uPVC | 10000 | R 200,00 | R 2 000 000,00 | 3550 | R 200,00 | R 710 000,00 |
| 50Ø HDPE | 20000 | R 120,00 | R 2 400 000,00 | 17350 | R 120,00 | R 2 082 000,00 |
| 25Ø HDPE | 27000 | R 100,00 | R 2 700 000,00 | 23700 | R 100,00 | R 2 370 000,00 |
| SUB-TOTAL Secondary and retic | 68000 | | R 10 900 000,00 | | | R 6 592 500,00 |
| Bends and fittings | | | R 100 000,00 | 1,5 | R 100 000,00 | R 150 000,00 |
| Chambers | | | R 600 000,00 | 2 | R 600 000,00 | R 1 200 000,00 |
| PRVs | 15 | R 75 000,00 | R 1 125 000,00 | 0 | R 75 000,00 | R 0,00 |
| household meters | 1200 | R 3 500,00 | R 4 200 000,00 | 1200 | R 3 500,00 | R 4 200 000,00 |
| Sub- total | | | R 16 925 000,00 | | | R 12 142 500,00 |
| P&G's and miscillaneous | 30% | R 16 925 000,00 | R 5 077 500,00 | 30% | R 12 142 500,00 | R 3 642 750,00 |
| **TOTAL CONSTRUCTION COST** | | | **R 22 002 500,00** | | | **R 15 785 250,00** |

## 21.3 Consolidated Costs

The consolidated cost requirements for the entire project scope of works as outlined in this report is shown in the table below, in line with the breakdown of the individual project work packages discussed in the sections above.

Table 13: Consolidated project cost estimate

| Description | Mpolweni | Thokozani |
|---|---|---|
| **CONSTRUCTION COST** | **R 71 956 300,00** | **R 15 785 250,00** |
| Add contingencies (10%) | R 7 195 630,00 | R 1 578 525,00 |
| Add Escalation (10%) | R 7 915 193,00 | R 1 736 377,50 |
| **Sub-total A - Direct Costs (excl.VAT)** | **R 87 067 123,00** | **R 19 100 152,50** |
| **Engineers Fees (14% of Sub-total A less contig.)** | **R 11 182 009,02** | **R 2 453 027,85** |
| - Inception (5%) | R 559 100,45 | R 122 651,39 |
| - Concept and Viability (25%) | R 2 795 502,26 | R 613 256,96 |
| - Design and Development (25%) | R 2 795 502,26 | R 613 256,96 |
| - Documentation and Procurement (15%) | R 1 677 301,35 | R 367 954,18 |
| - Contract Administration (25%) | R 2 795 502,26 | R 613 256,96 |
| - Close Out (5%) | R 559 100,45 | R 122 651,39 |
| Site Monitoring | R 1 500 000,00 | R 360 000,00 |
| ISD (3% of construction costs) | R 2 612 013,69 | R 573 004,58 |
| Enivronmental Consultant (incl. Construction audit/ ECO) | R 500 000,00 | R 350 000,00 |
| Geotechnical Consultant | R 300 000,00 | R 150 000,00 |
| Health and Safety Agent (Incl. construction audit) | R 360 000,00 | R 240 000,00 |
| Survey Consultant | R 350 000,00 | R 150 000,00 |
| Land and legal | R 200 000,00 | R 200 000,00 |
| Town planning | | |
| Disbursements, admin and other | R 632 201,37 | R 316 300,46 |
| **Sub-total B - Indirect Costs (excl.VAT)** | **R 17 636 224,08** | **R 4 792 332,88** |
| SUB-TOTAL (A+B) | R 104 703 347,08 | R 23 892 485,38 |
| Add VAT (15%) | R 15 705 502,06 | R 3 583 872,81 |
| **TOTAL** | **R 120 408 849,14** | **R 27 476 358,19** |
| **Cost per Capita** | R 3 947.18 | R 2 707.03 |
| **Cost per Capita (over 20-year horizon)** | R 2 551.04 | R 1 904.11 |

# 22 INSTITUTIONAL AND SOCIAL DEVELOPMENT

An Institutional and Social Development (ISD) consultant will be appointed on this project. The responsibilities of the ISD consultant is to:

- Form and capacitate the Project Steering Committee (PSC).
- Fully brief and keep updated the community, municipal and traditional structures on all aspects of the project such that buy-in of the project by the Mpolweni and Thokozani community is achieved.
- Submit monthly reports to the municipality providing brief details of meetings held, community perceptions of the project and any other matters of significance.
- Obtain an agreement from the community to provide access to properties for project staff and construction teams, well in advance of commencement of construction work on site.
- Learnership programme will be implemented where students will have access to site and learn about water pipeline construction.
- Training will be a requirement including formal training with certification.

# 23 Sanitation Proposal for Mpolweni and Thokozani

## 23.1 Mpolweni Sanitation

The Mpolweni area is currently serviced by Ventilated Improved Pit (VIP) toilets. 60% of households have this service hence there is a need for a waterborne sewer system in the area. With the provision of water services in the area, the need for the sewer infrastructure will become much greater.

Two options can be considered to service these areas:

- Water Borne Sewer system with a package treatment plant or,
- Water borne sewer system with tie-in to existing Wastewater Treatment Works.

### 23.1.1 Water Borne Sewer Network

A waterborne sewer network will need to be installed to collect sewage from individual dwellings. The undertaking from the municipality would be to provide bulk and reticulation sewer services to the community. The individual tie-in to the proposed sewer network will be for each household owners account.

Table 14:Mpolweni Sanitation Design Parameters

| | |
|---|---|
| Sewer Generation (Average Daily Flow – ADF) | 90% of water demand |
| Peak Factor based on 9440 houses | 1.8 |
| Allowance of stormwater infiltration | 15% |
| Sewer velocity range | 0.7m/s – 1.2m/s |

### 23.1.2 Design Calculations

Water Annual Average Daily Demand (AADD) is calculated as per section 8.2 above and as follows;
85l/c/day x 5ppl/ household = 425l/day per household

Hence sewer generation (ADF) per household is : 90% x 425l/day = 382.5l/day per household

Table 15:Mpolweni Sanitation Design flow

| No. Dwellings | ADF (l/erf/day) | ADF (l/day) | ADF ($m^3/s$) | Peaked Dry Weather Flow (ADWF) ($m^3/s$) | Peaked Wet Weather Flow (PWWF) ($m^3/s$) | Required Bulk sewer Outfall Diameter (m) | Recommended pipe diameter (mm) |
|---|---|---|---|---|---|---|---|
| 6101 | 382.5 | 2 333 632.5 | 0.02701 | 0.04862 | 0.05591 | 0.278 | 315 |
| 9440 (@ 20 year Horizon) | 382.5 | 3 610 800.0 | 0.04179 | 0.07523 | 0.08651 | 0.328 | 355 |

The estimated length of sewer bulk and reticulation pipelines with pipe diameters ranging from 160mm to 355mm class 34 uPVC is 147 000m.

Manholes are placed at every change in horizontal and vertical alignment or at a maximum spacing of 80m. Hence estimated number of 1050m diameter manholes for 355 to 160mm diameter pipes are 1950No.

Treatment Works.

With an ADF of 3 610 800l/day, the Peak Wet Weather Flow is 7.47Ml/day thus requiring a 7.5Ml/day treatment works to accommodate the sewer take up generated over the next 20 years.

Consideration was taken to collect these flows from the lowest point in Mpolweni and discharge into Trustfeeds Wastewater Treatment Works as shown in figure 4 below. However, this treatment works has a current capacity of 1Ml/day but is upgradable to 3Ml/day. Due to terrain between Mpolweni to the treatment works, a sewer pump station will be required to transfer the sewage to the New Trustfeeds Wastewater Treatment Works. This option will not be economically viable since the treatment works has a maximum capacity of 3Ml/day and the required capacity is 7.5Ml/day.

A package treatment plant will also not be economical viable due to the high capacity requirements and it being a temporary solution hence the only solution is to construct a new Wastewater Treatment Works for the Mpolweni area.

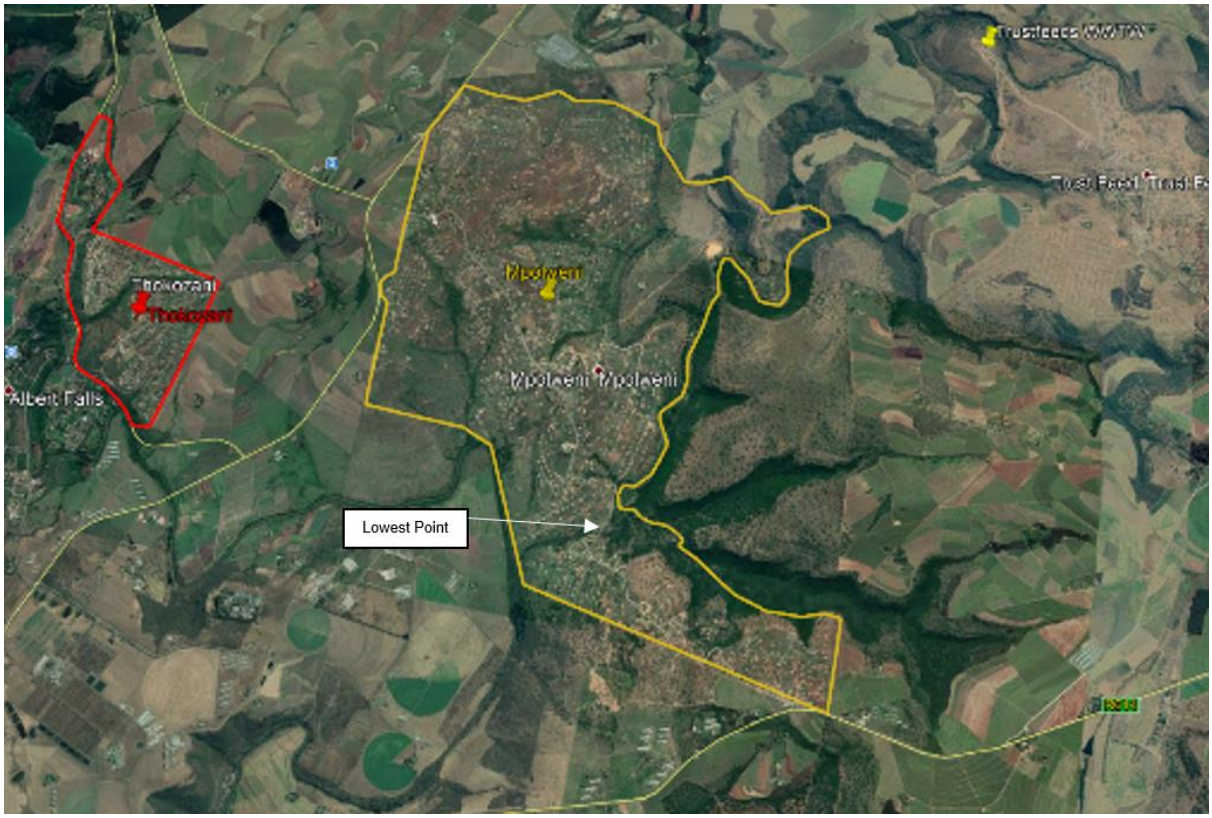



Figure 4:Trustfeeds Wastewater Treatment Works location

### 23.1.3 Mpolweni Sanitation Costs

Table 16:Mpolweni Sanitation Costs

| Mpolweni Sanitation - High level Estimate | | | |
|---|---|---|---|
| **Description** | **Estimated Qty** | **Rate** | **Amount** |
| Sewer Reticulation - including earthworks, bedding, pipelaying, jointing, backfilling, testing | | | |
| 355mm Ø uPVC Class 34 | 5000 | R 550,00 | R 2 750 000,00 |
| 315mm Ø uPVC Class 34 | 12000 | R 450,00 | R 5 400 000,00 |
| 250mm Ø uPVC Class 34 | 15000 | R 360,00 | R 5 400 000,00 |
| 200mm Ø uPVC Class 34 | 25000 | R 260,00 | R 6 500 000,00 |
| 160mm Ø uPVC Class 34 | 90000 | R 180,00 | R 16 200 000,00 |
| SUB-TOTAL Secondary and retic | 147000 | | R 36 250 000,00 |
| 1050mmØ Manholes | 1950 | R 13 000,00 | R 25 350 000,00 |
| pipe jacking | 1 | R 5 000 000,00 | R 5 000 000,00 |
| Wastewater Treatment Works (7.5Ml/d) | 1 | R 50 000 000,00 | R 50 000 000,00 |
| Sub- total | | | R 116 600 000,00 |
| P&G's and miscellaneous | 20% | R 116 600 000,00 | R 23 320 000,00 |
| **TOTAL CONSTRUCTION COST** | | | **R 139 920 000,00** |

## 23.2 Thokozani Sanitation

Similar to Mpolweni, for Thokozani a waterborne sewer network will need to be installed to collect sewage from individual dwellings. The undertaking from the municipality would be to provide bulk and reticulation sewer services to the community. The individual tie-in to the proposed sewer network will be for each household owners account.

Table 17: Thokozani sanitation Design Parameters

| | |
|---|---|
| Sewer Generation (Average Daily Flow – ADF) | 90% of water demand |
| Peak Factor based on 2886 houses | 2.1 |
| Allowance of stormwater infiltration | 15% |
| Sewer velocity range | 0.7m/s – 1.2m/s |

### 23.2.1 Design Calculations

Water Annual Average Daily Demand (AADD) is calculated as per section 8.2 above and as follows;
85l/c/day x 5ppl/ household = 425l/day per household

Hence sewer generation (ADF) per household is : 90% x 425l/day = 382.5l/day per household

Table 18:Thokozani Sanitation Design flow

| No. Dwellings | ADF (l/erf/day) | ADF (l/day) | ADF ($m^3/s$) | Peaked Dry Weather Flow (ADWF) ($m^3/s$) | Peaked Wet Weather Flow (PWWF) ($m^3/s$) | Required Bulk sewer Outfall Diameter (m) | Recommended pipe diameter (mm) |
|---|---|---|---|---|---|---|---|
| 2030 | 382.5 | 776 475.00 | 0.00899 | 0.01887 | 0.02170 | 0.195 | 200 |
| 2886 (@ 20 year Horizon) | 382.5 | 1 103 895.00 | 0.01278 | 0.02683 | 0.03086 | 0.223 | 250 |

The estimated length of sewer bulk and reticulation pipelines with pipe diameters ranging from 160mm to 355mm class 34 uPVC is 37 000m.

Manholes are placed at every change in horizontal and vertical alignment or at a maximum spacing of 80m. Hence estimated number of 1050m diameter manholes for 250mm to 160mm diameter pipes are 500No.
Treatment Works

With an ADF of 1 103 895l/day, the Peak Wet Weather Flow is 2.67 Ml/day thus requiring a 3Ml/day treatment works to accommodate the sewer take up generated over the next 20 years.

Option 1 – Trustfeeds Wastewater Treatment Works

Trustfeeds Wastewater Treatment Works could take on these flows for the next 10 years however, further upgrades to the treatment works will be required to accommodate the flows generated from Thokozani up to the 20-year horizon. Since Thokozani is further away from Trustfeeds Wastewater Treatment Works than Mpolweni, pumping will be required over a longer distance thus increased costs and maintenance.

Option 2 – New Treatment Works

Sewer flows from Mpolweni and Thokozani could be accommodated at a New Treatment Works positioned such that no pumping will be required since both Mpolweni and Thokozani have fall towards the Southern direction.

Option 3 – New Package Treatment Plant

An independent solution for Thokozani is to provide a 3Ml package treatment plant which will service the sanitation needs of the community over the next 20 years based on the calculated population growth. The quick, easy and cost-effective construction of the plant make this option the most viable.

### 23.2.2 Thokozani Sanitation Costs

Table 19: Thokozani Sanitation Costs

| Thokozani Sanitation - High level Estimate | | | |
|---|---|---|---|
| **Description** | **Qty** | **Rate** | **Amount** |
| Sewer Reticulation - including earthworks, bedding, pipelaying, jointing, backfilling, testing | | | |
| 250mm Ø uPVC Class 34 | 5000 | R 360,00 | R 1 800 000,00 |
| 200mm Ø uPVC Class 34 | 10000 | R 260,00 | R 2 600 000,00 |
| 160mm Ø uPVC Class 34 | 22000 | R 180,00 | R 3 960 000,00 |
| SUB-TOTAL Secondary and retic | 37000 | | R 8 360 000,00 |
| 1050mmØ Manholes | 550 | R 13 000,00 | R 7 150 000,00 |
| pipe jacking | 1 | R 1 000 000,00 | R 1 000 000,00 |
| Package Treatment Plant (3Ml) | 1 | R 8 000 000,00 | R 8 000 000,00 |
| Sub- total | | | R 24 510 000,00 |
| P&G's and miscellaneous | 20% | R 24 510 000,00 | R 4 902 000,00 |
| **TOTAL CONSTRUCTION COST** | | | **R 29 412 000,00** |

## 23.3 Overall Sanitation Costs

Table 20: Sanitation Overall Costs

| MPOLWENI & THOKOZANI SANITATION SCHEME | | | | |
|---|---|---|---|---|
| **Section** | **Description** | **Mpolweni** | **Thokozani** | **TOTAL ESTIMATED COST** |
| **CONSTRUCTION COST** | | **R 139 920 000,00** | **R 29 412 000,00** | **R 169 332 000,00** |
| | Add contingencies (10%) | R 13 992 000,00 | R 2 941 200,00 | R 16 933 200,00 |
| | Add Escalation (10%) | R 15 391 200,00 | R 3 235 320,00 | R 18 626 520,00 |
| | **Sub-total A - Direct Costs (excl.VAT)** | **R 169 303 200,00** | **R 35 588 520,00** | **R 204 891 720,00** |
| | **Engineers Fees (14% of Sub-total A less contig.)** | **R 21 743 568,00** | **R 4 570 624,80** | **R 26 314 192,80** |
| | - Inception (5%) | R 1 087 178,40 | R 228 531,24 | R 1 315 709,64 |
| | - Concept and Viability (25%) | R 5 435 892,00 | R 1 142 656,20 | R 6 578 548,20 |
| | - Design and Development (25%) | R 5 435 892,00 | R 1 142 656,20 | R 6 578 548,20 |
| | - Documentation and Procurement (15%) | R 3 261 535,20 | R 685 593,72 | R 3 947 128,92 |
| | - Contract Administration (25%) | R 5 435 892,00 | R 1 142 656,20 | R 6 578 548,20 |
| | - Close Out (5%) | R 1 087 178,40 | R 228 531,24 | R 1 315 709,64 |
| | Site Monitoring | R 1 500 000,00 | R 360 000,00 | R 1 860 000,00 |
| | ISD (3% of construction costs) | R 5 079 096,00 | R 1 067 655,60 | R 6 146 751,60 |
| | Environmental Consultant (incl. Construction audit/ ECO) | R 2 000 000,00 | R 1 300 000,00 | R 3 300 000,00 |
| | Geotechnical Consultant | R 300 000,00 | R 150 000,00 | R 450 000,00 |
| | Health and Safety Agent (Incl. construction audit) | R 360 000,00 | R 240 000,00 | R 600 000,00 |
| | Survey Consultant | R 1 000 000,00 | R 600 000,00 | R 1 600 000,00 |
| | Land and legal | R 200 000,00 | R 200 000,00 | R 400 000,00 |
| | Disbursements, admin and other | R 1 093 909,60 | R 505 765,56 | R 1 599 675,16 |
| | **Sub-total B - Indirect Costs (excl.VAT)** | **R 33 276 573,60** | **R 8 994 045,96** | **R 42 270 619,56** |
| | SUB-TOTAL (A+B) | R 202 579 773,60 | R 44 582 565,96 | R 247 162 339,56 |
| | Add VAT (15%) | R 30 386 966,04 | R 6 687 384,89 | R 37 074 350,93 |
| | **TOTAL** | **R 232 966 739,64** | **R 51 269 950,85** | **R 284 236 690,49** |

It is recommended that the sanitation for Thokozani be implemented based on the funds subject to the approval of the business plan. The total estimated Thokozani sanitation is **R 51 269 950,85.**

# 24 CONCLUSION

The following conclusions are made from the above investigation:

- The Gross Annual Average Daily Demand (GAADD) for the Mpolweni community is 2982Kl/day and for the Thokozani community is 993 Kl/day. The future demand is 4,767 kl/day and 1,317 kl/day respectively.
- The proposed upgrade must be divided into hydraulic water supply zones, to ensure that water pressures are within acceptable limits.
- Adequate pressure will be achievable under gravity at all sites.
- Implementation of this upgrade will ultimately ensure that all households received the required level of service viz. House Connection.
- The total estimated cost for this Mpolweni project is **R 117 505 310.88** (incl. VAT) and the Thokozani project is **R37 524 239,32** (incl. VAT). The total combined estimated cost is **R169 396 391,97** (incl. VAT).
- The sanitation for Mpolweni is recommended to be implemented post 10 years as the VIP's were recently constructed. Furthermore, detailed investigations are required in the project area to determine the viability of the various options available. The ADWF, at year 20, of 0.075$m^3$. Thus the total estimated Mpolweni sanitation is **R 232 966 739,64.**
- It is recommended that the sanitation for Thokozani be implemented based on the funds subject to the approval of the business plan. The ADWF, at year 20, of 0.031$m^3$. Thus, the total estimated Thokozani sanitation is **R 51 269 950,85.**

# ANNEXURE A

Schematic Water layout

# ANNEXURE B

Demand Calculations

# ANNEXURE C

Hydraulic Layout Drawings

# ANNEXURE D

Reticulation Layout drawings

# ANNEXURE E

Civil Designer Output

# ANNEXURE F

Robor Liquidation Letter and Certificate

# ANNEXURE G

GMS Specifications

# ANNEXURE H

PVC-O Specification

# ANNEXURE H

Environmental Authorisation